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Ministry of Juba Valley Development

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DEVELOPMENT OF THE JUBA VALLEY

PRESENT SITUATION, POTENTIAL, PLANNING

Project : Advisory Assistance to the Ministry of Juba Valley Development

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Foreword and Acknowledgement

This report presents in a summary form an inventory of information on the Juba Valley development. It describes the main features of the present situation, potential and constraints and the development prospects of the region. The information has been collected under the terms of the Project "Advisory Assistance to the Ministry of Juba Valley Development - Phase I", a technical aid project financed by the Government of the Federal Republic of Germany since September 1981. It reflects results of various studies carried out since the mid sixties by a series of different donors and study groups. The Project Team itself has during the last two years added to the efforts for studying and planning the future development of the Juba Valley which constitutes the most promising potential in Somalia in various sectors, mainly those of agriculture and energy.

The data basis achieved by the end of 1984 is not yet complete. Supplementary data collection and analysis programmes are either underway or in their preparatory phases. It is for this reason that the report concentrates on those fields where extended research work has already been carried out: agriculture, hydrology infrastructure and services. It is the firm intention of the Ministry of Juba Valley Development to complete data collection during the next four years and with the assistance of the Project Team, elaborate a masterplan for the Juba Valley which would then coordinate all efforts to develop the south of the country in an effective and integrated way.

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The Team would like to express its gratitude to all those persons who have collaborated in a helpful and effective way as colleagues, first of all H.E. The Minister of Juba Valley Development, Dr. Ahmed Habib Ahmed, also the Director of the Department of Planning, Mr. Aweys Hadj Yusuf and other staff members.

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1. Introduction

1.1 The Importance of the Juba Valley in the National Context

1.1.1 Delineation of the Juba Valley Region

Three different ways of defining the Juba Valley are possible:

- The Juba catchment area: the main catchment area for the Juba waters lies in Ethiopia. Three major affluxes join at the Somalian border near Dolow, from which point the Juba runs for over 700 kilometers in north-south direction to the Indian Ocean discharging near the township of Kismayo. It is not easy to delimit the valley part of the Juba basin, since there are no mountain ranges forming a clear-cut watershed. The catchment area in Somalia ranges in the north from the Ethiopian border to the Indian Ocean in the south. In the west, the Kenyan border may be considered as the limit. In the east most of the surface water of the inter-riverine area discharges in southern direction into the Shebelli. When stream flows and rainfall are extremely high, the waters of the Juba become mixed with those of the Shebelli in the triangle between Fanoole, Kamsuma and Haway. A line between Dinsoor, Yak Barawe and Homboy may approximately delineate the eastern border of the Juba basin. This area measures some 140,000 sq.km, thus covering roughly 22 per cent of the Somali territory.

- Political-administrative borders: the Juba Valley comprises three entire administrative regions: Lower Juba, Middle Juba and Gedo. Parts of the catchment area fall into the administrative regions of Bay and Bakool.

- Core development area: considering irrigated agriculture as the main sector for development, the area of major interest for planning purposes is a relatively narrow strip following the river on both sides from the envisaged dam site at Marcable, some 40 kilometers north of Bardheere, down to Goob Weyn close to the river mouth, some 20 kilometers north of Kismayo. Although the Technital Study (Ref. 3) identifies possible irrigation perimeters between Luuq and Dolow as well as between Fanoole and Afmadow, more recent planning considers only those areas which can be irrigated directly from the Juba. Without any doubt, the main potential for further development is in the area close to the river. The main settlements and infrastructure are and will in the future be concentrated here too.

Since the planned reservoir will have distinct effects on land use, settlement development and economy up to Luuq, this area must be considered to be of major interest in addition to the Kismayo area which, due to its outstanding economic importance as the biggest agglomeration of population, is the main central town in the region. Thus, the core development area covers roughly 30,000 sq.km i.e. 22 per cent of the catchment area and about 5 per cent of the national territory.

Further planning will certainly concentrate on the potential of the core area. Nevertheless, the rest of the region cannot be neglected because it will in some way be influenced by the development measures to be taken.

First of all there are the vast rangelands between the Juba and the Kenyan border and in the inter-riverine area east of the Juba. According to estimates of the Ministry of Livestock, 30 per cent of the national livestock population (expressed in animal units) are living on the Trans-Juba Rangelands, thus livestock holding is still the most important economic sector in the region. It therefore has to be considered in future planning as a potential as far as inter-sectoral influences are concerned.

Another sector which is only marginally represented in the core development area, but plays an important role in the inter-riverine area is rainfed agriculture. It is not yet exactly known how many people are occupied in this sector and what its quantitative importance is, but it is estimated that at present about half of the agricultural lands of the Juba Valley are cultivated under rainfed conditions (Ref. 10 p. 27), i.e. roughly 35,000 hectares with a marked concentration in the Districts of Saakow and Bardheere. Certainly this sector also represents a potential for future development and it will on the other hand be directly or indirectly influenced by the development in the core area.

A third item to be considered is the environmental and social aspect. If significant development takes place along the river, this area will attract people who at present are living under quite different conditions than they will be in the future. Impacts on the social situation are evident. Moreover, the Juba region constitutes one of the ecologically best preserved parts of the country. The development measures will considerably change the ecological conditions. The foreseeable effects will have to be taken into account in order to protect the environmental resources of the region.

It has been agreed upon to take the administrative borders of the three regions Lower Juba, Middle Juba and Gedo for the delineation of the planning region. Special emphasis will of course have to be placed on the core area along the river between Luuq and Kismayo, where development activities, settlements and infrastructure are presently concentrated and where they will remain concentrated in the future.

1.1.2 Contribution of the Juba Valley to the National Economy

Somalia belongs to the group of least developed countries in Africa. This is reflected not only by a low income per capita, but also by the structure of the national economy.

Historically, nomadic livestock keeping has been the main occupation of the Somalis. Crop production has played a comparatively unimportant role, mainly owing to the climatic conditions. Although a certain amount of change has taken place during the last decades, livestock is still the backbone of Somalia's economy. It is estimated that out of a population of about 5 million inhabitants, 60 per cent belong to the group of nomadic and semi-nomadic livestock keepers. The urban population is estimated to be 20 per cent and another 20 per cent are settled farmers. Thus, the livestock and agriculture sector provides income for approximately 80 per cent of the population and contributes about 50 per cent to the GDP. The livestock sector generates up to 80 per cent of the country's foreign exchange earnings, agriculture adds another 10 per cent.

Both agriculture and nomadic livestock are highly dependent on the unfavourable climatic conditions of the country. Average annual rainfalls range from 200 to 500 mm in the major part which considerably limits the capacity of rangelands and crop production under rainfed conditions. The equilibrium between rainfall and number of livestock becomes seriously disturbed in years with under-average precipitations. Periodical droughts which have devastating effects on the livestock belong to the reality of nomadic life. The same holds true for rainfed farmers who frequently harvest less than they need for their own consumption.

Estimating a population growth rate of 2.7 per cent, the country's population will have nearly doubled by the year 2010. Both of the traditional sectors, livestock

and rainfed agriculture, will not be able to offer occupation for such an increase in work force. The opinions on the capacity of the Somali rangelands are quite contradictory, but there is no doubt that the ecologically tolerable limit of number of animals is already exceeded in several parts of the country, i.e. parts of the rangelands show distinct signs of overgrazing. Therefore a considerable increase in the number of animals will not be possible if long-term ecological balance is to be preserved. For this reason, other sectors will have to offer occupation for the growing surplus of active population.

One of the most severe bottle-necks of the Somali economy is the earning of foreign exchange which is needed, not only for the import of investment goods, fuel oil, construction material and other similar items, but also for the import of basic foodstuffs. The balance of trade shows a serious deficit. In fact, considerable amounts of food imports prove that the country is a long way from being self-sufficient in food production. Increasing energy prices have put additional pressure on the balance of trade, resulting in expenditures of approximately 24 per cent of all official cash imports in 1980.

Taking into consideration these few but essential characteristics of the Somali economy and its natural conditions, it becomes evident that in the future other areas outside of the traditional sectors will have to be developed with the aim of:

- absorbing the population surplus by offering new sources of occupation,
- increasing food production in order to achieve self-sufficiency in basic food supply and thereby relieve the balance of payments,
- contributing to foreign exchange earnings by an increase in exportable products,
- substituting oil-fuelled energy generation by utilization of renewable resources.

After analysis of the development potential of the country, it becomes clear that the most promising sector which is likely to cope with this task is irrigated agriculture. Other sectors, such as manufacturing and services will not develop at the speed required, which would necessitate the use of a major percentage of the future work force surplus. Irrigated agriculture is limited to the south of the country where the only two

perennial rivers, the Shebelli and the Juba, flow. It is estimated that about 160,000 hectares are under controlled and uncontrolled irrigation along the two rivers. Uncontrolled irrigation is practised as flood recession cultivation at the borders of natural flood depressions (desheks) which are filled with water during the high flow seasons. The farmers plant the desheks, following the gradually receding water from the border towards the centre, using the remaining moisture in the ground (for details see Chapter 3.3 and Ref. 19). Nationwide, around 110,000 hectares are more or less intensively cultivated under any form of uncontrolled irrigation. Out of the 50,000 hectares under controlled irrigation in 1980, 38,000 were found in the Shebelli Valley and 12,000 in the Juba Valley. The latter figure was confirmed by MJVD own investigations in 1983 (Ref. 10).

Irrigated agriculture may be limited by two natural factors: soil and water availability. Along the Shebelli, water shortages occur almost every year, especially in the lower reaches of the river. It is estimated that the land potential for irrigated agriculture in the Shebelli Valley amounts to 85,000 hectares. Lack of water storage facilities, almost non-existent water management and a largely deteriorated canal system, resulting in rather low irrigation efficiencies, are limiting the irrigated area. The topography of the Shebelli Valley does not allow the construction of large-scale water storage works which would regulate the greatly varying average annual discharge of approximately 2,000 million cubic meters. This discharge varies greatly from season to season as well as from year to year. Thus, development measures will be restricted to the establishment of a proper water management system and the rehabilitation of the existing intake and canal network.

Whereas water availability is the restricting factor for irrigation development in the Shebelli Valley, the water resources of the Juba river are only being marginally exploited. The largest part by far of the average annual discharge of more than 6,000 million cubic meters flows unused into the Indian Ocean. Nevertheless, development of irrigated agriculture will come to a standstill if no major storage facillties are built. The discharge may vary from almost zero to more than 1,500 cubic meters per second within one year. At the present stage of development (12,000 hectares under controlled irrigation), in two out of five years there is a water deficit during the dry season between January and April, causing in one out of five years severe damage

to the perennial crops (mainly sugar cane and bananas). In 1984 for example, the Lower Sugar Project got only about one third of the required irrigation water during the months from February to April. As a direct result, the yields of the first cutting were exceptionally low.

On the other hand floods occur with the same statistical probability, menacing the crops even more seriously. In 1977 and 1981, the Juba waters inundated large areas, destroying thousands of hectares of crops as well as villages and infrastructure. During the last three years many kilometers of flood bunds have been constructed around banana plantations and the large projects but the cultivation areas are still far from being sufficiently protected against flood hazards. The risk of inundation even increased when the Fanoole diversion weir was completed. The structure, intended to divert water to the Fanoole Rice Scheme and, at some point in the future, to the Homboy Irrigation Scheme, was laid out for a peak flow of 800 cubic meters per second because it was assumed that the Bardheere Dam would be built in time. Discharges exceeding this amount have to be diverted into the old river channel Far Shebelli on the right bank of the Juba, from which position they will inundate the plantations "through the backdoor" as in the year 1981.

Once the Juba is regulated by the construction of a flood detention reservoir there will be enough water available to irrigate the large undeveloped land potential and moreover, to supply the entire south of the country with electricity. Although land and soil surveys have been carried out only for limited areas and not for the entire region, it can be assumed that more land is available for irrigation than can be developed within the next 25 years, taking into account the limited financial resources of the country. The success of irrigated agriculture in the Lower Juba Valley and in deshek and small-scale perimeters in the middle reach confirm the results of former studies which indicate an irrigation potential of up to 220,000 hectares between Bardheere and Yoontoy.

The 12,000 hectares of irrigated land which are at present under cultivation are concentrated in the lower reaches of the Juba, the major parts being cultivated with bananas on medium-scale farms and sugar cane on the 5,000 hectare plantation of the Lower Juba Sugar Project. Banana growing has been carried out with success for several decades, showing an occasional decline as after independence and also after the disastrous flood of 1981 when a good part of the plantation was destroyed. During the last three years it has regained its importance and bananas were contributing

7.2 per cent of the country's export earnings by 1983. Sugar cane production on large-scale plantations was only introduced in 1978 and is showing satisfactory results although restricted inputs, research facilities and water availability have been restraining the yields. Another crop being introduced on large-scale units is wet land rice in the Fanoole Rice Scheme and the Mogambo Irrigation Project. Both sugar and rice are basic food products which Somalia is importing in considerable quantities. Thus, any increase in production will relieve the trade balance.

The supply with basic infrastructure is rather deficient on the national level as well as on the regional level. A survey carried out in 1984 (Ref. 16) showed that social infrastructure (health and education) in the Juba Valley is still below the national standard. The Middle Juba and Gedo Regions between Fanoole and Bardheere in particular are undersupplied, a fact which is mainly due to the lack of all-weather roads. The only existing connection is a bush track which becomes impassable during the rainy seasons, cutting off the towns and villages from the rest of the country. The lack of road infrastructure is the main bottleneck for economic development. Trade is reduced to almost zero during half of the year since road conditions make access for traders' trucks impossible.

On the other hand, the connection between the Juba Valley and the rest of the country, mainly with the Mogadishu area, has improved substantially since the roads Golweyn - Jilib and Awdinly - Bardheere were completed. The first is now completely asphalted and connects the economically most important Lower Juba Region, including the main centre and port of Kismayo, with Mogadishu via Jilib. The second is partly asphalted, partly gravelled, but gives all year round access to Bardheere. Thus, the conditions for an integration of the Juba Valley into the national economy are quite satisfactory but the intra-regional integration is still severely hampered by the lack of an all-weather road parallel to the Juba river between Fanoole and Bardheere.

Another important infrastructural aspect of the Juba Valley is energy. At present, electricity in Somalia is almost entirely produced by oil-fuelled generators. Oil imports are a heavy burden on the trade balance. Although the main towns in the Juba Valley are equipped with diesel generators, electricity consumption is quite low due to the deficient distribution networks, technical problems occurring with the generators and lack of fuel. The Fanoole Project has installed two small hydro-power turbines with a firm capacity of 2.3 MW

each, but due to problems of water availability, power generation is restricted to periods with medium water levels in the Juba. Energy for cooking is gained from the firing of fuel wood which is gradually leading to the deterioration of bush and woodland.

The Bardheere Dam as it has been designed, would allow the installation of a hydropower complex with a capacity of 105 MW, sufficient to cover the energy demand of the entire south of the country until well into the next century, including the Mogadishu area, where up to 80 per cent of the national electricity demand is concentrated.

As a conclusion it can be stated that the Juba Valley is contributing to the national economy in the fields of food production and the earning of foreign currency through livestock and banana exports, but the region is still far from utilizing all its resources. From the point of view of its potential, the Juba Valley could substantially increase its contribution in the fields of:

- production of basic foodstuffs, thereby substituting imports,
- production of exportable agricultural products, thereby earning foreign exchange,
- production of energy, substituting a significant percentage of oil imports,
- processing of agricultural products and by-products,
- creation of occupation for the future when there will be a labour surplus.

1.1.3 Political-Administrative Framework of Juba Valley Development

Implementation of the first irrigation project (Fanoole) in the Juba Valley started in 1974 as an outcome of the Selchozpromexport Study (Ref. 2) with USSR cooperation. Feasibility studies and implementation of other projects followed during the second half of the seventies, e.g. Juba Sugar, Mogambo, Saakow and Homboy. Planning for the Juba Valley was under the responsibility of the State Planning Commission, then under the Ministry of National Planning. The technical ministries were responsible for the implementation of projects: the Ministry of Industries for the Lower Juba Sugar Project, the Ministry of Agriculture for the Fanoole and Mogambo Irrigation Projects, the Ministry of Livestock for the Trans Juba Livestock Project. The Ministry of Agriculture through the

National Banana Board was also responsible for banana production. Each project was managed by a project unit which had the form of an autonomous agency, i.e. they were bound to the rules of the public sector, but administered a budget on their own.

In 1979 a separate planning, implementation and supervision institution for Juba Valley Development was created: the Juba Valley Development Authority which was responsible to the Ministry of National Planning. In order to create clear lines of responsibility and to concentrate the policy clearly under one authority, this was replaced in March 1982 by the Ministry of Juba Valley Development which has since been responsible for planning, coordination, supervision and, to a certain extent, implementation of all projects and programmes in the Juba Valley. The ongoing projects remained under the responsibility of the Ministries of Agriculture and Industry. The Government of the Somali Democratic Republic hereby underlined once again the eminent importance attached to the development of the Juba Valley within the framework of national development. The MJVD is the only ministry in Somalia with regional competence, all other technical ministries being sector-bound.

The individual tasks of the MJVD are laid down in its Constitutional Law dating from 29 April 1982. They may be summarized as follows:

- management of the Juba waters,
- acquisition of the necessary funds for studies and implementation of projects,
- planning, coordination and implementation of studies relevant to Juba Valley development,
- coordination of development activities,
- planning, implementation and management of all projects that are being carried out in the Juba Valley.

Since 1965 the key element of Juba Valley development has been the Bardheere Dam Project. The ongoing irrigation projects were planned and implemented under the assumption that the dam and reservoir would be functioning at the beginning of their operational phases. The Somali Government has considered the Bardheere Dam Project to be of highest priority within the framework of its national development policy. Its efforts to implement the project as early as possible resulted in an

international donors conference in 1980 when seven different donors from European and Arab countries pledged 350 million US dollars, which, according to the estimates at that time represented about 70 per cent of the investment cost. Although in the meantime no additional funding could be found, the Government went ahead with preparatory steps for the start of construction. The Bardheere Dam Project Authority was founded and has been organizing the planning activities, mainly the final design study which was started in September 1983 and will be completed by mid-1985.

Since December 1983 an Advisory Committee, chaired by the Minister of Juba Valley Development and with the participation of various donors, has been advising the MJVD with respect to a coordinated and harmonized planning and implementation of an integrated economic and social development of the resources of the Juba Valley. Special attention is paid to the commission and evaluation of studies and the appraisal of plans and projects. The Advisory Committee, supported by a Technical Committee and a Technical Secretariat, meets periodically in Mogadishu to discuss pending problems and envisaged plans, to coordinate the different donors' contributions and to find the most economical way of developing the Juba Valley.

The following Figure 1 shows an organigramme of the MJVD and attached institutions.

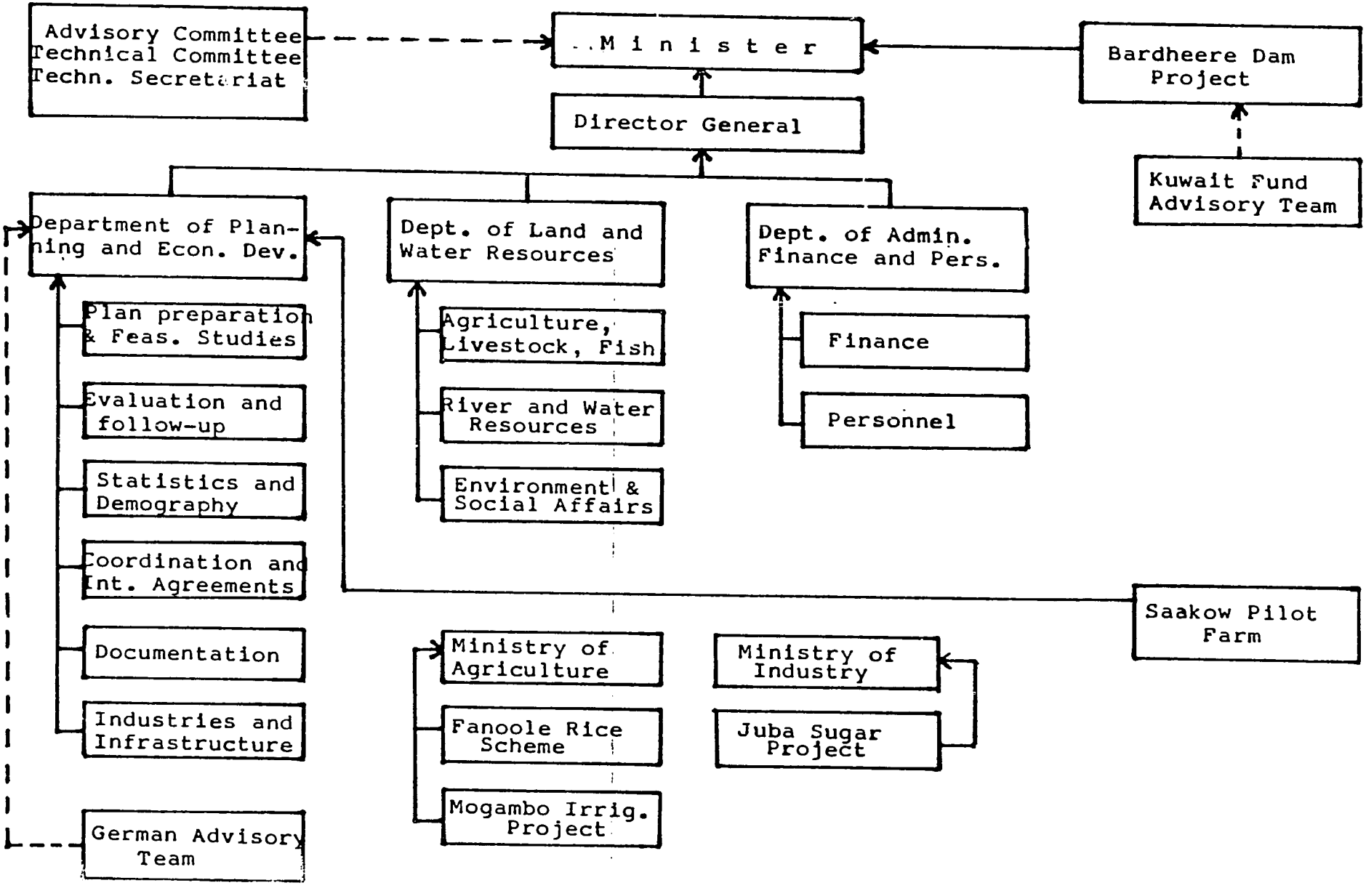
1.2 Existing Development Studies

1.2.1 Overall Studies

Since 1960 several studies, project reports and appraisals have been made on the development of the Juba Valley. In all of the studies, irrigated agriculture is considered to be the main sector for development, although promising prospects have been identified for other sectors as well, e.g. for rainfed agriculture, livestock, industry and services. The basic problem is how to control the water flow and how to make water available for irrigated agriculture throughout the year. The following is a brief summary of the main studies which have been undertaken so far:

- In 1960 the International Cooperation Administration (Ref. 1) conducted an exploration study of the Inter-riverine Region (USA). The agricultural potential of the Juba Valley was pointed out. Stress was mainly laid upon the improvement of rainfed agriculture, whereas irrigation was recommended only for the Lower Juba Region between Kamsuma and Yoontoy.

FIGURE 1 : Organigramme of the Ministry of Juba Valley Development and Attached Institutions



- The first overall development plan for the Juba Valley was prepared by Selchozpromexport (USSR) in 1965 (Ref. 2). Here for the first time it was recommended to construct a large on-stream reservoir in the vicinity of Bardheere to control floods, secure irrigation water for the agriculture already existing and also for projects to be developed and allow for hydropower generation. The construction of three diversion weirs at Saakow, Fanoole and Qaliakoko was proposed. As a result of the study. Fanoole was chosen as the first site for the construction of a diversion weir and the installation of an irrigation perimeter.

- In 1975 - 77 a new study was conducted by Technital S.p.A. Italy (Ref. 3 and 21). The viability of the Bardheere Dam Project as a basis for Juba Valley development was confirmed. More than 220,000 hectares were found suitable for irrigation, subdivided into several irrigation areas on both river banks between Bardheere and Yoontoy. The proposed dam would eliminate floods, provide enough water for the identified irrigation perimeters and provide for an installed capacity of 60 MW for power generation. The plan of constructing three additional diversion weirs was maintained. A detailed programme for agricultural development, design for the dam and tender documents were prepared.

- The Technital study was revised and updated in 1979 by Impresit S.p.A., Italy (Ref. 6), who again confirmed the viability of the scheme, but made some modifications, including the location of irrigation perimeters, the layout of cropping patterns, the speed of implementation, the irrigation system and omitted the Saakow and Qaliakoko diversion weirs. Completion of the Bardheere Dam was envisaged for 1987.

- In 1979 and 1981 the Government of Somalia through the Commission of European Communities appointed Coyne and Bellier (France) to review the previous studies (Ref. 26 and 30). The first of the two reviews determined form, size and layout of the dam; the second one did not only confirm again the viability of the Bardheere Project, but estimated a considerably higher rate of return, if the full power generation capacity of the dam were utilized and 70 per cent of the electricity transmitted to the Mogadishu area in order to replace the expensive fuel generated thermal energy.

- KfW (FRG) prepared an appraisal report on the Juba Valley Development Scheme (Ref. 27) in 1980, which as a result supports the positive decision on a financial contribution to the Bardheere Dam Project.

- In 1978 MMP (UK), (Ref. 22) reviewed the available studies and confirmed that the future regulation of the Juba River depends entirely on the construction of the Bardheere Dam. This conclusion was the result of the preliminary engineering study for the Saakow dam which proved that a low level barrage as an alternative would serve only for the abstraction for the adjacent irrigation district and may satisfy restricted short-term requirements of downstream irrigation development. This result was confirmed again in 1983 (Ref. 13) by a comparison between alternative dams at Saakow and Bardheere and flood regulation works without the construction of a major dam.

- In spite of the results of previous studies, a World Bank Review Mission in 1982 doubted the viability of the Bardheere Dam Project and instead recommended conducting a new comparative study on the combination of an interim storage solution and the postponed construction of the Bardheere Dam (Ref. 8a). The Mission argued that the full capacity of the dam would not be needed in this century and that therefore a phased approach of interim and definite solution would be more economic. Moreover, they recommended carrying out a masterplan for the development of the whole region and updating the feasibility studies.

- In 1984 Electroconsult (Italy) started the elaboration of the final design study for the Bardheere Dam. Their terms of reference also include a cost estimate, a power market study and an optimization of dam height and layout in accordance with an optimum water use for different purposes.

- In 1983 and 1984 the MJVD with the assistance of the German Advisory Team conducted a series of surveys with the purpose of establishing step by step a sufficient data basis for the elaboration of a masterplan. Such surveys have been conducted in the fields of settlements and infrastructure (Ref. 16), present land use (Ref. 10), land potential (Ref. 17) and agricultural services (Ref. 18).

- A specific study was dedicated to the existing small and medium-scale irrigated agriculture between Bardheere and Yoontoy (Ref. 19). The purpose of this study was to identify the potential for agricultural development on the lands close to the river,

which are partly under cultivation, irrigated either by natural flooding or by diesel pumps. Improvements in this sector can be made immediately in the before-dam-situation.

- In the field of river hydrology recordings for up to 33 years exist. Former hydrometric data processings had used these figures without analysing their reliability and without major consideration of the existing gaps. Therefore an extended programme was carried out with the aim of verifying existing information, correcting the recordings where necessary, filling in the gaps by applying stochastical models and updating all information to form a complete hydrological data bank (Ref. 20). The result of the hydrological data programme will not only serve for further planning purposes, but also for the establishment of a water management system.

1.2.2 Single Project Studies

The development studies conducted in the second half of the seventies and the growing interest of donors in the development of the Juba Valley at that time led to an optimistic view of development prospects. Therefore several single project studies were worked out which, in three cases, were followed by the implementation of large-scale irrigation projects. In the process of detailed project planning, it was assumed that the basic river regulation works would be constructed in time, i.e. that flood protection and the supply of sufficient irrigation water would be guaranteed. By 1984 the following state of planning and implementation of projects had been achieved:

- Fanoole Irrigation Project: Construction of diversion headworks and main canal was started by the USSR bilateral aid in 1974 and taken over by the People's Republic of China in 1979. A reconnaissance report for settlement was prepared (Ref. 40) and several internal project studies conducted. The implementation of an area of 8,000 hectares is progressing.

- Juba Sugar Project: In 1974 a feasibility study for a sugar complex was carried out (Ref. 35) and followed by a planning and design study in 1976 (Ref. 36). The planning led to the implementation of the project from 1977 onwards. About 5,000 hectares were under cultivation in 1984.

- Mogambo Irrigation Project: A first feasibility study for a potential area of about 6,500 hectares was prepared in 1977 (Ref. 39) and was followed by more detailed ones in 1979 (Ref. 42) and 1980 (Ref. 45).

Design studies for a first implementation phase covering 2,200 hectares led to the start of construction works in 1983.

- Homboy Irrigated Settlement Project: After the failure of a settlement crash programme at Dujuma, a feasibility study was conducted for the re-settlement of several thousands of families to the Homboy area in the Lower Juba/Shebelli reach (Ref. 43). About 9,000 hectares were recommended for irrigated and rainfed agriculture. No implementation of the project has taken place so far, although diversion headworks for the main canal were constructed on the Fanoole main canal.

- Saakow Irrigation Scheme: A feasibility study for the establishment of an irrigation scheme of 30,000 hectares was prepared in 1980. Design and tender documents for Phase I implementation of 5,000 hectares and for a pilot farm of 60 hectares were presented (Ref. 44). Construction works for the pilot farm were started in 1982, but the site had to be abandoned because of the inaccessibility of the area during 6 months of the year.

1.2.3 Conclusions

It can be stated that the marked interest of donors in the development of the Juba Valley caused intensive planning activities between 1975 and 1980. Overall development studies for the whole region were produced as well as a series of single project studies some of which were followed by the implementation of irrigation projects. Political decisions on the development strategy were made on the basis of these studies, determining the Bardheere Dam Project as the basic element for the development of the region.

By 1980 several donors considered the planning process to be advanced enough to pledge about 350 million dollars for the construction of the Bardheere Dam. It was the World Bank Review Mission in 1983 which cast doubt on the results of the previous planning process and emphasized the need for further studies. Their recommendations were partly recognized by the MJVD who included them in its planning programme up to 1987 (see Chapter 4.1).

The need for further studying was mainly due to the following:

- The existing studies prepared in the second half of the seventies suffer from several weaknesses, e.g. important gaps in the primary data base, unrealistic

assumptions and questionable strategy proposals. The availability of recorded information on the potential and constraints of the region was so limited that extended data research programmes should have preceded the determination of development programmes. Unfortunately, no means were available at that time for collection of primary data, thus planning was based on secondary material and relatively superficial observations rather than on secure findings.

