ENVIRONMENTAL ISSUES IN AFRICAN DEVELOPMENT PLANNING

edited by J.A. Seeley and W.M. Adams

CAMBRIDGE AFRICAN MONOGRAPHS 9

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The African Studies Centre was founded in July 1965 to facilitate interdisciplinary research and teaching on modern African Studies in Cambridge. The Centre publishes the Cambridge African Monograph Series and the Cambridge Occasional Papers. The aim of these series is to make available occasional research reports, seminar papers, conference proceedings and bibliographies relating to African Studies.

J.B. Sender
Director

Cover picture: Graders used in the preparation of land for irrigation at Bakolori in Sokoto State, Nigeria standing idle during disputes between farmers and developers over land reallocation and compensation. (Credit: Bill Adams).

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Bill Adams and Janet Seeley

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INTRODUCTION

Janet Seeley and Bill Adams

This volume is based on papers presented in two series of seminars at the African Studies Centre in Cambridge between 1985 and 1986. Both arose as a result of a workshop 'The Scramble for Resources: Conservation Policies in Africa 1884-1984' organised by David Anderson and Richard Grove in Cambridge in April 1985.[1] This workshop was an attempt to bring together natural and social scientists to discuss conservation policies and problems in tropical Africa. Debate at the workshop was vigorous and wide-ranging, over-running the alloted time. Consequently the organisers were prevailed upon by those interested to convene a follow-up meeting in Cambridge a few months later. This meeting was well attended, and debate continued to be lively. It was agreed at that meeting that the discussion should continue and an *ad hoc* committee was set up to organise a seminar series at the African Studies Centre to provide a forum and catalyst for debate. The result was a series in the year 1985/6 entitled 'Reconciling Conservation and Development in Africa', and another in 1986/7 on 'Environment and Development in Africa'.[2]

The 1985 workshop was a fascinating demonstration of why the subject of 'conservation and development' is so ridden with confusion and controversy. There was a significant meeting of minds, but on some important issues they met head-on: this demonstrated, most convincingly, the gap that existed between the 'wildlife people', natural scientists and conservationists of various sorts, and the 'people people', the anthropologists, human geographers and historians. The workshop thus stimulated a lively debate which we thought was worth continuing. It was with the hope of developing this interdisciplinary discussion that the seminars began.

To an extent, however, the seminars could not hope to continue the lively debate of the workshop; given the vagaries of audience attendance, there was not, perhaps, the continuity to generate great heat. The seminars revealed a number of significant constraints on the perception of people-environment relations in Africa, and hence ultimately any attempt to find a solution to the

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1 Papers from the workshop have been published in: D.M. Anderson and R.H. Grove (eds.) (1987) *Conservation in Africa: people, policies and practice*, Cambridge University Press.

2 A list of the members of the organising committee is given in Appendix 1, and a list of the seminars in Appendix 2.

many real and pressing problems. Five main constraints, revealed in the fora of the seminars, deserve closer examination.

First, language and terminology are often imprecise and loosely used. Words like conservation and development are seldom defined. Conservation and development of what and for whom? Phrases like 'sustainable development' and 'ecodevelopment' do not help; since they too have a range of meanings, they tend to be bland (almost tautologous) generalisations, and they ignore the whole question of political economy.[3]

Second, there is a significant failure to communicate between disciplines which stems from their very different content: biologists, for example, may know about (and indeed do research on) the physiology or ecology of savanna grazing systems or issues of ecosystem productivity. Anthropologists study kinship relations, the way people conceptualise space, place and nature. All are experts in their own field, but novices in the other. In short, all disciplines look simple, but only to outsiders.

Third, by their very nature issues of environment and conservation are inter-disciplinary. They are not the preserve of any one discipline, and there is no 'right' way of understanding them. Furthermore, this means that both natural science and social disciplines are talking outside their immediate field of competence when discussing these issues. It is no good natural scientists trying to theorise or understand solely within their own framework of thinking the way people respond politically to a conservation initiative, any more than it is helpful for anthropologists to assume that a knowledge of the way in which ecosystems respond to human action is simply or rapidly acquired.

Fourth, different disciplines want to conceptualise the separate (but related) actions of development and conservation differently. To natural scientists both are things which people quite obviously do, and interventions either work or they do not. Social scientists want to understand what is meant by these words, what motivates their use, and what people think they are trying to achieve. Social scientists want to theorise about development and conservation: natural scientists want to 'do' them.

Fifth, and most fundamentally, the deep philosophical split between rationalist science and relativist human studies cuts through the whole debate. Scientists deal in facts and tend towards a 'rationalist management' approach

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[3] See Adams, *Sustainable Development: environmental issues in the Third World* (in prep) for further discussion of this issue.

to development. Anthropologists, historians and others see that view (and hence both development and conservation) as part of a particular eurocentric (and perhaps capitalist) world-view, which they are prepared to step outside, or at least they try to do so.

These problems, and others, are behind the persistence, and the consuming fascination, of the conservation-development debate. Thus the debate of the 1985 workshop has continued in the Cambridge seminars. This is not merely a product of a university town with a changing population of students and visitors willing to hear the wheel re-invented in each successive year. It reflects the fact that the debate remains alive even for those who have attended both the workshop and the seminars. Indeed, the debate continues, and a conclusion is not immediately in sight. However, we may hope, by continuing the debate, to arrive at some form of synthesis.

The classic solution to intractable debates of this sort is to advocate more inter-disciplinary understanding and work. By attempting to understand the way other disciplines think and work we may hope to overcome disciplinary bias.[4] In theory this is fine, and, indeed, the seminars have been a form of continuing inter-disciplinary inquiry. However, like inter-disciplinary research and consultancy teams, the seminars have tended to perpetuate and accentuate disciplinary differences rather than overcome them. What is required in this instance, and indeed what we would hope for, is inter-disciplinary people (Chambers 1983) trained to integrate different ways of thinking and come up with an answer which (although inevitably a compromise) is both comprehensible and implementable.

There is another requirement, however, to bringing a productive output from debates of this sort, and that is to focus on the real world outside the seminar room. It is by grounding debate in the practicalities of Africa that sense is made of chaos. Only in the context of the field can rhetoric be replaced by productive debate. It is perhaps not surprising to find us, as an anthropologist and a geographer, advocating fieldwork: once reduced to the concrete, a substantial number of barriers between natural and social scientists disappear. That is the logic behind the choice of papers in this volume, most of which are based on, and certainly all are rooted in, field experience.

The coverage of this volume is selective rather than synoptic. The six papers cover a range of topics as well as a range of geographical areas in

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[4] See Robert Chambers (1983) *Rural Development: putting the last first*, Longman.

Africa. Three refer specifically to water resources. Adams and Grove assess the particular problems of river control in the context of drought in sub-Saharan Africa, and uncertainty about future environmental conditions. They question how sound and how useful are the technical methods used to predict future environmental conditions? They ask how much is known, and can be known, about the environmental impact of development projects in the face of environmental change? These questions are picked up by Francine Hughes, who examines the nature of the planning process in the Tana River Basin in Kenya. She asks whose responsibility is it to ensure that environmental effects are considered? A further aspect of the same problem is discussed by Richard Moorehead, who describes the ways in which patterns of control over resources in the Niger Inland Delta of Mali have been eroded in recent years. He describes how many have been taken over by the State. Both resource conservation and sustainable resource use are now having to be based on a reconsideration of a confusing morass of past controls and the present, often degrading, uses.

The other three papers all refer to dryland environments. Colin Barnes looks at the role of the small farmer sector in Algeria and its response to environmental risk. He describes how this response has often taken the form of a partial abandonment of agricultural production rather than the adoption of sustainable farming methods. He goes on to stress the need for this sustainability to become a central part of development planning. Vernon Robertson describes a series of development initiatives in the drylands of Sudan and Ethiopia, focusing on both the chances of success and the factors which lead to failure. Like other contributors he stresses the inadequacy of externally derived and imposed development. The need for careful appraisal and the central importance of a system of learning from past mistakes (and successes) is underlined in his paper. The last paper, by Dick Grove, discusses the role of economic assessments in arid land rehabilitation and development projects. Once again there are important insights here for developers who are careful, thoughtful and open to new ideas.

The Seminar Series at Cambridge is continuing in 1987/8. There is no doubt at all that there is still a great deal more to be learnt.

THE IMPLICATIONS OF CLIMATIC VARIABILITY FOR RIVER REGULATION

A.T.Grove and W.M.Adams

Introduction

Rainfall in the Sahel and Sudan zones of Africa is strongly seasonal, and typically restricted to a short period of three or four months. The Sahel itself is conventionally said to have between 200 and 600mm of rainfall (Grove 1978), and is an area of dry savanna vegetation where natural ecosystems and agricultural production are both dominated by the low rainfall, its seasonality, and high rates of evapotranspiration. Like most of Africa, the Sahelian countries have large and expanding populations which are increasingly urbanised. Governments have therefore turned to the rivers flowing through these dry areas and built dams and barrages to supply water for irrigation to grow food and cash crops, and to generate hydro-electric power. Most of the large rivers have been dammed, including the Nile (Hammerton 1972), the Volta (Hart 1980) and the Senegal and Niger (Adams 1985a, Watt 1981, Mabogunje 1973). Many smaller rivers have also been developed. The length of controlled river is increasing (Davies 1979). This river control has severe ecological and economic implications, which are now starting to be recognised. Some of them are described below. What does not yet seem to have been recognised is that the extreme variability of the climate of the Sahel, evidenced most graphically by the disastrous drought and famine of 1984, has serious implications for both an understanding of the effects of river regulation and the possibility of planning river basin development.

The effects of river regulation on floodplains

The environmental impacts of river regulation, reviewed by Petts (1984), are becoming better understood. Research in Africa was reviewed by Davies (1979) in the *Proceedings of the First International Symposium on Regulated Streams*. Most work has focused on the biological effects within the stream channel, or the geomorphological effects of regulation, for example Olofin (1984) in N.E. Nigeria. One particularly important African problem, however, which has received less attention is the significance of river control in floodplain environments, outside the river channel itself.

Savanna rivers, especially those of the Sahel, tend to have a strongly seasonal flow regime in response to seasonal rainfall. Rivers with large basins,

which include areas of equatorial rainfall, such as the Niger and the Nile, have a less extreme and more complex regime (Grove 1985), but even in these cases seasonal variation is large. Natural ecosystems and human productive activities are both adapted to the seasonal discharge pattern. River regulation alters that pattern, usually reducing wet season peak flows, extending the period of high discharge, and occasionally maintaining perennial flow in a previously seasonal channel. Obviously this can have a direct impact on the ecology of the river, and the erosion of the banks. It can also have effects, perhaps less immediate and direct but no less significant, on floodplain ecosystems and agriculture.

The importance of these effects is summarised by Scudder (1980), who draws attention to the balance between the gains of dam construction by irrigation and hydro-electricity generation and the potential economic losses from the disruption of downstream fisheries and agriculture. His paper suggests that the problem is under-studied and of considerable importance. The few pieces of research which have been carried out confirm this.

Hughes (1984 and this volume) investigates the structure and dynamics of groundwater-fed forests in the Tana River valley in Kenya. The regeneration of high forest trees seems to depend on the occurrence of low-frequency high-magnitude floods at intervals of many decades, and certainly the survival of existing trees depends on the supply of water to the floodplain sediments from floodplain inundation. A series of hydro-electric dams are being built on the Tana River and already regulate the river to the extent that peak discharges are reduced in height. Further dams are planned, and the future survival of the forest is in doubt. It contains two species of rare monkeys, the Tana River Red Colobus and the Tana Mangabey, and is used extensively for fuelwood and other supplies by local people.

Adverse socio-economic effects have been recorded following regulation in a number of basins in Africa. The impact of the Akosombo Dam on the *Egeria* clam fishery of the Volta River (Lawson 1963) had significant socio-economic implications, although the situation seems subsequently to have stabilised. On the River Niger, Adeniyi (1973) describes a decline in fish catches below the Kainji Dam, and a reduction in the number of fishermen able to work. A similar decline in the fishery of the Sokoto Valley in North West Nigeria has been reported by Adams (1985b). River regulation also disrupts agriculture adapted to the seasonal discharge regime of a river. Adeniyi (1973) records reduced yields and area under crops following the closure of the Kainji Dam, and Stock (1978) gives an account of considerable hardship over an extensive area of the Hadijia Jama'are floodplain below the

Tiga Dam in North West Nigeria. In the Sokoto Valley in North West Nigeria, river regulation caused a shift away from rice cultivation in the wet season towards less productive crops, and an overall decline in the area cultivated after the end of the rains to produce valuable dry-season vegetation (Adams 1985b). The social disruption in the floodplain below the Bakolori Dam was considerable, and the economic cost significant.

Clearly the social and economic implications of river regulation are beyond the scope of most natural science research. Equally, these are of prime importance if studies of river regulation are to be useful in formulating policy. It seems clear that, wherever possible, studies of river regulation should be broadened to include the whole floodplain area as well as the river channel. It is obviously also important that studies in the natural sciences should be integrated with those in the social sciences, and also with practical policy making. These broader frameworks for research are particularly important in a continent like Africa, where so much hope is placed on water resource development. Their importance is greatly increased by the very real uncertainties over climatic variability and river discharges in the Sahel Zone following the severe droughts of 1972-74, and 1983-85. These are described below.

Climatic variability and river control

River regulation in semi-arid Africa faces special problems related to climatic variability. The main features of the climate to which we wish to draw attention are the very marked clustering of years with above or below mean rainfall totals, and, second, the sub-continental extent of the regions affected by such long term departures from the mean.

Successions of dry years in the latitudinal belt south of the Sahara have been long-continued and intense since 1967 and were also experienced in the 1940s. In this zone and in East Africa, there was a widespread diminution in rainfall at the end of the nineteenth century and the first 14 years of the twentieth century were dry as compared with the last quarter of the nineteenth century (Kraus 1955).

The Nile

The consequences of persistence in precipitation values of this kind for river discharge and also for reservoir storage requirements were recognised by Hurst and his colleagues so far as they affected the Nile in Egypt (Hurst,

Black and Simaika 1965). They pointed out that the Standard Deviation of annual Nile discharge totals increased with time at a rate that was much greater than would have been expected had the variations from year to year been of a random kind and they went on to show that the same was true of many kinds of natural phenomena. In the mid-1950s the volume of storage required to even out the flow of the river at Aswan was very much greater if one took into consideration the discharge record from 1850 to 1950 than if the discharge record from 1900 to 1950 were used, because of the reduction in the discharge by about 25 per cent between the latter part of the nineteenth century and the first half of the twentieth century. In the event, for the High Dam, the storage capacity is about 150 cu km. In the 1970s this appeared to be adequate to even out the flow of the river for irrigation, navigation and power generation in spite of the low discharges experienced early in the decade. However, by 1985 the low level of Lake Nasser (or Nubia) was a cause for concern; deficiencies would have been felt in Egypt had it not been for White Nile discharges being higher than they had been in the first half of the century and by 1987 the situation had further deteriorated.

The White Nile is fed mainly from Lake Victoria. In the first half of the twentieth century, up to the time when Hurst (1952) wrote his book on the Nile, the precipitation over Lake Victoria was about equal to the evaporation losses from it and the flow over the Ripon Falls was about equal to the total discharge of the rivers entering the Lake, about 20 cu km. After the construction of the Owen Falls Dam in the early 1950s, the discharge from the Lake was regulated to provide the amount of water that would have been available had the dam not been there.

In November 1961, remarkably heavy rains in East Africa raised the level of Lake Victoria by about a metre, representing about 60 cu km of storage over and above the mean. In the following years the level of the Lake increased until 1964 and then slowly declined. The discharge between 1961 and 1980 was about 40 cu km, about twice the mean for the previous 60 years. The Owen Falls Dam was designed using discharge figures for the first half of this century and the question arises as to whether the higher discharges of the early 1960s are likely to be exceeded in the foreseeable future.