- Important basic data have changed in the course of the last five years such as the relation between world market prices for agricultural products and oil. New data are available such as experience from the ongoing irrigation projects and the results of the hydrology programme.

- Important changes in the strategical development approach for the Juba Valley have been brought into discussion, such as the change in relative importance of power generation and irrigation development, interim storage works, gravity irrigation instead of pumping, diversified agricultural enterprise structures instead of exclusively mechanized state farms and essentially higher percentage of perennial crops.

The single project feasibility studies have been worked out on an appropriate level. Although the overall development studies cover the whole region, they do not fulfill the conditions of binding planning documents. Their main purpose was to prove the viability of a development scheme in the Juba Valley and especially the feasibility of the Bardheere Dam Project. They have as such been very valuable for the decision-making of the Somali Government and of the donors, but they were not conceptualized as an integrated regional development programme with a binding character for all investments in the different economic sectors. Such a regional development plan (masterplan) is still lacking and should not be initiated before information on potential and constraints has reached a sufficient level. The study programme being conducted at the MJVD since 1983 is directed towards this aim.

2. Development Potential and Constraints

2.1 Land Resources

2.1.1 Introduction

A generally acknowledged analysis of the land resources in the Juba Valley does not exist. There are a number

of studies for single projects covering part of the Juba Valley which contain land surveys in sufficient detail to be of use for further development planning. Also there are overall development studies such as the Technital and Impresit Studies which, though covering the whole planning area, cannot be accepted as a sufficient basis for the assessment of land resources in the Juba Valley.

2.1.2 Geomorphology

There is no detailed information available on the geological or geomorphological characteristics of the Juba Valley. The general geomorphological features are presented in the Technital Study (Ref. 3) on which the following short description is based.
Within the Juba basin four morphological aspects can be distinguished:

- the Calcareous - Gypsiferous Plateaux which are situated in the upper part of the Juba Basin. They are characterised by extensive outcrops of Jurassic and Jurassic-Cretaceous limestone and gypsum with sub-horizontal beddings. This region consists of a series of flat, parallel plains coming down from 500m to around 100m and which grade towards the river and its tributaries. From the flat areas, especially those containing gypsiferous strata, inselbergs with concave profiles emerge. The bottom of the Juba Valley is covered with a layer of unknown thickness of unconsolidated deposits laid down during the recessive phases of floods;

- the Buur area, which is found in the north-eastern part of the Juba Basin, is marked by outcrops of pre-cambrian metamorphic and igneous rocks. This area was and still is subject to extensive erosion. It would appear that it was partly covered by marine sediments during the Jurassic period. The area is flat, with groups of inselbergs, called Buur in the Somali language. They consist of granite or quartz gneisses and the sides of the inselbergs are concave in shape;

- the lower Juba Plain, which occupies the most south-western part of Somalia. This area is situated between the calcareous-gypsiferous plateaux to the north, the Shabeellada Basin in the east, the Indian Ocean to the south and the Kenya border to the west. The terrain is flat, sloping gently towards the sea and crossed by the Juba river and its tributaries and to the west of Kismayo by courses coming from the Kenyan border, running to the Indian Ocean;

The plain is formed of alluvial material showing various particle sizes. This material has been being deposited by the river and streams since the late Tertiary period. The alluvial material may be several hundred meters thick, overlies Jurassic limestone to the north and Tertiary marine sediments towards the coast. Because of the flatness of the area, the river often meanders and water tends to stagnate in the lower parts, forming swamps;

- the coastal dune area, which is a morphological unit extending along the shore and reaching up to about 25 km inland. This strip is characterised by marine and eolian sediments with dunes, sand-bars and beds of coral limestone. Dunes, fixed or wandering, depending on the local morphology and vegetation and up to several dozen meters high, are especially evident north-east of Kismayo. They may form ridges but also create depressions with flat, swampy bottoms, surrounded by dunes of varying degrees of stability.

2.1.3 Soils and land suitability

2.1.3.1 Existing surveys

There are a number of studies containing soil analyses and land classification with regard to suitability for agricultural exploitation in the Juba Valley. A list of these is given in Table 1. The list also shows the area covered by the soil and land classification survey for each study as well as the mapping scale.

Principally, two different types of surveys can be distinguished. One group of surveys is directed towards the analysis of single project areas with a surface of about 10,000 to 30,000 hectares. These surveys fall mainly into the semi-detailed category (map scale 1 : 50,000) while some of them could be classified as belonging to the detailed category (map scale 1 : 10,000).

The second group of soil surveys is part of overall resources and development studies with a mapping scale ranging from 1 : 60,000 to 1 : 650,000.

The results of the first group of surveys are generally acknowledged and two of them are part of planning studies for projects (Juba Sugar and Mogambo) which are already under implementation. Two others have also been carried out as contribution studies on irrigation projects (Saakow and Hamboy), while the remaining one was an assessment of land suitability for agriculture in the Dujuma Settlement.

In total the surveys in this category have analysed an area of 117,400 hectares of land at semi-detailed and partly detailed level. This area represents about 20 per cent of a total geographic area of 450,000 hectares of land, which according to present estimates will have to be surveyed in order to determine the definite agricultural potential of the Juba Valley.

Otherwise, studies belonging to the second overall group have been carried out. The fundamental study with regard to soil and land classification is the Lockwood FAO Study (Ref. 51) on which all the following ones are largely based. Each subsequent study merely adds the results of some additional field work and changes the presentation. However, on the whole, there is no substantial improvement in quality. The most recent example of this is the Impresit Study (Ref. 6), which is the most comprehensive but which is not considered to be accurate enough to be taken for further development planning in the Juba Valley. To date however, this study, with the exception of the above mentioned Project studies, presents the best overall view of the land resources in the Juba Valley. In the Impresit Report, the most important issues concerning land classification are summarized in the following.

2.1.3.2 Land classification according to Impresit

The data used in the Impresit report were based on a computation of existing soil studies carried out in the Juba Valley supplemented by a field reconnaissance between Bardheere and Yoontoy. During the field survey forty soil profiles were examined from areas considered to be the most representative ones, in order to get further information on the soils and to check the results of the soil analyses against the existing information.

The existing FAO soil classification map, produced in 1968, was used as a base map to plot soil units on a new classification map 1 : 100,000 made by Impresit.

As the knowledge of soil characteristics alone is insufficient to classify the land suitable for agricultural use, the USBR land classification system was used to determine the limitations of the land for agricultural purposes. The basis for limitation, which provides a description of land classes, concerns three factors; soil, topography and drainage.

Table 1 : Soil and Land Classification Surveys for the Juba Valley

Survey (year)	Area of Survey	Area in km^2	Map Scale
ICA (1961):			
Inter River Economic Exploration	mainly Lower Juba	4,500	1 : 650,000
Selchozpromexport (1965):			
The Giuba River Scheme	Middle and Lower Juba	16,500	1 : 200,000
Lockwood/FAO (1968):			
Agricultural and Water Surveys	entire Juba and Shebelle	208,500	1 : 60,000
Technital (1975):			
Juba River Development Study	Juba Valley	4,480	1 : 200,000
Booker McConnell (1976):			
Planning and Design for the Juba Sugar Project	Jilib and Jamaame Districts, Middle and Lower Juba	255	1 : 10,000 + 1 : 40,000
HTS (1977):			
Inter-Riverine Agricultural Study	entire Juba and Shebelle	200,000	1 : 500,000
HTS (1977):			
Soils of Dujuma Settlement Area	Dujuma District, Middle Juba	290	1 : 50,000
Il Nuovo Castoro (1978):	Saakow District		
Saakow District Irrigation Study	Middle Juba	382	1 : 20,000
MMP (1979):	Jamaame District	96	1 : 10,000 + 1 : 20,000
Mogambo Irrigation Project	Lower Juba		
HTS (1979):			
Homboy Irrigated Settlement	Jilib District, Middle Juba/ Shebelle Valley	151	1 : 20,000
Impresit (1979):			
Juba River Valley Development Plan	Juba Valley	2,650	1 : 100,000

1) The complete titles are given in the List of Publications
Source : Ref. 19

The land classes involved in the Juba Valley are:

- three arable land classes (1, 2 and 3) suitable for all types of crops, but with productive capacity decreasing from 1 to 3;
- a limited arable land class (4) with marked deficiencies with regard to one of the factors, mentioned above. This land class however, can be used profitably if it is used for one given crop or purpose. In the case of the Juba Valley it has been recommended that the class 4 land could be used for the production of rice or for grazing purposes.

The results of the field survey, the incorporation of the existing soil data, the interpretation of the FAO soil units and the consideration of the USBR land classification system were used to prepare a 1 : 100,000 scale land classification map for the Juba Valley.

The following land classes in the Juba Valley have been characterized:

- Land class 1 consists of soils which are deep, skeleton free, medium to fine textured, subalkaline, free from salts and alkalis, showing a good permeability and which are level. These soils can be used for a wide range of crops.

- Land class 2, sub-class 2s, which consists of soils which are deep and alkaline free in the sub-surface horizons and of medium permeability. In the deeper horizons however, salts and alkalines are found which affect the horizontal and vertical permeability there. These soils need a drainage system to eliminate salts and to avoid the accumulation of an excessive quantity of water at depth. A wide range of crops can be cultivated on these soils.

- Land class 3, with the sub-classes 3s and 3d.
  Sub-class 3s consists of deep, skeleton free soils with a sandier texture showing subalkaline reactions. Salts and alkalis are found throughout the profile. The permeability is medium. These soils need a drainage network, as the salinity and alkalinity characteristics can be modified by leaching treatment with gypsum.
  Sub-class 3d soils show serious drainage limitations. The soil characteristics re similar to those found in land class 1. They w ll become good soils when an outlet to prevent the ponding of water is ensured. The low vertical permeability and a decidedly low horizontal permeability, resulting in difficulty in

From this table it can be noted that:

- The total net irrigable area in the Juba Valley amounts to around 183,500 ha.
- The majority of the land class 1 soils are situated in the area between Fanoole and Yoontoy.
- Bardheere irrigation area has no land class 4
- The majority of land class 4 soils are found in the Saakow/Bu'aale irrigation area.
- Land class 4 covers around 27.5 per cent of the total gross irrigable area.

2.1.3.4 Conclusions

Soil and land classification surveys have been carried out for the whole Juba Valley though they are only partly acceptable as a basis for future development planning. A proper survey still has to be carried out for over 70 per cent of the 450,000 hectares of land in the Juba Valley, the agricultural potential of which still has to be determined. The existing study by Impresit, although it gives an idea of the magnitude of irrigable land, is not considered to meet the standards required for further development planning. Therefore USAID has agreed to carry out an additional overall soil and land classification survey.

2.2 Water Resources

2.2.1 Hydrometrical Observation Network in the Juba Valley

Observation of water levels and meteorological parameters in the Juba Valley was started between 1920 and 1930 by the Italians. Water level data from that time are of limited use, as only mean monthly levels were recorded and the exact locations of the stations are not known. The meteorological data from that time are more useful. Quite a large number of stations existed both at colonial administration locations such as Bardheere and Luuq and at private farms such as Alessandria and Margherita near Jamaame.

World War II brought a long interruption to the observations. Rainfall recording did not continue before 1953 and regular observations of water levels were continued

at Luuq from 1951. Fresh impetus to hydrometry was given from 1963 onwards through the setting-up of new gauging stations; discharge measurements were performed and the first rating curves were established, covering low to medium ranges. However, data from that time are of limited use only, because of frequent recording errors, unsuitable location of the gauging stations, silting of inlets, discontinuity of recordings and low level of methodology.

In the seventies, the Fanoole Project and the Lower Juba Sugar Project installed new stations. Results from Fanoole were poor, whereas accurate water level recordings, discharge measurements and water quality monitoring were performed at the Sugar Project, where reliable rainfall data were generated too. The FAO gave valuable assistance on the evaluation of existing data between 1979 and 1981, but unfortunately the big flood of 1984 washed away several of the installations.

Meteorological observations in the Juba Valley were neglected for a long time and data for the period 1961 to 1982 are not only difficult to find, but also rather lacking in continuity. In 1982, the Early Warning Department of the Ministry of Agriculture set up a new, nationwide network of meteorological stations, including Bardheerè, Alessandria, Luuq and Bulo Guduud in the Juba Valley.

In 1983, following a recommendation of the FAO, the "Somalia Hydrometry Project" started. Besides work on data processing, this project includes the upgrading and rehabilitation of all river gauging stations run by the Ministry of Agriculture both on the Juba and Shebelli rivers. Discharge measurements were concentrated on the Shebelli, whereas the MJVD established a data bank of hydrological information for the Juba. All results of the latter are published in Ref. 20.

The present condition of the existing hydrometeorological stations in the Juba Valley is summarized in the following.

Luuq: Luuq has both a river gauging station and a meteorological station. The gauging station is the most important one on the Juba because of its location, the length of records and the good quality of the rating curve. Discharge measurements cover the whole range of observed stages. The station was rehabilitated in 1984. The meteorological station is located on a rather exposed site and lacks a number of important instruments, such as evaporation pan and rainfall recorder.

Bardheere: Bardheere has one river gauging station and two meteorological stations. Unfortunately, gauging has been neglected, thus there are much less data available than from Luuq. Discharge measurements cover only the lower and medium stages. Staff gauges frequently collapsed into the river at high floods. The station was rehabilitated in 1984.
The meteorological station of the Ministry of Agriculture is the best equipped one in the Juba Valley. However, most of the sophisticated recorders are not in operation due to the lack of recorder charts.

Kaytooy: The river gauging station has only historical importance, since from 1981 onwards it has been influenced by the backwater of the Fanoole weir.

Alessandria: Alessandria, located on the right river bank opposite Jilib, has a meteorological station. Rainfall recorder and evaporation pan are lacking.

Mareerey: The Juba Sugar Project installed a river gauging station and a meteorological station in 1977. Both stations are carefully operated. Discharge measurements cover only the lowest levels. Records include daily salinity measurements. The meteorological station is the only one in the Juba Valley with an operational class A evaporation pan.

Kamsuma: Careful observation of water levels and discharges was carried out between 1972 and 1976 only by the Fanoole Project.

Jamaame: The river gauging station is the lowermost on the Juba. Water level readings have a low accuracy because the inlet of the automatic recorder and the lower staff gauges are totally buried under mud.

Bulo Cuduud: A meteorological station was set up in 1982 by the Ministry of Agriculture.

2.2.2 Quality and Availability of Data

There are generally more data available than reported in former studies. The hydrometric programme of the MJVD contains all data which have been found by August 1984. All data are store on magnetic discs for the computer system in the Ministry.

The quality of the data varies. Wherever it was noticed that data had been fabricated by observers, it was omitted from the MJVD data bank.

Water level recordings are available from 1951 onwards. The quality is however impaired by the discontinuities and faulty recordings it contains. For discharge measurements, a single rating curve of the function $Q = a \cdot (H + b)^c$ is considered to be sufficient for the whole range of discharge of each station. There is no significant change in the stage/discharge relation during the observation period.

Salinity data are available only from the measurements at Mareerey. Almost continuous records over eight years give a very precise picture of the salinity in the Lower Juba.

Some continuous suspended load measurements have only been performed at Mareerey during the years 1980 and 1981. Bed load has never been measured.

Although partly discontinuous, rainfall measurements have been kept since over 60 years ago. For several years only monthly rainfall totals are available. Due to the lack of automatic rainfall recorders, no information on rainfall intensities can be kept.

Mareerey is the only location where evaporation has been directly measured. Daily records are available dating from 1977.

There are quite a large number of studies and reports which deal with hydrometrical data of either the whole of Somalia or more restricted individual project areas. Documents of major importance are the Fantoli Report from 1965 (Ref. 50), the FAO (Lockwood) Report from 1968 (Ref. 51) and the Gemmel Report from 1981 (Ref. 55). For an assessment see Ref. 20, pp. 19 - 23.

The availability of hydrometrical data is shown in Fig. 2.

2.2.3 Hydrometeorological Features of the Juba Valley

2.2.3.1 Rainfall

The major part of the Juba Valley has an arid climate, i.e. throughout the year monthly potential evaporation exceeds monthly rainfall. The average annual rainfall is about 400 mm. In the north represented by Luuq, this value is only 300 mm, whereas the area around Jilib, represented by the stations Mareerey and Alessandria, can be characterized as semi-arid with an average annual rainfall of 700 mm. Although annual totals over the remainder of the Juba Valley do not vary very much, considerable differences occur in the seasonal distribution.

Traditionally, the year is divided into four seasons:

- Jilaal, from December to April, dry season,
- Gu, from April to June, wet season,
- Xagaa, from June to September, mainly dry season with sometimes isolated showers,
- Der, from September to December, wet season.

Beginning and end of the seasons are not fixed by calendar dates but determined by the first and last rainfalls. They therefore usually vary from year to year.

At Jamaame, close to the sea, rainfall is most secure during Xagaa, though this season does not bring the highest amount of rain. The influence of the maritime climate is evident. Rainfall during the Der season is not regular. It may occur in September, sometimes in October. Agriculturally significant rainfall occurs mainly in the continuous period from April to July.

At Marcerey a little further inland, the influence from the Indian Ocean is less significant. Rainfall may still occur in June and July but both the Gu and Der wet seasons are much more pronounced than at Jamaame. The months with agriculturally significant rainfalls are April to July and October to November. The median rainfall in April, May and November exceeds 100 mm/month.

At Bardheere, rainfall during the Xagaa season is insignificant. The rainfall pattern of Der is similar to the pattern of Gu. The periods for which rainfall can be expected with some reliability are from the beginning of April to the middle of May and from mid October to mid December. The shortness of the rainy seasons explains why rainfed agriculture in Middle Juba and Gedo produces rather low yields in most of the years.

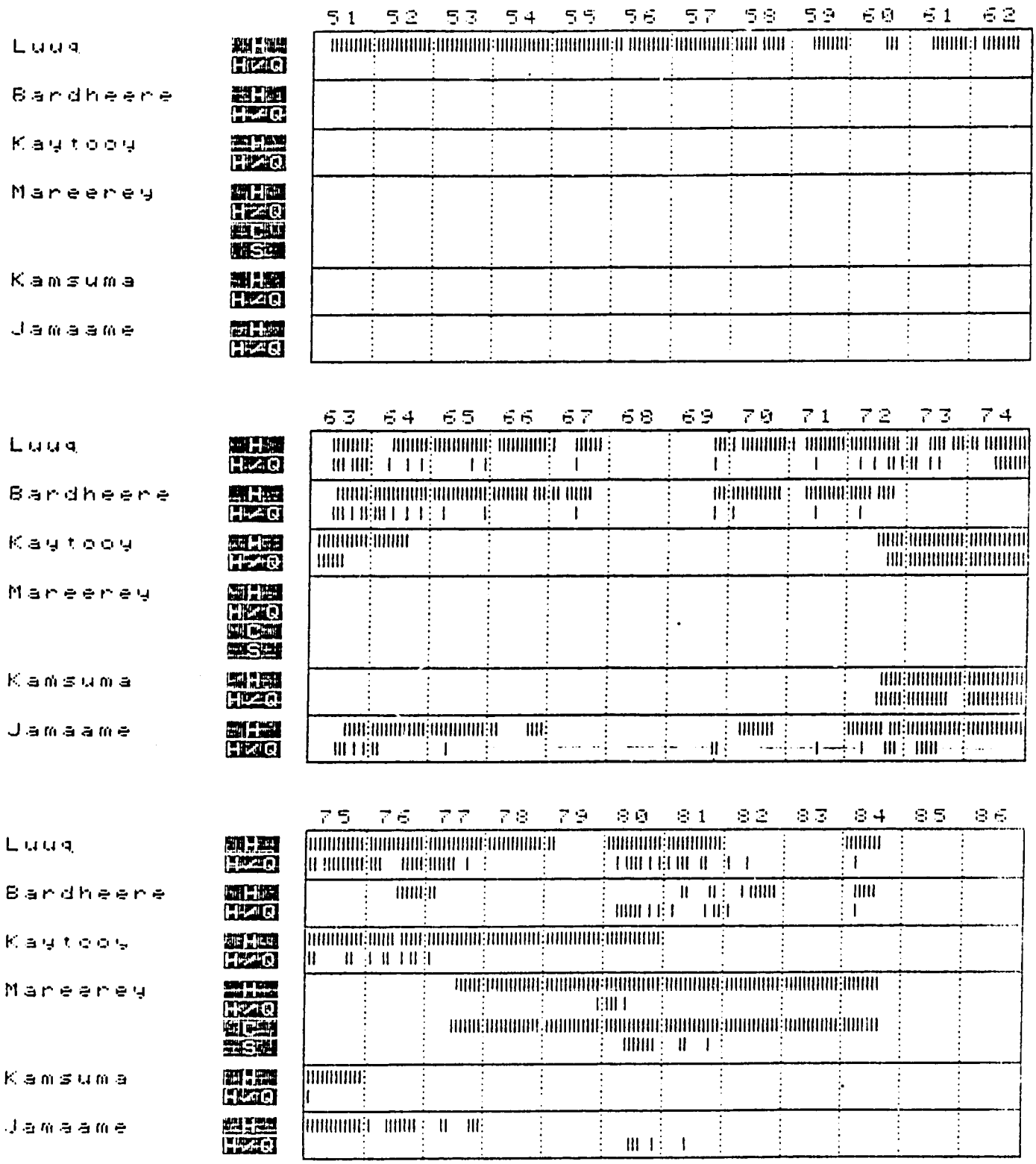
At Luuq, in the upper part of the valley, the periods during which rainfall can be expected in Gu and Der are still shorter than at Bardheere. There are hardly any rains during Xagaa, nor during Jilaal, as is the case sometimes in the upper parts of the catchment in Ethiopia. In the Luuq area, hardly any rainfed agriculture is possible. Further North, towards Dolow, it becomes even dryer (almost semi-desert climate).

2.2.3.2 Evaporation

The main climatic factors influencing evaporation are daily sunshine, temperatures and windspeed. Due to poor

Figure 2

JUBA VALLEY -- SOMALIA
AVAILABILITY OF HYDROLOGICAL RECORDINGS



Legend : Each bar stands for a month with at least one complete 5-days period , resp. at least one discharge measurement

Date of computation : 12.9.1984

Figure 3

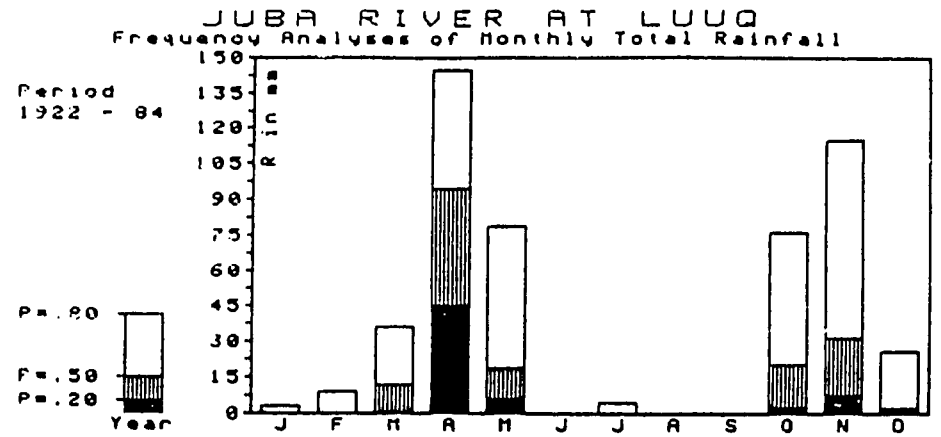


Figure 4

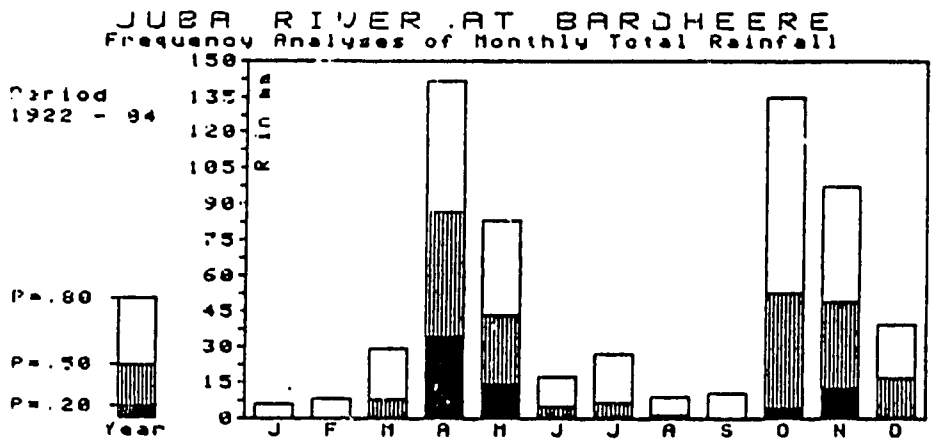


Figure 5

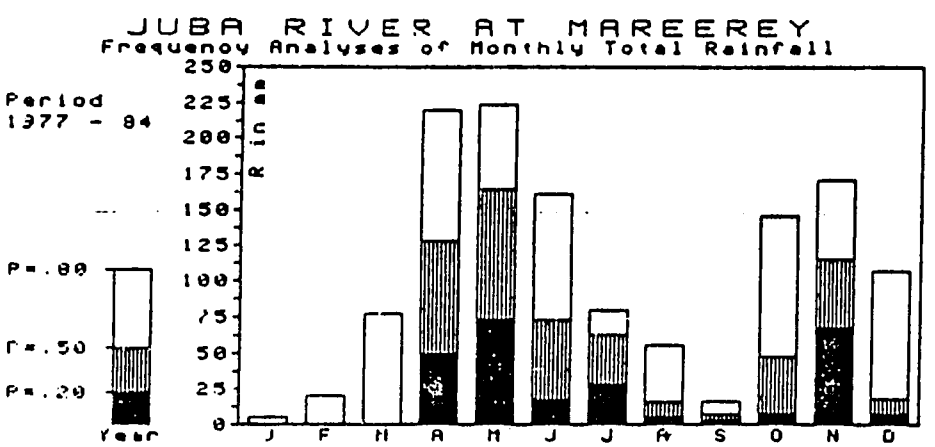
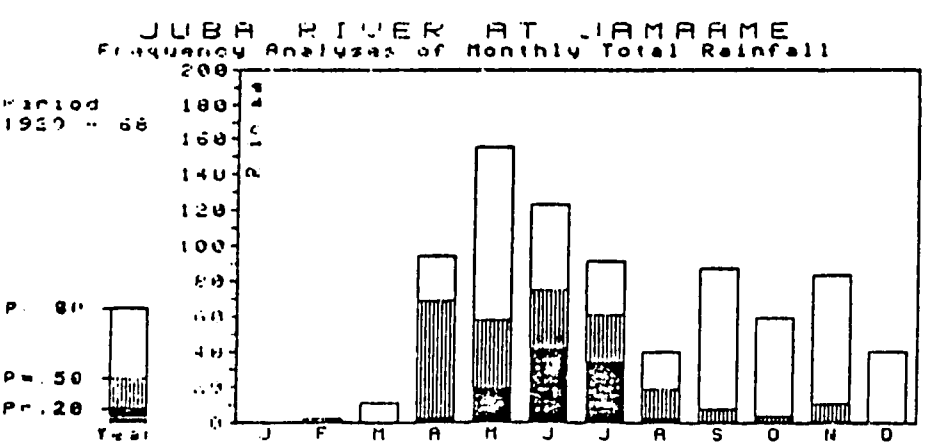


Figure 6



equipment in the meteorological stations, only a rough impression of these features can be given. With increasing distance from the coast, the climate becomes more continental, i.e. more daily sunshine, considerably lower humidity, larger differences between day and night temperature and a general increase in mean temperature. The mean daily temperature at Luuq is one of the highest in the country. At Bardheere, daily maxima may exceed 44°C, while close to the coast values hardly exceed 34°C. The hottest periods are March/April and September/October, i.e. before the onset of the rains. Lowest values of humidity occur during February/March when the land has dried out and temperatures are high. The highest values occur during June/July when vegetation is fully developed and temperatures are low.

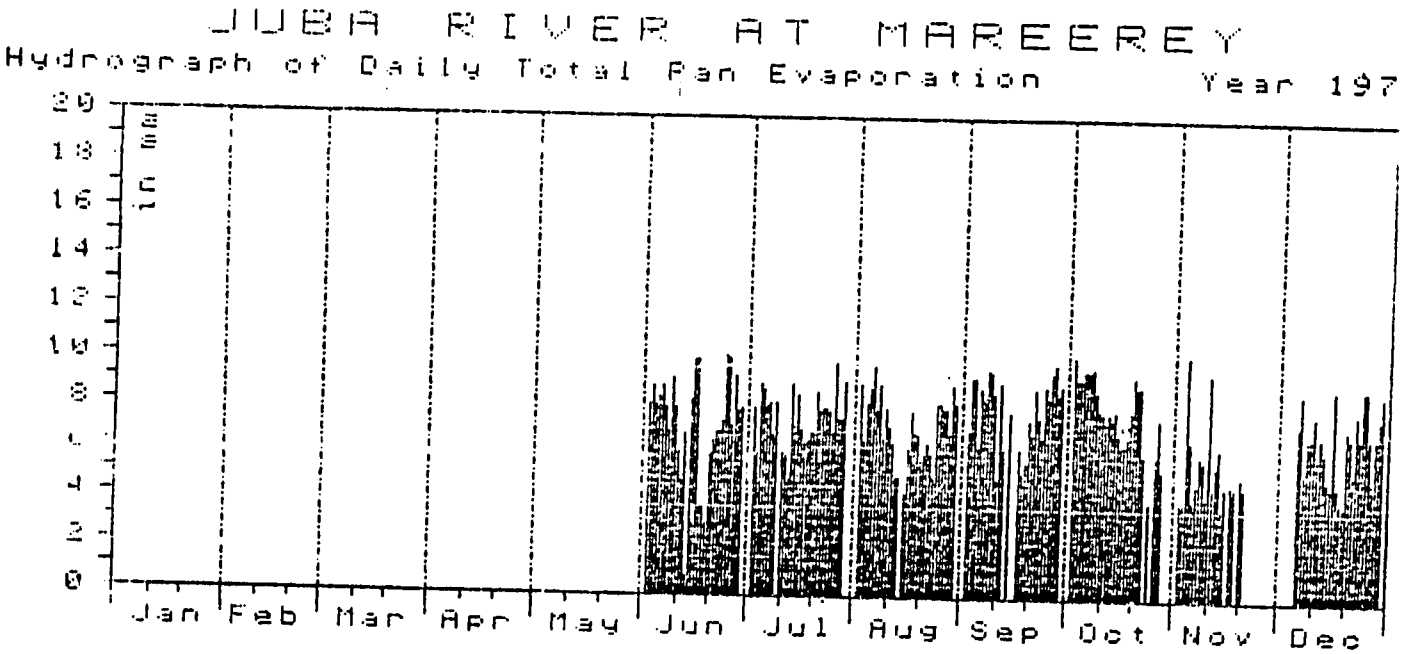
Direct measurements of evaporation are only available for Mareerey. The mean annual total amounts to 3,000 mm. This amount is considerably higher than the figures obtained through the application of one of the Penman formulae, used in previous studies.