It is known that all the lakes in East Africa and the latitudinal belt stretching across Africa from Ethiopia to Senegal were much higher in the Early Holocene, from about 9500 to 4500 years ago than they are now (Street and Grove 1979). It is also known that Lake Victoria was at or somewhat above its early 1960s level at times in the 1870s. Early explorers such as Sir Samuel Baker brought back sketches of the Kabalega (Murchison) Falls which

show them to have been even more voluminous than they were in 1964. The level of Victoria, according to the accounts of early French missionaries, was also slightly above that of the early 1960s maximum. On the other hand, sediments on the floor of Hippo Cave, near Entebbe, at the edge of the Lake, which contain charcoal dated to 3670 BP and are overlain by deposits containing archaeological implements, have not been disturbed by higher Lake waters since the time they accumulated. Bishop (1969) argued that the Lake had certainly not stood more than a foot or two about its 1964 level for the last 4000 years.

The fact remains that the discharge from Lake Victoria into Lake Albert (Mobutu) has been some 20 cu km per year greater for the last 25 years than in the first half of the century. The plans for the Jonglei Canal involve taking water out of the Nile in the Sudd near Bol and returning it to the Nile at Malakal. This would reduce evaporation losses in the Sudd by some 5 cu km, which would become available for use in northern Sudan and Egypt. Calculations were based on the discharge figures for the first half of the twentieth century, which have proved to be too low. The Canal has never been completed, but it seems likely that between 1962 and 1980 the Nile below Malakal was, in fact, carrying as much water as it had been intended it should carry after the completion of the Jonglei Scheme.

Lake Chad

Whereas Lake Victoria has helped to maintain the flow of the lower Nile and thus irrigation in Egypt, reliance on Lake Chad as a source of water has been disastrous for two newly-completed, very large irrigation schemes in Borno, North East Nigeria. Lake Chad, with a mean volume in this century of about 80 cu km, is largely dependent on the Logone-Shari system from which it derives about 40 cu km of water and precipitation over the Lake amounting to about 10 cu km plus seepage from the northern and eastern sandy margins balance inflow plus precipitation over the Lake.

When Lake Chad occupies 20,000 cu km, it consists of a southern basin almost separated from a deeper northern basin by a low ridge. Fresh water entering from the south, with an electrical conductivity of about 80 micromhos, moves slowly north and becomes slightly more saline until it reaches the northern and eastern shores where conductivity values amongst the former dune islands exceed 1000 micromhos. The fresh water in the south is ideal for irrigation purposes and the two schemes depended on pumping the water onto clay soils in the Marte area to the south west with the intention of growing crops of wheat in the winter and rice in the summer (See Kolawole

1987a, 1987b). The Lake is at its lowest from April to June and ever since the inception of the schemes in the early 1980s the water has been too low at that season to reach the level of the intake pipes. It has been possible to grow some thousands of hectares of wheat in the winter, pumping from the Lake at its maximum level in November to January, but in 1984-5 the flow of the Chari was so small that the Lake did not rise. It occupied an area of less than 2000 sq km and its volume was no more than 10 cu km.

Lake Chad was lower in 1985 than it was in the 1970s, 1940s or in the early years of this century. It is known that the Lake dried up entirely in the terminal Pleistocene when the dunes were formed that normally appear as linear islands along its northern and eastern shores. It is possible that it has dried up or has been as low as it is currently since then. We do not know.

In 1985 it was possible to distinguish blown sand on the floor of the northern lobe of the Lake. Cores obtained from this area might reveal similar sand layers in the past and suitable methods might provide dates for them. In 1987 the Lake is still very low and it is not known when it will fill again. A 'normal' rainfall year over the Lake catchment in Cameroun and the Central African Republic would cause the southern basin to be reoccupied by water, say 3m deep over 1300 sq km. This would suddenly provide a source of water for the irrigation schemes. But unless speedy action is taken a single very wet year might result in the flooding of the pumping station and problems for the Borno people who have moved out onto the Lake floor in recent years to plant crops and graze cattle.

West African Rivers

The large West African rivers have also been much affected by droughts over the last 17 years. In 1983, the Volta river in Ghana fell to such a low level that power generation at Akosombo was inadequate to serve the aluminium smelter at Tema. Power supplies from the Bandama in Ivory Coast and from the Kainji Dam on the Niger in Nigeria were much restricted. At the end of the 1984-85 dry season, low water discharges of the Niger and Senegal were lower than they had ever been. This affected areas of land in the catchments of these rivers that are normally flooded, especially in the Central Delta of the Niger between Segou and Tombouctou, and along the floodplain of the Senegal which is very close to sea-level for some hundreds of km upstream. In 1981, Faure and Gac pointed to the regularity of the curve of the seven-year running mean of the Senegal and indeed of the Niger and Shari-Logone. They were tempted to extend this curve into the future and to suggest that the Sahelian drought would come to an end in 1985. In fact, the drought

was never deeper than in 1984-85.

The situation in southern Africa has been somewhat similar but much less extreme. There were severe droughts in southern Africa in the early 1960s but these were replaced by quite abundant rains in the late 1960s and early 1970s. Tyson *et al.* (1975) had shown that the recurrence interval of droughts in the region of Southern Africa extending from Natal into Botswana was about 18-20 years, according to records extending back about a century. In the early 1980s severe drought conditions returned to the lands around the Kalahari as might have been expected, but in most areas the rains in 1984-5 reached an adequate level.

Conclusion

It is easy to be wise in retrospect, but the variability in Sahelian climate over the past two decades gives little comfort to those planning, or trying to manage, dams in Africa. We are not in a position to assess the present drought situation in relation to precipitation records over the last few centuries. Nor are we in a position to predict whether or not it will continue. The nature of this uncertainty is important. Although it happens that calculations of return periods have been of predictive value in southern Africa we have little information on which to base predictions between the tropics.

Many, indeed most, dams in Africa have been built using extremely short runs of discharge data, usually manipulated by hydrologists using techniques developed in temperate regions. It is clear that short records are unsatisfactory, and that extrapolations based on them are likely to be dangerously misleading. However, longer records would not necessarily improve the ability to predict climate or discharge. It is perhaps unfortunate (if understandable) that so much of the thinking about development in the drought and famine-stricken zones is based on more water resource projects, among them of course further river regulation. This may indeed be the only hope for these areas but quite obviously greatly improved planning procedures will be needed. These will have to involve better collection of primary metrological records, which are currently in a parlous state in the Sahel, far less optimistic assumptions about expected rainfall, and a more cautious approach to project development. As yet, more sophisticated modelling and hydrological prediction are not wanted: appropriate development would seem to demand a step back to more pragmatic and cautious approaches.

There are also implications for those conducting research into the impacts of river regulation. Just as no developer can take 'normal' rainfall as a fixed figure, it is necessary to see the impacts of river regulation in the Sahel against the background of climatic variability. This makes the work far more complicated, for the variability extends from the seasonal to the inter-annual decadal and inter-century scales. It also presents a field of exceptional interest and importance.

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THE ENVIRONMENTAL IMPACT OF RIVER BASIN DEVELOPMENT WHOSE RESPONSIBILITY?

Francine M.R. Hughes

Introduction

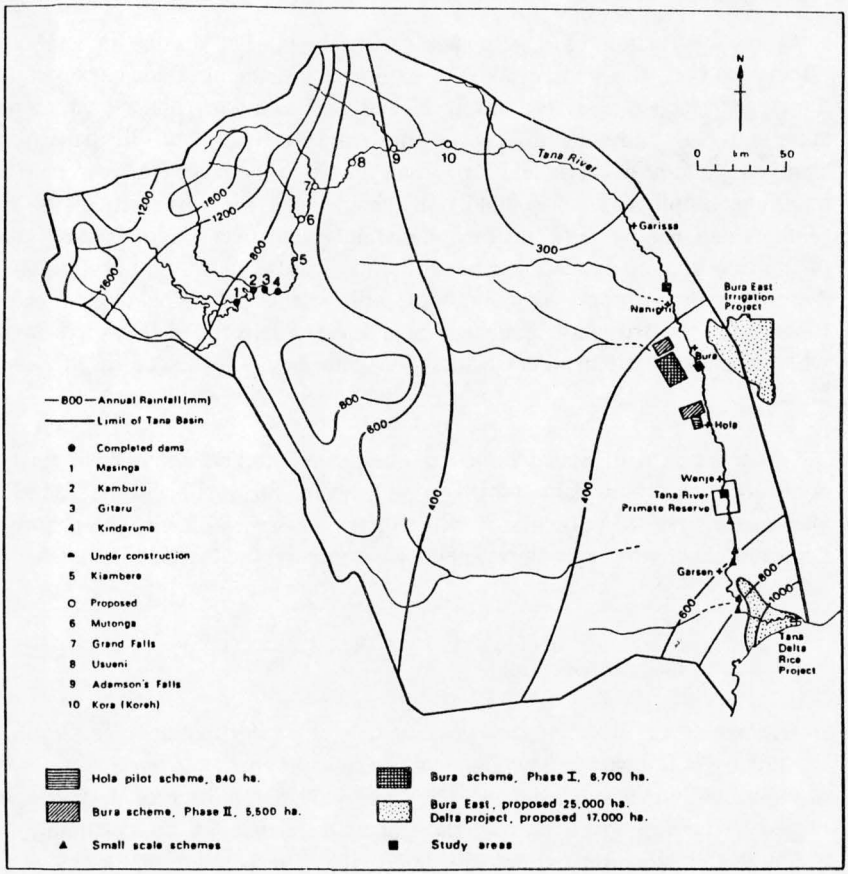
The construction of development schemes in river basins inevitably has effects on both the human and the natural environment. Dam construction in the upper reaches of rivers has local and fairly obvious impacts in reservoir areas but less obvious effects on downstream hydrology. In particular, a changed pattern of high and low river flows throughout the year can have enormous implications for floodplain areas which are very difficult to study (Adams and Hughes 1987). Floodplains are usually very fertile areas because of nutrient-rich sediments received during floods. In a semi-arid area they therefore often support agriculture or will be the only area able to support forest growth. Irrigation schemes also have numerous and varied impacts whether constructed in direct association with dam schemes or in downstream areas.

This paper will consider the environmental problems that have arisen in connection with both dam and irrigation scheme construction in the Tana River Basin in Kenya. In particular it will address the issues of why these problems occurred, and why they were neither accurately predicted nor satisfactorily solved.

Environmental considerations

Decisions on development projects are made for political and economic reasons by politicians and economists. Technical expertise from engineers is an obvious additional requirement. The environmental impact of a development project is at best given cursory thought at the feasibility and planning stage, although this situation is gradually improving. The possible real financial costs of environmental deterioration caused by a development scheme are not included in cost-benefit analysis for a number of reasons. First, aid agencies and engineering companies producing feasibility reports and project planning reports are not used to worrying about environmental costs. It is often easier to ignore possible problems which might make a scheme uneconomical and lead to the loss of contracts. Second, it is common that too few data are available to make any reasonable cost estimates for environmental effects. Third, there

The Tana River Basin, Kenya



seems to be eternal optimism that 'there won't be problems this time' despite innumerable examples of environmental problems in the past and no basic change in the approach to project planning or design. Fourth, there is a great keenness of politicians to support prestigious projects which on the surface appear to hold out a hope for bringing in foreign exchange.

It is only recently that aid-agencies, lending money for projects, have begun to appreciate that the environment must not just be an added chapter to a project planning report, often based on no field work and produced using some *ad hoc* EIA procedure. They have gradually taken on board the basic notion that development is completely interconnected with sustainable use of the environment. In fact, development should be **deliberate sound management** of the environment, rather than its steady degradation. Unfortunately, many projects presently under construction were conceived and implemented before this realisation and attempts to act upon it.

Achieving an ecologically sound development scheme (as advocated by the rather idealistic *World Conservation Strategy* [IUCN, 1980]) appears to be an impossible task given the current track record of development planning. However, it is only by studying where projects have already gone wrong that future plans might be made to be more ecologically sound (assuming, that is, that those involved at all stages of a project want to learn). That is why it is important to carry out post-mortem examinations of projects like those in the Tana River Basin.

The Tana River Basin – Background

The Tana River has a straight line distance of about 800 kms from source to mouth and has the greatest potential for supporting large-scale irrigation schemes in Kenya (Saha 1982). About 2 per cent of the basin is irrigable, mainly in the semi-arid lower basin, providing roughly half of Kenya's irrigation potential. There is an intensive programme of dam-building in the upper Tana to provide hydro-electric power. The fourth and largest dam was closed at Masinga in 1981 and Kiambere is now nearing completion. Another five dams below these are proposed (See map, p. 16). In the lower basin, a number of irrigation schemes have been built or are under construction.

Construction of Phase 1 of Bura West was begun in 1979. It was originally planned to cover about 6,700 ha and it is with this scheme that this paper is principally concerned. Another 5,000 ha of Bura West (Phase 2) await approval. A further area of 25,000 ha proposed on the East bank (Bura East)

will probably not be built. Recently, construction of a 17,000 ha rice scheme has begun in the delta of the Tana River. A number of small scale village schemes have also been implemented in the Tana with varying levels of success.

Local people already farming the river banks in the lower river come from the Pokomo and Malekote tribes and number about 30,000. Another approximately 30,000 Orma and Somali pastoralists also use the area. The floodplain supports an unusually rich evergreen forest in an otherwise semi-arid area. Activities throughout the river basin should be co-ordinated by the Tana and Athi River Basin Development Authority (TARDA) but this has concerned itself primarily with the dam-building programme and the delta rice scheme and not with the schemes at Bura.

The Upper Tana – Environmental problems

The largest dam at Masinga (known as the Upper Reservoir Scheme) is the most likely to have an impact on downstream hydrological patterns. In 1977 its estimated cost of construction was £68m with aid coming from the British Overseas Development Administration (ODA) and the EEC amongst others. The Kenyan Government also contributed to the scheme since its aid priorities lay with the schemes at Bura. In 1975, the ODA environmental adviser insisted that a proposed UNEP funded environmental assessment of the project be carried out. Up until this time the Tana River Development Authority (TRDA)[1] had assumed that no adverse environmental effects would arise (Abel *et al.*, 1979). The UNEP report concluded that there were no adverse impacts of sufficient magnitude to stop the project from going ahead but that a number of environmental issues in both the reservoir area and the lower catchment should be studied. It was particularly concerned with the impact that reduced flooding might have on the 30,000 Pokomo and Malekote people farming the riverbank downstream. The other aid donors showed no interest in potential environmental problems. The UNEP report recommended that a monitoring and control group should be set up to promote remedial activity in environmentally sensitive areas and that the creation of this group should be linked to the response given to the request for aid. After confrontation between donors and the Kenyan Government the idea of this group was eventually scrapped. By 1978, the Kenyan Government had become more environmentally conscious and developed an environmental protection programme which operated through the National Environment Secretariat. Most of their reports

[1] As the TARDA was then called.

have dealt with health aspects of the reservoir area rather than the downstream impacts.

Independent research was carried out by the author on relationships between the forests and the hydrological regime of the Tana floodplain between 1981 and 1983 (Hughes 1984, 1985, 1987a). This looked specifically at the role played by the Tana's flooding patterns in the regeneration and succession of these forests. The forests are unusually diverse and are of considerable importance as wildlife habitats for a wide range of animals including two endemic and rare monkeys, the Tana River Mangabey and the Tana Red Colobus (Marsh, 1976, 1986, Homewood 1976, 1978). They are also home for the Pokomo and Malekote people. Results of research on these forests show a clear relationship between frequency of flooding and the species composition of various forest communities. It suggests that reduction in floods as a result of dam construction may be one cause of the poor regeneration levels currently found in the forests.

The Bura Scheme – Environmental problems

Original cost estimates for Phase 1 of Bura West, to irrigate 6,700 ha to grow cotton, was 92 million US dollars of which almost half was provided by the World Bank. Other aid contributors included the European Development Fund, the Netherlands, the United Kingdom and the Commonwealth Development Corporation and some finance also came from the Kenyan Government. Within two months of the World Bank Appraisal Report for Bura West appearing in 1977, a planning report solicited by the National Irrigation Board (NIB) of Kenya (which would manage the scheme) and written by a consortium of engineering companies had appeared. This increased the total project budget by 22 per cent to 112 million US dollars (World Bank, 1985). A 13 per cent rate of return, however, was calculated in both appraisal and project planning reports; a quite unrealistic rate given the increased costs in the project planning report. By the time these discrepancies became apparent, funding agreements had already been made between the World Bank and the Kenyan Government so that the project began life underfunded using the costs from the appraisal report and not from the project planning report. Further doubts on soil quality and problems with the design of engineering structures escalated costs even more so that when construction began in 1979, the project had ceased to be economically viable in the eyes of the donors. The Kenyan Government rejected this notion, although alarmed at the increasing costs, and construction went ahead.

The scheme was already a much reduced version of the original proposed 14,000 ha on the West Bank (Stage 1 comprising Phases 1 and 2). Phase 1 was due to accommodate 5,150 settler families. In 1981, the first settlers arrived on the scheme, two years behind schedule and by 1984 approximately 1,850 tenant families had been settled. This was about half of the planned rate of settlement. Crop yields in those first years also fell short of expectation. By the time the World Bank's mid-term evaluation report was produced in 1984, a number of serious problems had arisen:

> Desertion rates were fairly high, especially after a serious malaria outbreak in 1982 which particularly increased child mortality rates.
>
> Yields of cotton were slightly lower than expected and food crop yields were much lower than expected.
>
> There was frequent technical failure of the temporary pump system bringing water into the canals, helping to reduce yields.
>
> Management of the scheme by the NIB was inadequate.

An irrigated fuelwood plantation was planned as part of the scheme (World Bank, 1985). The importance of this was recognised at an early stage since tenant farmers would cook on wood fires and insufficient wood grew locally. The floodplain forest was considered by the project planners to be a valuable ecosystem which should be protected in its entirety, primarily for environmental and conservation reasons. Trials for forestry plantation species had been carried out at Hola, the pilot project. However, when scheme costs rose an early casualty was funding of the forestry plantation as various Kenyan ministries directed funds to what were seen as more important areas of infrastructure. Forestry, home water supplies and health were all delayed as cost cuts by the various Kenyan ministries in charge. An inter-ministerial committee, reviewing the project in 1983, officially reduced the size of Bura West Phase 1 from 6,700 ha to 3,900 ha because of the shortage of funds. The Kenyan Government's share of project costs had risen to 40 per cent by that time.

The 1984 World Bank mid-term evaluation was highly critical of the scheme. In particular, it criticised management by the NIB and recommended more autonomy of management for Bura which had up until then been managed mainly from Nairobi. The project therefore became a parastatal under the Ministry of Agriculture and Livestock Development in 1985 (Vainio-

Mattila, 1987). Change in management was a condition of continuation of aid. In January, 1986 President Moi made a surprise visit to Bura – he too was heavily critical of scheme management, describing it as 'a failure, a disgrace and the height of mismanagement' (Daily Nation 22nd January 1986). Further changes in management organisation followed this. Nonetheless, later in 1986, the World Bank withdrew from further involvement with the scheme.

Fuelwood

All these problems have delayed funding and implementation of the fuelwood plantation at Bura. As a result the floodplain forests are the only source of firewood after the initial one of bush cleared from field sites, and are threatened with destruction. Emphasis on protecting the forest has always been incorporated in the project's plans. The World Bank has, since developing its own forestry policy in 1977, emphasised the forestry component of its projects. At Bura it suggested gazetting three blocks of forest for protection though only one of the three includes any floodplain forest. Their 1977 appraisal report emphasises the importance of preserving the complexity of indigenous forests and protecting entire forest ecosystems. They recommended funding an investigation of the riverine system, monitoring of forest extent, and study of possible management and exploitation of the natural vegetation. No funding was allocated for these although it would have been relatively inexpensive to fund students to collect the necessary data (Hughes, 1983).

On the scheme wood has been needed from the start of the construction phase in 1979, for the construction force and for both cooking and home building for the informal settlement at Manyatta which grew at the same time as the official scheme. Since 1981, tenant families have also needed fuel for cooking. Implementation of the forestry plantation only began in 1984, as part of the technical co-operation programme between Finland and Kenya. It is in a much reduced form from the original proposal and it cannot be expected to fulfil all fuelwood needs (Vainio-Mattila 1987).

In 1982 estimates of fuelwood use and needs were made at the start of the project and compared to available wood volumes in the floodplain forest (Hughes 1984, 1987a, 1987b). It was predicted that an increasing amount of firewood would come from the floodplain forest and that it could take as little as five years to destroy large parts of forests in the 80 km length of floodplain that lies adjacent to the scheme. Vainio-Mattila (1987) reports that the total population at Bura now numbers about 20,000 instead of the initial projected 60,000 so that destruction of the forest will have been less rapid.

However availability of wood has already decreased. The initial pattern of individual household collection by women in the early 1980s has changed to collection by men, who transport it by bicycle or donkey-cart and sell it at increasingly high prices. In many villages, firewood dealers have set up shop. The result of this trend is an increasing use of money to obtain firewood (Vainio Mattila 1987). This means that at certain times of the year (following the agricultural cycle) families are less able to purchase fuelwood than others, with obvious consequences on diet and health (Vainio Mattila 1987). A stove programme which may improve fuel efficiencies has now been introduced at Bura through the joint co-operation of the Institutes of Development Studies in Nairobi and Helsinki (in connection with FINNIDA – Finnish aid). However, pressures on the floodplain forest remain severe and are increasing. It is still used for direct collection by people in some scheme villages near the forest edge. It is also increasingly the source of charcoal for junior staff able to pay for it as a 'preferred' type of fuel. Local Pokomo and Malekote began producing charcoal from *Acacia elatior* in particular at an early stage in project development (Hughes 1987b) but this has increased, partly as a way of increasing incomes to compensate for reduced agricultural productivity on the floodplain farms (Vainio-Mattila 1987). A resurvey of areas surveyed in 1981 and 1982 (Hughes 1985, 1987) is required to quantify forest destruction.

In 1985 an environmental consultant was employed by the World Bank to draw up a list of the main environmental problems at Bura. This lists the threat to forest by cutting as the greatest (Allaway 1986). Other problems include wildlife poaching, loss of wildlife access to the riverine strip, use of pesticides and overgrazing by pastoral herds which are now confined to a smaller area.

Conclusions

Awareness of environmental problems which could be faced by all the projects in the Tana Basin was there at some stage prior to project construction. In the case of the upstream dams, the potential problems were reluctantly faced, but at Bura there was early recognition of, and even planning for, the possibility of floodplain forest destruction.

The dams were built for hydro-electric power and an early appreciation of the possible impact of reduced floods on the forests downstream would probably not have altered decisions to build. However it might be possible to arrange more sensitive water releases from dams so that they more nearly resemble natural conditions. Another possibility would be the construction of a

second structure downstream which could release water in a way which imitates natural flow patterns. This is particularly important for the indigenous agriculture on the floodplain. Townsend (1975) carried out detailed studies of Pokomo agricultural practices and it would be beneficial to study changes in these now.

The Bura Scheme was very expensive and recognised as not viable at an early stage. US $40,000 – US $50,000 per settler family has been expended so far compared to an average of US $20,000 for most World Bank schemes. The shortage of fuelwood has been a major problem for the scheme and destruction of the floodplain forest is likely to occur long before any indirect effects of dam construction on forest regeneration might be felt. The only protected area of the floodplain forest is the Tana River primate Reserve, downstream from Hola, and this needs better funding and protection to ensure its survival.

The question now needing to be asked is how could environmental problems in the Tana Basin, especially in the floodplain-forest zone have been avoided given that many *WERE* predicted? This is difficult to answer.

Aid agencies could perhaps have insisted on studies of forest ecology and importance as a condition of aid. Although aid was requested by the Kenya Government which has directed its use to a large extent, aid was conditional on certain criteria being met such as management structure, so why not on environmental issues as well? Lack of information on the forest at the time, certainly helped to give it a lower profile in preliminary appraisal reports.

Decisions regarding the priority of the forestry plantation were made within the Kenyan Government. There is a great awareness within Kenya of the importance of forestry resources yet low priority was given to the forestry plantation. The main reason for this was the inadequate funding for the scheme from the outset and the inevitable cutting of some aspects of the scheme. Emphasis on engineering structures and particularly, contract commitments to foreign companies meant that more irrigation infrastructure was installed at Bura than can be used, at the same time as cuts on other essential services were being made. Despite being greatly constrained, aid agencies would seem to be the only organisations able to exert pressure in this sort of situation since commercial companies will always encourage contracts.

The concern for the viability of the Bura Scheme expressed by the World Bank from the outset should perhaps have been followed up in more detail prior to commitment of funds. The indications are that at Bura the appraisal stages were inadequate and over-optimistic. In conclusion it becomes clear that

there is a great need for more data on many aspects of the environment. Funding of environmental studies may be the only way that aid agencies will obtain the information they need in order to assess properly the environmental impact of the schemes which they are appraising.

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ACCESS TO RESOURCES IN THE NIGER INLAND DELTA, MALI

Richard Moorehead

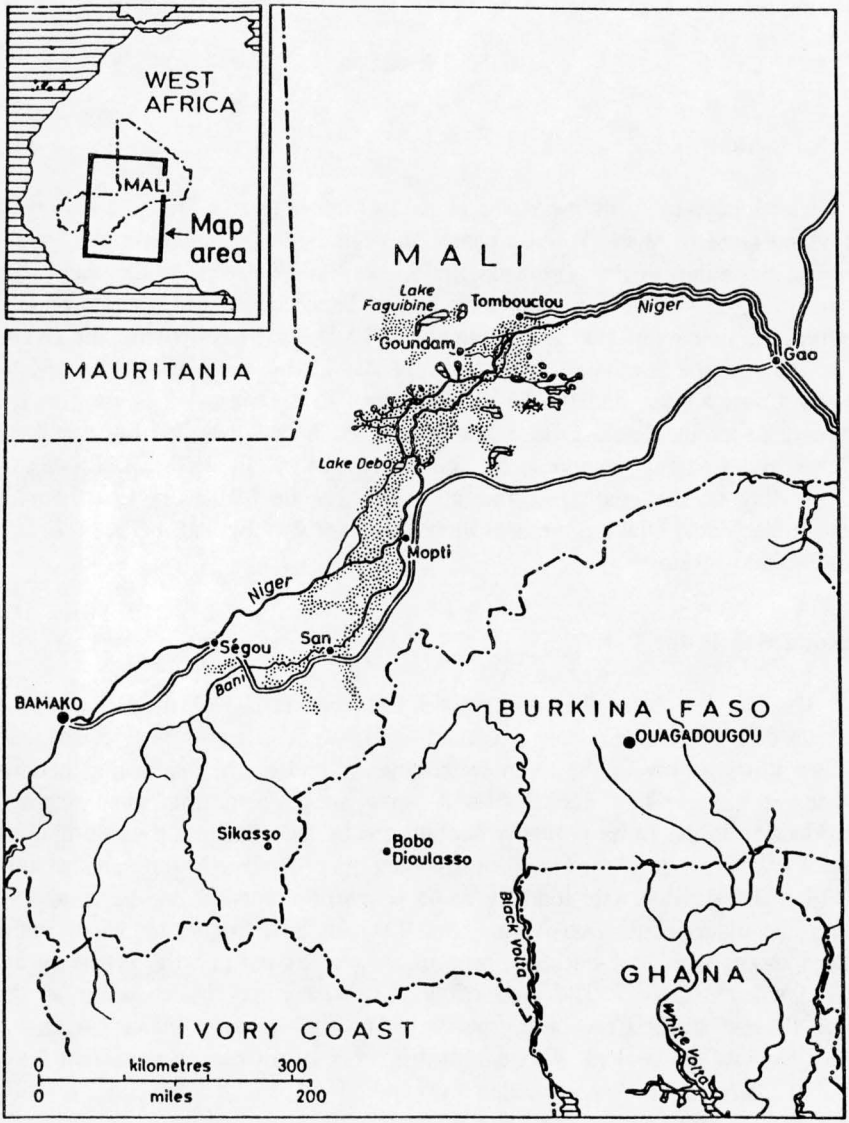
Introduction

The Inland Delta of the River Niger in Mali is one of the most important wetland areas of West Africa. Located in central Mali, it bridges two climatic zones, the Sahel to the north and the Sudano-Sahelian zone to the south (see map p.28). It receives an annual rainfall of between 250 and 550mm of rain during the months of July and September. The Delta is fed by two main rivers, the Bani to the southwest, whose origins lie in the mountains on the Mali-Ivory Coast border, and the Niger river itself to the west, which rises in the mountains of the Fouta Djallon. Each year the area floods, fed by rainfall in these zones many hundreds of kilometres away from the Delta itself. Depending on the amount of rainfall falling on the Mali-Ivory Coast border and in the Fouta Djallon, the area inundated may vary by half, between 20,000 and 40,000 sq km.

Production in the Delta

For four months of the year between October and January the Delta has the aspect of an inland sea; between March and July it is a vast dusty plain, with water flowing only in the main water-courses, and in the intervening periods water is either rising into the flood plains or draining from them. Natural production in the Delta is highly conditioned by the relationship and timing of the rains, flood level and rate of flooding. For inundated crops and pasture (which also provide wild food for Delta people) the flood should begin to spill over the plains about two weeks after the rains have begun, so that the new plant shoots have had sufficient time to grow so as not to be drowned by the flood when it arrives. The production of fish each year is dependent on the area flooded as their breeding grounds are on the inundated plains. Given the very shallow gradient of the Delta, a difference of a metre in maximum flood height can affect the area flooded by hundreds of square kilometres. A good coincidence between the timing of the rains and the arrival of the flood is rare in the Delta.

It is estimated that about 500,000 people occupy the Delta (1982), although population estimates tend to be misleading in describing how many people use the area simply because the bulk of the rural population both within the Delta


WEST AFRICA
MALI
Map area
MAURITANIA
MALI
Lake Faguibine
Tombouctou
Niger
Goundam
Gao
Lake Debo
Mopti
Niger
Ségou
San
Bani
BAMAKO
BURKINA FASO
OUAGADOUGOU
Sikasso
Bobo Dioulasso
Black Volta
GHANA
White Volta
IVORY COAST
0 kilometres 300
0 miles 200

and on its borders move to pursue their livelihoods. This figure represents about 8 percent of the Malian population. The density of population varies greatly within the zone, between 2.5 per sq km to 25 per sq km, with an average of 13 per sq km as a whole. However, the economic importance of the area is disproportionate to the population of the Delta, it is estimated that 1.5 million cattle, 2.1 million sheep and goats and 700,000 camels use the area each year, 20 percent of the entire Malian herd, and the production of fish is something in the region of 100,000 tons per annum in good years. The export of processed fish has in the past provided up to 6 percent of Mali's principal rice producing zones.

Over the last fifteen years the area has experienced, except in two years, an increasing level of drought. Only once over this time has rainfall come close to the average since 1906. Between 1982 and 1984 the dry conditions dramatically worsened, with flood and rainfall figures in 1982 equalling those experienced in 1973, and in the subsequent years falling below them to all time lows. The effect of this situation on production in the area was disastrous. Inasmuch as the patchy and inadequate data available allow, it has been estimated that dryland crop production fell by 90 percent, animal losses were of the order of 60 percent, and fish production fell by over 95 percent.

The production systems of the Inland Delta and its borders can be grouped into five: full-time farmers, transhumant fishermen and herders, agro-fishermen and agro-pastoralists. Migration, dual production systems and the practice of important secondary activities make up the basic principles of how rural inhabitants carry out their livelihoods in the area as rural people seek to maximise their production by moving to different ecological areas of the Delta in different seasons, in line with changes in natural productivity as the water levels in the area rise and fall, and in an attempt to minimise the effects of a high risk environment.

Agro-pastoralists and agro-fishermen, cultivate one cereal crop a year aimed at meeting their subsistence needs (for the former, who live on the drylands, a millet crop between July and October, and for the latter a floodland rice crop between July and December). To meet their cash needs agro-pastoralists also keep livestock, primarily goats, which they graze on browse in the forests of the zone, while agro-fishermen fish the plains at high water, the secondary streams and deep pools in the rising and falling flood level seasons, and the main water courses in the dry season. Both these groups also move at strategic moments of the year to gain access to other resources: the agro-fishermen to the drylands on the borders of the Delta to collect wood fuel at high water (October-November), to collect wild food (August-September) and

to take part in the millet harvest if it is productive enough (September-October); agro-pastoralists move into the floodplains after the millet harvest to collect wild food (water lilies, wild grass seeds) in October-November, and to take part in the rice harvest (December-January). Additionally younger members of agro-fishing communities traditionally go as far as the Ivory Coast for fairly extended periods (up to three years) looking for wage labour (often in the sea fishing industry), and agro-pastoralists move to the towns during the dry season.