The most probable explanation for the difference is that the data used for the Penman calculations were wrong or at least inaccurate. An important factor in evaporation is wind speed. Often windspeeds which are much too low have been measured due to poor maintenance of instruments. Furthermore, at Mareerey it has been observed that average wind speeds during the day (when the sun is strong and thus the larger portion of evaporation takes place) are up to five times as high as during the night. Working with mean monthly figures which do not distinguish between day and night must therefore result in evaporation values which are too low.

The Jamaame area which is closer to the sea than Mareerey may have an annual potential evaporation of less than 3,000 mm. On the other hand, the largest part of the valley, from Kaytooy onwards to Dolow at the border, is hotter and dryer than the Mareerey area and will therefore have a potential evaporation that exceeds 3,000 mm per year.

At Mareerey it has been observed (and this phenomenon will be valid for the whole of the Juba Valley), that the highest values of potential evaporation occur at the end of the Jilaal season (February, March). With no effective rainfall, water requirements for irrigated agriculture will be at their maximum during that period. Lowest values in potential evaporation occur in May, when rainfall is high and sunshine is least.

Figure 7



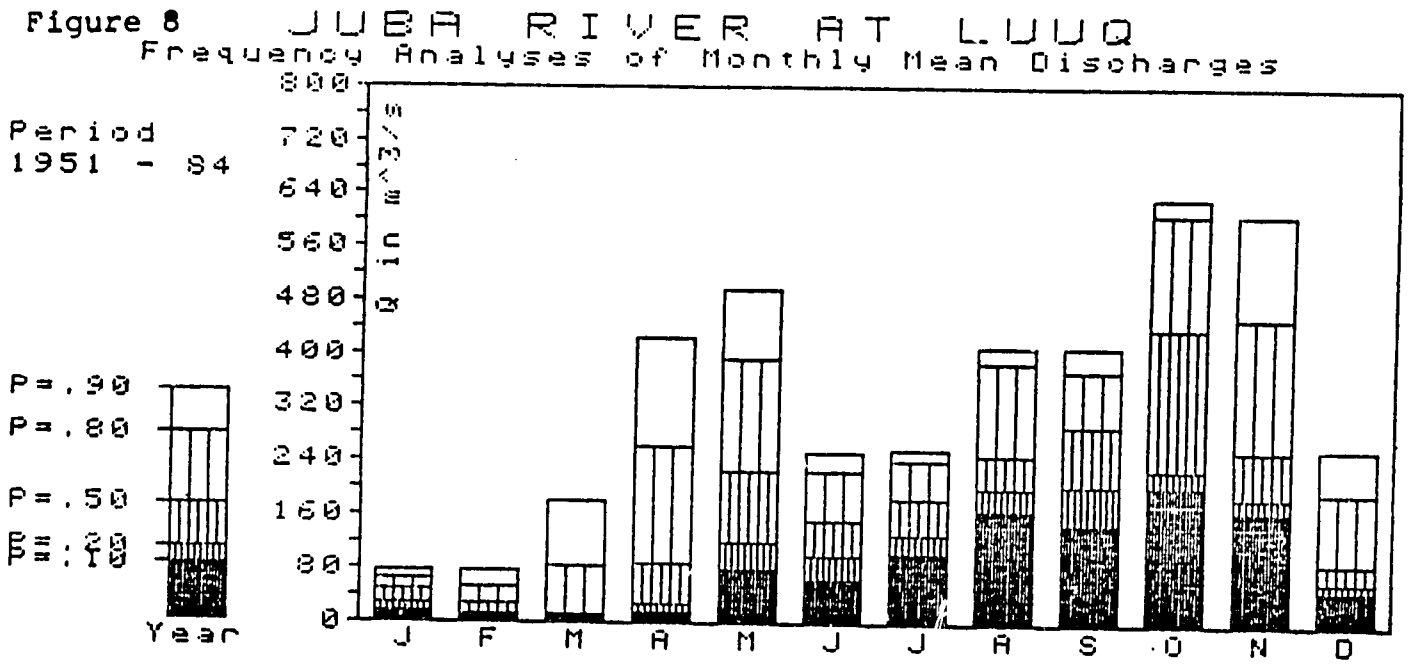
Date of computation : 9.7.1984

2.2.3.3 River Flows

The Juba River is formed from three tributaries: Daua Parma, Canale Doria and Webi Gestro. All three tributaries which rise in the Ethiopian highlands, join in the area of Dolow at the border between Somalia and Ethiopia. It is this upper catchment with an area of about 170,000 km^2 which mainly contributes to the flows of the Juba River. Within Somalia, the drainage systems of sub-catchments are generally poorly developed. In exceptional years however, considerable floods may rise from the sub-catchments upstream of Bardheere. This phenomenon was observed e.g. in 1981.

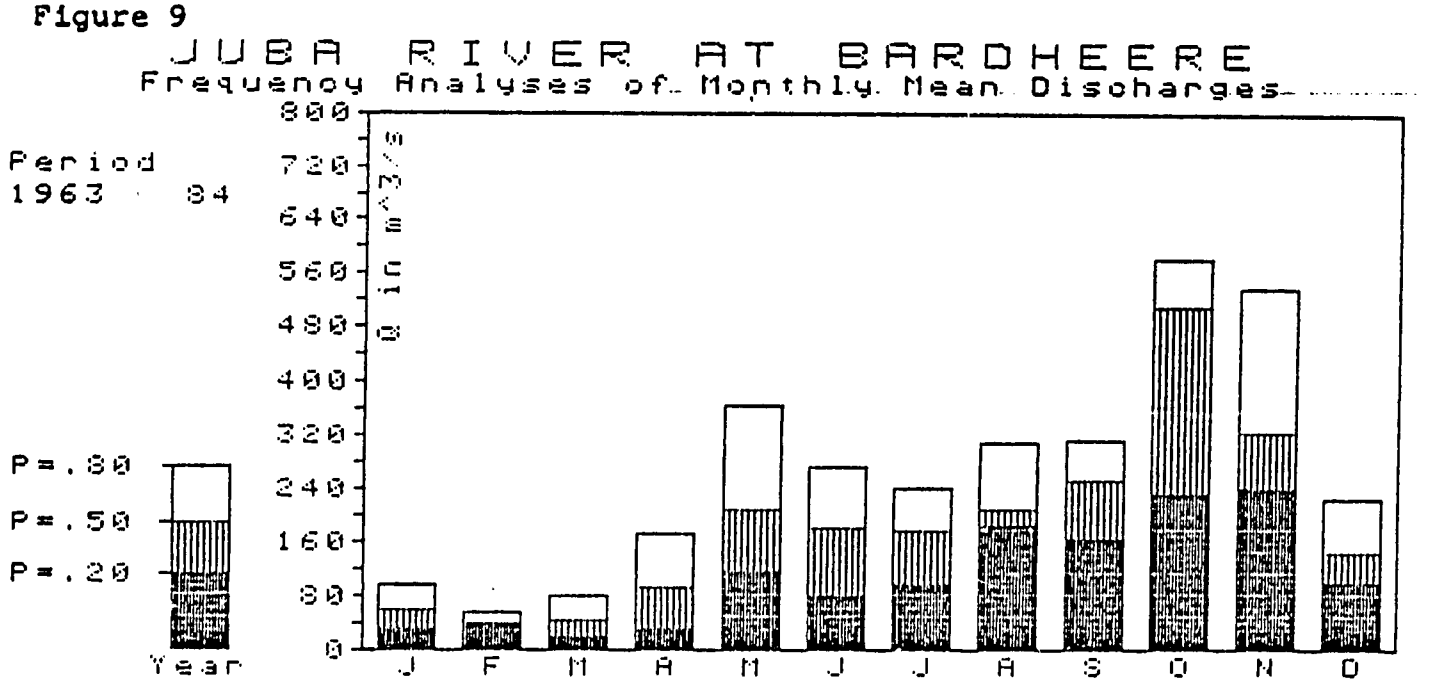
In the Ethiopian catchments with altitudes ranging from 200 m to more than 4,000 m above mean sea level, rainfall is even more variable than in the Juba Valley. Average amount of annual rainfall ranges from 200 mm to more than 900 mm and although most rain falls during Gu and Der in Ethiopia too, in the uppermost reaches only the months of January and February are dry. This explains the flow pattern of the Juba River which is essentially bimodal.

Figure 8



Date of computation : 9.9.1984

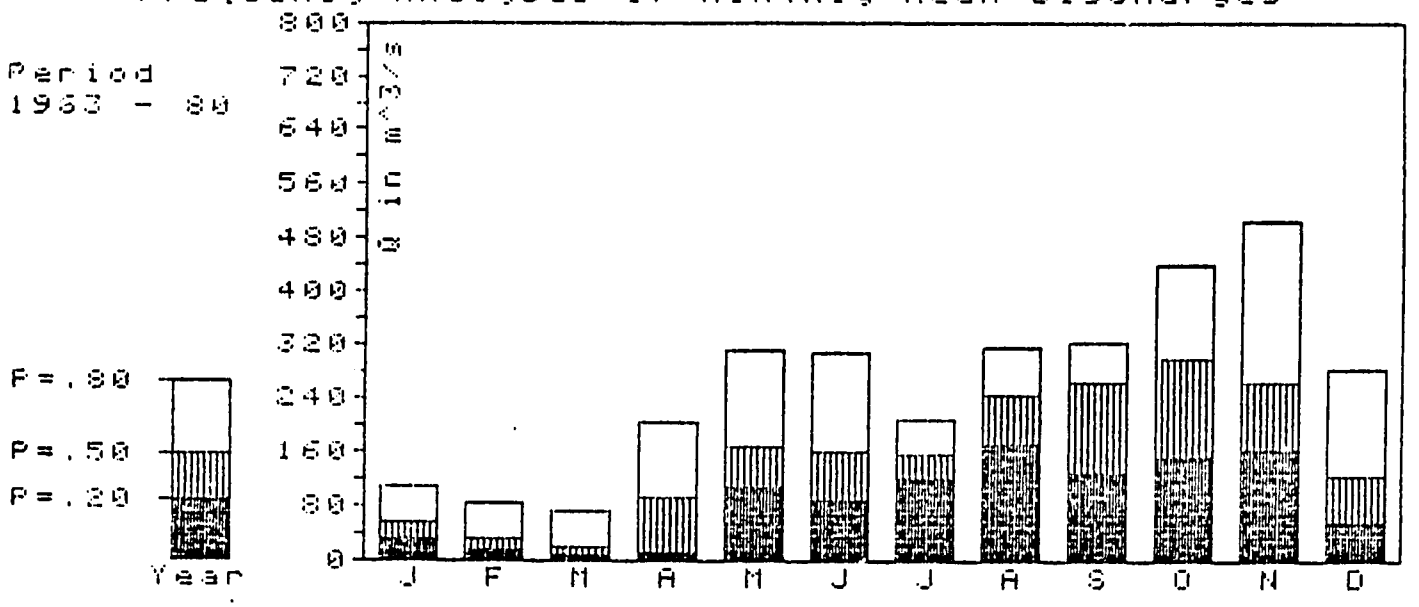
Figure 9



Date of computation : 9.9.1984

Figure 10 JUBA RIVER AT KAYTOOY

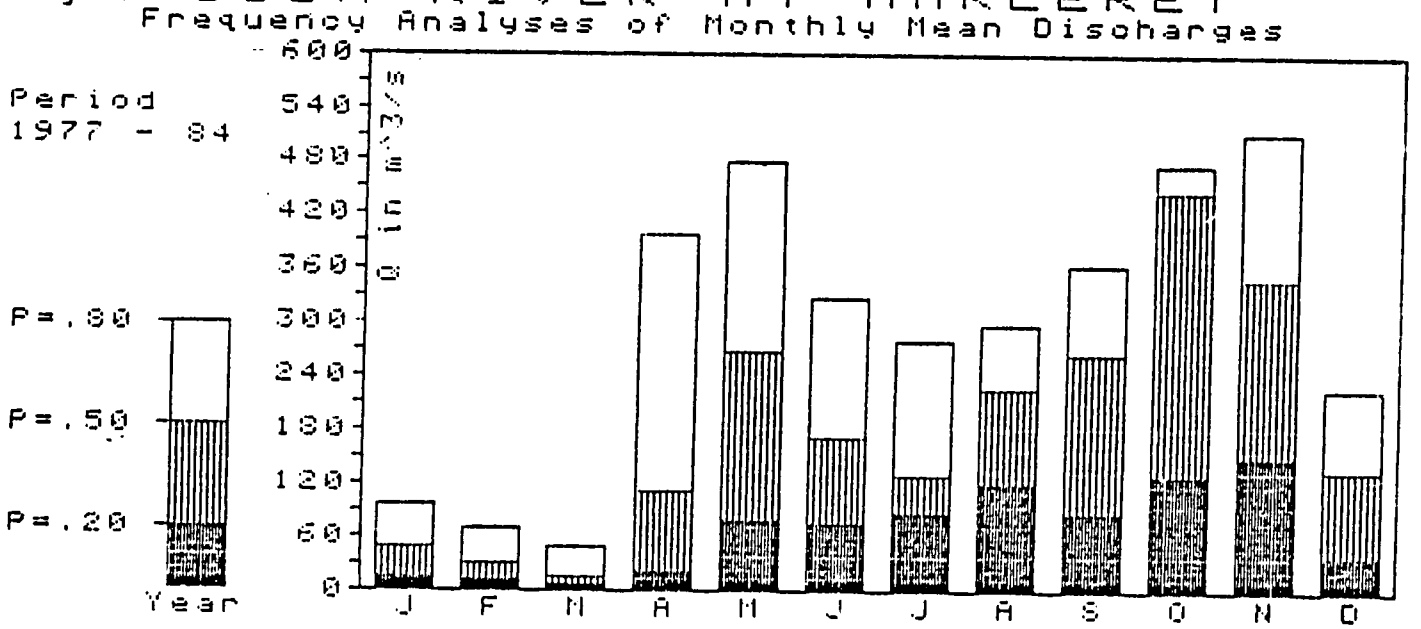
Frequency Analyses of Monthly Mean Discharges



Date of computation : 19.6.1984

Figure 11 JUBA RIVER AT MAREEREY

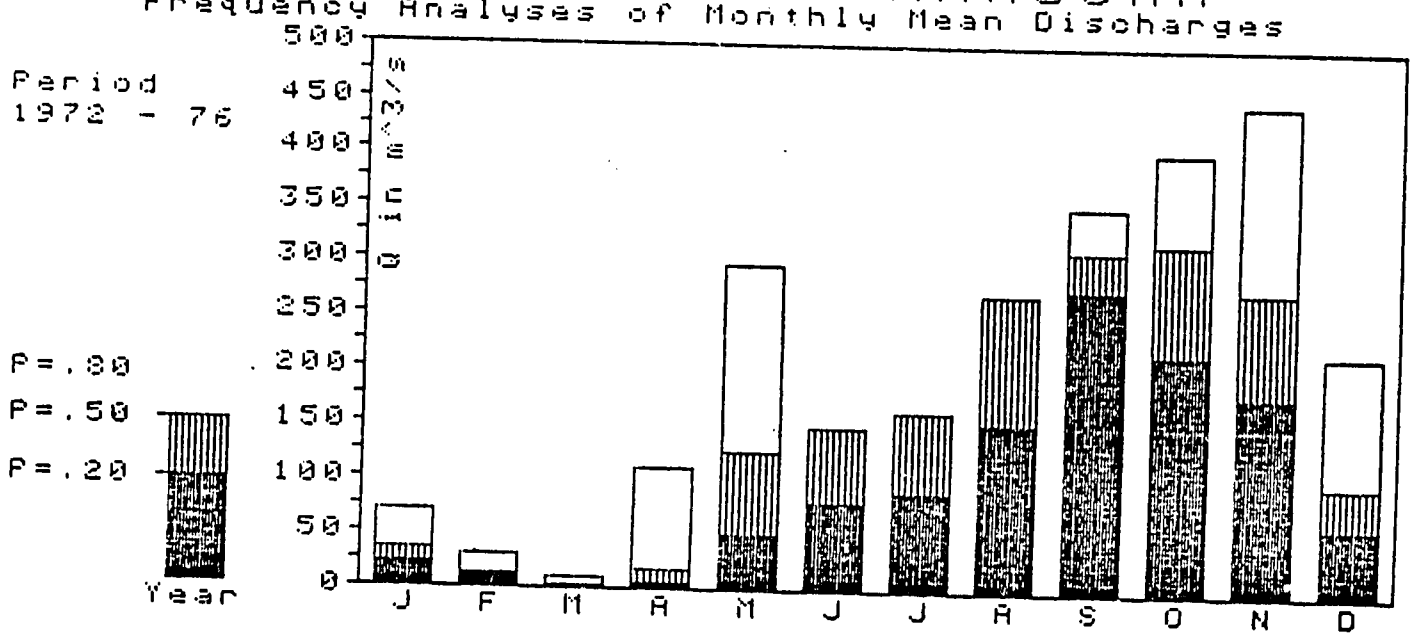
Frequency Analyses of Monthly Mean Discharges



Date of computation : 10.9.1984

Figure 12 JUBA RIVER AT KAMSUMA

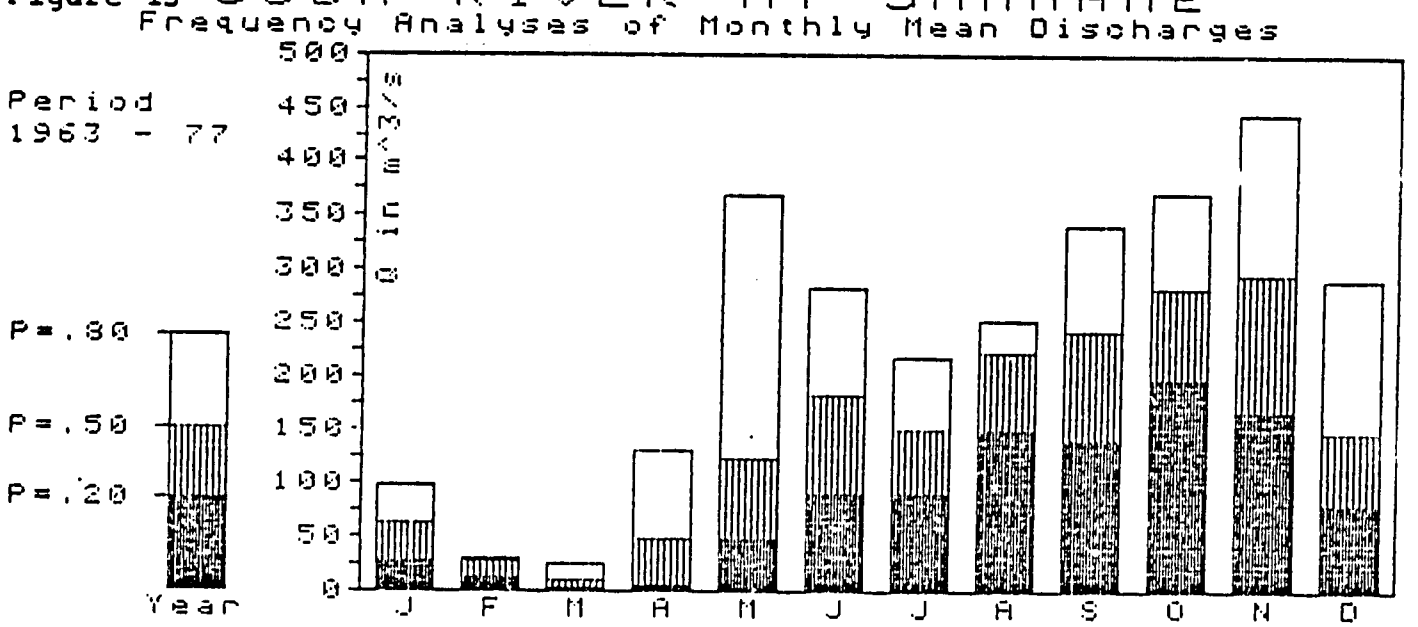
Frequency Analyses of Monthly Mean Discharges



Date of computation : 18.6.1984

Figure 13 JUBA RIVER AT JAMAAME

Frequency Analyses of Monthly Mean Discharges



Date of computation : 18.6.1984

Short and pronounced flood peaks occur in April and May and more voluminous floods are observed in October and November. Minor floods occur in Xagaa between June and September, maintaining the discharge slightly above the annual average of 200 m^3/s. In some years, however, small floods may occur even during January and February.

At the present level (1984) of agricultural development, the minimum irrigation water requirement of the Juba Valley is 15 m^3/s in the critical period of January to April. In this amount nothing is allowed for leaving some portion in the river for ecological reasons and for animal and human consumption. Even now the discharge in the Juba River is slightly less than the minimum requirement in one out of every two years for 5 consecutive 5-day periods. In one out of five years, the period of insufficient river flow is around 60 days and in one out of ten years this critical situation will last for almost three months, from the middle of January to the middle of April. At that time less than one quarter of the required quantity is available on days with the lowest flows. This critical situation is aggravated by the fact that during very low flows water is stored in the Fanoole reservoir, thereby reducing the flow to almost zero, this being the case in Gu 1984.

Due to the natural attenuation of flood waves and the lack of confluences, the highest discharges have been observed at Luuq. They usually occur in October and November, although in some years the annual maximum has been observed in May. In years without high floods during Gu and Der, the annual peak may even occur in Xagaa.

The median annual peak discharge at Luuq is around 860 m^3/s. This means for the Middle and Lower Juba that every second year bankful discharge is exceeded, i.e. inundations take place. More often than once in ten years floods occur which are of such a great volume (i.e. magnitude and duration) that long lasting and extended inundations in the Middle and Lower Juba cause serious damage to agriculture and infrastructure.

The flood which is likely to occur every ten years has a peak of 1,480 m^3/s. The values for 100 years are 2,200 m^3/s, for 1,000 years 2,800 m^3/s. This means that catastrophic floods like the one of 1981 are likely to occur every nine years. The value for the 1,000-year flood which were obtained also by purely statistical methods, are viewed sceptically by some hydrologists. In vew of the magnitude and the characteristics of the catchment, they assume that much higher peak discharges are possible.

Details for the propagation and deformation of the flood waves as they travel along the Juba Valley have been analysed for the flood routing model. Interpretation in terms of bank storage and ground water recharge, as done by Lockwood (Ref. 51), does not seem justified in view of the moderate accuracy of the discharge data. Travel speed and attenuation of flood waves as well as overspill, permanent losses and backflow can be quantified. All parameters for the flood routing model as well as main geometric parameters are shown in Figure 14.

Figure 14

HYDROLOGICAL FLOOD ROUTING MODEL OF THE JUBA RIVER
System Parameters

Station	Gauge-0	Width	Rating curve	Chainage	L	K	v	n	l	k	Qb
	m	m		km	km	h	km/h	-	km	h	m^3/s
Luuq	141.45	135.0	68.27*(H -.72)^1.815	105.0							
					234.6	45.0	5.21	23	10.2	1.96	900
Bardheere	88.98	100.0	45.67*(H +.39)^1.869	339.6							
					295.4	75.0	3.94	36	8.2	2.08	700
Kaytooy	25.50	82.0	31.43*(H +.34)^1.683	635.0							
					60.0	15.0	4.00	10	6.0	1.50	650
Mareerey	0.00	85.0	17.96*(H-14.55)^1.911	695.0							
					34.0	10.0	3.40	6	5.7	1.67	550
Kamsuma	6.00	85.0	44.86*(H -2.32)^1.419	729.0							
					48.0	15.0	3.20	16	3.0	.94	450
Jamaame	0.00	64.0	17.95*(H -.05)^1.684	777.0							

N.B.: Chainage starting from Doloow
L = distance between stations
K = Average flow time between stations
v = Average wave translation velocity
n = Model parameter = number of fictive reservoir cascades
l = Length per fictive reservoir
k = 'Kalinin parameter' = flow time within fictive reservoir
Qb= Average bankful discharge .

The parameters are either directly measured (geometric parameters), calculated by regression (rating curve) or found by trial and error (flood routing parameters k and n, bankful discharge Qb). From the numeric values of the table, it can be concluded that the hydraulic characteristics of the Juba are developing as follows from the upper to the lower reaches:

- slope is almost uniform,
- channel width is decreasing,
- parameter a of the stage/discharge relation $Q = a (H + b)^c$ is decreasing i.e. for the conveyance of the same discharge, a greater water depth is needed,
- bankful discharge, i.e. the hydraulic capacity of the river channel is decreasing,
- travel speed v of flood waves is decreasing,
- length of fictive reservoirs of the linear reservoir cascade model is decreasing i.e. the attenuation capacity of the river channel is increasing.

The above characteristics correspond to the normal features of a river stretch without major tributaries.

The characteristics of the flood plain in terms of reception, conveyance and release of the flood waters gained from overbank spill are not yet quantified. But it can be stated already that the storage capacity within the flood plain of the Upper Juba is very limited.

From Bardheere to Kaytooy, flood waters will be stored in natural depressions (desheks). Downstream of Kaytooy, considerable parallel overland flow is possible for discharges above 800 m^3/s. From all inundated areas, considerable losses through evaporation can be expected. The Juba River alone, assuming a mean width of 90 m and a channel length of 830 km (from Dolow to the Indian Ocean) has a surface of 75 km^2. This would result, with a net evaporation of 2,600 mm/year, in a total annual loss of 190 million m^3 or 6 m^3/s.

2.2.3.4 Water Quality

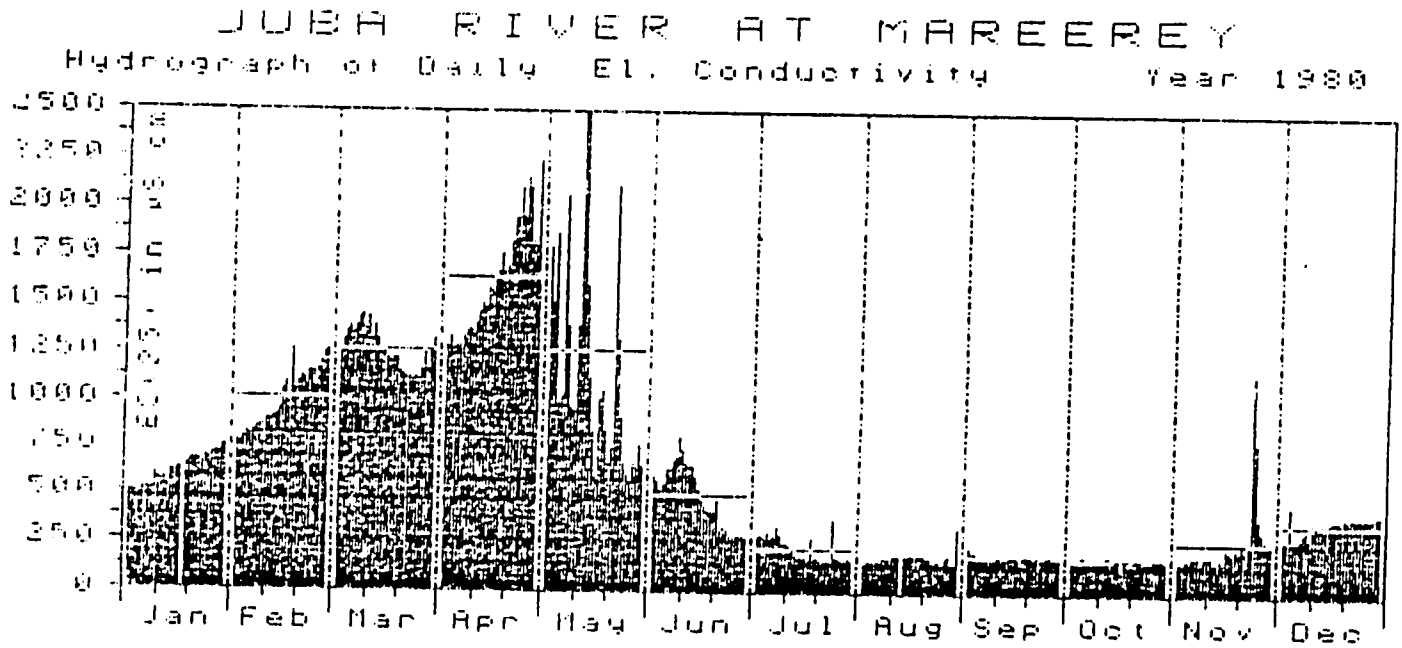
Under the term "water quality" both salinity and sediment concentration is understood. Organical pollution appears not to be a problem.

One or two saline crests do occur at the beginning of the Gu season. They rise rapidly (12 - 18 hours) and fall away almost as rapidly. The absolute peak measured in Mareerey between 1978 and 1984 was 4,700 micro S/cm in 1980. Values above 2,250 micro S/cm (irrigation water class 4) are observed almost every year, but during one to three days only.

As the saline crests occur either just before or during the rise of a single flood wave, they are only related to low and medium water discharges. It is generally assumed that the increase in salinity is due to the fact that salts which have accumulated at the surface during the dry season, are washed into the river by the first rain of the year. Obviously, this phenomenon takes

place only in some of the various sub-catchments, otherwise the number of saline crests would be higher. The Der floods may also cause some increase in salinity, but not up to agriculturally critical values (750 micro S/cm).

Figure 15



However, such values are often exceeded during the end of the low flow period. In the range of tidal influence (up to Kamsuma), the situation may be worse because of the intrusion of sea water.