Transhumant herders and fishermen exemplify the strategy of moving between ecological areas in the Delta and on its borders in order to gain access to resources at their most productive time of the year. Over the centuries herders have evolved a transhumant cycle which takes them out onto the drylands surrounding the Delta during the rainy season and as the Delta floods. In October-November they return, and cross into the rich pastures left by the retreating flood, following the falling water levels until they arrive in the zone around lakes Debo and Walado in March-April, where they remain until the rains begin once again. Transhumant fishermen from upwater regions of the Delta leave their villages of origin once the flood begins to fall; between October and June these fishermen inhabit large camps that move down the main waterways of the Diaka and the Niger, congregating at Lakes Walado and Debo towards the end of the dry season. When the flood begins to rise again and the rain to fall they turn upstream once more. Both transhumant herders and fishermen also move in search of barter exchanges for dryland (in the case of herders) and floodland crops, and take part in wild food harvests. As with agro-fishermen, transhumant fishing communities send significant numbers of primarily young men to the Ivory Coast looking for wage labour, while members of transhumant herding groups often walk their animals south, both to escape drought conditions, and to the cattle markets of Nigeria and Ghana.

The full-time farmers of the area cultivate dryland (millet), floodland (rain fed and inundated rice) and flood retreat crops in pools, when water levels allow (sorghum, peanuts, cotton etc.). To supplement these activities they also move to deeper flooded areas of the Delta to take part in wild food collection and the rice harvest, and to wild food production sites on the drylands. Especially in bad years they migrate to the central parts of the Delta to collect wild food and to take part in the rice harvest. and in the dry season they move into the towns in search of seasonal wage labour (in the wood-fuel trade, and the building sector).

People of the Delta

The five production systems found in the Inland Delta are composed of ten ethnic groups, reflecting on the one hand an ancient division of labour between the original inhabitants of the area, and on the other the progressive colonisation of the region by neighbouring peoples. To some extent ethnic identity implies professional specialisation, though recent movements into secondary lines of production and a general diversification of activities make the link increasingly tenuous (see below).

The farmers and agro-pastoralists of the zone, who form the larger part of the population (exact figures are unavailable, though they probably account for well over half the Delta's population), consist of the Marka, Rimaibe, Balla, Sonrai and Bambarra peoples. Of these the earliest inhabitants are elements of the Marka population, who specialise in floodland rice production. These elements of the Marka, whose name probably means 'Mali-ka', or the people of Mali, are the Noninke people, said to be original inhabitants of the Delta. The term Marka derives from the era when the Delta was part of the Mali Empire between the 13th and 15th centuries, and was an essential water-way link between the gold fields north of present-day Bamako and trans-saharan caravan trade arriving in Tombouctou. The Nono have been joined by others from a varied background linked to the Marka by their common religious belief (the Malian Empire saw the introduction of Islam into the Delta) and their involvement in trade. Marka settlements are primarily found on the banks of the River Niger, and the best rice producing areas of the Delta.

The Rimaibe are equally specialised in floodland rice production, and are found in communities primarily on the floodplains, and concentrated in the western parts of the Delta, reflecting their historical origin as the cultivating slaves of the Fulani, who dominated the area in the 18th and 19th centuries. They are derived from an heterogeneous ethnic background including elements of the Bozo, Bobo and Bambarra peoples, who were captured by their Fulani masters and implanted into the area, and given land to cultivate. The Sonrai and Bambarra communities are situated on dryland sites within the Delta and on its borders and specialise in millet production: the former, who also grow flood retreat crops, colonised the northern reaches of the zone in the 15th century, when the area was part of the Sonrai Empire based in Gao to the east, and the latter arrived in the 16th and 17th centuries, when the Bambarra kingdom at Segou was at the height of its power. The primarily agro-pastoralist Balla arrived in the area much more recently (for the most part since the beginning of this century), and cultivate millet as their staple crop. Like the Sonrai, they are primarily found in the northern part of the Delta,

having migrated from the north and north east, where formerly they were the cultivating and herding slaves of the Tamasheq.

The Bozo, Somono and Sorko people are fishermen and agro-fishermen. The oldest inhabitants of the Delta are the Bozo, said to be indigenous to the area, who, it has been argued, may in ancient times have been part of the Noninke people. Elements of their hunting and gathering society remain to this day in the form of their specialisation in shallow water trap and harpoon fishing techniques. They are found in smaller communities throughout the Delta.

The Somono, like the Marka, owe their origin to the Mali Empire, when disparate ethnic groups were formed into a navy in order to assure river transport for the Empire. They are found in large communities at 25 kilometre intervals (one day's travel by poled canoe) on the River Niger, and are distinguished by their specialisation in net fishing techniques and their activity in trade. The Sorko – a fraction of the Sonrai people – arrived in the northern parts of the Delta in the 15th century, and are the smaller ethnic group, often living in mixed communities with agro-pastoralist and farming peoples.

The agro-pastoral and full-time herding inhabitants of the Delta are made up predominantly of the Fulani, the dominant ethnic group, with seasonal visits by the Tamasheq. The Fulani arrived in waves from the west (the Fouta Djallon) between the 11th and 17th centuries and, as has been mentioned above, were the overlords of the Delta in the 17th and 18th centuries, in the latter period ruling the Delta as a unified theocratic state. The Tamasheq, more specialised in transhumant herding, have probably used the Delta for dry season pasture since ancient times though they were excluded from the area when it was under Fulani control in the 17th and 18th centuries. Today they are considered as outsiders, though they have access to floodland pasture in return for payment, and after the Delta Fulani have had first right of entry.

Customary access rules to natural resources

The foregoing discussion describes the diverse ethnic composition, and the varied systems of production found in the Inland Niger Delta, and demonstrates the importance of access to different resources in different ecological areas of the zone for the production strategies of rural inhabitants. Customary reciprocal access rules between rural communities and traditional agreements for the entry of outsiders to the area formed the basis for allowing production groups to move from one area to another, and provided the

conditions for an efficient strategy to minimise climatic risk both between seasons and year by year within the Delta.

In the 19th century, when the Delta was controlled as a unified theocratic state by the Fulani led by Cheikou Amadou, these access rules were codified under a system named after the Islamic law, the Dina. Under the Dina the Delta was divided into a number of grazing territories (about 30 in all), within which were subordinate farming and fishing territories. The Dina allocated these pasturing areas to loose Fulani clan groupings and a number of maraboutic (religious) leaders. Two of the most important effects of this system were to sedentarise groups of nomadic herders and fishermen, and to strictly codify grazing, fishing and farming rights. In doing this resource management systems that already existed in the Delta were formally established (and recorded in texts), and adapted to the interests of the Fulani.

The most ancient resource management system found in the Delta rests upon the primacy accorded to the founding lineage. Throughout the area, and across production systems, it is possible to differentiate between rural communities according to whether they are indigenous to the area or outsiders, and within communities between founding lineages, lineages that arrived later and married into the former, and more recently arrived strangers.

In general founding lineages were the inalienable owners of resources and heads of these lineages were the 'sacrificers', with clearly delimited territories. These lineages also provided resource managers in the form of 'masters of the water' and 'masters of the land'. Such managers, in consultation with a council of elders, were responsible for the allocation of resources, for bringing new resources into production, the adjudication of disputes, and setting dates for important economic activities at different times of the year (sowing, harvesting, collective fishing etc.). The principal rule governing access to resources was that members of the community (that is, founders, consanguine lineages and later settlers) had a right of access essentially free, or for a small tithe, while the outsiders had to pay. Revenue from these sources was used by the head of the community to pay for visitors, marriages and other ceremonies, grain stores, and was also shared out between the founding and consanguine lineages within the community.

The Dina system overlay grazing rights on what had essentially been a system of rights governing fishing, hunting and farming territories. While slave farmers (the Rimaibe) were made wholly dependent on their masters, other farming communities (Marka) and fishing settlements (Bozo and Somono) paid tribute to the Fulani overlords. The ordering of herds' entry into their

respective grazing territories was established and groupings of herds were formed to go on transhumance together, at a time when all Fulani cattle had to be protected once they left the confines of the Delta, due to the hostility of the neighbouring Bambarra kingdom to the West and Tamasheq areas of influence to the north and East of the area in the 19th century.

On the floodplains access to fields under the Dina system was controlled by the Dioro, the head of the Fulani clan in each pasturing territory, though more autonomous Marka and fishing settlements had customary authorities who controlled the distribution of farming land between lineages within their communities. There were three types of pasture: those belonging to the political head of the clan, the Dioro, those belonging to the founding lineages of the clan, and those belonging to settled Fulani villages. The Dioro controlled the number of outside herds visiting the territory each year in line with the availability of grazing. Fishing rights were under the control of the traditional 'masters of the water' in Bozo, Somono and Sorko communities. Access to browse and woodland resources in the 19th century were essentially free. Outsiders visiting the floodplain seasonally, and wishing to exploit the major fishing and pasture resources paid a tithe in kind, in the case of fishermen generally a third of the catch, and in the case of herders generally through the loan or gift of animals. Outsiders wishing to settle in the area to farm had to obtain the permission of either the Dioro or the local 'master of the land' (or both) to have access to fields usually, again, in return for a share of the crop.

On the drylands on the frontiers of Fulani influence access to resources was easier, and relied less on the Dioro's influence. Fields were the only resource under management, with permission to put new land under cultivation and the allocation of farming land to both outsiders and within the community under the control of village based 'masters' of the land'. Access to browse and pasture resources was generally open, though research remains to be done on traditional rights to water points.

In areas of higher population density where communities of agro-fishermen and agro-pastoralists coexisted there were commonly village territories, controlled either by sedentary Fulani authorities or their designated leaders, under whom were 'masters of the land', 'masters of pasture' and 'masters of the water'. Access to fishing, pasturing and farming land was, as elsewhere, subject to belonging to the community, and strangers wishing to settle in the area, as well as seasonal visitors, had to pay a tithe. Woodland resources were more freely open to outsiders use.

Changes in access rules

Towards the end of the 19th century the Delta was invaded by the Fulani of El Haj Oumar, from the Fouta Djallon to the West. For 25 years the area was subject to continuous warfare which laid destitute many of the communities inhabiting the floodplains, and saw the wholesale forced movement of fishing and farming peoples to the western borders of the Delta. In 1893 the French arrived in Mopti, imposed peace on the area, and remained there until 1960, when the Republic of Mali was granted its independence. In 1968 a military coup unseated the so-called socialist regime of Modibo Keita. Since then General Moussa Traore has held power, with increasing influence being devolved on the single political party, the Union Démocratique du Peuple Malien, in recent years.

In terms of access to resources the most important events over this period have been the imposition of peace and the breaking of Fulani hegemony in the Delta following the arrival of the French; the opening out of trade links and improvement of communications between the Delta and the rest of Mali and West Africa, and the formal take-over of ownership of natural resources by the Malian state.

During this time the Delta economy has become linked to a wider national and international market which has profoundly changed the terms of trade between Delta products: whereas formerly the value of produce was mainly defined in terms of supply and demand within the area, now it is determined by factors influenced by West African and European trends. This process has seen a growing dependence of rural producers on the market for the provision of essential foodstuffs and technical inputs (ploughs, fishing equipment etc.), greatly exacerbated by the 12 years of recent drought.

The spread of the cash economy into most of the major activities practised by rural inhabitants, accompanied by the breakdown in many of the traditional means of controlling access to resources (see below), and the availability of individual means of production on the market (fishing and farming equipment, mainly) has been accompanied by a growing differentiation within Delta production systems. Whereas before lineage heads, grouped under customary authorities, represented extended productive entities, nowadays the household is the main producing and consuming unit. Within Delta communities there now exist important differences between rich and poor households, with richer families able to diversify their productive activities, while poorer ones are obliged to pursue specialised production lines.

The breaking of Fulani hegemony in the Delta at the beginning of the century, without its replacement by any centralised power as effective as that which had existed before, began a process by which customary authorities within communities lost the power to control access to resources. Nowadays 'masters of the water', 'masters of the land' and pasturing authorities (the Dioro) have greatly diminished influence in the allocation of land and the control over who is given access to resources within their territories.

The formal ownership of natural resources by the Malian state, and the way in which the state manages them, have probably greatly exacerbated this process. Whereas before permission from customary authorities had to be granted (and rents paid) for the use of a particular resource by outsiders, nowadays in any dispute the state authorities are called in to act as alternative resource managers. Nor is the state a single undifferentiated unit, but a set of often competing interests, each of whom abrogate (or try to) the power of granting access: thus outsiders seeking access can address themselves to the customary authorities, the political party, the relevant technical service (of Waters and Forests, the Livestock Service etc.), or the administration.

Further the state has actively contributed to raising the cash needs of rural producers through the collection of taxes and the imposition of a set of fines and payments for permits to use resources. Nowadays the pasturing regime originally set up by Cheikou Amadou in the last century, and which probably allowed each pasturing territory to fix its own entry dates and decide on the number of outside herds that were to be allowed access, is controlled from the regional capital through an annual pastoral conference which fixes the dates at which all herds entering the Delta must cross into particular pastures.

At each crossing, state officials attend to collect a fee from each herd. Fishermen, in addition to paying all the normal taxes, also have to pay for permits for their fishing equipment and boats, and the collective fisheries which take place in the Delta as the water falls at the beginning of the dry season are managed by the administration in collaboration with the fishing service. Permits are also issued for cutting wood for sale. A series of fines accompany the deemed abuse of natural resources, such as grassland fires, or the mutilation of thorn trees to provide browse for goats (it is not proven that breaking the branches of thorn trees necessarily kills the trees or diminishes their productivity).

Of particular significance has been the redefinition of administrative boundaries (compared to the Dina limits) by the state, which has been continuing up to a recent date. The Delta, part of the fifth region of Mali, is

administered through a series of Cercles and Arrondissements, whose frontiers are not the same as the old pasturing territories which contained sub-farming and fishing territories within them. Combined with a policy of attributing fishing rights to communities on the banks of rivers (who formerly may have been a community of farmers, with no fishing rights), this has led to a transfer of rights to resources from one production system to another, and to the attribution of resources to different communities within the same production system.

Conclusion

The outcome of these processes on access rules in the Delta, and the way in which they are managed and exploited, has been threefold. Firstly there has been a movement towards the 'privatisation' of resources. In the most extreme case farming land that formerly belonged to lineages now pertains to individual households; rental agreements linking 'masters of the land' to outsiders now are rarely paid; prime wetland sites in some areas have been put into the production of cultivated pasture by individuals. In a wider sense resources formerly managed in the interests of Fulani pastoralists have now fallen under the direct control of farming and fisherman-farming communities who, especially since the drought, have moved their fields into deeper-lying areas (formerly used for pasture) on the floodplains, without pastoral authorities being able to prevent them.

Secondly, evidence points to the progressive take over of the better resources (again particularly since the drought, when fewer reliable resources are available) by influential groups within rural communities. Often these groups are the higher-status members (members of founding and consanguine lineages). In addition, former customary managers who still perceive revenue from the management of resources now use their revenue to provide for their own household requirements rather than distributing them to other members of their society. In these circumstances the acceptance of strangers each year is more dependent on their ability to pay, than on long-standing reciprocal agreements.

Thirdly, resources that had few rules of entry before (pasture and browse in the drylands, fisheries in the high water season) are now subject to increasing control, either through the attempt by dryland communities – who have increasingly moved into raising goats as dry conditions persist – to create their own reserved forest land, through the increase of control exercised on woodland sites within the Delta or through the actions of the state that requires

permits, or imposes fines on users of these formerly free resources.

In the latter case the ethnic allegiance of exploiters is not of primary importance, thus access to resources can be conceived as being more open (i.e. free to all Malian citizens) where it is granted to people who formerly either never used the area, or where they had no traditional right to do so.

The consequences of this situation for the future are the probable increasing take-over of the better resources in the Delta by the more powerful members of communities, often attached to outside interests, especially if the drought is to continue. The knock on effect of this will be to push poorer households, and seasonal strangers unable to pay rents for access, onto more marginal lands where they will face charges and fines from state technical services for their exploitation of the area.

Neither of these groups will or can have an interest in conserving the resource base upon which their livelihood depends. The fact that natural resources belong formally to the state undermines any incentive on behalf of rural producers to invest in the productivity of the natural environment, in the knowledge that they have little control over who benefits from their actions. Poorer people without ownership of their own resources lack by definition the choice to make decisions that would support conservation ends. The Malian state, in view of its paramount requirement for revenue, is unlikely to lessen its cash demands on rural inhabitants.

Development intiatives over the last fifteen years, primarily geared through the para-statal 'Opérations de Développement', have invested the greater part of their resources in technical inputs and infrastructure, while at the same time seeking to take over control of access to resources. Over this same period a process of net disinvestment has taken place if the amount of revenue actually taken out of the Delta (primarily through taxes) is compared to the amount of development assistance that has actually reached the ground. Unless resources in the future are redirected towards rural inhabitants with the accumulated knowledge and experience of the area they live in, the ambiguous and disorganised situation governing the access of rural inhabitants will persist, increasing the mismanagement of the natural environment that presently exists and leading to a futher drop in the productivity of the natural resources of the Inland Niger Delta.

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SMALL FARMERS AND ENVIRONMENTAL RISK IN ALGERIA

Colin Barnes

Algeria and the Agricultural Sector

Introduction

Algeria, as a case study in development, has attracted a considerable amount of interest, not merely because of its geographic position and politico-cultural allegiances, as an Arab and African state and as a leading non-aligned nation and one of the more influential states of the Mediterranean Basin, but also because of its development strategy. This strategy has been of interest to development specialists because it is orientated towards the development of a modern industrial state within a centrally planned economy. It makes use of the concept of workers' self management which has been applied in both the agricultural and industrial sectors (Clegg 1971).

This paper will concentrate on the private sector within Algerian agriculture, and its response to environmental risk and degradation. Reference will be made in particular to three regions of Algeria where the author has worked,[1] Aures, Jijel and Tiaret (see map p.43) which all demonstrate the problems of the small private sector farmer.

First, however, it would be useful to put the agricultural sector in Algeria in context. Algeria has a total land area of 2.4 million ha, of which approximately 80 percent is desert, which means that the vast majority of the population and its economic activities are concentrated in around 20 percent of the national territory. The current population is estimated at 25 million, with one of the world's highest annual population growth rates, 3.2 percent.

Since independence in 1962, the emphasis of public investment and national development has been towards the development of a modern industrial state supported by an adequate infrastructure: housing, roads, education and training. The Soviet model, centred around the establishment of basic industries – iron and steel, hydrocarbons, chemicals and engineering – has had

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[1] The author has worked with the Algerian Ministry of Agriculture, the World Bank, the Agencé Nationale d'Amenagement du Territoire (ANAT) and the International Fund for Agricultural Development (IFAD)

a considerable influence on national development strategy. The most recent estimation of the composition of gross value added (1983), gives the following breakdown by sector:

Table 1: The Algerian Economy 1983

Sector	Algerian Dinars (million)	%
Agriculture	16607.6	9
Industry	25336.0	14
Hydrocarbons	62138.7	34
Building/Public Works	32156.1	17
Trade	28870.8	16
TOTAL	184784.9	100

Source: Annuaire Statistique de l'Algérie, 1985

By contrast, investment in the agricultural sector has been low. Although over 25 percent of the national work force is employed in the agricultural sector, and 40 percent of the national population live in rural areas, agricultural production has stagnated since Independence, and in some cases, notably cereals, meat and dairy products has declined in relation to population growth.

More recently, the fall in hydrocarbon prices (oil and national gas) over the past five years, has increasingly called into question the concentration on industrial and infrastructure investment at the expense of agriculture.

ALGERIA : LOCATION OF CASE STUDIES

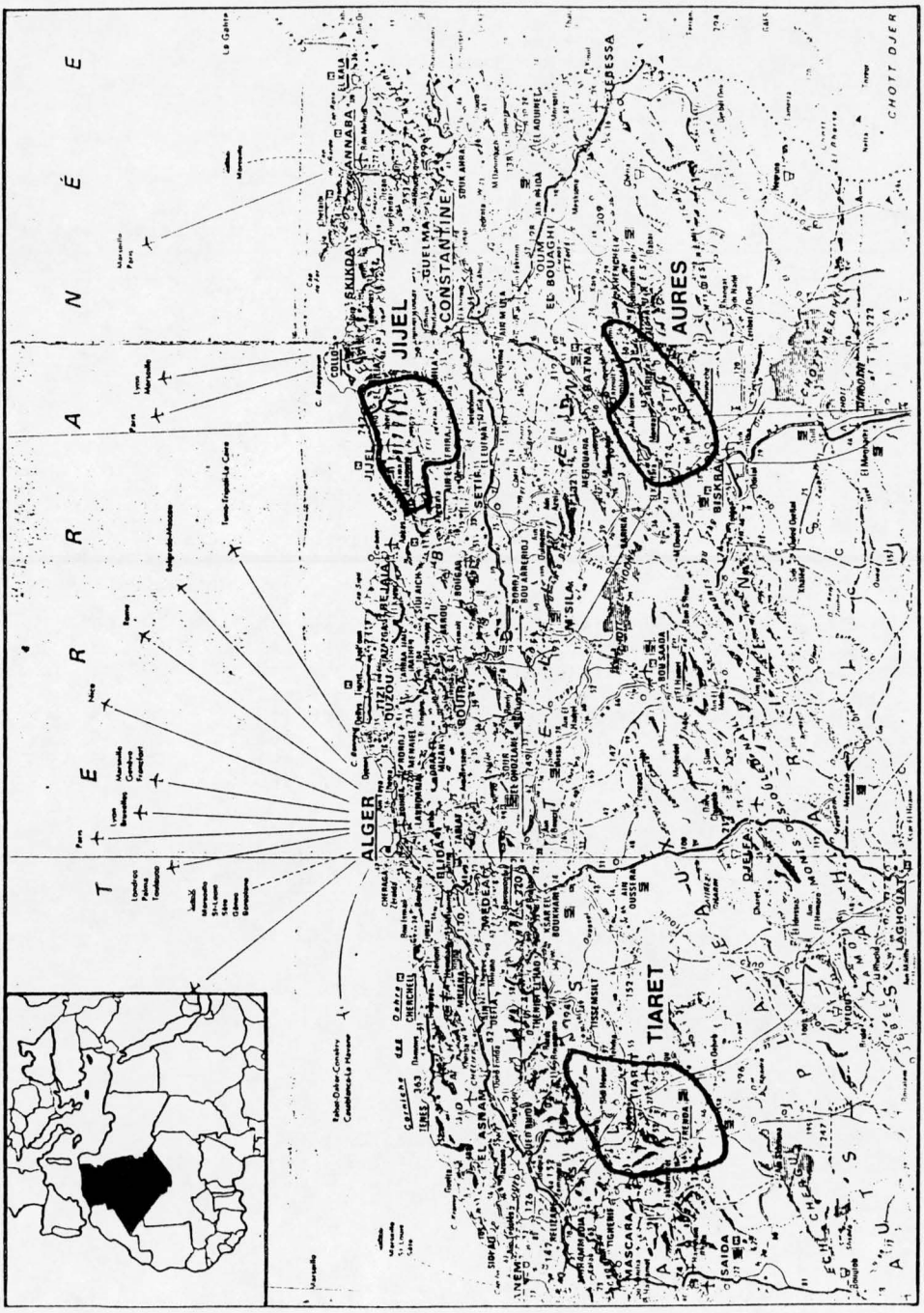

Table 2: Land Use in Algeria

Land Area	km2	% of Total Land Area
Total land used by agriculture (1982/83)	397,082	17
Forests	33,000	1
Alfa zones	47,200	2
Unproductive (deserts etc.)	1,904,459	80
Total Land Area	2,381,741	100

Total Cropping

Crop	Private Sector (ha)	Total (ha)	Private Sector as a % of Total Area Cultivated
Cereals	1,603,620	2,669,460	60
Pulses	51,282	156,592	33
Vegetables	144,590	202,040	72
Industrial crops	10,800	21,610	50
Fodder crops	204,790	468,840	44
Natural fodder	112,490	131,360	86
Table grapes and vines	31,090	177,160	18
Citrus (in production)	3,620	44,870	8
Olives	122,370	161,260	76
Dates	67,020	71,160	94

Source: Annuaire Statistique de l'Algérie 1983-84

The agricultural sector in the national economy

Out of a total area of 2.4 million km2, only 0.4 million km2 or 17 percent is used by agriculture (including grazing), and only 0.07 million km2 or 2.9 percent of the total area is cultivated including occasional cultivation with fallow (Table 2).

Within the overall context of the Algerian economy, the performance of the agricultural sector has not been very satisfactory since Independence. For most agricultural commodities the country's production does not satisfy domestic demand and large quantities of foreign exchange are spent on the import of basic commodities such as cereals,[2] vegetable oils, milk and other dairy products. For instance over the period 1981-1984, imports of agricultural commodities and products averaged 7058.8 million Algerian dinars (AD) per year, equivalent to over 12 percent of the total value of hydrocarbon exports in 1984, a percentage which is likely to have risen with the fall in the absolute and real value of hydrocarbon exports over the last five years. In fact, the share of agriculture in national GDP has shown a continuing decline and was estimated to have dropped from 11 percent in 1975 to 9 percent in 1985.

Over a 20 year period domestic production of cereals has stagnated or declined in absolute terms. Only in the livestock, fisheries and fruit and vegetable sectors has domestic production kept up with demand. Historical estimates of agricultural production are unreliable. However it is estimated that annual national production of cereals, which was 0.52 million tonnes in 1850, had risen to over 2.3 million tonnes in the 1950's but averaged only 1.6 million tonnes over the period 1976-1984.

The decline of agricultural production has been a function of several factors: the exhaustion of land through systems which reduced fertility (Chaulet, 1980), under investment in the private sector, environmental degradation, the effects of the war of liberation and the lack of Government investment and commitment to agriculture, compared with other sectors. There has also been a dramatic decline in the population actively employed in agriculture from 63 percent in 1970/71 to around 28 percent at present.

A large proportion of the foreign exchange earnings from hydrocarbon exports have been spent on financing the growing national debt raised to finance post-independence investment in the basic industries and infrastructural

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[2] Algeria has one of the highest annual consumption rates of cereals in the world, estimated at 173 kg per head over the period 1982-84.

development as well as to pay for agricultural imports, referred to above.

At the macro-economic level, the proportion of national investment allocated to the agricultural sector has declined until recently and as a result agricultural productivity and performance have suffered. This is borne out by the allocation of investment to the agricultural sector which has always been well below that of other sectors notably industry, infrastructure and construction which have always received higher priority from central government. In the 1985-89 Plan, agriculture and the water sector received 14.4 percent of the total allocation as opposed to 27.2 percent for social infrastructure and 31.6 percent for industry.

In fact economic policy in Algeria has been mainly directed to the development of a modern industrial state. The development of essentially capital intensive industries has done little to create employment. It has indirectly worsened the situation of the private agricultural sector by not providing employment opportunities outside the agricultural sector and there is little integration between industrial development and agriculture, except with the manufacture under licence of certain farm machinery, notably tractors, cultivation equipment and combine harvesters. This agricultural machinery and equipment has been distributed mainly to the state sector.

Agriculture and the Environment

Algeria lies in a physical environment which presents risks particularly of erosion. Steep slopes and calcareous soils and marls lend themselves to this erosion. The intense rains of a Mediterranean-type climate occur at a time (October to March) when plant and vegetation cover are low. Other physical factors increase the risk for agriculture, for example the constraint of water availability in large parts of the steppe and high plateaux which restrict the development of a more intensive agriculture and the threat of the northern advance of the Sahara.

Additional to these physical factors are the problems of:

(i) rural population pressure on land leading to environmental degradation, particularly in the mountainous zones, the Aures, Kabylie and the Ouarsenis;

(ii) the expansion of urban areas and industrial zones onto agricultural land without adequate physical planning controls, this is particularly

marked on the Mitidja Plain;

(iii) degradation of pastures and forest through overgrazing;

(iv) the destruction of the forest cover through illicit exploitation and forest fires;

Historically, it should be emphasised that the setting for environmental degradation in the agricultural sector was already being developed during the colonial period. The acquisition of large areas of fertile soils on the coastal plains and to a lesser extent in the plateaux, meant that the Algerian peasantry had virtually no possibility of purchasing land. The concentration of the rural population on land increased the pressure on grazing land, lowered productivity (there was no real advance in technology in the peasant sector) and led to the increased removal of forest resources for firewood and housing construction.

The concentration of the rural population in certain zones was a deliberate policy pursued by the French, during the liberation war (regroupement), to control the movement of nationalist guerrilla groups. In addition the French, in the bid to control these groups, made the forest zones (which provided good cover) a target for extensive bombing, including the use of napalm. These effects continue to manifest themselves in the Aures mountains and the Ouarsenis (in particular see Sari, 1977).

These factors together present tremendous risks to existing and future agricultural production in the country, to food supply and to the incomes of a large number of small farmers.

Various authors have drawn attention to the problems of the environmental threat to agriculture in Algeria. Apart from official reports, this threat has been analysed by Stewart (1975), Sari (1977) and Blaikie (1985). Estimates of the annual loss of good agricultural land to erosion vary between 40 – 50,000 ha per year, while other threats include an annual loss of forest cover estimated at around 30,000 ha through fires, and the degradation of natural pastures in mountain areas through overgrazing of around 200,000 ha (quoted by Gauthier and Kermarec [1978]).

The areas of the Aures massif and the Jijel typify the environmental problems of the mountainous areas which account for over 60 percent of the areas of agricultural and grazing importance. Tiaret, the third study area includes the plateau/steppe and the southern fringes of the Ouarsenis, with

environmental degradation being most marked in the latter area.

The study areas of Jijel and the Aures are particularly important in terms of their forest resources. The Jijel contains some of the major cork oak and oak resources of the country, while the Aures have cedar and pine forests with a major replanting programme at the north eastern periphery of the region. The forest resources of Jijel represent a major economic resource in cork and construction wood as well as a protection against erosion, while the forest cover of the Aures has an importance mainly as a protection and transitional zone between the Sahara and the High Plateaux to the north.

In national terms, the area under forest has declined from 4 million ha in 1830 down to around 3 million ha in the 1980's. One of the fundamental problems is the integration of agriculture, pastoralism and forestry, where not only new plantations but also established forests are threatened by the extensive grazing patterns of livestock herds.

The modes of production in the agricultural sector

There are three major modes of production in Algerian agriculture. The state or socialist sector (*secteur socialiste* or *étatique*) which consists principally of medium to large sized farms. These were formerly the farms of French settlers and are concentrated mainly on the good soils of the coastal plains and in the High Plateaux. These farms produce a large proportion of pulses, industrial and fodder crops.

State sector farms have until recently received a disproportionate amount of investment in terms of machinery inputs and credit. One estimate, by the FAO/World Bank Investment Centre, shows that the state sector while accounting for approximately 41 percent of the cultivable area in 1985, received 58 percent of fertilisers, 49 percent of pesticides, and 70 percent of the tractors in the same year, while in 1986 81 percent of the loans given by BADR (Algerian Bank for Rural Development) went to this sector. Since 1980, there has been some attempt to make this sector more accountable and in some cases their land has been redistributed to the co-operative and private sectors. In many cases, these farms are in deficit, over-capitalised and with a poorly organised work force.

The co-operative sector (*secteur reforme agraire*) represents farms reallocated as a result of land holding ceilings established after the Revolution for the private sector.

Finally there is the private sector which is now gradually receiving more recognition by government because of its importance in overall agricultural production, rural employment and incomes. Within the private sector it is important to differentiate between the different sizes of farms and their environment; the small marginal farms of the mountain areas are very different from the intensive irrigated smallholdings of the coastal plains and the larger (30-50 ha) rainfed cereal farms of Tiaret.

The rest of the paper concentrates on the importance and threat of environmental degradation and risk in the private sector.