Throughout the year, high salinities are mainly caused by chloride. Referred to total salt content, the portion of chloride ranges from 10 - 20 per cent (low salinity) to 40 - 60 per cent (high salinity). At the Sugar Project, the following linear correlation was established between chloride content Cl (in milliequivalent/liter) and electrical conductivity EC_{25} (in milli S/cm):

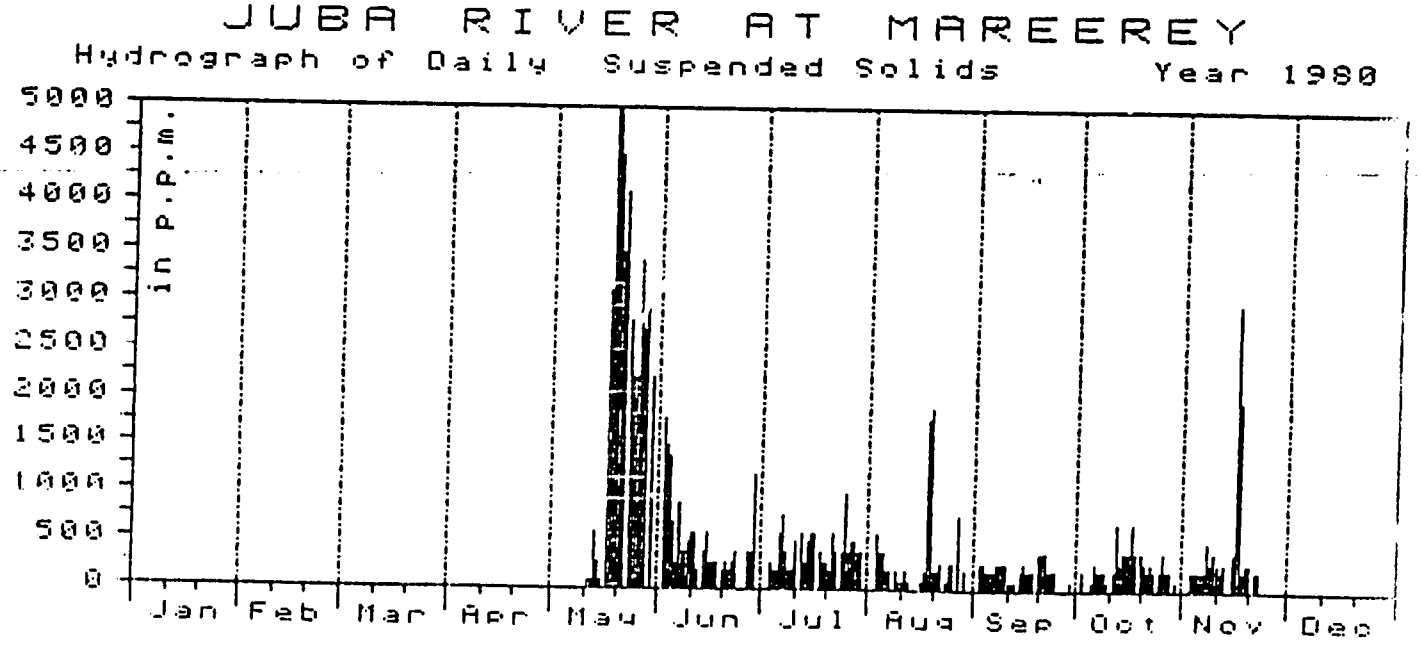
$$Cl = 5.25\ EC_{25} - 0.77$$

During Xagaa and Der, electrical conductivity is usually below 250 micro S/cm (i.e. irrigation water class 1). During this time, bicarbonate is the predominant anion, but it is also significant throughout the year. Concentrations of sulfate ions are rather low and have their highest concentration (relative to other ions) during the period of low salinity.

Calcium and magnesium are the predominant cations, but not during periods of low water levels and not during saline crests, when sodium predominates.

In order to get a comprehensive picture of the transport of undissolved solids, many more measurements are required than are at present available. Both the characteristics of rainfall, causing the runoff (short, heavy rainfall or long, moderate one) and the erodibility of the sub-catchment, where the runoff is formed, influence the sediment concentration of the river water. As with salinity, sediment content is highest during the onset of the flood, especially after the Jilaal season, when the vegetation cover has been reduced. Relations which express sediment transport simply as a function of discharge are therefore inaccurate. The best approach would be to perform daily measurements of sediment concentration over a period of several years. This was done in 1980/81 at Mareerey, but samples were probably taken from the surface near to the river bank and are thus not representative. Nevertheless, these records are very useful to show the variation of suspended sediment concentration.

Figure 16



It generally varies from 100 to 800 ppm during periods of flood recession and/or constant flow. The relationship established in 1977 by Sir M. MacDonald

$$Qs = 0.212\ Qr^{1.97}$$

with Qs = sediment transport in tons/day
and Qr = water discharge in m^3/s,
may be valid for these conditions.

The mean annual discharge of the Juba River of 210 m^3/s would thus correlate to about 8,000 tons/day or 440 ppm. During the rise of the Gu floods, values between 3,000 and 10,000 ppm may be expected.

In the above considerations, only suspended load transport was analyzed, but not bed load, which is much more difficult to measure. As the bed material of the Juba is of rather uniform grain size, it may be more appropriate to calculate it through formulae based on tractive force theories.

2.2.4 Present Water Use

Crop water use at pump level for the various irrigation perimeters in the Juba Valley is shown in Table 3.

Table 3 : Present Crop Water Use at Pump Level in Irrigation Perimeters in the Juba Valley

District	Seasons				
	Jilaal	Gu	Xagaa	Der	Annual total in million m^3
	in million m^3				
Bardheere	5.33	8.31	11.16	8.38	33.18
Jamaame/Kismayo					
- Banana farms	70.20	68.22	70.20	69.21	277.33
- Fanoole Rice Scheme (1)	-	2.30	-	2.30	4.60
- Juba Sugar Estate (2)	38.40	24.00	27.60	30.00	120.00

Source: Ref. 19, ANNEX 2, Table 25

1) Based on a cropped area of 225 ha per season; water use at gate level.
2) Information from Juba Sugar Project and estimates.

In order to compare the amount of the water intake and the availability of water in the river Juba during the different seasons, the figures shown above have been converted into m^3 per sec. The results of these calculations are shown below:

- Bardheere District:
  - Jilaal season 0.7 m^3 per sec
  - Gu season 1.1 m^3 per sec
  - Xagaa season 1.4 m^3 per sec
  - Der season 1.1 m^3 per sec

- Jamaame/Kismayo Districts:
  - Jilaal season 14.0 m^3 per sec
  - Gu season 12.2 m^3 per sec
  - Xagaa season 12.6 m^3 per sec
  - Der season 13.1 m^3 per sec

The figures shown above for the Jamaame/Kismayo Districts have to be raised by 1.5 m^3/s in the Jilaal and Xagaa seasons. This amount of water is led into the main irrigation canal of the Fanoole Rice Project in the dry seasons in order to maintain a certain water level in the canal system to prevent the canal dykes from drying out and cracking.

In addition, allowance has to be made for water offtake for animal and human consumption. This amount cannot be quantified at present, since the number of animals and people using water from the river is unknown.

During field research work, it could be observed that irrigation water use on the banana plantations is exaggerated. This is partly due to a low field irrigation efficiency. On the other hand, due to limited diesel supply, the Juba Sugar Project is pumping less water than would be appropriate.

2.2.5 Water Management

No water management at all takes place on Juba waters, i.e. there is no coordination of take-off between the different important users like Fanoole Project, Sugar Project and banana farms. In the near future, the Mogambo Project has to be added to that list. Flood and drought forecasts are not being performed, although protective measures could to a certain extent avoid flood and drought damage.

Currently, during the period between January and April, the flows of the Juba river are not sufficient to satisfy the demand of all users. In 1984, the situation was especially severe. The unusually late onset of the floods was worsened by the poor communication between recording stations and projects. The Fanoole Project required at that time 1.5 m^3/s. Being without information about river flows from its station at Luuq, it was believed that the natural river flow was about that amount and the weir therefore completely closed. Actual discharge was 8 m^3/s, but most of this was percolating in the reservoir area. The Juba Sugar Project could not pump any more water for irrigation, because downstream from the Fanoole weir, the river was almost dry. Downstream from Kamsuma, due to groundwater influx, there was again water in the river, but it was almost stagnant and had a very high salinity. Having no information about the salt content, this water was used for irrigation of bananas, thus causing severe damage to the plants.

This experience from 1984 makes it clear how vital a water management system is. The increase of areas under irrigated agriculture will make the situation even more critical.

2.6 Conclusions

Comparing the water availability in the Juba during the different calendar seasons and the water pumped at present from the river, the following conclusions can be drawn:

- Sufficient irrigation water in all agricultural seasons is available in the Bardheere District.

- Water in Jamaame/Kismayo and Jilib Districts is insufficient during Jilaal season, in particular:
  - In two out of ten years there is insufficient water to irrigate the perennial crops adequately during the months from January to April.
  - In every second year the amount of water in the Juba is insufficient to irrigate crops between beginning of March to mid April.
  - In one out of ten years river flow downstream of the Fanoole weir is close to zero.
  - In only two out of ten years is there sufficient water to satisfy all water users.

- Based on these findings, it can be stated that in line with information received from the farmers in Jilib, Jamaame and Kismayo Districts, water shortage affects the growth and yields of the perennial crops.

- Furthermore, the intrusion of salt water from the ocean is noticed during the dry season of Jilaal, during very dry years up to Kamsuma. As the farmers are not aware of the quality of the water, they pump it onto perennial crops, thus causing severe damage.

- Deshek cultivation is uncertain because of the irregularity of floods. Crops are often destroyed by unexpected floodings.

- Every second year bankful discharge is exceeded, i.e. inundations take place. Catastrophic floods such as the one of 1981 are likely to occur every nine years.

- Salinity in the Juba waters is relatively low and does not present a major risk for agriculture (Exception: intrusion of ocean water in the lower reaches).

- Information on sediment concentration is scarce, but from the limited number of measurements it can be concluded that suspended sediment load is quite low.

- A water management system for the Juba River is virtually non-existent. This would involve coordination of water take-off, flood forecasting as well as a communication system. First steps to establish such a system have been undertaken at the MJVD.

- Average annual water discharge is around 6,400 x $10^6 m^3$, or 200 m^3/s. Allowing for a minimum permanent flow of 10 m^3/s and for other than irrigation uses, this quantity would be sufficient to irrigate at least 200,000 hectares if the water flow could be regulated.

2.3 Human Resources

The situation concerning population statistics is most problematic. The last and so far the only nationwide census was undertaken in 1975. This particular year was a year of extreme drought and consequently, a considerable distortion of results must be assumed, due to a high degree of nomadic movement. In addition, the census was combined with the "Ololaha" campaign, a mass adult education and vaccination programme and only participants in this campaign were enumerated. Total population figures for a particular area were simply taken from the campaign records stating the number of registered persons and persons medicated. As population number the highest figure for each District was taken.

Therefore on the one hand, the official figures were certainly underestimated. On the other hand, as always

occurs in periods of drought, many nomads had migrated to the river valleys, thus inflating the population figure for the region. No realistic quantitative estimate of the two contrary movements is possible. In addition, the census was based on an administrative/political division of the country into Regions and Districts that was changed between 1976 and 1983.

As a result, it is extremely difficult to estimate the overall population as well as the breakdown per District. Since no other source than the census of 1975 has been available, estimates in all recent documents are based somehow on the 1975 figures. However, different assumptions and analytical methods lead to quite different results about present population. Analyzing the results and the different approaches of a considerable number of documents, it can be assumed that the overall population of the three Regions Lower Juba, Middle Juba and Gedo amounts to between 800,000 and 860,000 in 1984. Assuming this range, it has to be taken into account that there are considerable fluctuations from year to year as well as between the seasons due to the migration of nomads. In general, population is higher in dry seasons and in dry years because of an increased influx of nomads to the riverine areas. Not included in this estimate are the refugees settled in camps in the Gedo Region. Here again, no reliable figures are available.

As long as no new detailed population census, or at least a survey based on aerial photography, is carried out, the above rough estimate has to be applied.

An important assumption for further planning is the population growth rate. Estimates are entirely based on theoretical assumptions and range from 3.3 to 2.7 per cent. Given that life expectancy in Somalia is one of the lowest in the world, the lowest rate of 2.7 per cent is applied.

Impresit (Ref. 6, Voll III, Chapter 3, Table 3-8) presents a breakdown of population on the District level which seems to be the most realistic one. It has been taken as a basis for a population estimate of the core development area which is of major importance for further planning. Table 4 shows the Impresit estimate for the year 1978.

Table 4 : Population per District 1978 (Impresit)

District	Total	District Centre	Major Villages	Minor Villages
Kismayo	46,720	37,500	4,010	5,210
Jamaame	68,390	20,000	10,140	38,250
Jilib	50,660	15,000	20,700	14,960
Bu'aale	17,920	7,000	7,380	3,540
Dujuma	29,140	28,000	-	1,140
Saakow	10,690	3,500	1,800	5,390
Bardheere	34,180	10,000	3,600	20,580
Total	257,700	121,000	47,630	89,070

In order to achieve updating of this structure to 1984, the following assumptions have been applied:

- The population of Dujuma has been reduced to some 5,000 people due to large movements to take up employment in the Juba Sugar Project at Mareerey. Therefore, the proportion of 23,000 of the 28,000 inhabitants of Dujuma are transferred to Jilib District under "Major Villages".

- A growth rate of 2.7 per cent per year is applied to all Districts, a higher rate is estimated only for Jilib town (6 per cent), withhigher growth of this centre mainly due to the initiation of development projects.

- The population of Dujuma is included in Bu'aale District.

- The reservoir area is excluded here.

According to these assumptions, the population structure would be as shown in Table 5.

Table 5 : Structure of Settled Population by District (1984)

District	Total	District Centre	Major Villages	Minor Villages
Kismayo	54,800	44,000	4,700	6,100
Jamaame	80,200	23,400	11,900	44,900
Jilib	86,200	21,300	47,300	17,600
Bu'aale	26,100	8,200	13,700	4,200
Saakow	12,200	4,000	2,100	6,100
Bardheere	40,100	11,700	4,200	24,200
Total	299,600	112,600	[illegible]	[illegible]

In order to find out the proportion of people occupied in different sectors, the following percentages have been assumed:

Sector	Somalia	Juba Valley	Core Dev. Area
Nomadism	60%	65%	38%
Agriculture	20%	23%	38%
Sec./Tert.	20%	12%	24%

As far as nomadism is concerned, this would imply that some 184,000 nomadic people have to be added to the 300,000 sedentary inhabitants of the core development region. It is estimated that roughly a further 200,000 to 300,000 nomads are involved periodically in movement to the Juba River.

The breakdown of population depending on occupation in the three different sectors would show as follows:

- Nomadic livestock holding: 184,000 ≙ 38%
- Agriculture: 184,000 ≙ 38%
- Secondary/tertiary sector: 116,000 ≙ 24%
- Total population of core area: 484,000 ≙ 100%

Impresit has assessed the available material on average family sizes (Ref. 6, Vol. III, p. 35) and concluded that an urban family would have 6 members on average and a rural family 7. An inventory of all registered farm-holdings done by the MJVD in 1983 (Ref. 10) showed a result of 19,300. Adding a margin of non-registered farmers and about 5,000 families depending on the Sugar Project and the Fanoole Project, the inventory coincides with the above estimate as far as agricultural population is concerned. As for the population depending on occupation in the secondary and tertiary sectors, estimates made for the districts of Kismayo, Jilib and Bardheere confirm roughly the result derived here.

It has to be pointed out here that all figures on population are of indicative character only. No reliable survey has been carried out so far. The figures are rough estimates derived from previous studies, analyses of the assumptions made there and observations made in the area. Moreover, population estimates in areas influenced by nomadic migration are rather difficult to conduct, not only due to the fluctuations caused by migration, but also from the point of view of exact definitions and, subsequently of clear classification criteria.

The same holds true when these considerations are extended to labour force availability. It can be assumed that in the agricultural sector out of a farm family of seven members, on average 2.5 are full labourers. Thus,

the agricultural labour force in the core development area would amount to about 65,000 at present. This merely quantitative estimate does not allow further conclusions about the work force reserves for future development. There are a whole series of qualitative questions to which answers can be found only through extended sociological research work:

- actual average working time,
- proportion of semi-settled families,
- process of sedentarization,
- conditions under which this process takes place,
- appropriate measures to control this process,
- average area cultivated by one labourer or one family,
- possibilities of increasing the relation cultivated area/labourer,
- willingness of refugees to be re-settled,
- problems of part-time and seasonal employment,
- repartition of work among family members,
- attractive income,
- land tenure problems,
- marketing facilities and influence of prices for agricultural produce.

At present there is practically no information concerning such problems and subsequently concerning the labour force potential. All that can be done is to draw some rather superficial conclusions from the research work conducted so far at the MJVD:

- There is no labour shortage in small-scale and deshek agriculture. Labour is not a bottle-neck for an extension of this sector.

- People clearly prefer to cultivate their own land, rather than to work as hired labourers on large-scale projects.

- The management of the large-scale projects (Juba Sugar and Fanoole) complain about serious labour shortage especially in peak times. Salaries paid are obviously not high enough to attract a sufficient number of labourers, although from a mere quantitative point of view there is under-employment in the area.

- A quite high proportion of agricultural work is done by women.

- Due to problems in the nomadic livestock sector (rangeland capability, water availability, market capacity), a process of sedentarization takes place.

A labour force reservoir may exist in the following population sectors:

- A natural growth rate of 2 per cent is assumed for the population presently active in agriculture (2.7 per cent of overall natural growth rate minus 0.7 per cent of out-migration). However, this growth will be absorbed by an extension of small- and medium-scale farm holdings.

- If irrigation agriculture offers attractive incomes and working conditions, it can be assumed that people will migrate to the core development area from the rest of the Juba Valley, the adjoining rainfed agriculture areas and possibly from other parts of the country.

- The future labour force surplus in the nomadic sector will have to search for gainful employment in other than the livestock sector. The process of sedentarization observed at present will very probably not only continue, but increase substantially. It will depend on the attractiveness of irrigated agriculture, whether a considerable proportion of that group will settle in the Juba Valley.

- A considerable number of refugees are still living in camps. Although a relatively high percentage consists of children, women and elder people, a certain proportion may be considered as a labour force reservoir for future development in the Juba Valley.

3. Present Stage of Development

3.1 Settlements and Infrastructure (1)

3.1.1 Settlement Pattern and Hierarchy

The settlements of the area may be classified in five categories:

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1) This chapter presents a summary of the Settlement and Infrastructure Interim Report, published by the MJVD in March 1984. The study of that survey was restricted to the core area between Bardheere and Yontooy, thus all considerations and figures of this chapter refer to the same area. The townships of Kismayo, Luuq, Garbaharey, Faxfaxdhun and Afmadow are excluded, although all of them are of importance for the future development of the Juba Valley (especially Kismayo). They had to be excluded, because there is not sufficient information available about their population, infrastructure, role as a central place, etc.

Category I: Primary Urban Centres
This category includes towns of more than 10,000 inhabitants and presence of infrastructural facilities which imply inter-regional influence. This includes inter-regional central administrative public and non-public services, crafts and industries and important non-food commercial establishments. Of this category and apart from Kismayo, two towns exist in the study area: Jilib and Bardheere.

Category II: Secondary Urban Centres
Towns of this category are defined as being larger than 3,000 inhabitants and having important regional and inter-district infrastructural facilities, such as regional and district administration, important commercial, industrial and crafts establishments, which, however, are limited to relevance within the region or district itself. Jamaame, Saakow and Bu'aale are towns of this category.

Category III: Primary Rural Centres
This group includes 12 villages that may be rather large population-wise, but they would lack key urban facilities. In some cases they may have a dominant factor, such as geographical key location (e.g. junction of inter-regional communication links, bridge) or important sectoral facilities (e.g. secondary school), but such factors would be limited and would lack the complexity required to be defined as urban.

Category IV: Secondary Rural Centre
Under this group, which comprises a total of some 45 villages, generally with a population of 1,000 - 2,000 those villages are included that serve administratively and infrastructure-wise as local poles of gravity for a number of more than 8 small unclassified villages and one or two "Satellite" villages of category V. The criterion to be included under this group is the presence of more than one infrastructural facility or factor, or a particularly large area of influence with high rural population density.

Category V: Tertiary Rural Centre
This category comprises 76 villages of population over 500 that include just one factor of dominance over few surrounding small unclassified villages (e.g. a primary school, a community health worker, a beel chairman, a dominant geographical location).

It can be seen from Figure 17 that the highest proportionate number of low grade settlements exist in the northern part of the valley, where villages are normally smaller and farther apart from each other. The establishment of permanent road links has in the past induced rapid

development and it can be assumed that the construction of the Jilib - Bardheere road only will spark off a considerable self-induced dynamism even without any further consideration of large-scale development projects.

On the other hand, as the Juba Sugar Project clearly demonstrates, large-scale projects attract a great number of people and induce settlements of higher grade or upgrade existing settlements, as was the case with the villages of Mareerey, Hargeisa, Red Sands and "No Name". Even the project centres themselves may in the future develop into places of considerable importance, at least on the district level, because they may include a reasonably sized housing area, be connected with good road links and offer or require central services, such as schools, medical centre, workshops etc.

There is no established system of urban development planning in the Juba Valley. The issue of guidance of physical expansion of towns lies in the hands of municipalities or local governments, mainly concerning the land development committees responsible for land allocation. They are to a certain extent seconded by sectoral administrations for aspects such as road planning and construction, drainage, water supply, etc. But, unfortunately, coordination of all such activities, the setting of priorities, the selection of particular development zones, preconditions for proper urban development, either does not exist, or is informally left to the initiative of motivated people, who, even if they desire to achieve results, lack the required tools for planning and implementation of an institutionalised urban development system.

3.1.2 Social Infrastructure

The level and efficiency of health facilities in the Juba Valley reflects clearly the most difficult situation of the health sector in Somalia.

A multitude of serious waterborn diseases, tuberculosis and diseases caused by lack of hygiene and malnutrition prevails; facilities, equipment and staffing in the public health sector are dramatically insufficient. This fact is aggravated by the seasonal, almost total isolation of a large part of the population due to the lack of transport and communications. Even during the remaining dry period, road conditions and the almost complete lack of transport defeats the transfer of seriously ill patients to health facilities in regional centres or in Mogadishu. The deplorable lack of awareness of the population concerning hygiene and its influence on health conditions is another important fact.

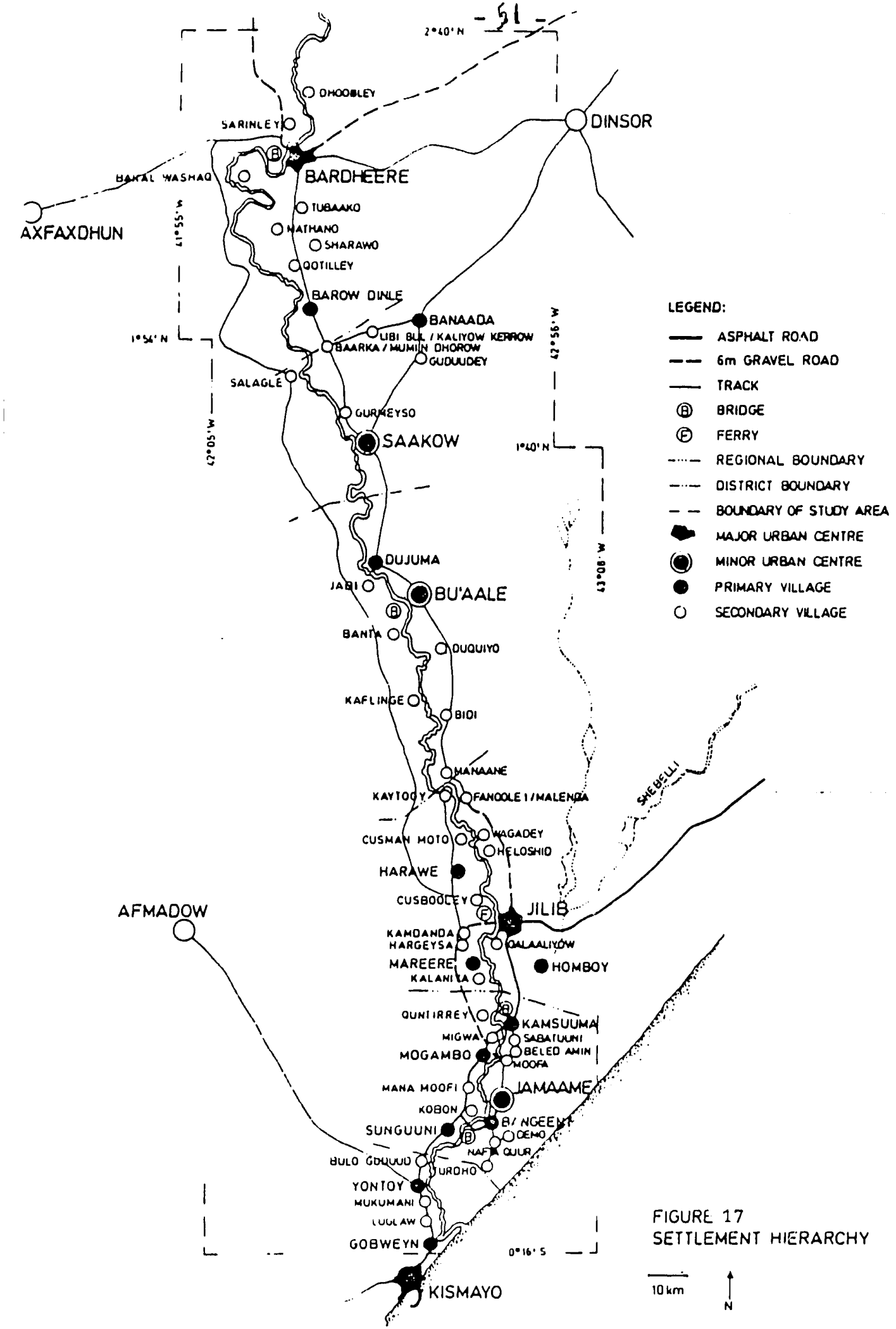


FIGURE 17
SETTLEMENT HIERARCHY

Health facilities are under the Ministry of Health which is represented in each Region and District by Coordinators. The only statistics available at the Ministry of Health are those concerning its employed personnel. Neither information on the prevailing pattern of diseases, nor on in and outpatients in the different health facilities is available.

Table 6 shows the ratios between public health staff and population.

Table 6 : Ratios of Public Health Manpower (1983) by Regions

Region	Population	Population per physician	Population per nurse	Population per all trained staff (1)
Benadir	567,000	2,300	950	400
Mudug[2)]	339,100	339,100	11,300	4,100
Galgadud[2)]	278,800	139,400	13,900	5,800
Gedo	256,100	64,000	3,600	2,300
Lower Juba	296,800	74,200	4,300	1,900
Middle Juba	161,000	53,700	7,700	2,200
Somalia	5,528,400	15,700	3,600	1,600

1) excluding physicians and technical staff
2) included for comparison

Source: Ref. 16, p. 29.

A number of interesting conclusions can be drawn from this table:

- There is an extraordinary imbalance between the situation in Mogadishu (Benadir Region) and rural areas which influences the overall national ratios.

- The regions in the study area are well below the national average. They are however, better equipped than other regions and range somewhere in the overall average of the rural areas.

- Considering the information of the Ministry of Health that even in Mogadishu drugs, supplies and equipment are seriously short and that there is a lack of qualified staff, it is obvious that the situation in rural areas is objectively dramatic.

Including Kismayo, only about 200 hospital beds are available in the area in two regional hospitals in Kismayo and Bu'aale, one TB hospital in Kismayo and four District hospitals in Jamaame, Jilib, Saakow and Bardheere. Moreover, there is a Leprosy Centre in Alessandria. Since all hospitals are very poorly equipped and drug supply is very limited, frequentation is rather low.

The Ministry of Health started a Primary Health Care Programme in 1982 with the purpose of covering the whole of Somalia. In 1984, only the Gedo Region was included in the activities of that programme.

In the Middle Juba Region, the situation will improve through a primary health care programme set up by the Swedish Church Relief Group.

The situation in the educational sector is somewhat better than in the health sector. Nevertheless, here also a marked imbalance between the urban centres and rural areas can be stated, although the Ministry of Education has in the past made considerable efforts to achieve rapid development of the sector both in urban and rural areas. It has been possible within the last ten years to considerably decrease the level of illiteracy of the population as a whole. In the same period, the percentage of school attendance of the age bracket from 6 - 15 was raised from 15 per cent to 24 per cent with an increase of female attendance from 23 per cent to 35 per cent.

According to information and observations in the field, the following problems and shortcomings exist:

- Farm families are reluctant to send their children to school for three reasons:
  - they cannot afford the expenses involved,
  - they need the childrens' labour force on their farms,
  - the distance to the next school is too long.

  Similar problems exist among the nomadic part of the population whose mobility adds to the problem.

- Teachers, although generally sufficient in number, are on average young (about 25 years) and not very experienced. Particularly in rural areas, secondary school graduates act as teachers during a one year period of national service, a system which is doubtful with regard to skill and continuity. A serious shortage of teachers could be observed in the secondary schools.

- School premises are often inadequate, particularly in the case of elementary and intermediate schools in rural areas. They also lack sanitary facilities and water supply.

- Teaching equipment, particularly audio-visual aids, demonstration equipment and material are almost completely lacking because of limited financial resources.

3.1.3 Physical Infrastructure

The existing road network in the Juba Valley is presented in Figure 18. As can be seen from the small map insert, the area is in a key location in relation to the national and international net-work of primary trunk roads in the South of Somalia with links to Kenya and Ethiopia. It is dominated by the sphere of influence of Kismayo, with international port and airport facilities.

Whereas the primary trunk road axis Mogadishu - Kismayo via Jilib is presently in good condition (the section Jilib - Kismayo however, requires rehabilitation), and the axis Mogadishu - Bardheere via Baidhabo is presently under rehabilitation and upgrading, no North-South link exists between Luuq/Bardheere and Jilib. Thus, every year twice, almost the entire middle Juba Valley is inaccessible and all North-South communication interrupted. The unsurfaced track between Jilib and Bardheere has extensive sections of black cotton soil and becomes totally destroyed by every rainy season.

In the following, a brief description of the main roads is given:

Jilib - Mogadishu (370 km)

The section of trunk road starting from Jilib in the direction of Mogadishu was completed in 1983. Nevertheless, first serious deteriorations can be observed mainly around Modun.

Jilib - Kismayo (110 km)

This road is asphalt surfaced throughout. In some sections, the body of the road is breaking apart longitudinally and the heavy traffic for the construction of the irrigation projects as well as for the transport of agricultural produce has resulted in serious road deformation beyond repair. As is the case with all roads in general, the total lack of periodical maintenance and repair, particularly of eroded shoulders, contributes to rapid deterioration.

Bardheere - Baidhabo - Mogadishu (470 km)

This trunk road is partly under construction (Bardheere-Baidhabo) and partly under rehabilitation (Baidhabo - Mogadishu) as a 6m tarmac road. Bardheere is accessible during the whole year.