Table 3: The Development of Agricultural Production in Algeria (million tonnes)

CROPS	1976/77	1978/79	1980/81	1982/83	1983/84
Cereals					
Private Sector	0.5	0.7	0.89	0.64	0.81
Total	1.14	1.62	1.83	1.29	1.46
% of Total	44	43	49	50	55
Vegetables					
Private Sector	0.59	0.71	0.89	1.00	1.16
Total	1.03	1.16	1.29	1.37	1.55
% of Total	57	61	69	73	75
Natural & Artificial Fodder Crops					
Private Sector	1.53	2.11	2.88	2.80	4.43
Total	5.65	7.57	8.54	7.37	9.18
% of Total	27	28	34	38	48

LIVESTOCK SECTOR (Million Head)

	1981/82	1982/83	1983/84
Sheep			
Private Sector	14.23	16.56	14.80
Total	15.50	17.70	15.66
% of Total	92	94	95
Cattle			
Private Sector	1.41	1.55	1.32
Total	1.50	1.64	1.40
% of Total	94	95	94
Goats			
Private Sector	2.84	2.95	2.81
Total	2.86	2.96	2.80
% of Total	99	99	99

Source: Annuaire Statistique de l'Algérie 1983-84

The private sector in Algerian agriculture

Private sector agriculture in Algeria is normally under freehold tenure and holding size is subject to certain ceilings established by the state. There are in addition, customary forms of land tenure (arch and melk) and other land owned by the communes or municipalities.

The private agricultural sector, despite the comparatively small allocation of resources, continues to provide a very significant proportion of the country's agricultural production, particularly for cereals, fruit and vegetables and meat (Table 3). The private sector with 55 percent of the agricultural area in Algeria, produces approximately two thirds of cereal production and has 95 percent of the national herd of sheep and cattle. Furthermore a large proportion of domestic poultry production is now coming from the private sector.

A change in the attitude of the central authorities towards the private sector has really got under way since 1983 and particularly under the presidency of Chadli Bendjedid, and both the current National Plan (1985-1989) and the National Charters place considerable emphasis on the need to modernise this sector. This has been manifested by the intent to grant a larger proportion of farm inputs and credit to the private sector. Furthermore a number of production co-operatives and socialist sector farms have been restructured and land redistributed to the private sector in recent years.

Estimates of the agricultural area actually lost to various forms of erosion are difficult to come by but some estimates suggest that up to 50,000 ha per year is lost (Rousset 1975). Stewart (1975) has attempted to define the problem by taking into account rainfall, slope and soils. These figures suggest that in the areas of comparatively high rainfall (greater than 400 mm), 72 percent of the area would either be difficult to restore or it is in the more mountainous parts of the country where the private sector is predominant.

There has since been considerable investment in reafforestation particularly as a measure against the advance of the Sahara Desert, including the *barrage vert* project. However, problems arise in reconciling environmental protection with existing farming systems, especially the role of cattle, sheep and goats, in the more marginal mountain zones, which provide a capital asset to farmers as well as by-products, such as milk, meat and fibre. In addition the rate of reafforestation has been woefully inadequate to keep up with annual losses of forest and maquis cover.

The productivity and total production of the private sector has in general stagnated since 1976, this may be ascribed to a number of reasons including lack of investment and support to the private sector, government pricing policy and other factors. Among these is the problem of land denudation.

Even in areas where there has been an inflow of funds, for example, remittance earnings in France, investment has not been in the agricultural sector. Returns are more rapid and less risky in other sectors such as construction, transport and more recently, catering and tourism.

The rural population is increasing in relation to a land resource which is declining in both productivity and area through erosion, desertification, and the removal of land for urban and industrial development. This is contributing to the problem of lower productivity and the fragmentation of holdings. In some areas this has been relieved to some extent by out-migration from rural areas, although in a recent visit to the country the author was told that increased unemployment due to the slowdown in economic activities in urban areas was contributing to a reversal of this trend.

The problems mentioned in the previous paragraph have led to very high rates of unemployment and under-employment, estimated by some writers (for example Rousset [1975]) to be as high as 60 percent in some rural areas, although it is clear that in certain areas, for example the coastal zone in Jijel, there was in some cases a labour shortage in the private and socialist sectors because of competitive wages in neighbouring industrial and manufacturing plants.

Competition for resources and the small farmers

In terms of resource allocation, both agriculture and environmental protection have, until recently, received comparatively low priority in Algeria. During the colonial period, there was a low level of investment in the small sector and low investment in environmental protection. The principal investments were in productive forests and the protection of river catchments surrounding dams, although towards the latter part of the colonial era there were some programmes for environmental protection incorporated in the special programmes for the Aures and Kabylie.

Since 1962, within overall investment in agriculture and the environment (the latter including forestry, anti-erosion works and the restoration of soil and land) the small farm sector has, until very recently, continued to receive

adequate investment or technical support.

In the three case study areas which represent the mountain and high plateaux areas of Algeria, the private sector has not received resources commensurate with its importance in terms of the total cultivable area and the active population occupied. In the case of the Jijel and Aures regions there is a major constraint of difficult topography and a limited area suitable for cultivation and a limited grazing area in relation to the numbers of small ruminants.

In these three areas, resources and investment by the state tend to be concentrated into state farms and co-operatives rather than the small farm sector and, because of the higher potential return on investment, private capital accumulation (from mainly the non-agricultural sector and remittance earnings from France) concentrated in the more profitable sectors of building, construction, property and transport rather than in the agricultural sector. This is particularly the case in the mountainous areas of Jijel and the Aures.

What is also clear is that the increasing liberalisation within the agricultural sector may increase the economic strength of private sector farmers on the more productive land of the coastal plains, while leading to a relative increase of impoverishment of the private farmers in areas of acute environmental risk, namely the mountain zones (for example the Aures, Jijel) and some of the high plateaux (for example Tiaret).

The possible restricting of parts of the state agricultural sector into individual privately owned farms may lead to an acceleration in the development of capitalist agriculture in rural areas, a factor analysed recently by an Algerian academic (Bedrani 1986).

The response to environmental degradation

Overall, it is estimated that Algeria is losing some 40,000 ha per annum through soil erosion and a considerable proportion of its natural vegetation and forest cover through factors including overgrazing and forest fires. Several authorities have pointed out a national requirement for reafforestation of over 4 million ha (Rousset 1975).

The response of government to environmental degradation has been inadequate and in some cases, for example the *barrage vert*, misguided. There have been a number of programmes for environmental protection including reafforestation, terracing and specific measures against particular erosion areas.

At the individual farmer level in the three case study areas the small farmer has responded to the environmental risk mainly by:

outmigration to urban areas or, historically, France in order to seek a reasonable income;

where possible a reduction in dependence on agricultural activities which offered a comparatively low return on investment and in some cases represented a high risk.

In very few cases has there been any substantial investment in erosion control or environmental protection. This is beyond the scope of the individual farmer in terms of resources and management, and may be in conflict with the traditional farming systems of cereals and semi-nomadic livestock husbandry.

Of the three areas considered in this paper, the Aures and the mountainous parts of Jijel (Petitie Kabylie) have traditionally been areas of outmigration to other parts of Algeria or France. In the case of Tiaret, the northern part of the zone is effectively part of the Ouarsenis, a plateau area whose severe environmental degradation has been analysed by Sari (1977), in his fascinating study of the Ouarsenis massif.

Conclusions

This paper has sought to show the importance of the private sector in Algerian agriculture, its precarious position with respect to the environment, and its response to this situation. Certain conclusions may be drawn:

In general terms agricultural production and productivity in Algeria has declined since independence, both in absolute terms and particularly in relation to population growth. This is especially the case for basic food crops, such as cereals. The private sector continues to play a very significant role in terms of its contribution to national agricultural production, especially for cereals, livestock and horticultural production. This role is increasingly being recognised by the Government. However, the response of the private sector to its marginalisation with respect to access to finance, has been a stagnation in terms of overall production and productivity. The response to environmental risk has, in many cases, been the abandonment or partial abandonment of agricultural production in the search for employment in other sectors of the economy or in France. In particular, in areas such as Jijel and the Aures, outmigration to France has

traditionally been important although, with the new immigration laws in France, this outlet for emigration is becoming more limited.

The reduction of environmental degradation and risk in the private sector will, in the long term, require a fundamental change in farming systems and practices. This will include the reduction of human and livestock pressure on the more marginal land and the creation of alternative agricultural opportunities, for example on irrigated lands and in other economic sectors. Government policy has not yet addressed these problems. It is clear, however, that the resources of the private sector must be mobilised if Algeria is ever to reverse the overall decline of agricultural productivity and the dependence on imported food supplies which will continue to increase with rapid population growth and urbanisation.

There is still considerable potential for raising agricultural productivity in the private sector through the introduction of more intensive cropping, the reduction of fallow and an expansion in the area under irrigation. A recent World Bank Appraisal Report for an irrigation project in Algeria shows that, compared with other countries in the Maghreb, Algeria was irrigating only 37 percent of the potential irrigable area, whereas in Tunisia the proportion was over 80 percent.

The increasing power of the state bourgeoisie and the tendency towards the state capitalist development model analysed by several authors (Raffinot and Jacquemot 1977, Rousset 1975 and Tlemcani 1986) is likely to continue. One can expect that the private sector will reinforce its position in the national economy. Perhaps more significantly, the position of the larger private firms may be strengthened, while the position of the private sector in the more marginal zones becomes worse. The contradictions between the stated political objectives of the state and reality will cause strains, particularly among the more conservative religious lobbies as well as with traditional radical and nationalist forces.

The transformation of the private sector will require considerable investment and reassessment of the relationship between the private, state and cooperative sectors. If the private sector is to be transformed, investment in it should not consist merely of farm inputs and equipment but should also include applied research and extension. To date, support services to agriculture have almost entirely been channelled into the socialist sector and there has been little technical support or transfer of technology from the state to the private sector. The fact is that post-independence development in the agricultural sector, apart from providing

some investment for and some structural adjustment to the private sector has tended to reproduce the same dualistic type of development that existed during the colonial period.

The lack of a clear policy for the development of the small farm sector will, in the long term, not merely reduce agricultural production to this sector, but will lead to a reduction in rural employment opportunities. The capital intensive nature of industrial development and the limited possibilities for employment creation in a transformed state and private sector, notably through irrigation development, is unlikely to make up for loss of land through degradation and the reduction in rural employment opportunities.

The technological transformation for agricultural production in the small farm sector, while maintaining an environmental balance is one of the key issues in development planning, particularly in Algeria where land and water resources are limited while the threat to the environment becomes greater.[3]

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ENVIRONMENT AND DEVELOPMENT IN SUDAN AND ETHIOPIA

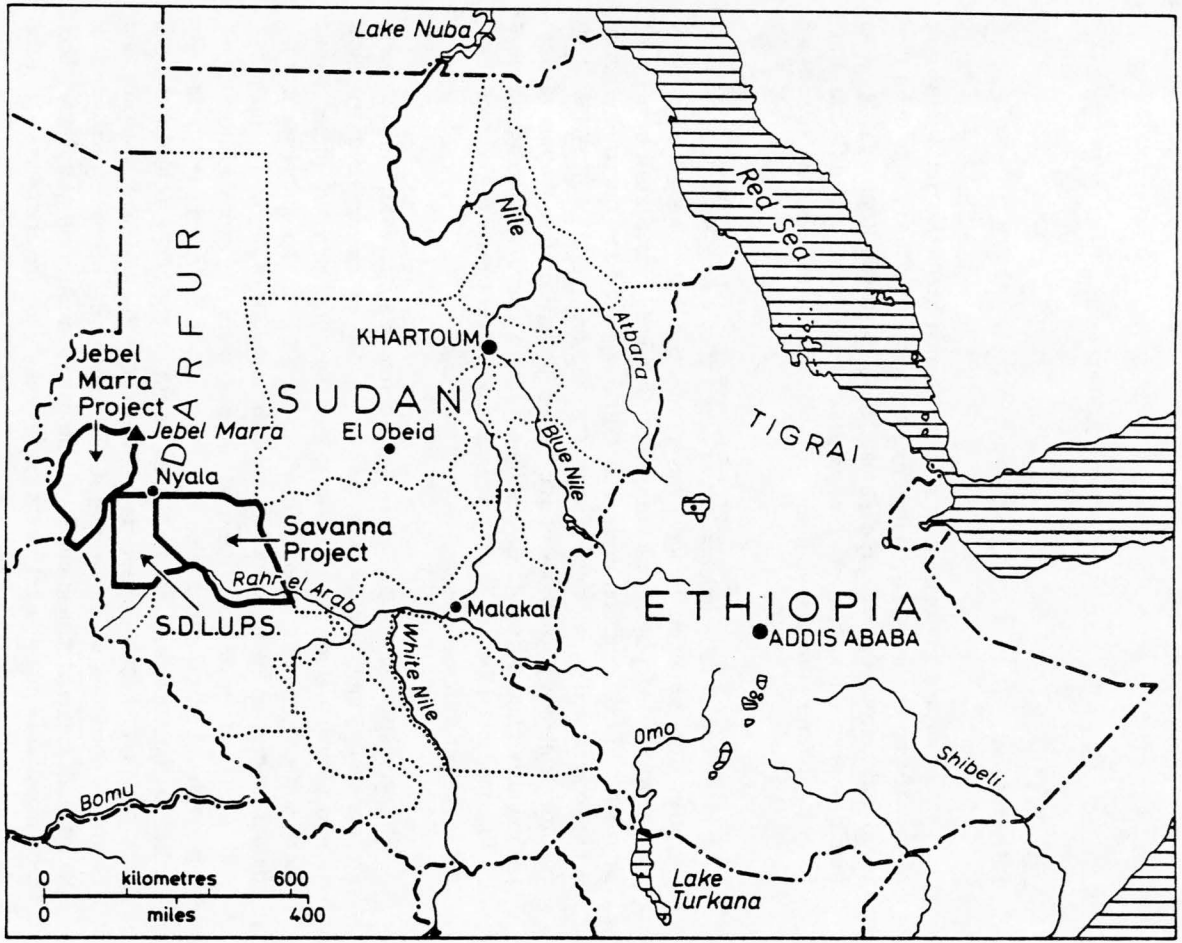
Vernon Robertson

Introduction

The Sudan and Ethiopia, with a long common frontier, cover a large area of the African continent, stretching from the eastern coast to points more than 1,000 miles from the sea. The climate of both ranges from true desert to humid tropics, although in other ways these countries are very different. Both have large rural populations, many of which live at or near bare subsistence level.

Sudan became fully independent in 1955, after a long period as an Anglo Egyptian Condominium. Ethiopia has the longest history as an independent state in Africa: independence interrupted, in relatively recent times, only by the short-term British incursion in the late 19th century and the longer-term Italian occupation which was ended during the Second World War. While both countries embrace populations of very different racial origins, the mix of races is obviously quite different. So is religion, Coptic Christianity being dominant in Ethiopia and Islam in Sudan. Separatist tendencies exist in both countries, but for rather different reasons.

It is perhaps in landscape where the differences are greatest: Ethiopia being predominantly mountainous whereas the Sudan is characterised by great sweeps of plain. Both the sheer scale and the different nature of the terrain make surface communications difficult and expensive. The main legacy of the Italian occupation of Ethiopia has been the network of permanent highways, still the basis of surface transport in a country of extravagantly rugged topography. Surface communications in much of Sudan, though technically easier to construct, still rely to a large extent on seasonally graded dirt roads or completely unmade desert tracks: reflections of the large distances and enormous costs that would be involved in constructing permanent ways to link small and scattered communities. Communication difficulties and the sheer remoteness of many rural areas are central to the problems of rural development in both countries.