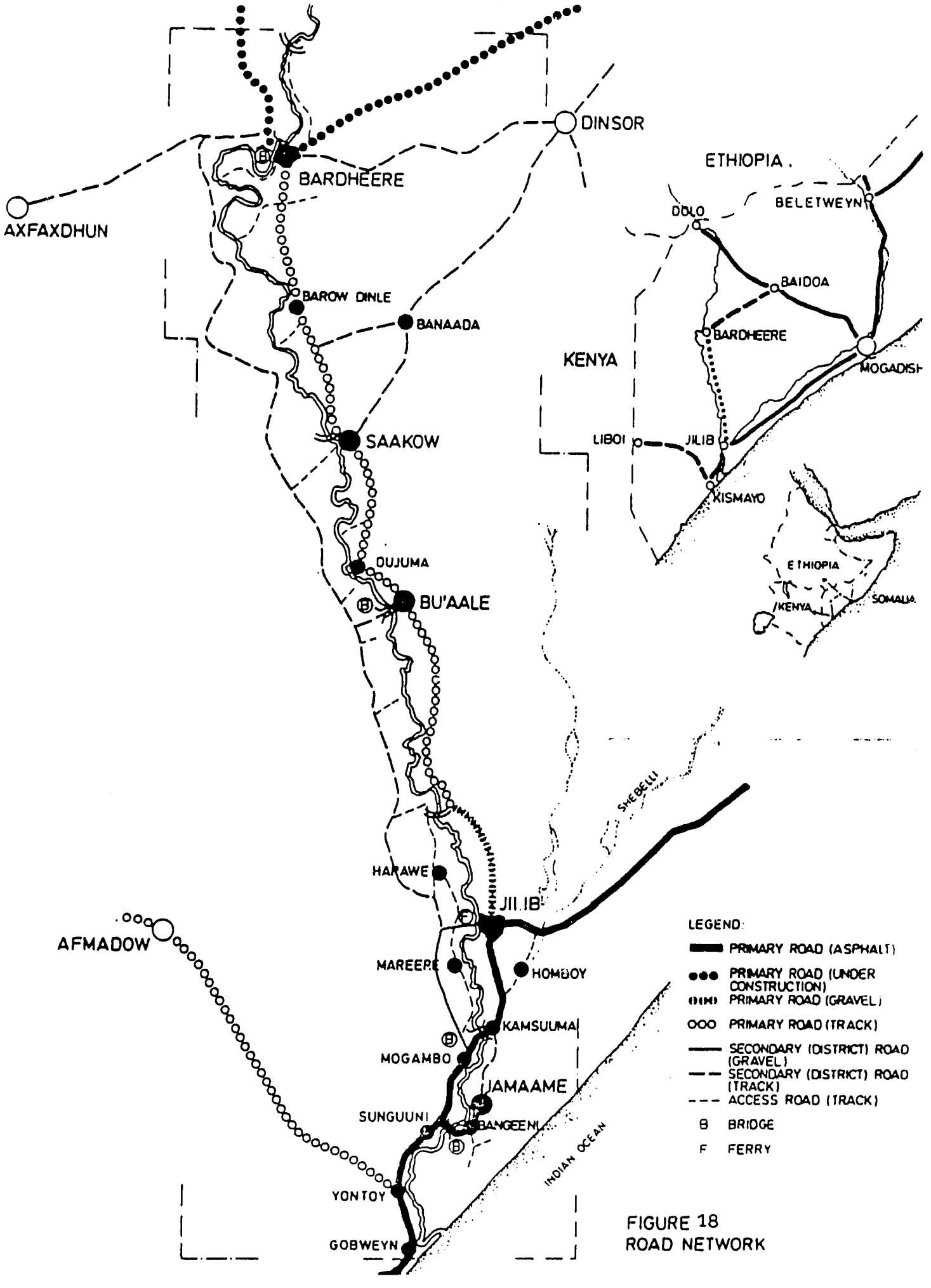


FIGURE 18
ROAD NETWORK

Araare - Jamaame (15 km)

This section is asphalt surfaced and in relatively good condition (including the Araare bridge). However, traffic density is quite low.

Mogambo - Mareerey (35 km)

This is a newly constructed gravel road as access to the Sugar Project. It is in good shape, since the Sugar Project takes care of maintenance.

Jilib - Fanoole 1 (35 km)

This section was constructed by the Fanoole Project as an access road to the site of the diversion weir. The Fanoole Project carries out some maintenance work.

Bardheere - Mareerey (right bank) (290 km)

This road is a seasonal track not subject to any maintenance and hardly used for motorised traffic, apart from short sections close to the Bardheere, Bu'aale and Fanoole bridges.

Fanoole 1 - Bu'aale - Saakow - Bardheere (230 km)

This road, despite its importance as an inter-regional link of the category of a primary national trunk road, is only a seasonal track without defined alignment and unusable during the wet seasons. As such, the period, during which it can actually be used, may only be some 4 to 6 months per year, a fact which has numerous repercussions on economic and social conditions in almost the whole Middle Juba and Gedo Regions.

Bardheere - Garbaharey - Luuq

This road as well is a bush track only, although there are only few sections of black cotton soil. The road is partly being upgraded to a gravel road.

Other district and access roads

Throughout the Juba Valley, a number of tracks exist, e.g. between Bu'aale/Saakow/Bardheere and Dhiinsor, Bulo Guduud and Afmadow, Kismayo and Badaade, Mareerey and Kenyan border. All of these tracks are seasonal and even during the dry season motorable for strong vehicles only. Several other tracks exist providing access to villages located off the main roads. All of these tracks are in very poor condition, seasonal and not subject to any maintenance.

Road construction and maintenance is generally the responsibility of the Ministry of Public Works. Execution of projects is delegated to the National Highway Department or the Somali Construction Agency. Both organizations are maintaining basic staff and equipment for such tasks, including sub-stations in regional centres. However, efficiency is in both cases limited by a general lack of qualififed staff and equipment. To some extent, projects are also totally or partly sub-contracted to private enterprises. Bigger construction and rehabilitation projects are normally carried out by international contractors.

Post and telecommunication facilities exist in Regional and District centres only. They are extremely deficient both in quantity and in quality of premises and equipment. At present, only Kismayo has a direct TC link to Mogadishu by microwave via Merca with automatic and manual telephone, morse and three telex lines. Jilib and Bu'aale have a line of sight HF link each to Mogadishu. Manual telephone links exist between Kismayo, Jilib and Jamaame.

The three major projects in the Juba Valley, Fanoole, Mogambo and Juba Sugar, as well as the Fisheries Project in Kismayo, have their own independent telecommunication links to Mogadishu. In the northern part of the valley, morse links exist between Bu'aale and Saakow/Dujuma and Bardheere. Further north in the Gedo Region, a morse link connects Luuq to Garbaharey which, again, has HF communication to Mogadishu.

It appears that any communication along the Juba River between Luuq and Kismayo is rather complicated, unreliable and time consuming.

Post offices exist in each District Centre for mail conveyed by road using private vehicles. This service is severely hampered by seasonal inaccessibility.

At present, apart from the large-scale projects, a total of 11 towns have electrical supply from diesel generators. Due to the high cost and frequent shortages of diesel, supply is normally restricted to some hours during the evening. Another problem is maintenance of, and the limited availability of spare parts for, the generators.

The Fanoole weir has an installed turbine capacity of 4.6 MW and an additional diesel power station of 1.62 MW. Operation of the turbines is limited to periods with medium river flow, because in low flow periods water pressure is not sufficient, and in high flow periods the difference between water levels in front of and behind the weir is too small.

Apart from public networks quite a considerable number of private generators exist in factories, on banana farms and in commercial enterprises: 42 generators with capacities ranging from 12 to 500 KW.

In general it can be concluded that electricity supply is insufficient. It can only provide a rudimentary illumination and any use for economic purposes, even on a small scale, is impossible. This fact also contributes to the economic stagnation of the area, particularly in places that lack road access in addition.

The water supply system in the Juba Valley is very rudimentary too. A piped supply system exists only for the town of Kismayo, where a treatment plant at Yontooy provides 3,000 m^3 per day which is conveyed to the town by a 16" pipeline. The system is subject to leakages and installations are in need of repair and maintenance.

Deep wells exist in Jamaame, Jilib, Bu'aale, Dujuma and Saakow. Water is pumped to overhead cisterns, from where it is either conveyed by pipes to public fountains or directly collected by the people. A number of deep wells have been drilled in the rangeland area between the Juba and the Kenyan border for animal and human consumption. According to information collected in that area, water is mostly brackish and thus a permanent source of diseases for men as well as for the animals.

In a number of villages, shallow wells have been constructed, partly on a self-help basis, partly (only south of Jilib) by the Water Development Agency. The quality of the wells varies considerably. In some cases, they are well lined and properly kept, but many are neglected and polluted.

The common sources of water for drinking and other uses, however, are the Juba River, desheks, water ponds and a number of water collecting basins ("wars") which have mostly been constructed in self-help with food aid provided by the Ministry of Livestock. In all these cases, water is used under most deplorable hygienic conditions, livestock and humans sharing drinking water from muddy, bilharzia polluted, mostly stagnant ponds.

3.2 Present Land Use

3.2.1 Introduction

The picture of the present land use in the Juba Valley is still incomplete. Apart from fairly comprehensive information on irrigated and deshek agriculture in the small and medium sized farms and on the large irrigated projects,

no further reliable information exists. Little is known about rainfed agriculture, which constitutes an important economic factor in the area. There is also a gap with regard to information on the use of rangeland as grazing grounds for nomadic herds. There are only vague ideas about the magnitude and moving patterns of animals and the lands required to maintain the traditional nomadic system. Nothing is known about arrangements between the nomadic herdsmen and the settled agriculturalists as regards the use of rangelands and cropped fields for grazing, the existence of passage corridors, grazing reserves or access corridors to water points at the river or at lakes and desheks. Neither is there information on land use for purposes other than agricultural and livestock production, e.g. the exploitation of woodlands for charcoal production, hunting, beekeeping, fishing etc.

It is expected that the "Southern Somalia Land Use Survey" which will be published in early 1985, together with the survey on rainfed agriculture which will be carried out by MJVD during the course of 1985 and also the envisaged Environmental Study, will answer these questions which are still outstanding on present land use in the Juba Valley.

3.2.2 Land Tenure

Since 1975, when the Land Registration Law came into force, all land is state owned and the Government is entitled to grant timely limited concessions to individuals or groups which give them the right to land use for certain purposes under defined conditions.

It is generally known that countrywide the reach of the Land Registration Law is limited to the more densely populated urban areas and to those areas which are more intensively used for agricultural production along the Juba and Shebelli Rivers and in the Inter-Riverine area. It is assumed that the traditional livestock sector is still based on the ancient nomadic land use rights. These rights and in particular the customary land use patterns of the nomadic and semi-nomadic population in the Juba Valley are due to be carefully investigated.

The Land Registration Law does however have a certain effect on the crop cultivators in the Juba Valley. Under this law the Ministry of Agriculture is responsible for granting leases by registration of individuals or corporations for a period of 50 years. The leases, though renewable and inheritable, can not be sold or

transferred. The land use right of registered farmers ceases if the state needs the land for certain purposes. In this case however, the farmer has the right to compensation for immovable assets which he has placed upon the land. The farmer automatically loses his right to the land if he fails to use it for a period of two years after registration. Despite the fact that area limits for individuals of 30 hectares for irrigated land and 60 hectares for rainfed land are laid down, in practice these limits are exceeded.

Registration of the private small and medium sized farms has been carried out by the Ministry of Agriculture's Land and Water Department since 1977. The land for cooperatives is registered at the Cooperatives' Administration or at the Settlement Development Agency. The large projects such as the Juba Sugar Project, the Fanoole Project and the Mogambo Project are state farms and are administered by the Ministry of Industries (Juba Sugar) and the Ministry of Agriculture (Fanoole, Mogambo).

The bulk of the farms in the Juba Valley come under the responsibility of the Ministry of Agriculture's Department of Land and Water Resources. Farmers who wish to become registered apply for a certificate at the office of the District Coordinator of the Ministry. The certificates are forwarded to Headquarters at Mogadishu for approval and registration. There are a great number of farmers in the Juba Valley who are not officially registered but who are listed in land books which are kept by the Agricultural Coordinators at District level. The claims of such farmers with regard to use of the land they possess are obviously recognized by the village communities and also by the Ministry, since the inclusion in the land book is regarded as a first step towards registration. However, they do not have the above described rights of registered farmers.

A third group of farmers use the land without being registered or listed at the Ministry of Agriculture. It seems that these farmers are tolerated as long as no land pressure occurs. It is hard to assess without further investigation to what extent the Land Registration Law in reality governs the use of agricultural land in the Juba Valley. It is suggested that in general land tenure in the agricultural areas is still based on customary right rather than on the recently established codified right.

According to a survey (Ref. 10) carried out in early 1983, of the estimated total of 20,000 small and medium sized farms in the Juba Valley about 56 per cent were registered or listed at the Ministry of Agriculture, possessing around 60 per cent of the cultivated land.

3.2.3 Farm Structure

The following farm types can be distinguished in the Juba Valley:

- deshek farms
- small-scale irrigated farms (less than 20 ha)
- medium-scale irrigated farms (20 to 200 ha)
- rainfed farms
- large-scale irrigated projects
- cooperative and other farms.

The deshek farms are located in the natural depressions (desheks) in the flood plain of the Juba river which are seasonally flooded by the river water and in addition can be flooded by ground water flow from the river and rainfall run-off from adjacent areas. The desheks are found in the Districts of Saakow, Bu'aale, Jilib and Jamaame.

Small-scale pump irrigated agriculture is concentrated in the Bardheere District and a small area in the neighbouring District of Saakow.

The medium-scale irrigated farms consist mainly of the banana farms in Lower Juba in the Districts of Jamaame and Kismayo, the total number amounting to 76 with a total cultivated area of about 4,900 hectares. In Table 7 the cultivated area of deshek, small-scale and medium-scale agriculture, the number of farmers involved and the average farm sizes are given.

A further analysis of the farm sizes of each of the different farm types shows that the average farm size of the small-scale irrigation schemes is 3 hectares in Bardheere District and 1 hectare in Saakow District. Medium-scale farms have an average size of 65 hectares. The distribution of farm sizes in the desheks is shown in Table 8.

Table 7 : Cultivated area, number of farmers and average farm size of deshek, small- and medium-scale agriculture at district level in the Juba Valley.

District	Area cultivated in ha			Total cult. in ha	Number of farmers	Average farm size in ha
	Desheks	Small-scale irrigation	Medium-scale irrigation			
Bardheere	-	1,522	-	1,522	450 - 550	2.8 - 3.4
Saakow	1,101	84	-	1,185	1,400 - 1,500	0.8 - 0.85
Bu'aale	2,206	-	-	2,206	2,[illegible] - 2,100	1.05 - 1.1
Jilib	1,525	-	-	1,525	650 - 750	2.0 - 2.3
Jamaame and Kismayo	7,883	-	8,287	16,170	3,600 - 5,100	3.2 - 4.5
Total	12,715	1,606	8,287	22,608	8,100 - 10,000	2.3 - 2.8

Source : Ref. 19 Main Report, Table 2, p. 12.

Table 8 : Distribution of Farms in Desheks According to Size.

Farm size in ha	Saakow	Bu'aale	Jilib	Jamaame and Kismayo
	Distribution in per cent			
0.25 - 1	55	45	42	35
1 - 2.5	25	38	43	40
2.5 - 5	15	13	9	22
over 5	5	4	6	3

Source : Ref. 19, Main Report, Table 3, p. 13.

Rainfed agriculture is carried out in each district of the Juba Valley. However, the centres of rainfed production are Saakow and Bardheere. The distribution of rainfed farmland in the districts, the number of farmers as well as the average farm sizes are presented in Table 9. It must however be pointed out that the figures are only a preliminary assessment giving an idea of the magnitude of this part of agricultural activity, rather than an exact inventory which is due to form part of a survey to be carried out in 1985.

Table 9 : Cultivated area, number of farmers and average farm size of rainfed agriculture at district level in the Juba Valley.

District	Area cultivated in ha	Number of farmers	Average farm size in ha
Bardheere	22,000	4,500	4.9
Saakow	36,000	3,500	10.3
Bu'aale	600	100	6
Jilib	4,000	1,000	4
Jamaame	7,600	1,500	5.1
Kismayo	-	-	-
Total	70,200	10,600	6.6

Source : Ref. 10, 19.

Three large scale projects are under implementation in the Juba Valley, the Fanoole Project, the Juba Sugar Project and the Mogambo Project. All of them are state farms. The Fanoole Project is designed for the cultivation of rice on a total area of 7,500 hectares under irrigation. In 1984, 800 hectares were planted. The Juba Sugar Project had at the end of 1984 about 6,100 hectares of sugar cane under irrigation. The target for the first phase of the project is 7.700 hectares. An extension up to 13,500 hectares is possible in a second phase. The Mogambo Project was by the end of 1984 at the initial stage of implementation. It is intended to cultivate mainly rice on an area of in total 2,200 hectares under irrigation.

In addition to the above mentioned farm types there are a number of cooperatives and other farms such as military and police farms, government workers' farms etc. Although the number of cooperatives amounts to almost 100, they are of no importance as regards agricultural production in the Juba Valley and they will therefore no longer be considered in the present analysis. The same holds true for the other farms which are both low in number and cover a minimal area.

3.2.4 Conclusions

Apart from the three large Development Projects in the Juba Valley the legal aspects of land use regarding agricultural and livestock production as well as the use and exploitation of land for other purposes are still not sufficiently known. Particularly unclear are the land tenure regulations under traditional right which, according to present knowledge, still prevail in the livestock sector and compete with the only recently established codified law in the agricultural sector.

It is considered to be of great importance for future development planning in the Juba Valley to get a clear picture of the land tenure situation of both the agricultural and the livestock sectors in the Juba Valley because they will be directly involved in future development projects. For example, lands will be required for irrigation perimeters, infrastructure and settlements. For the provision of such lands arrangements will have to be made which allow planning to be carried out on a clear basis as far as the rights of land use are concerned.

The availability of data on the present land use situation is also unsatisfactory. There are still major gaps in the fields of rainfed agriculture and livestock production.

It is planned that the analysis of land tenure aspects will be carried out within the framework of the "Environmental and Social Impacts Study" to be conducted by USAID.

Information on the livestock sector can be expected from the "Southern Somali Land Use Survey" which will be available in early 1985. It is not yet known, whether the results of this study will meet the required standards and cover all necessary aspects.

Rainfed agriculture will be analysed by the MJVD in 1985, so that the results will be available on time.

3.3 Agricultural Production

3.3.1 Introduction

As already mentioned in Chapter 3.2.3, the agricultural production in the Juba Valley is carried out by means of different farm categories such as deshek farms, small-scale and medium-scale irrigated farms, large-scale irrigated projects, rainfed farms and cooperatives and other farms.

Detailed information is available on the deshek farms and the small and medium-scale irrigated farms. The information was collected in the course of an MJVD study on "Deshek and Small and Medium-Scale Irrigated Agriculture in the Juba Valley" in 1984 (Ref. 19). Information on the large-scale projects of Juba Sugar, Fanoole and Mogambo was also prepared by the MJVD in 1984 and presented in Project Profiles for each of the projects.

While cooperatives and other farms have been left aside because of their negligible importance, the analysis of rainfed agriculture is still outstanding.

In the following chapters a summary is presented of the issues known with regard to agricultural production.

3.3.2 Deshek and Small-Scale Irrigated Agriculture

3.3.2.1 Crop Production

Desheks are defined as natural depressions in the flood plain of the Juba River. Such depressions are seasonally flooded by the river water and in addition can be flooded by ground-water flow from the river and rainfall run-off from adjacent areas.

Small-scale irrigation perimeters are defined as irrigated areas not exceeding 20 ha.

Four calendar seasons can be distinguished in which crop cultivation can take place:

- Jilaal	21st December	-	20th March
- Gu	21st March	-	20th June
- Xagaa	21st June	-	20th September
- Der	21st September	-	20th December

Gu and Der seasons are the rainy seasons in which cultivation takes place, mainly in desheks. Some precipitation may fall in Xagaa season in Jamaame and Kismayo Districts, but this is not sufficient for crop cultivation. In irrigation schemes cultivation may take place in all four seasons.

Two types of desheks can be distinguished from an agricultural point of view:

- desheks which dry up completely in the course of dry seasons and which can be fully used for crop production,
- desheks where water does not disappear completely. In this type of deshek, crop production is practised at the peripheries.

The main crops grown in all districts of the area are maize as a food crop, sesame and tobacco as cash crops. The area cultivated with each crop however varies greatly between the districts.

In Bardheere District major crops are also onions and bananas, both to be marketed within Somalia.

In Saakow District some sorghum is grown in a few desheks. In the small-scale irrigation perimeters of this district onions are cultivated for inland marketing.

In Jilib District cultivation of water-melons is an important agricultural activity. This crop is also marketed solely within Somalia. Furthermore, some groundnuts are cultivated here.

In the desheks of Jamaame and Kismayo Districts some cotton is grown.

In all districts tree crops are found. Mangoes grow on the banks of the Juba River and around the villages. In Bardheere District papaya trees are found marking the borders of farm holdings.

In Jamaame and Kismayo Districts coconut trees and citrus trees are found. In these two districts only, mangoes and some citrus fruits are sold on the local markets. In the other districts fruit is only sold to a very limited extent.

Interplanting of beans, peas, vegetables (pumpkins, water-melons, tomatoes etc.) amongst maize and sesame is widely practised. These crops are mainly used for home consumption.

The crop varieties in the area are local ones. Only the banana variety Poyo and the cotton variety Acala 4-42 have been imported. The maturing times of the varieties cultivated are:

- maize	100 days
- sorghum	90 days
- sesame	90 days
- tobacco	70 days
- onions	120 days
- cotton	120 days
- groundnuts	90 days
- water-melons	120 days
- bananas	first fruits after around 8 months. Production life of a banana tree is around 3-4 years.

Table 10 shows the cultivated areas in the desheks and of the small and medium-scale irrigated schemes in each district. It also presents figures for the cropped area of each of the main crops in the districts and the total crop production.

In Table 11 a comparison is made between the presently used area (1984) and the potential area which is still available for agricultural activities in these farm categories. The potential area has been identified by means of aerial photograph interpretation (Ref. 19). In Chapter 4.2.2.1 Table 23 of this report, estimates are presented with regard to a possible development of farm land for deshek and small and medium-scale agriculture.

Table 10 : Cultivated and Cropped Areas and Crop Production in Deshek and Small and Medium-Scale Farms per District

District	Total culti-vated area in ha	Area cultivated in ha		Crops	Cropped area in per cent		Total area cropped in ha	Weighted yields in t per ha		Total prod. in t
		Deshek	Irrigated schemes		Deshek	Irrigated schemes		Deshesk	Irrigated schemes	
Bardheere	1,522	-	1,522	maize	-	126	1,918	-	1.50	2,877
				sesame	-	62	944	-	0.60	566
				onions	-	118	1,796	-	8.57	15,392
				tobacco	-	24	365	-	0.53	193
				bananas	-	1	15	-	11.00	165
Totals	1,522	-	1,522		-	331	5,038	-	-	-
Saakow	1,185	1,101	84	maize	125	200	1,544	0.64	1.60	1,150
				sorghum	36	-	396	0.45	-	179
				sesame	39	50	471	0.38	0.60	188
				tobacco	3	50	75	0.30	0.40	27
				onions	-	50	42	-	6.50	273
Totals	1,185	1,101	84		203	350	2,528	-	-	-
Bu'aale	2,206	2,206	-	maize	127	-	2,802	0.54	-	1,513
				sesame	73	-	1,610	0.41	-	660
				tobacco	3	-	66	0.40	-	26
Totals	2,206	2,206	-		203	-	4,478	-	-	-
Jilib	1,525	1,525	-	maize	120	-	1,830	0.97	-	1,775
				sesame	67	-	1,022	0.52	-	531
				water melons	12	-	183	19.90	-	3,642
				groundnuts	2	-	31	0.80	-	25
				tobacco	4	-	61	0.50	-	31
Totals	1.525	1.525	-		205	-	3,127	-	-	-
Jamaame and Kismayo	16,170	7,883	8,287	bananas	-	77	3,804	-	28.00	106,512
				maize	92	21	7,491	1.35	2.30	10,340
				sesame	107	4	8,480	0.44	0.50	3,734
				groundnuts	-	2	23	-	0.60	14
				cotton	3	-	236	0.30	-	71
Totals	16,170	7,883	8,287		203	104	20,034	-	-	-
Grand total	22,608	12,715	9,893		-	-	35,205	-	-	-

Source: Ref. 19, ANNEX 1, p. 72.

Table 11 : Present and Potential Land Use of Deshek and Small and Medium-Scale Farms

District	Cultivated area in ha (1)	Potential area in ha (2)	Percentage of total land (1 + 2) presently used
Bardheere	1,522	2,092	42
Saakow	1,185	2,556	32
Bu'aale	2,206	13,257	14
Jilib	1,525	4,338	35
Jamaame and Kismayo	16,170	10,273	61
Total	22,608	32,612	41

Source : Ref. 19. Main Report, Table 2, p. 12.

3.3.2.2 Cropping Pattern, Cropping Intensity and Crop Rotation

Cropping pattern is defined as the sequence of crops grown on farm holdings and irrigation schemes. In the small-scale irrigation schemes of Bardheere and Saakow Districts, maize and sesame are mainly grown during the rainy seasons Gu and Der. Onions and tobacco are mostly cultivated duringthe dry seasons under irrigation, when plant diseases are less intensive than in the rainy season.

In desheks, crops are often destroyed by floods. Therefore the emphasis is laid here upon the ensurance of the production of the food crop, maize. Both maize and sesame are cultivated during Gu and Der seasons. Tobacco is generally interplanted with maize and sesame at the end of the rainy season, Gu, to benefit from the last precipitations. It ripens in Xagaa season.

Water-melons and groundnuts in Jilib District are grown in Der season.

Cotton in the desheks of Jamaame District is interplanted with maize in Gu season. It is picked in Xagaa.

Although in most desheks crop production is carried out according to the calendar seasons, crops grown on receding flood areas may be cultivated all year round.

Cropping intensities vary between the different production systems. In the small irrigation schemes with the possibilities of irrigation throughout the year, the cropping intensity is 331 per cent per annum in Bardheere District and 350 per cent per annum in Saakow District.

In desheks where the land is used only during the rainy season the cropping intensities amount to slightly over 200 per cent in Saakow, Bu'aale, Jamaame and Jilib Districts.

For desheks and small-scale irrigation schemes, this cropping intensity may seem to be very high. However, it has to be borne in mind that the cropping intensity does not equal the harvest intensity. Crops may be destroyed by floods and re-cultivation on receding flood water areas may also fail, as insufficient water is available for grain and oil seeds to establish or to ripen.

Crop rotation is defined as the sequence of crops grown on the same piece of land over a certain period.

A distinct crop rotation in small-scale irrigation schemes cannot be distinguished. Crops and cropped areas are determined by market demands and food requirements of the farmers. Only in the irrigated perimeters in Saakow District is a crop rotation to be found: maize-maize-onions/tobacco-sesame.

For desheks, the crops grown and cropped areas are determined by the yield achieved in the previous season and the needs of the farmers for cash.

3.3.2.3 Agricultural Practices

Most of the land in desheks and small-scale irrigated perimeters is prepared by hand. Table 12 shows the estimated percentage of the cropped land mechanically ploughed.

Table 12 : Soil Preparation in Desheks and Small-Scale Irrigation Schemes

District	Annually cropped area	Area Ploughed (ha) By tractor	By hand	Percentage of cropped area ploughed
Bardheere	5,038	457	4,581	9
Saakow	2,529	253	2,276	10
Bu'aale	4,478	537	3,941	12
Jilib	3,127	610	2,517	20
Jamaame and Kismayo	16,002	3,942	12,060	25
Total	31,174	5,799	25,375	19

Source : Ref. 19

Ploughing is mainly carried out by the Agricultural Tractor Service ONAT, which is present in all districts with the exception of Saakow. This district is served from the ONAT station at Bu'aale. Farmers growing cotton may rent tractors from SOMALTEX. In some cases farmers own tractors themselves, which they also rent to other farmers.

Mechanical soil preparation consists only of ploughing. Other activities e.g. disc harrowing is hardly carried out, due to lack of equipment. The soil to be ploughed, is well cleared of shrubs, bushes and stumps.

Animals are not used for soil preparatory work.

Soil preparation by hand is carried out with a short-handled hoe. In addition to the loosening of the soil, basins in which crops are cultivated are only prepared in small-scale irrigation schemes and desheks of Jilib District. The construction of basins aims at an increase of field application efficiency during irrigation and an improved water retention of the soil in desheks.

In order to achieve an even better use of water, ridges may be made in the basins by hand. Crops are then grown between, or at the sides of the ridges.

Sowing and planting of crops is carried out by hand. Mostly, seeds from the previous season's crops are used. Maize cobs are stored for this purpose in trees, where according to the farmers, they are less susceptible to insect attacks. Other seeds are stored in the farmers' houses.

Banana shoots are generally taken from the farm itself, but they may be acquired occasionally from the research station at Alessandria.

Re-sowing of crops is widely practised, due to a reduced germination capacity of the seeds and attacks by birds and rats. Tobacco and onions are sown in seed beds and transplanted. Planting is mostly done in rows, but the planting distances vary widely.

The weighted average seed amounts used for the crops are for maize 11 kg, sesame 7 kg, onions 3 kg, tobacco 2 kg, groundnuts 26 kg, water-melons 2 kg, cotton 22 kg and bananas 2,350 shoots per ha.

Inputs for crops grown in desheks and small-scale irrigation schemes are hardly used due to lack of supply and shortcomings in the distribution.

Credits are not available to farmers in desheks and small-scale irrigation schemes. Only cotton growers have access to credits from Somaltex.

Crop maintenance in desheks and small-scale irrigation schemes consists of hand weeding. All farmers in the area carry out at least two weedings per crop. The proportion of farmers carrying out a third weeding varies between zero for the annual crops in the banana schemes in Jamaame and Kismayo Districts to 80 per cent of the deshek farmers in Saakow District. The first weeding is carried out after around 10 days, the second after 35-40 days and the third one after 55-60 days of planting. Only onions and bananas are weeded more often.

Diseases and pests are common in the cultivated crops. Maize is mostly attacked by stalk borer, maize ear-worm and aphids; sesame by leaf spot; onions by thrips; tobacco by sucking insects; cotton by the cotton stainer bug and boll-worms and bananas by the banana root borer and leaf spot.

Severe damage to the crops caused by wild animals such as monkeys, wart hogs, hippopotami and birds (the latter picking the seeds) is reported.

Damage caused by nomadic livestock whilst going to the river for watering occasionally occurs, but problems are always solved in an amiable way. Attacks of queleas do not seem to be a major problem in desheks and small-scale irrigation perimeters.

Harvesting is carried out by hand. Maize cobs are broken from the stalks, heaped and brought home. In Jamaame and Kismayo districts the maize is cut, stacked, left for drying in the fields and later brought home, where the kernels are removed. Sesame is pulled, stacked and later threshed in the fields. Tobacco plants are pulled, sun-dried in the field and taken home where the leaves can be plaited into rings. Onions are pulled, left on the fields for drying, bagged and transported to the markets. Bananas in the small-scale irrigation schemes in Bardheere District are marketed through Ganaana Cooperative at Bardheere. Cotton is picked by the farmers and collected from the fields by Somaltex.

The yields achieved per crop, ha and season vary widely between and within desheks and irrigation schemes. To arrive at a weighted average yield per ha and season, the cropped area per season and crop is multiplied with the average seasonal yields per ha. This figure is divided by the total cropped area of a specific crop.

The weighted average yields per season for the different districts are shown in Table 13.

Post-harvest activities consist of transporting the produce from the field to the villages, storage and use of crop residues.

With the exception of bananas, onions and water-melons, all crops are either transported manually or with donkey carts. In cases where farmers own tractors, tractor and trailers are used for transport purposes.

The percentage of the farmers using donkeys for transport (either owned or rented) varies between the districts. In Bardheere, Jamaame and Kismayo Districts around 90 per cent of the farmers use donkey carts. In Jilib District this figure is 75 per cent, in Saakow 50 per cent and in Bu'aale District 25 per cent.

Storage of the food crop maize is done in underground pits or in barrels. The extent of storage losses in such pits is not determined. Other crops, e.g. sesame and tobacco, are stored in the houses until sold.

The use of crop residues, mainly stalks, is limited. Only farmers with some animals around their houses use the stalks as fodder. Crop residues are hardly even sold. Other crop residues are burned on the fields.

3.3.2.4 Labour

Agricultural activities in desheks and small-scale irrigation schemes are very often carried out by hired labourers. They are mostly engaged in the more strenuous work such as soil preparation by hand, the making of basins and the construction of irrigation systems. Work is mainly carried out on a contract basis and the required labourers are hired in times of need. They come mostly from the same village or from the same area.

Labour is available for all activities in desheks and small-scale irrigation perimeters. However, a strain on labour availability at certain times of the year does occur.

In the small-scale irrigation schemes in Bardheere a special form of employment is found. Farmers take tenants onto their farm holdings and they in turn cultivate a part of the land. The owner supplies mechanisation services, a pump and inputs. The yields are shared either in kind or in money.

Table 13 : Weighted Average Yields in Desheks and Small-Scale Irrigation Schemes

District	Maize	Sorghum	Sesame	Onions	Tobacco	Bananas (1)	Ground nuts (2)	Water-melons	Cotton
	Weighted average yield in t per ha								
Bardheere	1.50	-	0.60	8.57	0.53	11.0	-	-	-
Saakow									
- irrigation schemes	1.60	-	0.60	6.50	0.40	-	-	-	-
- desheks	0.64	0.45	0.38	-	0.30	-	-	-	-
Bu'aale	0.54	-	0.41	-	0.40	-	-	-	-
Jilib	0.97	-	0.52	-	0.50	-	0.80	19.90	-
Jamaame and Kismayo	1.35	-	0.44	-	-	-	-	-	0.30

Source: Ref. 19

1) Average yield per annum
2) Unshelled groundnuts

For the desheks it generally can be said that farmers cultivating up to 1 ha of their own will go as hired labourers. Farmers cultivating up to 1.5 ha hire labourers as well as working as hired labourers. Farmers cultivating over 1.5 ha are in need of labourers to cope with the agricultural work on their farm holdings.

3.3.2.5 Farm Income

In order to gain an impression of the annual enterprise profits farmers receive from their farm holdings, agro-economic calculations have been made for some selected farm holdings, being representative of the various districts. The basis for determining representative farm holdings has been:

- for the small-scale irrigation schemes in Bardheere and Saakow Districts, the average size of farm holdings has been taken as 3 and 1 ha respectively;
- farm holdings of 0.5 and 2 ha have been used for agro-economic calculations of deshek cultivation.

In addition to the income received from crop production, an average amount of 2,400 So Sh per annum, achieved from bee-keeping has been added.

Table 14 : Enterprise Profits for Selected Farm Holdings per District

District	Cultivated area per farm holding in ha	Cropped area per farm holding in ha	Annual enterprise profit in SoSh per farm holding
Bardheere	3.0	9.91	134,631
Saakow	1.0	3.50	30,718
- irrigation schemes	0.5	1.03	4,654
- desheks	2.0	4.06	11,186
Bu'aale	0.5	1.02	4,785
	2.0	4.06	12,012
Jilib	0.5	1.04	7,716
	2.0	4.10	23,419
Jamaame and	2.0	4.06	26,635
Kismayo	0.5	1.03	8,523

Source : Ref. 19.

3.3.2.6 Flooding and Flood Recession

Deshek cultivation with receding water levels largely depends on regular flooding of the depressions adjacent to the river. Most desheks retain flood water for three to six months after the recession of flood levels. Some have permanent lakes, but the majority dry out completely towards the end of the Jilaal season.

To evaluate flooding patterns, present flood protection and farmers' practices in respect to inundated areas, information has been gathered on the sources of flooding, frequency, depth and duration of flooding, present flood-control practices and flood damage.

Flooding may be caused by:

- over-bank flow from the Juba River,
- over-bank flow from its tributaries,
- rainfall induced run-off from the adjacent marine plains,
- rainfall induced run-off from within the deshek and
- ground water.

Flooding caused by the river originates either from the flow over the natural levees between the river and the depressions, from breaches in the levees or from man-made gaps in levees and flood bunds.

In desheks situated along tributaries, flooding may be caused by backwater during high discharges in the tributaries after heavy rainfall in the marine plains.

Run-off from the marine plains is generally not a serious problem unless the catchment area is large. This is the case with a.o. Waamo Deshek (Jamaam District), where natural drainage to the Juba is only possible above a water level higher than the elevation of the agricultural areas along the fringes of the lake. Prolonged flooding (up to five years) may occur and prevents any form of deshek cultivation. Flooding caused by rainfall induced run-off is of importance in desheks which have a large catchment area.

When river levels increase, the ground water table will rise. It may happen that depressions situated below the river level become waterlogged and recharged by ground water.

Flooding from one source may be compounded by water from another source, especially when river levels are high and natural drainage is either difficult or impossible.

The frequency of flooding depends on the size of floods, on the season, the location of the deshek and on the presence and quality of flood protection systems and breaches in the levees and bunds.

The frequency increases towards the lower reaches of the river. This can be attributed to the decrease in capacity of the river bed. On average, the return periods during the Gu season vary from more than ten years in Bardheere Districts to two to three years in the southern part of Bu'aale District. The figures for the Der season vary between four to five years and one year respectively.

South of Bu'aale District, return periods of floods during both Gu and Der amount to one to two years without flood protection systems and five to six years with flood protection systems. The desheks in Jamaame and Kismayo, which are situated on the left bank near the border of the flood plain and the marine plains, experience flooding once in four to five years.

Short duration flooding during Gu is generally caused by run-off after heavy rainfall.

Depth of flooding depends largely on the size of the floods, but ranges from 1 - 1.5 m above the levees and 4 - 6 m in the depressions, depending on the elevation of the depressions.

The duration of flooding is mainly determined by the elevation of the area and the presence of natural drainage. For the levees and areas with natural drainage to the river the duration is seven to fourteen days on average. In the depressions which cannot drain freely, the duration varies from three to six months and occasionally nine months. Recession of the water level is then dependant on the evaporation rate, rainfall, infiltration rate and seepage to the river.

Protection against floods is effected through embankments on the river side and on the side of the marine plains. In Bardheere District, 80 per cent of the small-scale irrigation schemes situated on the banks have a bund between the flood plain and the marine plains. In Saakow and Bu'aale Districts, the rate of protection is about 50 per cent, while this figure amounts to 80 - 90 per cent in Jilib District. Desheks in Jamaame District are hardly protected.

Most flood bunds at the desheks are 1 - 1.5 m high and consist of sandy levee soils. They are poorly constructed and improperly maintained. They are regularly breached after excessive seepage has caused failure at the toe.

Earth-moving equipment for the repair of breaches and the construction of new bunds is lacking. To allow flooding of the depressions during Der, farmers cut gaps in the bunds. These are regularly scoured to 10 - 15 m wide and 1.5 - 2 m deep breaches, which are difficult to close without machinery. A second flood, after the start of cultivation, will inundate the desheks again through the breaches and will destroy crops.

In the districts north of Jilib, cultivation of crops is completely dependant on flood recession. In the districts of Jilib and Jamaame, however, cultivation is mainly practised under rainfed conditions. Most desheks in these districts have a flood. When rainfall in the Der season is insufficient, farmers resort to cutting gaps to flood the desheks and to cultivate crops on areas with receding water levels. The latter practice is also adopted after crops have been destroyed by floods.

Some have been destroyed by floods or bank erosion, others have not survived the many years of lack of maintenance. Canals leading into the depressions are silted and overgrown. A complete reconstruction of embankments and structures will be required if proper flood protection and controlled flooding of the desheks are to be provided.

During floods, large quantities of sand and sandy silt are deposited on the farms near the points of inflow.

Gaps are often scoured to dimensions where closure by hand labour is almost impossible. Occasionally, embankments with irrigation canals are destroyed. Due to bank erosion, flood bunds collapse and leave weak spots.

The most serious damage, however, is the destruction of crops.
Farmers complain about regular crop failure, especially in the Der season at times when desheks and small-scale irrigation schemes (especially in Saakow District) are flooded. Not only are the growing crops then destroyed, but also the crops re-sown after the flood recession will not yield well due to water stress during the tasseling stage.

Activities with respect to flood protection and controlled flooding in desheks are organized by the village heads. In the small-scale irrigation schemes management and organization are either in the hands of the owners or the responsibility of a farmer acting for the owner

3.3.2.7 Irrigation

Small-scale irrigation schemes are mainly situated in Bardheere District with a few in Saakow District. They consist of private enterprises with an average irrigated area of three ha per farmer/owner and six ha per pump. The number of pumps in Bardheere District amounts to approximately 250 for a total irrigated area of 1,500 ha. There are 13 small pumps in Saakow District irrigating a total of 84 ha. The number of farmers irrigating is 52.

The total number of irrigation schemes for cooperatives is about 30. Most of these schemes have never been operational on account of insufficient organization and management and technical constraints.

Irrigated crops include maize, sesame, onions, groundnuts, tobacco, vegetables and bananas. Papaya and lemon are irrigated mainly for home consumption. In Bardheere and Saakow Districts all crops are grown in basins with or without ridges, varying in size between 2m x 2m to 6m x 6m.

Irrigation intervals depend on the crop, soil texture and growing stage but vary from two days for onions in initial stage to 13 days for bananas in Bardheere District.

The lengths of the irrigating seasons vary from three months for maize, groundnuts and sesame to two to three months for tobacco and three to four months for onions.

Duration of irrigation depends on the distance from the pump and the dryness of the soils. For the small-scale irrigation schemes, where the average capacity of the pump amounts to 18 - 20 l/s, the duration is the same for all crops and varies from 30 hours/ha for first irrigation at 15 l/s, remote from the pump, to 7 hours/ha for other irrigations at 25 l/s, near to the pump. During Jilaal, night irrigation is practised by full moon and half moon. Daily operating hours amount to five to six on average, with peaks of twelve to fourteen hours per day.

The basins in the small schemes are supplied by earthen canals with a capacity of 15 - 200 l/s. The full delivery of the pump is diverted to the basins to be irrigated. The conveyance and distribution systems consist of a main canal over the levee, with furrows perpendicular to the main canal and spaced at 15 - 20 m intervals.

The field irrigation efficiency in the small schemes is high on account of the presence of basins with ridges. However, conveyance efficiencies are low because of the sandy soils in the levees. Overall efficiency is estimated at 50 - 60 per cent.

Small pump units are located in the small-scale irrigation schemes and consist of diesel driven, mixed-flow pumps with a capacity of 18-20 l/s on average and a started delivery head of 10-18 m. Dynamic heads never exceed 8 m. The capacity of the engines varies from 2.6 kw to 22 kw. The units are movable and are situated on the banks of the river. Suction and delivery are by flanged steel pipes or hose. Most equipment is well maintained but a severe lack of repair facilities and spare parts keeps units out of order for relatively long periods. Fuel is often scarce.

Large stationary units are found in the cooperative schemes. The majority of the units in the cooperative schemes are of one type and one make with a capacity of 300 l/s at a dynamic head of 8 m. Most units are either not in use or out of order due to lack of spare parts and repair facilities. The pumps are poorly sited in inadequate shelters; suction and delivery systems are inadequate or insufficiently supported.

3.3.2.8 Drainage

External drainage systems for the evacuation of excess water before it enters the cultivated areas are present in Bardheere District. In combination with a 1 - 1.5 m high protection dyke they prevent flooding of the small schemes by run-off from the marine plains.

Internal drainage systems in desheks, small-scale irrigation schemes and the cooperative schemes are non-existent. The recession of the water levels in the desheks depend completely on evaporation, infiltration and seepage to the river. As the supply of moisture to the crops during the Jilaal season is probably assured by capillary rise from the water table, control of the ground water table needs special attention when drainage facilities are provided.

Salinity in the desheks and irrigation schemes is quite erratic. In desheks salinity occurs in the deeper parts with heavy soils. This can be attributed to evaporation and infiltration of 4-6 m flood water with medium to high salinity hazard. On one occasion, a deshek had been abandoned on account of extensive salinity.

In the small-scale irrigation schemes, salinity in the Jilaal season is temporary. Due to the presence of basins, rain water can be effectively used to leach salts from the surface down to the ground-water table.

Soils in some cooperative schemes have become unproductive due to salinity after four to five years' irrigation without an adequate sub-surface drainage system.

3.3.2.9 Conclusions

With the elaboration of the study on "Deshek and Small- and Medium-Scale Irrigated Agriculture in the Juba Valley" (Ref. 197), it has been possible to obtain a most comprehensive picture of these categories of agriculture in the Juba Valley. The information available comprises:

- number of farms and farm families and farm structure,
- crops, cropped areas and yields,
- agricultural practices,
- water management,
- requirements and availability of labour,
- farm incomes.

The analysis of this information and data has resulted in the identification of constraints which hamper further development. It has been concluded that improved agriculture in desheks and small-scale irrigation schemes depends mainly on improvements in water management. The constraints in water management can be distinguished as flood protection and controlled flooding, irrigation and drainage in desheks and small-scale irrigation schemes.

The main problems with regard to flood protection in desheks consist of generally insufficient flood protection bunds and inadequate design of flood bunds where they exist. Controlled flooding in desheks is hindered by insufficient regulating structure, by a general lack of operation and maintenance as well as by a lack of organization and management.

As regards drainage in desheks, the main problem is the lack of drainage facilities for removal of excess water and for prevention of salinization.

Irrigation in small-scale irrigation schemes is constrained mainly by the lack of distribution and service centres and workshops for pumping equipment, by a severe lack of spare parts and scarcity of fuel and by inadequate conveyance systems. There is also a lack of drainage facilities to prevent salinization in the small irrigation schemes.

In addition to water management problems, the desheks and small-scale irrigation schemes have problems related to crop production. There are technical problems such as the insufficient availability of machinery and equipment and the lack of draught animals. There are also constraints with regard to production techniques and the availability of farm inputs.

It has been found that one of the basic preconditions for overcoming these problems, namely the existence of a well organized agricultural services system, is also lacking (1). All the above mentioned available information is considered to be sufficient to comply with the requirements for future development planning.

3.3.3 Medium-Scale Irrigation

3.3.3.1 Crop Production

Medium-scale irrigation schemes are defined as schemes with an area between 20 and 200 ha. Such schemes exist in the banana farms in Jamaame and Kismayo Districts and in cooperatives. The latter are not functioning and have not been further considered. On the banana schemes bananas are cultivated mainly for export purposes. In addition some annual crops e.g. maize, sesame and groundnuts are cultivated during the rainy seasons. In Jamaame and Kismayo Districts coconut, citrus and mango trees are found. Mango and citrus fruits are sold on the local markets.

The total cultivated area of the medium-scale irrigation schemes is 8,287 ha. Table 15 gives the area cropped annually and the total production of the crops grown in this farm category.

Table 15 : Crop Production in the Medium-Scale Irrigation Schemes.

Crop	Cropped area in ha	Yield per ha in t	Total production in t
Bananas	3,804	28.0	106,512
Maize	239	2.3	550
Sesame	45	0.5	23
Groundnuts	23	0.6	14
Total	4,111	31.4	107,099

Source : Ref. 19.

1) An evaluation of the agricultural and livestock services system in the Juba Valley is presented in Chapter 3.5.

3.3.3.2 Cropping Pattern, Cropping Intensity and Crop Rotation

Around 77 per cent of the average medium-scale irrigation perimeters are covered with banana trees. The rest of the farm holdings are used for the rotation of bananas. On this land the annual crops maize, sesame and groundnuts are grown.

These perimeters show a cropping intensity of 104 per cent per year. A distinct crop rotation for the annual crops is not practised, as the land reserved for the banana rotation is not fully utilized for the production of these crops.

3.3.3.3 Agricultural Practices

The land cultivated in the medium-scale irrigation schemes is prepared by tractors. The average lifetime of the banana trees is 3.5 years and the cultivation of annual crops takes place twice a year during the rainy seasons. As a result, 46 per cent of the schemes' land is ploughed annually, amounting to about 2,400 ha per year.

Most of the farmers possess their own soil preparatory equipment. Some of the required machinery can be hired from the Agricultural Tractor Service ONAT, which is present in Jamaame and Kismayo Districts. Mechanical soil preparation consists mainly of ploughing and discing the land. Furthermore irrigation canals and laterals are constructed with tractors and ditchers.

Sowing of the annual crops and planting of banana shoots are carried out by hand. Banana shoots are generally taken from the farm itself, but they may also be acquired from the research station at Alessandria.

Resowing of the annual crops is widely practised, due to a reduced germination capacity of the seeds and attacks by birds and rats. The average planting distance of the banana shoots is 2.00 x 2.20 meters. All annual crops are planted at a distance of 1.00 x 1.00 meters. The average seed amount for maize is 12 kg per ha, sesame 8 kg per ha and groundnuts 30 kg per ha. Around 2,350 banana shoots are planted per ha.

In the banana schemes fertilizers and means of plant protection are used. Ammonium phosphate and occasionally also urea are used as fertilizers. Plant protection is carried out by hand as well as by aerial spraying with aircraft from the Desert Locust Control Organization in Nairobi, Kenya.

Banana producers have access to credits through Somalfruit, the marketing organization for bananas and through the Somali Development Bank.

Crop maintenance in the banana schemes consists for the bananas of:

- cutting old banana leaves from the trees;
- pruning of the trees;
- weeding by tractor and rotovator during the first four months after planting. For another eight months hand weeding is carried out. After one year setting up, weeding is stopped as weeds are suppressed by leaves lying on the ground;
- fruit protection, which is carried out to prevent leaves from bruising the fruit skins, making them unsuitable for export. Fruit protection can be carried out by putting polyethylene bags around the fruit or keeping leaves away from the fruit by putting sticks to them;
- guarding of the banana crops to prevent theft of fruits, especially at the end of Xagaa and Jilaal seasons, when the stocks of staple foods seem low.

Crop maintenance of the annual crops is carried out twice per season by hand.

Diseases and pests are common in the crops in these schemes. Bananas are attacked by banana root borer and leaf spot. Maize is attacked by stalk borer, maize ear worm and aphis; sesame by leaf-spot. No diseases and pests were reported in groundnuts.

The only means used to combat diseases and pests in banana plantations are doses of carbofuran of around 30 kg per ha and year.

Farmers have reported severe damage to their crops from wild animals, e.g. monkeys, wart hogs, hippopotami and birds.

Harvesting of the annual crop is carried out by hand. The banana fruits are packed in packing centres, either managed by Somalfruit or privately owned firms. About 70 per cent of the bananas are suitable for export. The rest is marketed within Somalia and partly given to the farm labourers. The bananas suitable for export are sold through Somalfruit.

The average yield of bananas is around 28 t per ha and year. The weighted average yields of maize, sesame and groundnuts is calculated at 1.35t, 0.44t and 0.60t per

ha and seasons respectively, whereby the weighted average yield means the cropped area per season per crop multiplied by the average seasonal yield per ha. This figure has been divided by the total cropped area of a specific crop.

The harvest is transported from the fields to the farm homes by tractor and trailer. The same means of transport is used for bringing bananas to the packing stations and from the packing stations to Somalfruit. Crop residues are hardly used or sold.

3.3.3.4 Labour

The agricultural activities in the medium-scale irrigation perimeters are in general carried out by a permanent labour pool, which is replenished with casual labour at peak times in agricultural activities. On the banana schemes it can be said that a labour shortage is existent, preventing farmers from increasing the amount of cropped land. This may be due to the competition for labour with large-scale irrigation schemes, such as the Juba Sugar Estate and Fanoole Rice Project.

3.3.3.5 Farm Income

To get an impression of the annual enterprise profit of an average medium-scale irrigation scheme, calculations of production costs and income have been compared. Under the assumption that the farm holding of an average banana farm is 65 ha, the sales price for bananas is 3,160 So Sh per to, the enterprise profit would come to around 2,450,000 So Sh per annum. This amount entails also an estimated income of 35,000 So Sh per annum and farm holding, resulting from the sale of mangoes and the financial income of the annual crops maize, sesame and groundnuts.

3.3.3.6 Irrigation

Bananas in the medium-scale irrigation schemes are grown in furrows. The annual crops are grown on the flat soil.

Irrigation intervals depend on the soil texture, growing stage and crop. During the initial stage of the bananas the irrigation interval is around 13 days. For the annual crops this is around seven days. The lengths of the irrigation seasons for maize, groundnuts and sesame are three months.

The daily operating hours on the banana schemes amount to ten on average, with peaks of fourteen to sixteen in Jilaal season when river levels are low and crop water

demand high.. On average the duration of irrigation is about 2.5 - 3 hours per ha with an average pump delivery of 160-170 l/s.

The furrows for bananas are spaced at 2.00 - 2.20 m intervals and are supplied by field laterals and field canals, branching from the main canal. There are few diversion and distribution structures. No measuring devices are on hand. The irrigation efficiency is mainly determined by the lack of skilled irrigation and leaching. The overall efficiency is estimated at 50 per cent. Irrigation water is pumped by large stationary units with a capacity of more than 50 l/s. These units are kept in running order but a severe lack of spare parts hampers proper operation.

3.3.3.7 Conclusions

A comprehensive picture of the agricultural activities of the medium-scale banana farms has been drawn in the "Deshek and Small- and Medium-Scale Irrigated Agriculture in the Juba Valley". (Ref. 19). Information is available on

- number of farms and farm structure,
- cropped areas and yields,
- agricultural practices,
- water management,
- requirement and availability of labour,
- farm incomes.

By analysing the above information it has been concluded that an improvement of the agricultural production in the banana schemes depends mainly on improvement of water management and only secondarily on improvement of production techniques.

The main problems regarding water management are lack of water in the first three months of the year, lack of spare parts for pumps, lack of measuring and distribution structure, lack of control of water abstraction and lack of extension for irrigation methods.

With regard to drainage it was found that there are insufficient drainage facilities for leaching and that salinity problems result in decreasing yields.

The constraints to crop production lie in the insufficient availability of machinery, equipment and spare parts as well as in improper pest and disease control. In addition shortage of skilled labour trained in irrigation techniques and mechanisation is reported.

Overall, it is considered that the information on medium-scale irrigation schemes is sufficient for the planning activities to come.

3.3.4 Large-Scale Irrigation Projects

3.3.4.1 Juba Sugar Project

Implementation of the project started in 1976. It was planned to cultivate about 7,200 hectares by 1982 and to produce 65,000 tonnes of sugar p.a. by that stage. In a second phase it was intended to extend the area under cultivation to 13,500 hectares.

The project is designed as a state farm financed by the Somali Government and foreign financiers such as the Abu Dhabi Fund, the Saudi Fund for Development and the OPEC Special Fund. It has a central management structure with a permanent pool of labourers (1984 about 1,700) who are replenished by casual labourers (1984 about 3,000) at peak times. Management and supervisory functions were planned to be mainly carried out by expatriates in the initial phase of project implementation. Replacement by Somali nationals for all positions was foreseen by the end of the first project phase in 1982. A training component for all levels of skilled labour and for supervisory as well as for managerial staff was included in order to achieve this aim. It was, however, not possible to occupy most of the key positions with Somalis in time, so that the management contract for the consultant had to be extended and even at the end of 1984 a large proportion of managers and supervisors were expatriates.

In Table 16 the original targets for cane cultivation are compared with what has actually been achieved. According to these figures, only 70 per cent of the target set for cane cultivation could be achieved by the end of 1982 when the first phase of the project was due to finish. It is expected that in 1986 the planted area will reach its full extent.

Table 16 : Cultivated Area in the Juba Sugar Project

Year	Area under cane in ha	
	planned	actual
1977	2	-
1978	165	174
1979	2,368	2,211
1980	4,475	3,528
1981	5,704	4,041
1982	6,145	4,255
1983	-	5,321
1984	-	5,847

Source : Juba Sugar Project, Annual Reports 1980-1983

The agricultural works of bush clearing, harrowing, ploughing, land levelling and furrowing are carried out mechanically by the Project's own equipment. Planting, weed control (to a certain extent), fertilizing and cane cutting are carried out by hand. For this work mainly casual labourers are hired on the basis of payment by result.

Since the beginning of the project, the agricultural development has been hampered by the problem of recruiting skilled, semi-skilled and unskilled labourers. In particular there is a regular shortage of casual labour for cane cutting. Increasingly there are problems with regard to the availability of agricultural machinery. This is due to the fact that the supply of spare parts was always insufficient and that more and more machines are falling into disuse.

The construction of irrigation and drainage works was let as a contract between the Juba Sugar Project and the Water Development Agency (WDA) to be completed in 1982. By this time however, only 65% of the total amount of works could be completed and the contract with WDA was terminated. New arrangements were made in 1983, but no significant progress could be achieved since then. The main obstacles to the achievement of the targets regarding irrigation infrastructure were the lack of spare parts for the construction plant and the subsequent recurrent breakdown of equipment. In addition, there was a continuous shortage of diesel fuel.

Irrigation is mainly carried out by means of an overhead system whereby water is pumped from the canals into the piping system and distributed by sprinklers. By the end of 1984 the irrigation system included the main canal (26 km), secondary canals (17 km), the Little Juba Canal (17 km) and a total of 72 pump stations including 11 relift stations and 61 sprinkler pump stations. The amounts of water pumped and the area irrigated are shown in Table 17.

Table 17 : Irrigation Performance in the Juba Sugar Project 1980-1983

Year	Area due to be irrig. in ha	Actual area irrig. in ha	per cent of total area	amount of water pumped in million m^3
1982	90,054	56,282	62	118.3
1983	106,471	49,930	47	119.3

Source : Juba Sugar Project, Dept. of Engineering and Irrigation

Table 18 : Planned and Actual Cane and Sugar Production 1980 - 1984

Description	1980		1981		1982		1983		1984	
	plan.	act.	plan.	act.	plan.	act.	plan.	act.	plan.	act.
Area harvested in ha	2,222	1,463	4,416	2,669	5,645	3,324	5,996	4,909	5,996	3,133
Average yield of cane in t per ha	89	94	89	82	86	93	84	68	84	68
Total yield of cane in '000 t	199	138	393	219	487	309	506	334	502	212
Sugar production per ha in t	8.1	5.4	8.3	5.5	8.2	6.7	8.2	5.7	8.3	6.4
Total sugar production in '000 t	18	8	37	15	47	22	49	28	50	20
Tonnes cane per tonnes sugar	11.0	15.2	10.7	14.9	10.5	13.4	10.3	12.0	10.1	10.8
Sugar percentage of cane	9.1	6.6	9.3	6.7	9.5	7.5	9.7	8.3	9.9	9.2

Sources : Juba Sugar Project, Agricultural Annual Reports 1980-83; Factory Man gers Annual Reports 1980-83.

The deficient irrigation performance which is shown for the years 1982 and 1983, but which also occurred in the preceding years, was mainly due to the shortage of diesel fuel for the pumps and in the second place to the low river level during the months January to March.

A main drainage system does not exist in the project. During 1984 the construction of an open drainage system was started.

In Table 18 the production of cane and sugar since 1980 is presented. A comparison of the production planned and the production actually achieved shows that as a result of the above mentioned delays and problems in project implementation, the total annual sugar production was far behind the target every year and only exceeded 50 per cent of the envisaged amount in 1983. It is evident that the low performance is not only due to the fact that the harvested area was always smaller than anticipated, but also to the generally lower yields per hectare and the sugar content of the cane.

The sugar factory which could be established in time (1980) and which, despite many smaller problems, could so far be kept running is facing two major problems which will have to be urgently overcome. One is the shortage of skilled labour, mainly artisans and engineers and the other is the lack of spare parts for the factory which becomes more critical every year. Unless satisfactory solutions to these problems are found, the factory will soon be in grave danger.

3.3.4.2 Fanoole Rice Project

The project was initiated with the assistance of the Russians in 1963 and after a long interruption between 1965 and 1971 taken over by the Chinese in 1979. The project consists of two parts.

Part one comprises the construction of a barrage in the Juba River at Fanoole. The barrage is designed as headworks for a main irrigation canal. It contains a power plant for the generation of 4.6 mw. The maximum discharge of the barrage, which has almost no storage capacity, is 800 m^3/sec. The main canal which is 52 km long and reaches from the weir to Kamsuma, has a capacity of 33 m^3/sec. In addition, part one includes the construction of transmission lines from the hydro-power station to Jilib and to the farm area, the implementation of a communication system and the provision of drinking water. For a transition period until the generation of hydro-power and as a later stand-by, a diesel-power plant with

a capacity of 1.62 mw was foreseen. With the exception of the communication system, which was completed in 1984, all components of the project's part one were completed in 1983.

Part two of the Fanoole Project consists of the development of a rice farm which is designed for an area of about 7,500 hectares of net irrigated land. For the protection of the project land against floods a km flood bund has been constructed along the Juba River. The bund protects the project against a maximum discharge of 1,500 m^3/sec. By the end of 1984, in addition to the main canal, the infrastructure for gravity irrigation and drainage including a road network for 1,500 hectares was completed. Bush clearing was carried out in an area of 2,000 hectares. 1984 was the first year when the gravity irrigation came into operation.

Rice is the main crop on the farm. Two crops are grown each year, for each crop 50 per cent of the total cultivated land will be devoted to rice and the other 50 per cent to green manure and to beans.

The cropped area of rice was 310 hectares in Gu season and 450 hectares in Der season. In 1985, 750 hectares will be planted with rice in Gu and 1,000 hectares in Der season.

In the years before 1984 only small areas up to a maximum of 200 hectares in 1983 were planted. The irrigation water was pumped from the river onto the rice fields.

Agricultural operations such as harvesting, final levelling, fertilizing (partly) and harvesting are carried out mechanically by machinery brought in by the Chinese. The remaining works are carried out by hand.

The only rice variety used is IR 24 which gives yields of around 5 t per ha in the Fanoole Project. High doses of urea of 450 kg per ha and in addition 150 kg DAP are applied. Different types of herbicides and insecticides are used.

In February 1985 the project's rice mill will come into operation with a capacity of 200 t per 24 hours. The rice will be stored in silos (2,000 t) before being sold to ENC, the National Trading Corporation, which is responsible for the marketing of rice. The management has been carried out jointly by Somali and Chinese staff for the two parts of the project until July 1984. Since that date the Somali side has taken over the sole responsibility for part one, the barrage including the hydropower station and transmission lines and the main canal.

The farm management is still under Chinese responsibility. The number of Somali managerial and supervisory staff was 40 at the end of 1984. At the same time the Chinese had 415 staff on the site. The number of permanent labourers in the project was around 1,400. Additionally 300 - 600 casual labourers were employed during 1984.