Lake Nuba
Red Sea
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Marra
Project
SUDAN
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El Obeid
TIGRAI
Blue Nile
Nyala
Savanna
Project
Rahr el Arab
Malakal
ETHIOPIA
ADDIS ABABA
S.D.L.U.P.S.
White Nile
Omo
Shibeli
Bomu
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Turkana
0 kilometres 600
0 miles 400

The Sudan

I first visited the Sudan in 1956, and spent considerable time there over the following 20 years. If one omits the desert north, where little development is possible except by small-scale irrigation development along the Nile, and (for present purposes) the extreme south, which has been in partial or total insurrection for much of the period since independence, the key zone of the Sudan, in the rural development context, is the great central savanna belt stretching from the Ethiopian border to the western frontier of the country and of course forming part of the Sahel zone continuing westwards across the African continent. Until relatively recently rural, or agricultural, development in the Sudan concentrated almost wholly on the eastern part of this central zone and particularly on the great clay plains of the Blue Nile. The first really major development on these clay lands was the Gezira scheme built in the 1920's primarily to grow cotton for export. Many small irrigation schemes, many of them private sector enterprises, developed also: mostly along the White Nile. The construction of the Roseires Dam on the Blue Nile, well upstream of the Gezira and relatively close to the Ethiopian border, opened up the possibility of greatly expanded irrigation development as well as hydro-power. The first major scheme to benefit from the additional control of the river exercised by Roseires was the Rahad Project, on the other side of the river from the Gezira, which came into full operation in 1978.

Gezira

Much has been said and written about the Gezira and the successive development of irrigation on the Blue Nile clay plains.[1] The original scheme, specifically orientated towards export cotton (and cotton as a source of foreign exchange is still critically important to Sudan) was designed on an extensive (low intensity) crop rotation operated by tenant farmers under tightly controlled conditions and efficient overall management. Tenants had some freedom to grow other crops, including food crops but the emphasis was very clearly on cotton. There were sound technical reasons for designing a low cropping intensity scheme: the clay soils are difficult to manage and have virtually no internal drainage when wet. The scheme had no formal drainage network for this reason and could manage without one provided the rotation was such that the land dried out thoroughly (producing deep cracks) between crops. Salt build-up was not feared (and did not occur) because the Blue Nile water is exceptionally free of dissolved salts. Over the last two decades or so there has

[1] Most notably the work of Tothill (1948), Gaitskell (1959), and Barnett (1977).

been considerable pressure to 'fill-in' the low intensity cropping pattern and wheat has become a second crop of almost as great an importance as cotton. This intensification has not been without its problems, but has probably worked better than many people, including myself, originally expected.

Overall management, however, has not always maintained the original high standards, and cotton yields remained static or (at least in the 60's and early 70's) actually declined. One rather interesting social result of the scheme is that the tenant farmers (especially the original Gezira tenants or their successors) have become a relatively wealthy rural group and wield considerable political influence.

The priority given to development of irrigation on the eastern clay plains did mean that relatively little attention was given to rural development elsewhere.[2] Irrigation development has come in for some criticism on this score. One line of criticism, for example, suggested that money had been wasted on expensive low-intensity irrigation when it should have been used to halt the 'desertification' of the northern parts or the Savannah belt. Such criticism was, to my mind, seriously flawed and based on a very poor understanding of what was going on, or indeed could be done, in central Sudan. The spread of desertification especially, at that time, in northern Kordofan, was largely the result of increasing pressure on soil and vegetation by people and their livestock. Such pressure could not be relieved unless people could be persuaded to move away from these increasingly destabilized and impoverished areas: further development of irrigation on the clay plains could provide economic opportunities for such people. In addition, the whole thrust of new irrigation at that time was aimed at intensification of cropping, not the reverse. What was needed was to look at irrigation and measures to combat desertification as linked or complementary activities.

The Savanna Zone

Nevertheless, a serious look at rural development in the Savanna zone was overdue. At the height of the oil boom, extravagant claims had been made, usually by people who had never been there, about the untapped agricultural resources of Sudan's savannas, the 'future bread-basket of the Arab world'. Outside the clay plains, which remained largely uninhabited because the soils are so difficult to cultivate (virtually impossible by hand tools), a combination

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[2] The exception, at least during the Anglo-Egyptian Condominium, was in Equatoria in the extreme south, where a lot of valuable research and development was initiated.

of nomadic pastoralist, sedentary farming (on lighter soils) and occupations such as the collection of gum arabic formed the main economic activities. Rainfall was not over-generous and was very seasonal: in the range 200-800 mm. All traditional agricultural or grazing activities were (with one exception I will describe later) wholly extractive and a steady build-up of both human and livestock populations was resulting in a general degradation of the resource base. Recent droughts had accelerated this process. Except for a few areas where the lack of any water, or soils too difficult to cultivate by hand, prevented settlement, almost none of this huge central and western savanna belt could be described as virgin or untapped. Most of it needed regeneration, some of it urgently.

The first study in the savanna zone, in the extreme west, was commissioned in 1957 (Lebon and Robertson 1961). This was not, in fact, conceived initially as a savanna development project but as an irrigation scheme, sponsored by the then all-powerful irrigation department and based on the fact that a high mountain in the west, the Jebel Marra in Darfur Province, enjoyed a locally high rainfall and generated substantial surface water flows, some of them perennial. Hunting Technical Services (HTS) were commissioned to undertake a six-month reconnaissance study of irrigation potential during the winter of 1957-58, under my leadership. It turned out to be one of the most interesting experiences in my life. We had a huge area to cover, some 25,000 square kilometres, with poor tracks and some rough terrain (see map, p.60). We had new aerial photographs and a helicopter, which proved invaluable; although the logistics of supply were fairly horrendous. The area was inhabited by a negroid people (the Fur, who have given their name to the Province, Darfur) who are farmers: but in the dry season, nomadic cattle owners (of various Arab-descended tribes, loosely known as the Baggara) move in and through it. This seasonal mixing of two totally different peoples has led to the exceptional system of land use mentioned earlier. Most of the land farmed by the Fur, except on the Jebel Marra itself, was on the alluvial terraces bordering the seasonal rivers, especially the largest, the Wadi Azum. These terraces support an open woodland of large acacias (*Acacia albida*) which are leafless in the wet season, bearing fruit and leaves in the dry season, the reverse of most trees in the area. The Fur therefore grow crops of sorghum, bulrush millet, chillies etc. amongst the trees which, being leafless in the wet season, do not impede growth. In the dry season, the Baggara move in with their cattle, grazing the crop residues and acacia fruit under trees now comfortably shady. The cattle, of course, also provide manure for the next season's crops. The system seemed to work with very little friction, though I believe that has not been the case in very dry periods such as have been experienced recently.

The overall conclusion of the initial study was that the potential for development was essentially small-scale, rather than any kind of 'second Gezira' which had clearly been in the minds of some of the promoters of the study. Nevertheless, what could be done would significantly improve life for the people in a very remote area, and perhaps also provide surplus food for the drier areas to the north and east. A wide range of new crops including fruits could be introduced. However, the export of produce (even to Khartoum), with the possible exception of tobacco, was not seen as feasible because of the difficulties of transport.

Further Studies

It was hoped that we would be asked to undertake further work leading to actual development, but after some delay it was decided to call in UNDP, who appointed a team from FAO. There were again inflated ideas about what could be done, but little was achieved except for some useful basic resource surveys. A particularly sad experience was the commissioning of construction of a 10,000 ha. irrigation project: a scheme which, after seven years operation and an expenditure of over three million pounds, was limited to fifty ha. in three 'service centres', with no farmers being supplied with water at all. The scheme has since been dropped altogether, one of its consequences being the destruction of large numbers of the big acacias I have just described.

Sense began to emerge again with the commissioning of a new study of agricultural development in the Jebel Marra in 1977, on which was based the first Rural Development Project, reported on in 1979 (Wilson 1979). With EEC funds, this project then got under way, and continues at the present time. The aim of the project this time was altogether more modest but a great deal more relevant: to improve the agricultural production in the area by provision of a basic road network and an effective agricultural extention service backed by an adaptive research programme. By this time development programmes for southern Darfur were just moving out of the planning stage, with a new Development Corporation, the Western Savanna Development Corporation (WSDC) being based in Nyala. The Jebel Marra project was initially set up as an autonomous unit within WSDC, with its own project Manager and expatriate staff; although the ultimate intention was and is full amalgamation with WSDC. As now organised the Jebel Marra project embraces four main operational divisions (Agricultural Services, Engineering Services, Community Development and Monitoring and Evaluation). Agricultural Services, the largest of these, covers agriculture as such (direct crop trials, extension, pest and disease control etc), adaptive research, horticulture, forestry and credit and marketing. Substantial numbers of extension staff have been trained and

contact with local farmers has been enormously expanded, via extension areas numbering 52 by the end of 1985. Recent experience has of course included the severe drought years of 1982-1984 and the effect of those years have been very serious in terms of loss of vegetation and soil deterioration. As a recent report puts it, 'the Jebel Marra is no longer the green jewel that captured the imagination of the agricultural planners only thirty years ago'. Nevertheless, owing to what is now being done, the area is in better shape to withstand the rather lower average rainfall which all local records seem to indicate.[3]

One interesting footnote is that, in 1985, the project collected 32,000 sacks of millet and sorghum under the EEC grain purchasing schemes, for shipment to drier areas in food-short Northern Darfur.

During the 1960's another and quite different activity was initiated in the savanna belt. This was large-scale mechanised crop production on the clay plains. Large areas of unsettled land were available and production of rain-fed food crops seemed feasible. The development was sponsored by the World Bank and, initially at least, enthusiastically supported by the Government in Khartoum, since surplus grain for export could be envisaged as well as enhancing local production. The concept was however, in my opinion, seriously flawed in that there was no real attempt to establish permanent viable production systems of cropping. As a result short-term opportunists moved in, using equipment supplied by international funds, without any obligation to maintain the land in production. A lot of sorghum and sesame was in the early years produced, no doubt some quick profits were also made, but the operation was almost wholly extractive. A flight over the area in the 1970's showed hardly a sign of any crop and cleared land being recolonised by grasses and scrub. A large area of mature acacia savanna (*Acacia seyal* in this case) had been destroyed without any permanent development replacing it.

Southern Darfur

I have already mentioned the Western Savanna Development Corporation. Rural development in Southern Darfur was initiated in 1972-1973, when HTS undertook the first study (Wilson, 1979). This covered an area of 92,000 square kilometres starting immediately south of the town of Nyala to the Bar-el Ghazal in the south, and reaching to the border with Kordofan Province in the east (see map p.60). This is a zone with rainfall between 400-800mm,

[3] Nyala records show mean rainfall over the period 1920-1985 as 462 mm, for the ten years 1975-1985 it was 350 mm, with only 198 mm in 1984. El Fasher, with records since 1916, demonstrates a similar trend.

mainly on basement complex rocks (and therefore generally thin and stony soils) but with large areas of sandy 'goz' and some alluvium along the Wadi systems. The soils cropped were mainly the sandy ones (some 400,000 ha. at the time) and there were large numbers of livestock (about 2 million cattle and numbers of smaller stock and camels) owned by nomadic pastoralists. Except for one large area of goz in the south west, where there was no surface water, the whole system was under pressure from increasing numbers of people and livestock (a pressure, incidentally, vastly increased during the recent drought by incursion of people from further north, and from neighbouring countries to the west). Positive development was not possible without arresting and reversing long-term degradation. Some spontaneous settlement of nomadic pastoralists was taking place, but as they kept their cattle with them for much of the time, local devastation of vegetation was becoming acute. A number of approaches were formulated, including resettlement of people from worked-out alluvium on to the unused goz areas (which necessitated a water development programme also), mixed farming projects in better alluvial areas, flood irrigation schemes, a range management programme, and the setting up of nucleus development centres to provide extension advice and to undertake adaptive research.

There is not time to go into the complex history of the project which followed. It must suffice to say that the problems encountered in setting up a programme of this kind in a remote area with almost no existing infrastructure and services (and involving a new Development Authority), with several aid donors and Government departments with conflicting views, was severely under-estimated. Indeed, had it not been for the flexibility and understanding shown by the Overseas Development Administration (ODA), there might have been a gap of several years when nothing happened at all. To get something moving, ODA commissioned a Southern Darfur Development Project, which was to set up and operate three Development Centres and an agricultural machinery workshop, as an interim measure until the overall Development Authority could be established. With this exception, what had been envisaged from the start as a largely field project became one of developing the necessary infrastructure.

The project has now made considerable progress, with the WSDC firmly in being, and the whole strategy backed by an indicative plan for land-use produced in 1986.

Ethiopia

Now, finally, to move to Ethiopia. I first went there in 1958, and have travelled fairly extensively around the country. But I really want to talk about one project only, a rural development project in Tigrai Province. This is an area terribly hit by the recent droughts: it had also suffered in the early 1970's, and it was to attempt to relieve the situation there that ODA commissioned a study at that time. Its initial object was to improve water supplies, but the most interesting thing about it was that it was not intended to be simply a planning exercise but an operation which would lead directly and immediately to action on the ground. We were given six months to appraise the situation, starting in June 1974, following which an integrated development plan covering more than 12,000 square kilometres in central Tigrai was to be worked up. This would cover a broad perspective programme for a ten year period, and an action programme for the first five years, with specific projects being started as soon as possible.

The initial appraisal fairly rapidly moved the focus of the study from water resource development per se to improved land and water use: a soil and water conservation programme being at the heart of the new approach.

To understand why this approach was adopted, it is necessary to appreciate the physical situation of central Tigrai. The bulk of the area consists of a high, rolling limestone plateau, mostly between 2,000 and 3,000 metres above sea level. A small area of land, at a lower elevation on the edge of the Rift Valley was also included. Rainfall falls mostly in a short 2-2.5 month period, (July-September) and increases from east to west – only 200-400 mm in the Eastern Lowlands, 500-600 mm on the eastern part of the plateau rising to as much as 1,000 mm in the extreme south west. In the extreme south , there is a secondary rainy season (March-May), but the bulk of the plateau area, the main focus of the project, has only the one short rains.

This upland landscape was cultivated wherever soils permit, almost regardless of slope. Increasing pressure of population had extended cultivation more and more into unsuitable land, initiating a new cycle of erosion and damage to better land by surface floods and soil wash from steeper lands being brought in cultivation without safeguards: terracing is not traditional in central Tigrai. Furthermore, much of the limited rainfall runs off before the soils become amenable to local methods of cultivation. Rivers originating at the higher altitudes tend to occupy deeply cut gorges by the time they carry substantial flows, so that raising water back on to the plateau for irrigation was not feasible. The limited surface water resources available were already being

exploited. Groundwater of good quality was available, but with one or two exceptions in insufficient quantity to provide more than domestic water supplies. On the remaining uncultivated land, natural vegetation was being destroyed by excessive grazing and cutting for fuelwood, increasing the problems of rainfall run-off and flooding. Land tenure was complex, land being allocated by each village essentially on residence or family qualifications, with the result that individual holdings were small (average 2.2 ha) and often fragmented. There were no large landowners, as in other parts of Ethiopia at that time.

For farmers living under what, even in years of good rainfall, were not easy conditions (a 2 or 2.5 month rainy season is not long), their apparent lack of appreciation of the need for soil and water conservation was somewhat surprising. Considerable discussion with farmers about their needs and aspirations never once elicited a wish to save or improve the land they already cultivated, even when the signs of loss or damage were so clear. They all wanted more land and more cattle: only when the idea of conservation was put to them did the need for it (and the benefits to themselves) seem to register.

Projects

In 1975 HTS established the first model catchment for soil and water conservation, establishing simple hand dug contour banks on the cultivated land, and stone check walls at the bases of steeper uncultivated slopes to minimise run-off and so protect the farmers' fields from erosion. Local young people were recruited and trained to lay out these simple works, all of which could easily be constructed either by the farmers themselves or locally hired labour because the Tigraians are good stonemasons. Results, after the first rains, were quite dramatic and the farmers were delighted. All seemed set for the rapid expansion of this basic work.

At the same time we instituted a first livestock management project, again based on and supported by the people of one village, in an attempt to show how degradation of the remaining natural vegetation could be halted. This was called the Quiha Catchment Stabilization Project, and again received enthusiastic co-operation by the locals when they appreciated what it was all about.

Other enterprises initiated were the improvement of existing surface irrigation in one of the villages, a hand-dug well project for growing irrigated vegetables, and a deep groundwater drilling programme. Many other enterprises and programmes were planned, based on division of the whole

project area into 14 Rural Development Units, coordinated by a Regional Development Organisation under the Provincial Chief Administrator at Makalle, capital of the Province and in the middle of the project area. We had all, at this time, become very enthusiastic about the project. Things were getting done, and the local people were getting involved, some to the extent of themselves initiating work in areas near our original trials and demonstrations. But the country was becoming increasingly unstable, following the removal of the Emperor and the take-over by the predecessors of the present Government. Tigrai was one of the most troubled areas at that time and reluctantly we were forced to withdraw our team: a bitter disappointment, since we really felt we were achieving something, but feeling that our departure at this point was certainly too soon for the things we had started to become self-generating. A sad end to what could have become something of a success story.

Conclusion

The projects and endeavours I have tried to describe concern a huge sector of third-world agriculture, subsistence farming systems coming under stress and in some cases breaking down under pressure of increased population, which has until relatively recently been to a great extent neglected (or wrongly approached) both by Governments and aid agencies. It is of course easy to see why other kinds of development have had priority: the problems of areas like the Sudanese savannas and the highlands of Tigrai are difficult to solve and progress is slow to bring about. In conventional economic terms, it is difficult to justify substantial investment in such areas. Yet this whole area of agricultural development is of the greatest importance, and I believe it can be tackled. It is of course fashionable these days to say that only the local people know what they want, and to pour scorn on 'outside' consultants who try to impose unworkable solutions. If I have learned anything over the last 30 years, it is to appreciate the difficulties of people struggling to survive in impoverished conditions, and the importance of gaining a thorough understanding of their motivation and aspirations. But I don't go along with the view that only these local people know what is best for them: their horizons may be so limited that they simply cannot comprehend what could be done to help them. What is needed is an approach that combines the closest rapport with, and involvement of, small farmers with an organisation which can provide the physical, administrative and financial infrastructure to feed in what they need. External help can do this, provided the basic concept, the will, and the dedication are there.

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SOME COMMENTS ON THE ECONOMICS OF DRYLAND DEGRADATION AND REHABILITATION

A.T.Grove

Introduction

Attempts have been made to quantify the costs of dryland degradation in relation to the costs of conservation and rehabilitation. According to the United Nations Environment Programme (UNEP), the cost of desertification throughout the world in the 1970s, through loss of production, was 26 billion US dollars annually of which 12 billion was in developing countries. The 1977 United Nations Conference On Desertification (UNCOD) drew up a Plan of Action to combat Desertification. This plan, though mainly presented in physical and ecological terms, estimated that action to combat desertification would cost 4.5 billion US dollars per year over 20 years, 2.4 billion US dollars per year of this being needed for work in developing countries.

Although a Special Fund was established to supply finance, contributions to it were negligible. At the same time, bilateral and multilateral donor agencies provided several hundreds of millions of dollars for desertification control in the developing world between 1978 and 1983. Of the total, 90 per cent was spent on planning and coordination, infrastructure and public awareness; only 10 per cent went towards operations in the field.

From a questionnaire survey made by UNEP in 1983, it was concluded that the desertified area of the world was extending rapidly. Dr Tolba, Director of UNEP felt that insufficient attention had been paid to economics at the United Nations Conference on Desertification in Nairobi and in the 'Plan of Action'. He asked the Australian government to take a hand in helping to explore the costs of degradation and the benefits of rehabilitation in an effort to convince governments of the need for action. This was a wise move because the Australians have a lot of desert experience and they have been developing quite sophisticated methods of costing dryland degradation and rehabilitation (Dumsday *et al.* 1983, Peck *et al.* 1983, Thomas *et al.* 1985).

At about the same time, the East-West Centre in Hawaii, which involves Australians as well as Americans and East Asians, was developing methods in the environmental economics of watershed management, especially in relation to south-east Asia, and was interested in applying these methods to dryland

degradation (Hufschmidt *et al.* 1983). The outcome was an international conference, held in Canberra in March 1986, to work out executive guides for policy makers and technical guides for those concerned with putting the policies into effect and to provide a set of case studies. These guides and case studies were elaborated over the next few months and there were further meetings in New Delhi, Beijing and finally, in January 1987, in Nairobi.

The development arm of the EEC, Directorate General 8 in Brussels, has also been taking a considerable interest in desertification, especially in the Sahel. A report published in January 1986, *Conservation of Natural Resources – Countering Desertification in Africa*, notes that operations against desertification must be on a scale sufficiently large to reach a minimum threshold; it refers to 'a critical mass', with 'clustering of projects' if they are to be effective. At the same time it advocates some degree of decentralisation by making local groups responsible for administering such schemes, with local financial responsibility and the involvement of Non-Governmental Organisations (NGOs) rather than central governments as executive agents.

A 1984 estimate quoted in the EEC document as the global budget required for anti-desertification measures in 21 African dryland countries is 26 billion ECUs (say 30 billion US dollars) over five years - though it adds that 'it is difficult if not impossible at this stage to give detailed estimates of the amount of money that will be required'. With such large sums at stake there would seem to be good reasons for environmentalists to think in economic and monetary terms, to assist in costing degradation, the measures to prevent it, and of rehabilitating degraded land.

Environmental economists who specialise in these matters usually adopt a social welfare type of approach; their analyses are intended to assist in the allocation of scarce resources by individuals and institutions to the benefit of the society as a whole. What are the problems presented by dryland degradation in such analyses?

Nature of desertification and the resource changes which have to be costed

It is generally accepted that desertification involves changes in the quantity and quality of resources, notably soil, vegetation and water, resulting in a decrease in their value to the people living in the areas concerned. Conservation involves attempting to preserve, rehabilitate, restore and increase the value of those resources.

1. SOILS are degraded by water and wind action
   a. soil material, especially organic matter, is removed and either broken down or deposited where it is not wanted
   b. nutrients are removed and become deficient
   c. soils may become more saline or alkaline

2. PLANT COVER is changed and reduced
   a. pastures deteriorate with reduced carrying capacity for livestock
   b. woody cover deteriorates reducing its value for browsing and fuel
   c. sylvan products such as honey and gum arabic become scarce

3. WATER, especially groundwater, changes in availability and quality with:
   a. falling water tables and greater extraction costs
   b. increased salinity
   c. increased turbidity

Some economic assumptions

Environmentalists recognise that, as a result of human use of soil, plant and water resources, ecological changes are inevitable.

Some biological degradation is necessarily involved in using the land for agricultural purposes; organic topsoils waste away, plant diversity is reduced, and wildlife is restricted. But most environmentalists would look towards the establishment of some kind of equilibrium allowing production to be sustained over the long term.

Economists see soils, plants and water resources as mineable; they are inclined to think in terms of an optimal rate of degradation for the society involved. With their primary aim being the maximisation of community welfare, they would see some environmental degradation as being consistent with optimal use of resources; (equally, environmental enhancement might be seen as optimal). Several years ago, Bauer and Yamey (1957) in quite a well-known textbook argued that under-developed countries might have to accept soil erosion as one of the costs involved in building up their economies.

Clearly a community would not necessarily be better off if action were taken to rehabilitate or repair areas where damage has been done in the past. Previous degradation, it can be argued, is a sunk cost. If repairing degraded land is under consideration, then the discounted benefits must be compared

with the costs.

Discounting

Discounting is the process of determining the present value of benefits to be received in the future. If the benefits are great and appear rapidly, and if interest rates on the money used to procure them are low, then rehabilitation may well be worthwhile. But in dryland environments, rehabilitation is slow; it often involves planting trees which take many years to mature, in view of the nature of climatic variability in drylands, progress is unpredictable. What discount rates should be adopted in making an economic assessment of worthwhileness – market rates or special low rates? Subsistence farmers, it has been calculated, seem effectively to use rates of return of 20 or 30 per cent, so the individual and the local community will be unwilling to carry short-term costs for long-term benefits. Money has to be attracted from outside sources.

The same kind of argument applies in connection with the use of conservation practices. The economic notion is to maximise the net present discounted value of activities. Conservation practices and reservation of land with the intention of maintaining existing resource stocks entail increased costs in time and money and land. Effectively, such measures of conservation and reservation redistribute resource use from the present to the future. It can be argued that such measures should be employed only to prevent current land degradation rates exceeding the optimal level. But the optimal level of land degradation depends on many factors affecting the future of the resources involved and the uses to which they might be put. Such factors include prices of inputs and outputs, consumer tastes, technical change. None of these are predictable for even a few years ahead.

Procedure: a sequence in the economic assessment of dryland degradation and rehabilitiation

Policies and policy decisions with regard to dryland degradation and rehabilitation must take some account of the economics of the situation. Such decisions, it can reasonably be argued, should take into account the benefits, the discounted benefits that may be expected, in relation to costs as heavy as those mentioned earlier. Thus values must be placed on the changes in resources resulting from the policies followed and the expenditure involved. The changes or the rate of change in resource quality and quantity involved

must therefore be measured in some way in the area or in relation to the problem that has been identified. Thus, in dealing with the economics of dryland degradation, Dixon (1986) follows a sequence considering in turn a) identification, b) quantification, c) valuation and d) evaluation.

a. Identification

One of the main problems in assessing the costs of degradation is involved in identifying it – measuring degradation physically, for instance distinguishing between the effects of drought (rainfall deficiency) and human-made causes of desertification in dryland areas like the Sahel, especially in the case of changes in plant cover and water availability.

Rates of soil erosion are not easily measured. Plots are costly to run and supervise, and extrapolation over time and space is not easy. Gully erosion takes place rapidly in short intervals of time. Calculations of rates of sheet erosion can be made from the 'Universal Soil Loss Equation', but they are of doubtful value. Many gullies in the Sahel-Sudan zone are complex features, originally cut in ancient times, in some cases when woodland was cleared for making charcoal used in iron smelting. Studies of sedimentation in closed basins may help to throw some light on the history of rates of erosion, but such studies are in their infancy.

Relationships between vegetation cover and runoff are complex. In the EEC report mentioned earlier, special attention was drawn to the importance of the 'reservoir' areas, the catchments of the Senegal and Niger headwaters in the Fouta Djallon, for example, and the need to safeguard them.

b. Quantification

Because of the large areas involved, remote sensing methods would seem to be appropriate. Careful ground surveys are needed if imagery is to be interpreted with the required degree of accuracy. The earliest air photographs were Trimetrigon pictures taken by the Americans about 1944, but they are not easily obtained. The more accessible cover dates from about 1948 to 1955 but much of that has been destroyed or seems to be inaccessible.

Considerable problems arise when attempts are made to distinguish change by comparison of the early air photographs with current photography or satellite imagery. Nearly always there are problems of compatibility, calibration and ground truthing, especially in arranging for the collection of ground data at the same time as the remote sensing is done. Costs of survey

and monitoring are high but might perhaps be kept down by using local university and other relatively low cost sources of labour, and possibly by the use of micro-light aircraft for 'down-market remote sensing'.

c. Valuation

The value of soil, vegetation cover and water resources depends very much on exactly where they are in relation to the users or potential users. This is of special importance in areas like the Sahel where the users, villagers for the most part, have no means of transport but a donkey or their own two feet. Some soil or water resources are of no use, and thus of no economic value, unless a water source is nearby; similarly, a well is of little value if there is no grazing in the vicinity. Should resource change valuation be based on the assumption that there will be some redistribution of population in the future to accord with opportunities provided by the resources, or should the valuation depend on the present population distribution?

The valuation of crops or livestock is always difficult in part-subsistent communities where only a proportion of the product comes onto the market. Furthermore, market prices vary markedly from season to season and year to year, as well as with inflation.

There is a general tendency for the private land user or individual irrigation project to profit at the expense of the larger community. In the drylands there are some circumstances which make this especially important. Very often, the use of extensive areas of woodland and grassland is dependent on the availability of resources in restricted areas. A case in point is the use of extensive grazing areas in the rainy season and succeeding months being dependent on the availability of quite limited areas of dry season grazing, watered by rivers, as in the Inland Niger Delta, or by lakes as in the case of Lake Chad. In other words, boundary conditions of projects or economic assessment areas must be carefully considered.

With special regard to land degradation in drylands, account also has to be taken of some special externalities which are difficult to quantify but in general indicate that costs of desertification are greater than might at first be thought, and the possible benefits of rehabilitation greater.

The costs of soil erosion are not felt only by the user of the eroding land. The increased sediment load of rivers causes clogging of stream channels, flooding of bottomland, and high costs for bridge construction and repair. In Morocco, erosion in the Atlas mountains provides sediment that is blown by

the wind into mobile dunes that threaten valuable oases. There is also the danger of reservoir siltation. The catchment areas of reservoirs intended for irrigation and other purposes have to be large in drylands; if sediment yields per unit area are high, naturally or as a result of accelerated erosion, reservoirs may fill with sediment within a decade or two; Khashm el Girba on the Atbara in Sudan is an outstanding example. Once they are silted, alternative sites are rarely available. The value of the benefits should be taken into account when soil conservation measures are contemplated, and the cost of the damage avoided should also be considered.

One of the current features of the Sahel is the greater frequency of extensive dust storms and dust clouds than in the past. The occurrence of such dust seems to be associated with drought as much as by land use. The dustiness is not confined to the dry season but satellite imagery shows that it is also common at the height of the rainy season. Photographs of cumulus clouds taken from the Space Shuttle strongly suggest that the dust inhibits vertical cloud development and may well be effective in reducing rainfall in the region. At the same time the imagery indicates that the dust sources are relatively restricted. In assessing the worthwhileness of treatment of wind erosion such considerations have to be borne in mind – could one attempt to quantify the economic benefits derived from dust suppression and consequent increased rainfall? It is doubtful whether any meteorologist would be prepared to attempt any such calculation at present.

In Australia, clearing of woodland has been shown to result in rising watertables, increased soil salinity and increased salt content of streams draining the cleared areas – in other words, costs of land degradation extend well outside the cleared area. In the Sahel-Sudan, there is evidence to indicate that rising water tables are the outcome of tree clearing but in this region, so far as I know, the side effects are economically beneficial; in the 1950s they allowed irrigation to take place in valley bottoms where the water table had formerly been too deep.

d. Evaluation

This involves the comparison of different project options and different policy options not only related to land degradation but to policy in other fields.

With regards to projects in particular areas it may turn out that none of them is economically viable – in the sense that the costs outweight the discounted benefits every time. This does not mean that nothing will or should be done:

a. In famine situations money is made available and it has to be spent.

b. Consideration has to be given to the question of what losses will be suffered if no action is taken to combat land degradation. In some cases the result could be a reduction of productivity levels below those needed for continued sustenance of a community. The costs of resettlement then have to be taken into account. Some attempt has also to be made to consider the cost of human misery and social disorder. This projects us into the centre of the political field.

c. It is the job of economic analysts of dryland degradation and other environmental situations to organise information so as to provide structured arguments that will allow political decision makers to choose between the various options open to them – so as to maximise benefits to the community in relation to costs and to allocate the costs and benefits equitably between communities and between members of such communities.

d. Evaluation also involves looking at the conservation or rehabilitation policies being considered in relation to other policies, such as resettlement or villagisation policies, to visualise how they will interact at different levels. At the micro-scale, how will they affect the individual farmer or project. At the national or international level, how far are conservation and rehabilitation policies compatible with other policies relating to population, commodity pricing (not only crops but also fertilisers and petroleum), and with regional development policies.

One can see that if large sums of the kind I have mentioned are directed by international agencies into projects designed to combat desertification and land degradation, distortions will follow. The returns from investments in deteriorating drylands are likely to be lower than those from humid lands. Spending in the drylands may retain people who would otherwise have emigrated from them or may even attract people from naturally better favoured areas. It is possible that in attempting to prevent famine and desertification, international assistance may cause deep-seated problems to persist.

Can economic analysis and evaluation help in these matters? I think that it probably can. The methodology of the approach may justify its adoption even if the numerical outcome does not. But economic evaluation is not the only or main criterion involved in decision making. It can reasonably be argued that socio-political objectives must have priority.

The data requirements are very heavy. Data in a form immediately suitable for processing by environmental economists are scarce. Perhaps one of the main results of greater attention being paid to the economics of degradation will be changes in the ways in which environmental information is gathered and presented.

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Appendix 1

Seminar Committee Members 1985/7

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Robin Pellew	Conservation Monitoring Unit, IUCN
John Scherlis	Department of Zoology, University of Cambridge
Janet Seeley	African Studies Centre, University of Cambridge

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