There is no information available on the reasons for the altogether slow implementation of the Fanoole Project. With regard to the agricultural development however, it is apparent that the lack of skilled labour as well as the insufficient supply of diesel fuel are the main obstacles to a more successful project performance.

3.3.4.3 Mogambo Irrigation Project

By the end of 1984 the project was under construction. The project aims in its initial stage to cultivate 2,215 ha of rice and cotton under irrigated conditions. The ultimate size of the project is envisaged to be 6,500 ha. The development of the 2,215 ha irrigated land has been planned as follows:

- 459 ha for surface irrigation should be ready for the Gu season 1985,
- 1,134 ha for surface irrigation should be ready for cultivation in Der season 1985 as well as 122 ha for sprinkler irrigation,
- 2,052 ha under surface irrigation and 163 ha for sprinkler irrigation would be completed by the beginning of 1986, so crop production on the total area of 2,215 ha would commence in the 1986 Gu season.

The required amount of seeds will be procured from the Fanoole Project. The only variety available at present is IR 24. Cotton seed will be obtained from Somaltex, the governmental cotton processing agency. The main variety grown in Somalia is Acala 4-42.

The cropping intensity for rice is calculated as 150 per cent per annum, whereby 75 per cent of the cultivable land per season would be cropped. This system however will be adopted in a flexible way in accordance with precipitation and river flow. Cotton will be grown once a year on the area laid out for sprinkler irrigation.

The production of both crops is planned to be carried out under full mechanized conditions. Land preparation will consist of primary and secondary soil cultivation by means of heavy disc-harrows. Land levelling is to take place between the two cultivation activities.

Rice and cotton seed will be drilled in a dry seed bed. The amounts of seed will be 140 kg and 10-12 kg per ha respectively. It is proposed to use chemical fertilizers for the production of rice and cotton.

The amounts to be used for rice are as follows:

- 150 kg urea per ha, applied by a fertilizer spinner before sowing,
- 75 kg DAP at the time of planting, to be applied during the planting with the seed drill,
- 100 kg urea applied by hand at the plant tilling stage.

The amount of fertilizers required for cotton production are as follows:

- 170 kg of urea, broadcast by spinner and to be applied between the primary and secondary tillage,
- 50 kg DAP to be applied with the seed drill at the time of planting.

Rice will be irrigated by means of surface irrigation, while cotton will be irrigated during the night-time, by sprinkler irrigation. For weed control in the rice fields, herbicides will be applied. Application will be by tractors with mounted sprayers. In addition spot spraying would be carried out if necessary. Weed control for cotton will be by the incorporation of a herbicide into the soil prior to planting. Hand weeding will complete the control of weeds.

In order to prevent major damage to the rice crop, bird scarers will have to be employed to reduce crop losses. Knapsack sprayers will be used to combat pests and diseases in cotton. Harvesting of rice will be with combines, while cotton will be hand picked.

During the initial phase of the project, rice will have to be milled in the rice mill at the Fanoole Project, which will be ready in February 1985. It is envisaged to construct a project-owned rice mill at a later stage of project implementation. Cotton will be collected in the field by Somaltex and brought to the ginnery at Balad.

The irrigation structures of the Mogambo Project consist of:

- pumping station at the Juba River with a pumping capacity of 5.05 m^3/sec. plus an additional reserve of 1.25 m^3/sec.,

- main canal, earth canal of a length of 1.9 km with a maximum discharge of 6.5 m^3/sec.,
- secondary canals, earth canals of a total length of 18 km,
- drainage system consisting of earth canals of in total 28 km and a pumping station with a capacity of 0.66 m^3/sec,
- sprinkler irrigation system, consisting of one pumping station at the main canal and a system of tubes for an area of 163 ha.

The project has flood protection works against flood water which may be diverted from the Juba into a flood relief channel which lies in the northern part of the project.

The Mogambo Project is designed as a state farm giving allowance for a minimum of 10 per cent of the cultivated area for private smallholders who are already settled in the area.

3.4 Livestock

An estimation of the livestock population in the three Regions of Gedo, Middle Juba and Lower Juba has been made by the Ministry of Livestock, Forestry and Range in 1983. These figures and their comparison with those estimated for the whole of the country are shown in Table 19.

Table 19 : Estimated Livestock Population in Somalia and the Juba Valley in 1983

Area	Cattle	Camels	Sheep	Goats
	in '000 head			
Somalia	5,000	6,000	12,000	18,000
Juba Valley Regions				
• Gedo	668	867	635	870
• Middle Juba	463	261	32	864
• Lower Juba	1,090	245	89	152
Total Juba Valley	2,221	1,373	756	1,886
Per cent of total in Somalia	44.4	22.9	6.3	10.5

Source : Ministry of Livestock, Forestry and Range and own Calculations.

From this Table it can be noted that nearly half of the country's cattle population, 25 per cent of the camel population and one sixth of the small ruminants are kept in the Juba Valley. It must however be pointed out that the figures shown represent an extrapolation of the 1975 census figures, the only livestock census which has been carried out in Somalia so far. It cannot be judged at present whether it is realistic to take these figures as a basis for the assessment of present livestock numbers because 1975 was a drought year. In such years the nomadic herds are concentrated near the rivers so that it may well be that the registered numbers of animals do not represent the normal distribution of livestock in the area. Also it is not sure how precise the annual increase rate is.

Livestock in Somalia is mainly kept in the traditional nomadic way. More detailed information on these animals such as production parameters and nomadic movements, carrying capacity of the grazing areas etcetera, is not available. At present a "Southern Somalia Land-Use Survey", financed by the World Bank is being carried out, the results of which are expected to be available by the beginning of 1985.

Some information on animal husbandry of the sedentary livestock keepers has been collected in the course of the field survey on desheks and small and medium-scale irrigation projects in the Juba Valley in 1984 (Ref. 19). In this survey, investigations were limited to those animals living permanently in or around the villages along the Juba River. The animals found here are:

- cattle of the Zebu type, predominantly of the Boran breed,
- sheep of the Somalia Black Head type,
- goats of the Somalia White Head type mixed with indigenous types and
- camels, donkeys and poultry.

Cattle is mostly kept for cash reasons and sold at times when cash is needed but there are no other means of obtaining it. Sheep, goats and camels contribute to the meat supply. Camels are also used for driving locally made oil mills. Donkeys are used for transport. As far as the number of animals per farm holding is concerned, the answers received from the farmers varied so much that an average number can not be given.

Animal diseases in the Study Area are Trypanosomiasis, Rinderpest, CBPP, Antrax, Blackquarter and internal parasites. Treatment is given by the farmers themselves as well as by the Veterinary Offices in the District Centres.

Beekeeping is an important source of income for the farmers mainly in the Middle Juba Area. From information gathered during the field work it was noted that the number of beehive owners increases from the Bardheere District via Saakow District to Bu'aale District. From Bu'aale District over Jilib District towards Jamaame and Kismayo Districts the number of owners decreases again. The same applies for the number of beehives per owner. This trend is confirmed in a technical report about beekeeping in the Juba and Shebelle River Valleys made in 1983 (Ref. no. 57). According to this report the total honey production in the Juba Valley was around 146,000 liters in 1982, generating an average producer income from beekeeping of 2,400 So Sh per annum.

3.5 Services Sector

3.5.1 Agricultural Service

3.5.1.1 Introduction

The structure and performance of the agricultural services sector in the Juba Valley was analysed by the MJVD in 1983/84. A report (Ref. 18) was prepared and published in 1984, showing the present situation of this sector as well as some observations with regard to future development prospects. The following analysis is based on this report.

3.5.1.2 Crop Marketing

During the seventies and at the beginning of the eighties, marketing of agricultural crops was exclusively carried out by institutions which were in Government hands or at least controlled by the Government. In recent years however, a trend towards liberalization of marketing has appeared with private traders participating increasingly in the marketing of agricultural produce.

In the Juba Valley the following marketing channels for crops are important:

- Agricultural Marketing Corporation (ADC); marketing of grains (sorghum, maize, rice, oilseeds).
- National Banana Board (NBB); marketing of export quality bananas from private plantations.
- SOMALTEX; marketing of cotton.
- Private traders; marketing of sorghum, maize, tobacco, fruits, onions and other vegetables.

In addition to these channels, marketing of sugar is organized by the Juba Sugar Project and marketing of bananas is carried out by SOMALFRUIT for the produce from its own plantations in Lower Juba (2,500 ha) and also increasingly for the production of bananas from private farmers.

Until mid-1982 the Agricultural Development Corporation (ADC) had the monopoly on grain marketing. Farmers were obliged to sell all their produce except a subsistence allowance to ADC. There is no doubt that this obligation was never met by the farmers in the Juba Valley since there was no possibility for control. However, there is also no question that until 1982 most of the grain produce marketed went through ADC. Apart from those quantities which may have been sold at village level, by far the major part of the grain produce was sold to ADC, stored in ADC owned stores and transported by ADC owned trucks. The control over marketing at District and Regional level was - unlike the control at village level - relatively easy and could be maintained by means of control posts along the few existing roads.

Since 1982, private traders have become more and more active in the production areas with good road access, such as the Bardheere, Jilib, Jamaame and Kismayo Districts. To a lesser extent, private merchants also go as far as the Districts of Saakow and Bu'aale. However, this is only possible in the dry seasons for a total period of six months per year.

For the collection of sorghum, maize and sesame ADC establishes a network of buying points at village level in the harvesting periods each year. Farmers transport their produce to those points on donkey carts, on donkeys or even on their own shoulders. Farmers who live near the ADC stations in the District and Regional Centres deliver their harvest directly to the ADC stores.

Storage of sorghum and maize at farm level is in underground stores which are established in the fields after harvesting and threshing.

ADC keeps the sorghum and maize produce in flat stores but also in underground stores.

The purchase and processing of seed cotton in Jamaame was transferred from ADC to SOMALTEX in 1979. No further processing of crops is being carried out by ADC at present in the Juba Valley.

ADC has established a distribution system which provides intra-regional and inter-regional redistribution of sorghum, maize and also to a limited extent, sesame and rice.

Grain prices are fixed by the Government. Buying prices as well as selling prices are the same all over the country. Since there is no quality grading of produce, no price distinctions are made.

Since 1982 and probably even in the years before, private traders in the Juba Valley have, on an illegal basis, paid higher prices to farmers than those fixed by ADC. There are no reliable data available for the development of grain prices paid by private buyers during the last years. However, it can generally be said that immediately at the end of the main harvesting period after the Gu Season, prices paid by private traders are close to ADC prices. During the course of the following months however, prices increase until the harvests of the second cropping period, the Der Season are brought in. If the Der harvests provide surpluses to the market, prices may stagnate or even decrease slightly for a few weeks. After that there is an increase again until the next harvest of the coming Gu Season. As compared with the official ADC prices, the following prices were found to be paid by private buyers in the Juba Valley in March 1984:

Table 20 : Comparison between Prices paid by ADC and private traders in early 1984 (So Sh per Quintal)

Crop	ADC	Private
Sorghum	260	1,400
Maize	220	1,600
Sesame	745	4,000

Source : Ref. 18.

Since liberalization of grain marketing in 1982, the role of ADC has been on the decrease. This is due to the fact that prices paid by ADC to the farmers were kept low and, although they have been adjusted from time to time, they have not kept up with domestic inflation. As a result it may generally be said that the production of grains has stagnated during the last ten years. This is probably the reason why the Government finally decided to liberalize grain marketing.

As a result of the liberalization of crop marketing, there is now competition between ADC and private businessmen for grain marketing. Private buyers have become increasingly involved during the last two years, even in those areas of the Juba Valley which are difficult to reach. It seems that the private traders can easily compete with ADC although the organization appears to

be well established. Although they often pay considerably higher prices than ADC, the business must be profitable. This leads to the conclusion that prices paid by ADC to the farmers are much too low.

The increasing competition between ADC and private buyers has, on the one hand, had positive consequences for the farmers through a general increase in producer prices. On the other hand however, farmers are now confronted with seasonal price fluctuations which cannot be anticipated. As a result of erratic climatic conditions, grain production which is largely rainfed based, fluctuates strongly and accordingly consumer and producer prices are subject to enormous fluctuations. This situation makes it very difficult for the farmers to make rational planning for crop production. Therefore, at present the risk has become higher for farmers who are increasing production for the market.

In addition, such price fluctuations are not in the interest of the consumer, who has to pay exaggerated prices in times of low supply.

Marketing of bananas which are grown on private farms used to be marketed through the National Banana Board (NBB) which is a Government enterprise under the Ministry of Agriculture. The functions of NBB have recently been more and more taken over by the SOMALFRUIT Company.

In the Juba Valley, the activities are concentrated on marketing of the production from about 50 banana growers. Marketing services include transport and packing of bananas. It is the impression that the marketing system in connection with supplementary services offered to the banana producers such as machinery hire, input and credit supply as well as technical advice to farmers was functioning quite well in recent years, although the banana growers were strongly dependent on the policy and conditions for marketing and input supply.

Cotton marketing is organized by SOMALTEX which is also a public enterprise. The activities are concentrated in the Jamaame District. Due to the fact that SOMALTEX offers a package of services of which marketing is one component and organization and management are efficient, cotton farmers are well supported.

3.5.1.3 Machinery Service

Farm machinery service is provided by

- Farm Machinery and Agricultural Service Organization (ONAT);

- National Banana Board (NBB/Agricultural Assistance Centre AAC);
- Somaltex.

The Juba Sugar Project and the Fanoole Project have their own machinery, equipment and workshop facilities.

ONAT maintains a Central Agency and a Regional Workshop in Jamaame and Agencies and District Workshops in Jilib, Bu'aale and Bardheere.

The Central Agency of Jamaame is the biggest ONAT station in the Juba Valley. The ONAT Coordinator in Jamaame is responsible for Lower and Middle Juba Regions, including the Agencies at Jilib and Bu'aale.

ONAT in Jamaame concentrates its activities mainly on land preparation including bush clearing, land levelling and ploughing. In addition, irrigation canals are constructed and flood protection works are carried out. The bulk of work carried out consists of land preparation. In 1983 about 2,500 hectares of land was prepared for cultivation. Preparation work consisted mainly of ploughing but also bush clearing and levelling. The main clients of ONAT are the banana farmers and other small and medium size farm owners. In addition, a limited amount of work is carried out for the Juba Sugar Project.

In the two regions of Lower and Middle Juba it is not possible by a long way for ONAT to meet the present demand for machinery services. As an estimate, the demand is twice the amount of work which is carried out at present. The main problem of ONAT in Jamaame is the lack of spare parts for the machinery. Another major problem of the ONAT station in Jamaame and also of the other ONAT Agencies in the Juba Valley is the low level of qualification of the technical staff. Most of the technicians need training. On the other hand however, due to the low salaries, the qualified personnel leaves in order to find better paid jobs elsewhere.

The Jilib Agency comes under the Jamaame Central Agency. The main work of this Agency is the transport of sugar cane in the Juba Sugar Project. For this purpose about half of the fleet of tractors is regularly used. The remaining tractors are used for field preparation, mainly ploughing, on small and medium sized private farms.

The Agency of Bu'aale is also under the responsibility of the Jamaame Central Agency.

The work carried out is concentrated on field preparation for small and medium sized private farms in Bu'aale District as well as in Saakow where no machinery service station exists. The distribution of work between the two Districts is about 50 per cent for each. Again, the demand for machinery hire was much higher than ONAT was able to provide.

The ONAT Agency of Bardheere is placed under the responsibility of the Central Agency at Buur Dhuubo. The available tractors are mainly used for ploughing and harrowing of the rainfed fields and to a certain extent also of the irrigated fields on private farms. A bulldozer carries out bush clearing and some flood protection work.

The Government has fixed low prices for the supply of machinery services in order to support the mechanization of agriculture. Private farmers pay So Sh 120 per hour for hiring a tractor and So Sh 250 for a bulldozer. Cooperatives and state farms pay So Sh 150 per hour for tractor hire and So Sh 280 per hour for a bulldozer.

The prices are too low by far to cover the real costs which are estimated to be in the range of 100 per cent above the fixed hiring prices. This means that ONAT is heavily subsidized by the Government.

On the other hand it is known that farmers are prepared to pay twice as much as demanded by ONAT during periods of-peak-demand, mainly during the months of February and March when the fields are prepared for Gu cultivation. Such prices are achieved by private tractor owners who hire out their tractors. It is also believed that farmers have to pay higher prices to ONAT than the official ones, during periods when the demand is high.

The National Banana Board (NBB) with its Agricultural Assistance Centre (AAC) in Jamaame District is of secondary importance as far as machinery service in the Juba Valley is concerned. The four tractors from the station are hired out at So Sh 120 per hour (same as ONAT), for those banana farmers who do not have their own tractors, to carry out field preparation on the banana plantations. The tractors are fully used and they seem to be adequate to cover the demand. AAC is of great importance for the repair and maintenance, not only of their own machines, but also of the machinery privately owned by the banana farmers. The impression has been gained that the workshop and store are well organized and equipped and that the work is efficiently carried out so that the banana farmers are well served.

SOMALTEX is the third institution in the Juba Valley offering machinery services to the farmers. The clients are the cotton farmers in Jamaame District. SOMALTEX hires out five tractors with which the total demand of the cotton farmers for field preparation can be covered.

3.5.1.4 Agricultural Extension and Research

Extension work for farmers in the Juba Valley is carried out by

- Agricultural Farm Management and Extension Training Project (AFMET)
- National Banana Board (NBB)
- SOMALTEX.

AFMET was started in 1980 as a project under the Ministry of Agriculture. The extension approach is based on the "Training and Visit System". The first project phase is designed for a period of five years up to 1985.

Since late 1982 AFMET has also been carrying out its programme in the Juba Valley. First, the Central Agency of Lower Juba in Yontoy near Kismayo was established. Attached to the Central Agency at Yontoy is a 150 hectare experimentation farm. It is planned to establish demonstration plots with perennial crops such as mango, coconut and banana as well as with seasonal crops such as maize, sesame, rice, beans etc. The fields will be irrigated by three pumps.

In addition to the Central Agency at Yontoy AFMET has established Agencies at Jamaame and Badade Districts. The District Extension Officers at these stations supervise a number of Field Extension Agents distributed in different villages of the Region.

The impression exists that the extension work of AFMET in the Lower Juba Region is still in its initial stages. Great effort will be necessary in the future to enable the Extension Service to carry out efficient work in the interest of the farmers.

The Central Agency of Middle Juba Region is located in Jilib. Agencies were established in Saakow and in Bu'aale in 1984. The Central Agency of Jilib is staffed with the Regional Extension Officer and officers responsible for monitoring and evaluation. In addition, a few Field Extension Agents are working in the District of Jilib. On the whole the activities of the Extension Service in Middle Juba are even less developed than those in Lower Juba.

In the District of Bardheere which comes under the Regional Extension Officer of Gedo District, the Extension Agency was established in 1982. As in the other districts of the Juba Valley, the extension work in Bardheere District is still in the process of being established and consolidated.

The extension work of SOMALTEX is directed to the cotton farmers in Jamaame District. Technical assistance is part of a package offered to the cotton producers which consists additionally of farm credit, tractor hire service and supply of farm inputs, mainly seed and insecticides. These packages are offered under the terms of the recently organized "cotton campaign" which is financed with foreign aid. As long as such financial sources are available, the programme is expected to be carried out successfully.

The National Banana Board (NBB) is also active in giving technical advice to the banana growers. Through its Technical Office in Arare in Jamaame District, NBB gives support to the group of about 50 clients of the organization. Special attention is given to advice with regard to the application of fertilizers and pesticides as well as to problems of financing farm machinery.

Research work in the Juba Valley is carried out by

- AFMET's research station at Yontoy,
- MOA's research sub-station at Alessandria,
- MOA's experimentation farm at Bu'aale.

AFMET's research farm at Yontoy covers an area of 150 hectares. The experimentation plots for perennial and annual crops under pump irrigation are under preparation. Results will not be available in the near future.

The research station at Alessandria near Jilib has been carrying out investigations during a period of several years. However, there are no evaluations of results available, so there is no benefit for the farmers of the region.

A small 1.5 hectare experimentation farm for irrigated agriculture was recently established near Bu'aale in 1983. So far no systematic research programmes have been initiated. In the future the station will be taken over by the AFMET Project.

The implementation of a 60 hectare pilot farm for irrigated agriculture near Saakow was stopped in 1984 due to various problems of access to the area. The project will possibly be transferred to Bardheere.

3.5.1.5 Input Supply

Inputs for agricultural production in the Juba Valley are provided by the following institutions:

- Ministry of Agriculture (MOA)
- Agricultural Farm Management and Extension Training Project (AFMET)
- Somalfruit
- SOMALTEX
- WAGAD.

The Ministry of Agriculture, through its Department of Plant Protection and Locust Control, provides limited amounts of insecticides and fungicides in emergency cases when outbreaks of pests and diseases are reported in a certain area.

Since funds for the purchase of chemicals and sprayers are very limited and transport facilities are practically not available, the small number of Plant Protection Officers in the Juba Valley are in no way able to meet the demand for pest control on the farms.

The import and distribution of fertilizers, pesticides and seeds to the farmers was the responsibility of ONAT until 1983. Since then the AFMET Project has taken over this activity. The AFMET Department of Farm Inputs was in 1984 still in the establishment phase. So far no major activities have been carried out in the Juba Valley. In the future, farm inputs are planned to be distributed through the Regional and District Extension Agencies, which are being established in all Districts of the Juba Valley. The production and certification of seeds comes under a special project of the Ministry of Agriculture. Since the performance of this project with its seed production farm at Afgoi is poor, no seeds for the agriculture in the Juba Valley are made available.

The SOMALFRUIT Company provides farm inputs, mainly fertilizer and pesticides for the banana farmers of the Lower Juba Region. Inputs are purchased abroad by letters of credit which have to be authorized by the Board of Directors. Inputs are extended to the farmers who may pay in cash or receive them as a credit. Repayment is in delivery of banana produce.

It is the impression that SOMALFRUIT is able to completely satisfy the demand of their clients for fertilizers and pesticides.

The cotton growers of Lower Juba are provided with seeds free of charge by SOMALTEX. The supply of insecticides on a credit basis constitutes a component of a package offered to the cotton producers. The cotton farmers are well supplied with seeds and pesticides.

The supply of machinery and spare parts has been organized since 1975 by WAGAD. In the Juba Valley, where WAGAD runs a store at Kismayo, no activities are carried out at present. The import and distribution of machinery and spare parts is almost exclusively in the hands of SOMALFRUIT.

3.5.1.6 Credit Supply

The existing sources of farm credit for the farmers in the Juba Valley are as follows:

- Somali Development Bank (SDB)
- Commercial and Savings Bank of Somalia (CSBS)
- SOMALFRUIT
- SOMALTEX.

The activities of the Somali Development Bank (SDB) which has a branch in Kismayo, are rather limited. E.g. in 1983 only 20 farmers received medium term loans. Clearly, the average farmer has no access to credit extended by SDB. The Commercial and Savings Bank of Somalia (CSBS) provides credit mainly to the commercial and trade sector in the Juba Valley. The Kismayo branch has also extended loans to the banana farms in former years, but has completely stopped serving the agricultural producers.

The activities of the Kismayo branch are now concentrated on financing the export of livestock. On average So Sh 20 to 25 Million per annum of short term credit has been extended to the livestock exporters during recent years. The loans are used for purchasing livestock and their transport to the markets on the Arabian peninsular. Normally credits are paid back within a period of a few weeks only.

SOMALFRUIT is also involved in credit activities. Farm inputs such as fertilizers and pesticides may be acquired by the banana farmers on short term credit basis. On request of the farmers, farm machinery and implements are also imported by NBB on the basis of letters of credit and provided as a medium term loan. Repayment of credits is by delivery of banana produce.

The group of cotton growers in Lower Juba receives crop loans free of interest from SOMALTEX for financing pesticides, farm labour and tractor hire.

3.5.1.7 Promotion of Farmers' Organizations

The Government has placed much importance on the development of a cooperative movement in all sectors of the economy in Somalia. Following socialist models, a Cooperative Law was established in 1973. After that an

impressive number of cooperatives with large numbers of members were created. Financial, technical and administrative support was given by the Union of Agricultural Cooperatives (UAC).

A total of 36 multi-purpose cooperatives and 62 group farm cooperatives had been established by 1983 in the Districts along the Juba River between Bardheere and Kismayo. The total membership was about 10,600. This means that of the total number of farmers, roughly estimated at 25,000 in the above indicated area, 42 per cent were organized into cooperatives.

However, during the various trips through the Juba Valley which were carried out between the end of 1982 and the end of 1984, no cooperative was found to be operating. It can be quite simply said that agricultural cooperatives in the Juba Valley exist only in the files of UAC. Nowhere are services made available by the cooperative administration, as provided for by the Cooperative Law. Much the same applies to the group farm cooperatives. However, the latter category of cooperatives has been allocated common land for cultivation. As a rule, these lands are unused and not available for private cultivation.

3.5.2 Livestock Services

3.5.2.1 Introduction

Some information on livestock services was collected and presented in a report on agricultural and livestock services (Ref. 18) in 1984. However, the picture is still incomplete as far as the traditional private livestock marketing system is concerned. This gap will have to be filled in by the time when the nomadic sector is due to be analysed.

3.5.2.2 Livestock Marketing

Until 1981 the Government was involved in livestock marketing through the Livestock Development Agency (LDA). LDA intended to organize the livestock movement along the Juba River and was trying to become active in the purchasing and selling of livestock. With the assistance of foreign donors, the Trans Juba Livestock Project was established with the aim of strengthening livestock marketing by improving the facilities along the trade routes of the Juba Valley, those facilities being livestock markets, holding grounds, quarantine stations, marshalling yards etc. It was also the intention of the Government to channel the livestock of the southern regions of Somalia along

the Juba Valley to Kismayo where a meat factory was established and where meat processing for export was carried out. However, the Project was not successful and the activities of LDA also proved to be a complete failure.

In 1981 the Department of Livestock Marketing of the National Range Agency took over the responsibility of LDA with the exception of purchasing and sales of livestock.

As far as it could be observed in the Juba Valley, the activities of the Range Agency with regard to livestock marketing are almost non-existent at the moment. Most of the facilities which were established some years ago have not been maintained and are mostly not being used with the exception of those at Kismayo which are necessary for veterinary services before livestock is exported.

As already mentioned above, the Government intended in the 1970 s to channel livestock marketing through Kismayo and the Kismayo Meat Factory. The factory was constructed with the assistance and finance of the Soviet Union in the 1970 s. The capacity is about 60,000 head per year. Until 1977, when the relations between Somalia and the Soviet Union were broken, the factory produced mainly canned meat for export to the Soviet Union under a special financial agreement. After the loss of the Soviet market, the factory cut down its operations and in 1983 it only produced small quantities of canned meat for the Somali military forces. Internationally, the Kismayo Meat Factory cannot compete any longer because of its poor technical and hygienic standards. There are also problems with regard to the supply of animals because of the low prices offered by the Government which are less than one third of the prices which can be gained by exporting live animals to the Arabian Peninsular.

In contrast to the Governmental involvement in livestock marketing, the traditional private marketing system seems to be well established all over Somalia including the Juba Valley. The beginning of the marketing channel is the bush or village market where producers offer animals to the traders. Brokers are involved to facilitate market sales. In larger villages and towns small traders and producers sell to large traders who export the livestock. The infrastructure of market centres is usually very simple with a holding ground and watering facilities. Sales are based on visual appraisal and prices are per head. The District and Regional Commissioners of the local governments collect market levies which include a tax as well as a development levy. Movement permits are given free of charge.

3.5.2.3 Veterinary Services

The Department of Animal Health of the Ministry of Livestock, Forestry and Range (MLFR) is responsible for Veterinary Service, including vaccination and treatments. Vaccination campaigns are carried out by the Regional and District Officers in the Juba Valley whenever an outbreak of disease occurs or on request from livestock owners. Additionally, drugs against various parasites are distributed.

In total, the Ministry of Livestock has a number of about 110 officers located in the Districts of the Juba Valley. Most of them are involved in the Veterinary Service. The work is supported by the Veterinary Laboratory at Kismayo. The impression was gained that the performance of work of the Veterinary Service is hampered by various problems of which the following are most dominant:

- lack of qualified staff,
- lack of funds for drugs and equipment,
- lack of vaccines,
- lack of transport.

The National Range Agency (NRA), as an autonomous entity under MLFR is also involved to a certain extent in the provision of veterinary services. Through its Department of Livestock Marketing, NRA is responsible for veterinary services along the marketing channels of livestock marketing such as:

- livestock markets,
- holding grounds,
- quarantine stations,
- marshalling yards,
- watering points.

The problems of NRA as regards the efficiency of work performance are the same as mentioned for the Animal Health Department above.

The Tsetse and Trypanosomiasis Unit under MLFR is concerned with the eradication of tsetse flies along the infested areas of the Juba Valley. The Unit receives technical and financial assistance from ODA and the Arab Fund and has, during the first project phase (1981-84), concentrated on investigating the most economic and technically feasible method of tsetse fly eradication. Spraying programmes will be carried out in the following few years along the Juba River.

3.5.2.4 Range Development

The Range Department of the National Range Agency (NRA) is responsible for the development and conservation of grazing land for nomads in the country. It is thought that the tasks of the Department with regard to range development, which consists mainly of the establishment and supervision of grazing reserves are scarcely carried out.

There is a project for the development of the southern rangelands under preparation, similar to those being executed for the northern and central rangelands.

3.5.2.5 Conclusions

There is a fairly comprehensive picture of the structure of the different agricultural service organizations in the Juba Valley. In contrast, there is still insufficient information on the services in the livestock sector. The coverage of agricultural services in the Juba Valley is shown in Table 21.

Table 21 : Portion of Farmers Served in the Juba Valley

Service	Estimated percentage of farmers served
Marketing	90
Machinery Hire	15
Agricultural Extension	10
Input Supply	10
Agricultural Credit	2 - 3
Promotion of Farmers' Organizations	0

Source : Ref. 18, p. 62.

With regard to future planning for the agricultural services sector, the following considerations can be made according to the present level of information:

Marketing

It is estimated that almost every farmer in the Juba Valley has the possibility of marketing his produce under reasonable conditions. This is due to the extended ADC station network and the increasing participation of private traders entering the region, as well as to the involvement of the specific organizations confined to banana and cotton marketing.

The liberalization of crop marketing has resulted not only in generally higher producer prices, which is in the interest of the producers, but also in seasonal price fluctuation which is neither in the interest of the producers nor the consumers. Therefore, some consideration should be given to ways in which the market could be regulated in the interest of the producers as well as the consumers.

Machinery Service

It is the impression that ONAT, despite certain organizational deficiencies, offers many of the prerequisites for playing an important role now and in the future, with regard to the mechanization of agricultural production on the small and medium sized farms in the Juba Valley. The present situation shows a generally efficient use of machinery, although the total number of machines available for hire is too low. The machines and workshops are in relatively good condition. Also the enthusiasm and interest shown by the staff in their work seems to be comparatively high. The good work performance, which is thought to be above average for a government agency, can probably be explained by the additional incentives which are given to ONAT staff. In fact, it seems that the members of ONAT stations charge extra rates in addition to the official low hire costs. Such unofficial revenues appear to considerably increase the efficiency of the institution which is also in the interest of the farmers.
Judging by this, it is obvious that the farmers are willing to pay higher rates than the official ones. It is also evident that the efficiency can be increased with a certain degree of private participation.

ONAT as a whole is subsidized by the Government because it makes big losses every year. One of the major problems is the lack of financial control within the organization. Such a service system, which is a heavy burden for the governmental budget, can probably not be maintained in the long run.

Therefore, if a collapse of the institution is to be avoided, one has to think about a reorganization.

Agricultural Extension

The National Extension Service is being implemented with the support of foreign assistance on a national level. The aim of covering the whole agricultural production area in the Juba Valley is still a long way off. This

aim can only be achieved if the AFMET Project continues after June 1985 when the first Project Phase is due to finish.

The question arises of what will happen if the foreign contributions are not continued. What will happen in that case e.g. with the extension staff, who are presently most probably being held only because they receive higher salaries, as compared with other governmental institutions. It is surely realistic to assume that without foreign financial contribution, as well as the assistance in management and technical know-how, the newly established system will not survive very long.
This must be avoided at all costs, both in the interest of the farmers and of the food supply for the nation.

It has also to be taken into consideration that if the extension service suffers a set-back, this will result in an almost irreparable loss of confidence on behalf of the farmers in Government service institutions, for some time to come. Experiences made in other countries have shown how difficult it is to repair such damage.

Apart from the low performance of work of the extension service in the Juba Valley, an additional weak point of the system is research. Support from agricultural research work has been found to be essential for the success of extension work. At present the activities of the extension agents are not backed by investigations which point the way to optimal crop cultivation methods. Therefore, the implementation of research stations is of great importance for the long term progress of the extension activities.

Promotion of Farmers' Organizations

It is obvious that the cooperative movement has completely failed in the Juba Valley to establish agricultural cooperatives which function according to the defined aims. The farmers were forced, at a given time, to join cooperatives which had been established by the Government. There was no sufficient preparation or training of farmers and administrative staff and the main error was that there was no real interest on the part of the farmers for the types of cooperatives provided for them.

This does not mean that there is no need for the establishment of farmers' groups for various purposes which they feel able to achieve more easily by grouping together.

Visits to the Juba Valley and discussions held with farmers as well as with Local Authorities have revealed the interest of farmers in creating groups for e.g.:

- purchase and use of machinery and implements,
- marketing of products,
- purchase and use of irrigation pumps,
- establishment of irrigation works,
- construction of access roads,
- purchase of inputs,
- use of credit.

Input Supply

There is still no general system for the provision of inputs for the farmers in the Juba Valley. At present only the small groups of banana and cotton farmers have regular access to inputs and MOA contributes as much as possible to combat pest outbreaks, but this is only minimal.

The National Extension Service took over the nationwide responsibility for farm input supply from ONAT in 1983. However, so far there have been no activities in this respect in the Juba Valley.

Agricultural Credit

There is no specific institution responsible for credit supply for the agricultural sector. Only the special groups of banana and cotton farmers are provided regularly. The Somali Development Bank (SDB) extends only medium term investment loans for a small number of privileged farmers in the Juba Valley. The Commercial and Savings Bank of Somalia (CSBS) extends only short term credit to the livestock exporters from Kismayo.

It is suggested that there is considerable need, especially for short and medium term credit among the farmers of the Juba Valley. The requirements will increase even more as soon as the work of the extension service becomes effective and an input supply system is established.

3.5.3 Other Services and Trade

Information on non-agricultural services and trade in the Juba Valley was collected in a survey carried out by MJVD on the economic structure of urban centres in 1984. The investigations were concentrated on the towns of Jilib, Bu'aale and Bardheere.

It was found that the total amount of enterprises involved in this sector is rather low. Table 22 shows the distribution of the different types of services and trade enterprises in the three selected towns.

Table 22 : Services and Trade Enterprises in Jilib, Bu'aale and Bardheere

Type	Number of enterprises in Jilib	Bu'aale	Bardheere
Metal-working	3	1	-
Carpentry	3	1	-
Electro-repairs	4	2	-
Other repairs	4	2	-
Tailoring	9	n.i.	2
Sesame pressing	3	3	1
Mills	7	5	2
Shoemaking	2	1	-
Bakeries	9	8	-
Total	44	23	5

Source : Own Investigations.

The main reasons for the small number of establishments in this sector are the low demand for handicrafts, tools etc. by the nomads and the non-availability of raw materials in the region. This has resulted in the fact that no local trades have ever been established in the urban centres of the Juba Valley. Rather, they have developed as commercial centres. Thus the social image of this group of entrepreneurs is low and at present there are only a few skilled artisans and craftsmen, most of them having been trained outside the region. Due to the fact that prices of imported raw materials are steadily increasing and that imported products are cheaper than locally made ones, some of the traditional trades (e.g. weaving) have completely disappeared.

After analysis of the development in the three urban centres it becomes evident that Jilib presently shows the most dynamic development with regard to population as well as to economic structure. The reasons are almost certainly connected with the recent establishment of the two large-scale development projects for rice production in the Fanoole Project and for sugar production in the Juba Sugar Project, as well as in the provision of all-year-round road access and electricity. It can be expected that the recent development trend in Jilib will continue and that the services and trade sector will increase in the future.

The situation in Bu'aale is different. After the place had been chosen as Regional Centre for Middle Juba and the establishment of the refugee camp in neighbouring Dujuma was begun, Bu'aale experienced a certain economic boom in connection with an increase in population, in particular Government employees. But as soon as the refugees of Dujuma started emigrating, the services and trades sector also decreased. It can be assumed that the situation will not considerably change unless an all-weather road connects Bu'aale with Jilib and/or Bardheere.

Bardheere again has had a different development as compared with the two other urban centres. It has always been more a traditional religious centre rather than an economic one. It can however be expected that the economic development, including services and trade, will speed up in the near future because of its substantially improved road access and its increasingly market oriented agricultural production. Furthermore, the town will certainly experience an economic boom in all sectors, after the ultimate decision for the construction of the Bardheere Dam has been made.

4. Development Prospects

4.1 Planning Programme

Planning as a responsibility of the MJVD is mentioned in Article 3 of its Constitutional Law of 29th April 1982. Overall planning shall concentrate on the identification and analysis of development resources and studies shall be conducted for single projects.

As far as overall planning is concerned, three attempts have been made to work out a study for the development of the Juba Valley (Ref. 2, 3, 6). By now the first two of them can be considered as outdated, since they propose essentially different approaches compared with the alternatives which during the last years have been identified as being the most appropriate ones. Although the Impresit study has been taken as a basis for appraisals, evaluations, reviews and single project studies and, finally, for the decision of several donors to contribute to the financing of the Bardheere Dam Project, its data basis is deemed to be rather insufficient and therefore serious doubts were raised about the planning assumptions and parts of the planning approach.

One of the main items which would alter the strategy, is the reversed weighting in the purposes of the Bardheere Dam Project. The dam was originally planned mainly for

the storage of irrigation water. Following the estimates presented by Coyne et Bellier in 1981 (Ref. 30), the dam project seems to be much more viable, if the Mogadishu power supply alternative would be adopted. The question whether the demand for electricity will be big enough to absorb the output of the envisaged power generation capacity was positively answered by Electroconsult (Ref. 33). The final design for the Bardheere Dam is in any case being conducted under the assumption that the power component bears at least half of the investment cost. This makes a much more flexible, less ambitious and more realistic planning approach possible for irrigated agriculture.

On this basis, the MJVD in early 1983 defined the short and medium-term planning needs for Juba Valley development (Ref. 9). Prior to any new overall study, a comprehensive and sound data base is to be established. Therefore the MJVD has concentrated on resource planning with the purpose:

- of determining the development potential of the Juba Region in more exact and reliable terms and identifying constraints and problems,

- of having sound information available for the elaboration of a regional development plan as well as for the planning of single projects,

- of increasing the ability of the MJVD to lead the coordination of Juba Valley development.

After an extended period of data collection and analysis, the elaboration of an integrated regional development plan of binding character was envisaged.

In 1983, the World Bank Review Mission proposed to carry out the following additional studies, before any major new investment is undertaken in the Juba Valley:

- a study of a small interim storage project for a reservoir with a capacity of 200-300 million cubic meters which would provide irrigation water in the dry season and which might be brought into service in five years,

- a soil and land resources survey in the Juba basin and in the Lower Shebelli area,

- a masterplan for the Juba Valley,

- an updated and in-depth feasibility study for Bardheere.

The major part of these recommendations coincided with the intentions of the MJVD, who in October 1983 presented a brief planning programme including the following major studies:

- evaluation of development resources and constraints,
- final design for the Bardheere Dam and Reservoir,
- feasibility study for the Bardheere Irrigation District,
- masterplan for the Juba Valley,
- soil and land classificati n study,
- environmental and social impacts study.

In the meantime, following partly the recommendations of the World Bank Review Mission, the programme has been extended and detailed as shown in Figure 19. In the following, some explanations are given for each of the planning components:

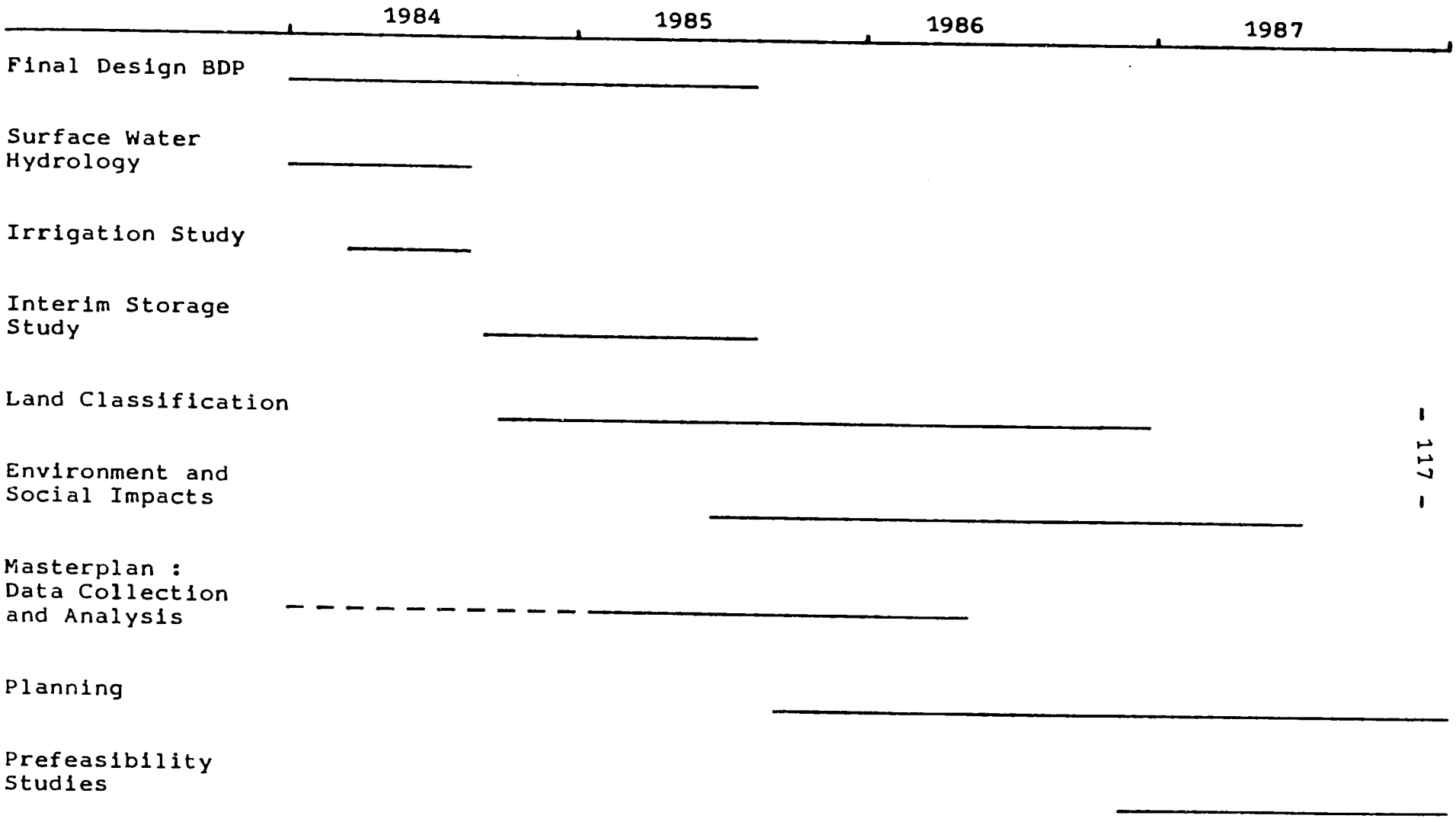
- Final Design Study Bardheere Dam Project: The contract for the study was signed on 14th July 1983 with Electroconsult, Italy; work was started on 1st September 1983. The terms of reference comprise not only the technical design of dam, reservoir, power complex and power lines, but also include some components of feasibility analysis e.g. power market study, hydrology and optimization models. Moreover, tender documents for the construction contracts will be prepared by August 1985. The drafts of the power market study and hydrology and optimization analyses were submitted in 1984 (Ref. 33 and 34).

- A survey has been prepared for flood recession and irrigated agriculture on small and medium-sized farms by the German Advisory Team at the MJVD (Ref. 19). This study was intended to serve as an information basis for a programme which aims at the improvement of small and medium-scale irrigated agriculture on a short term basis, i.e. before the completion of the Bardheere Dam (see Chapter 4.2.2).

- The MJVD, with the assistance of the German Advisory Team,. started a data collection and processing programme in some fields of major importance for future planning:
  - A computerized system of data collection, processing, analysis and application including rehabilitation of gauge stations and recording system was established for surface water hydrology (Ref. 20). All hydrological information up to August 1984 is stored in a data bank (see also Chapter 2.2).
  - Surveys of the present situation have been carried out in the fields of agricultural services (Ref. 18), agricultural development potential (Ref. 17), agricultural production (Ref. 10), settlements and infrastructure (Ref. 16).

  The intention of this programme is to prepare a data basis for masterplanning.

FIGURE 19 : Planning Programme of the MJVD



- Interim Storage Prefeasibility Study: The contract for this study was signed in September 1984, work was started on 15th October by the Consultant Lahmeyer International, F.R.G. The terms of reference include a prefeasibility analysis of three proposed interim storage alternatives (a low dam at Saakow, raising of the existing Fanoole diversion weir, an off-stream storage in the lower reaches of the river) and a comparison between development sequences with and without an interim solution.

- USAID has agreed upon financing and execution of two studies in fields of major importance which are considered as inputs for the masterplan:
  . Soil and land classification,
  . Environmental and social impacts of Juba Valley development.

  The agreement for both studies was signed on 29th September 1983. Terms of reference foresee very detailed analyses, extended primary data collection, mapping and recommendations for development measures to be integrated in the masterplan. Both of the studies were preceded by pre-reconnaissance missions. Work for the soil and land classification study was started in November 1984; the environmental and social impacts study is at present in its tender procedure.

- Masterplanning is scheduled for the period 1985-1987, and will be carried out under the terms of the FRG-financed project "Advisory Assistance to the MJVD - Phase II". The intensive planning phase preceded by data collection activities and including the elaboration of a regional development plan and pre-feasibility studies for a limited number of projects, will be 1986-1987. The masterplan shall not only give a clear picture of the existing potential and a comprehensive integrated regional development concept, but also present an investment plan for a time horizon of 25 years which is to be included in the National Development Plans. Selected projects identified by the masterplan to be of highest priority will be taken to feasibility standards at post-masterplan phase, starting from 1988 onwards.

The single components of the planning programme are financed by different donors and carried out by different study groups, each of them bound to different administrative rules and certainly following different perceptions of contents, methodological approach and relative importance of the individual studies which will finally have to be integrated in one harmonized planning framework for the development of the Juba Valley. Therefore a strong coordination has to guide and integrate the efforts in order to achieve an optimum result, a task which has to be carried out by the MJVD with the assistance and advice of the Technical and Advisory Committees.

4.2 Development Scenarios for the Juba Valley

4.2.1 Alternative Strategies

Analysing the present situation and the development potential in the Juba Valley, it becomes obvious that the main precondition for any further development is the regulation of the river. Extension of irrigated agriculture is mainly hampered by too low discharges in the dry season and by the danger of inundations in the rainy seasona. Following the land surveys undertaken so far, there are at least 200,000 hectares of irrigable land on both sides of the river between Bardheere and Yoontoy. According to the final design study for the Bardheere Dam, water would be available to produce around 450 gwh of electricity per year and to irrigate a minimum area of 175,000 hectares. Irrigated agriculture and energy offer the most promising prospects and must therefore be considered as the two key sectors for future development. This is perfectly in line with the Government's policy aims of achieving self-sufficiency in basic food supply, substitution of imports and increase of exports.

Development measures would concentrate on a relatively narrow fringe following the Juba River from the Bardheere District down to the Indian Ocean. Three major complexes of land for irrigated agriculture have been identified as offering the most suitable conditions:

- the area around and downstream of Bardheere,
- the area between Saakow and Bu'aale,
- the lower reaches of the Juba downstream of Fanoole.

A development of all three of these areas would imply the construction of a flood detention reservoir upstream of Bardheere.

Development would then be concentrated, although not restricted, in the core area, i.e. the axis between Bardheere and Kismayo. The towns of Kismayo, Jilib and, to a minor extent, Bardheere have already acquired certain functions of central places, a process which in the future will be accelerated. The road connections Mogadishu - Jilib - Kismayo and Mogadishu - Baidhabo - Bardheere have contributed to the dynamic development of those towns. Due to the lack of a permanent road connection, the entire middle reach of the Juba is still quite undeveloped. The construction of a road parallel to the river between Jilib and Bardheere is an indispensable pre-condition for the integration of the region. Tender procedure for the final design of that road was initiated recently. The study will be conducted in 1985 and it is hoped that construction can begin in early 1986.

Although two key sectors have been identified for future development, the planning approach for the Juba Valley will be of integrated character. Both energy and irrigated agriculture, together with an improved road network, will create incentives for other sectors, mainly services, industry and construction. Livestock and fisheries offer possibilities for development. Ecological aspects will have to be taken into consideration as well as health and education. It will be the task of the masterplan to design a detailed integrated regional development programme.

Since the mid-sixties, the Bardheere Dam has been the basic element in the planning for the Juba Valley. The search for a suitable dam site concentrated on an area upstream of Bardheere, where the river forms a narrow gorge between 70 - 100 m high hills. From the topographical point of view, the site at Marcable offers obviously the best conditions for the construction of a dam. Population density is very low and hardly any agriculture is found between Marcable and Luuq. Geologically, first surveys showed that there is no obstacle from that point of view for the installation of an artificial lake.

For these reasons, there was no doubt that the construction of a dam at that site would be the basis for the development of the Juba Valley. A comparison of three alternatives (Bardheere Dam, Saakow Dam, offstream reservoirs in connection with flood protection measures) carried out in 1983 (Ref. 32) confirmed that in the long run the Bardheere Dam would be the most viable solution.

Nevertheless, it was the World Bank Review Mission visiting Somalia in May 1983, who proposed to re-calculate the benefits of the Bardheere Dam in comparison with an interim storage solution. The idea was to consider the possibility of constructing a smaller reservoir as soon as possible which would supply water to the existing irrigation perimeters in the Lower Juba Valley and to the ongoing projects and delay the construction of the Bardheere Dam. The argument behind this proposal was that the full capacity of the Dam would be needed only early in the next century. The mission proposed to study three alternative interim solutions: a small dam north of Saakow, the raising of the existing Fanoole diversion weir and an off-stream reservoir behind the Juba Sugar Project in the course of the former river bed known as Far Shebelli. A consultant was contracted to conduct such a study on prefeasibility level, final results of which will be available by mid-1985.

Therefore, the two theoretically existing alternatives for Juba Valley development are:

- the undelayed construction of the Bardheere Dam,
- the earliest possible completion of interim storage works and the construction of the Bardheere Dam at a later stage, the timely determination of which would depend on the result of an optimization study.

Before sketching strategy alternatives, the characteristics of the Bardheere Dam and of the three proposed interim solutions shall be briefly described.

Bardheere Dam

A detailed proposal for a dam was first presented in 1977 (Ref. 21). A concrete gravity solution was recommended with a storage capacity of 4,100 x 10^6 m^3, incorporating three turbines with an installed firm capacity of 60 mw. The related programme for agricultural development was based on rather optimistic assumptions. However, even after a correction of those assumptions, the IRR was calculated at 13.9 per cent.

Two reviews produced in 1980 (Ref. 26) and 1981 (Ref. 30) recommended a gravity buttress solution and included power supply to the Mogadishu area. Because of the unfavourable development of world market prices for agricultural products compared with a steep increase in oil prices, the alternative purpose of hydropower generation became more viable than storing water for irrigation purposes.

The final design study for the Bardheere Dam was started in September 1983. Important details have been presented in interim and draft reports (Ref. 33, 34), being summarized as follows:

- A solid gravity solution has been found to be the better solution when compared with a buttress gravity one. The cost of the former would be US $ 162 million in February 1984 prices and would be cheaper than the latter by 3 per cent.

- A crest level of 150 m a.s.l., i.e. 75 m above foundation level has been identified as being the optimum height.

- The power station would be equipped with three Kaplan turbines having a rated capacity of 105 mw resulting in a firm capacity of 97 mw. The plant would generate 423 gwh of primary (firm) energy and 101 gwh of secondary energy per year.

- Dam and reservoir are laid out in such a way that a peak flow of 3,850 m^3/s and a 30 day maximum inflow volume of 4,800 x $10^6 m^3$ (both for a return period of 1,000 years) could be handled. The discharge for a 100 year return period flood would be limited to 700 m^3/s. Thus, the Dam would provide full flood protection for the entire downstream valley.

- The maximum elevation of the sediments against the Dam resulted in 119 m a.s.l.. The effects of such sedimentation on the reservoir capacity are negligible.

- The power and electricity demand forecast estimates that the production of the envisaged capacity of 97 mw (423 gwh) would be fully absorbed before the year 2,000. (The by then installed capacity of about 65 mw in the Mogadishu thermal plants would be needed for stand-by purposes).

- The Dam would store enough water to irrigate a minimum of 175,000 hectares of agricultural land. Assuming an implementation rate of 3,000 hectares per year from 1992 onwards, this figure would not be reached before 2,030, i.e. water availability will not become a bottleneck for agricultural development.

- The total investment cost of the project, including Dam, hydropower complex, power lines, access road and engineering costs, would amount to US $ 306.4 million according to prices in February 1984.

- The IRR has been calculated, allocating three different cost proportions to power generation: 55, 50 and 45 per cent. The result is 16.5, 17.5 and 18.5 per cent respectively.

It should be noted here that only the Bardheere Dam can provide full flood protection, enough water for an undelayed development of irrigated agriculture and power supply for the electrification of the Juba Valley and the Mogadishu area. Planning procedure has been progressing in a way that construction could be started in 1986 which, conservatively assuming a construction period of six years, would provide the full benefits from 1992 onwards.

Saakow Dam

In 1976, the construction of a diversion weir in the Saakow area was proposed as part of a hydraulic system comprising the Bardheere Dam and three diversion weirs. Similar to the situation in 1984, a study was started in 1978 on the construction of a dam which would be commissioned

earlier than Bardheere and serve as an interim storage as well as diversion headworks for the Saakow Irrigation Scheme. The engineering part of the study was carried out (Ref. 41). A site 10 km upstream of Saakow, known as 14K2 was selected by the consultant as the most appropriate one. Storage capacity behind an earthfill or rockfill dam would be 380 x $10^6 m^3$.

However, shortly after, the decision was made to delete the Saakow Dam and instead proceed directly to the undelayed construction of the Bardheere Dam. It was considered that Bardheere would make additional storage superfluous. Even a diversion weir would be unnedessary as electrical pumps instead of gravity systems were envisaged for the supply of irrigation water.

The idea of constructing a low Dam at Saakow was reborn in 1983. The purpose of the Dam would, according to the World Bank Review Mission, be to store water during an interim period before the commissioning of the Bardheere Dam and it would have the further long-term advantages of:

- acting as head works for the Saakow Irrigation Scheme,
- providing a balancing reservoir to re-regulate the variable discharge of the turbines at Bardheere,
- providing 8 - 12 mw of hydropower,
- perhaps serving as headworks for water transfer to the Shebelli.

A definite assessment of the benefits of such a dam will be available by mid-1985 only. Nevertheless, some of the doubts concerning the usefulness of the Saakow Dam as an interim solution shall be noted here:

- The Bardheere Dam would cover all functions of flood protection, irrigation water supply and power generation. A re-regulation reservoir would not be necessary.

- Pump irrigation is envisaged to serve the Saakow Irrigation Scheme. Even for a gravity system, only a diversion structure, but not a dam with a storage capacity of the envisaged magnitude would be needed.

- As long as enough irrigable land is available in the Juba Valley, water transfer over a long distance to the Shebelli area appears not to be a suitable concept.

- Any major project in the Middle Juba Region, including Saakow, depends on the construction of a road, either to Bardheere or to Jilib. Although it would serve other purposes as well, part of the investment cost would have to be attributed to the Saakow Dam.

- Taking into account that construction has to be preceded by further planning steps (feasibility study, final design study) and by road construction, the Saakow Dam could certainly not come into function earlier than the Bardheere Dam.

- The Saakow reservoir would be much shallower than the Bardheere reservoir. Thus evaporation losses would be much higher. A considerable area cultivated at present would be inundated and lost for agricultural production.

- The Saakow Dam would not provide considerable flood protection. On the contrary: the Dam itself would have to be protected against flood hazards.

Concluding, it appears that the Saakow Dam would not pay back the investment cost in a reasonably short interim period, all the more under the assumption that the latest cost estimate for the Bardheere Project of US $ 306.4 million is realistic.

Raising of Fanoole Barrage

Very little information concerning the technical details of the Fanoole diversion weir is available. The present storage capacity is negligible. It seems rather unlikely that raising the weir would be technically and economically feasible, when considered together with the construction of dykes for the adjoining reservoir. Moreover, the topographical features of the area upstream of the weir seem not to be favourable for the construction of a reservoir.

Offstream Reservoir South of Fanoole

In 1983, on reconnaissance level, the construction of offstream reservoirs in connection with flood protection measures was studied as an alternative to the Bardheere Dam (Ref. 32). The identification of potential sites was made on the basis of 1:100,000 scale maps. Three factors were to be taken into account:

- Natural depressions are the most suitable location for offstream reservoirs, because necessary earth movements on such sites are reduced.

- A suitable location for water diversion from the river had to be found.

- The site should be located close to the river in order to minimize the length of intake and outlet canals. On the other hand, present or potential agricultural land had to be avoided.

The identification of natural depressions on the basis of the above mentioned maps can only be of indicative nature. Therefore the other two factors determined the selection.

The existing barrage at Fanoole offers a diversion site from which supply canals can be routed to reservoirs on both sides of the river taking full advantage of the barrage retention level. If reservoir sites at lower altitudes can be found, they could be flooded by gravity. On the other hand, potential irrigation schemes are identified just downstream of Fanoole. One of them, the Juba Sugar Project, is in full development process.

After consideration of the above circumstances, two sites were chosen: one on the east side behind the envisaged Fanoole/Jilib Scheme in the lowest reaches of the Wadi Harar Naga and the second one on the western bank, northwest of the Sugar Project area between flood plain and the old river channel Far Shebelli. In both cases the stored water would be released back into the Juba, on the eastern side through an artificial canal, on the western bank through the natural bed of the Little Juba. The latter alternative was chosen to be studied as a site for an interim storage solution, mainly because the Juba Sugar Project could be irrigated by gravity from the reservoir and because of the shorter distance to the river.

The topographical features of the selected site do not appear to be favourable. It is located on the marine plain levees between the lower lying flood plain and the old river bed. This location would certainly entail the need for surrounding the entire reservoir by bunds. Together with intake and outlet structure and about 12 km of canals, the construction will require relatively high investment costs. Provision of flood protection would be negligible. Evaporation losses would be rather high. Details will have to be worked out under the terms of the "Interim Storage Prefeasibility Study". Since planning process and establishment of some basic infrastructure would delay the start of construction, it is assumed, as in the case of the Saakow reservoir alternative, that an offstream reservoir would not be commissioned before 1992.

Considering the above, two different phases can be distinguished in the future development of the Juba Valley.

- A medium-term development phase, during which present development will continue until the commissioning of major storage works and without considerable improvement in the road infrastructure. It has been assumed here that this phase would last until 1992,

when either the Bardheere Dam or interim storage works would start functioning. Small and medium-scale agriculture would grow at a modest rate; ongoing large-scale projects would be developed and completed as envisaged. No new large-scale project would be started.

- A long-term development phase which would commence in 1993. Two different scenarios will be described in the following chapter, one basing on the assumption that the Bardheere Dam would be constructed between 1986 and 1992, the second one assuming that an interim storage reservoir would be completed during the same period. In the first case, energy would be available for the Juba Valley and for the Mogadishu area and development of irrigated agriculture could continue in the entire core area downstream of the Dam site. In the latter case, little or no additional energy would be generated, but irrigated agriculture would obtain stored water in the dry season in the lower reaches of the valley. There would only be a small chance of accelerating development in the Middle Juba and Gedo Regions.

Apart from these two basic cases, further possibilities are not considered here (e.g. the possibility of implementing the Bardheere Dam Project in different phases). A time horizon of 25 years has been chosen for the assessment of development, i.e. predictions will be made up to the year 2017. In this report, the description of scenarios is restricted to irrigated agriculture. It will be the task of the masterplan to take other sectors into account in detail and to present a comprehensive and integrated regional development plan.

4.2.2 Medium-Term Development (until 1992)

4.2.2.1 Cultivated Area

The following assumptions have been made for the development of deshek and irrigated land:

- Agriculture on deshek and small and medium-scale farms would be developed by the population at present engaged in that sector.
- New large state farms would not be established.
- No considerable number of farmers from outside the Juba Valley would settle there.
- The development of agricultural land would consist of an extension rather than of an intensification of the presently cultivated land.

The annual development rate for deshek and irrigated land has been assumed as follows:

- Deshek land: an extension of the presently cultivated deshek land would be based on a natural growth of existing deshek farm population. It has been assumed that the farm population would grow at a rate of 2 per cent per year (compared to an overall population growth rate of 2.7 per cent), making an allowance of 0.7 per cent for people settling in townships or outmigrating.

  Between 8,100 and 10,000 farmers cultivate deshek and small-scale irrigated farms. It has been assumed that 8,500 farmers are at present engaged in deshek cultivation.

  The average size of farmholdings in Saakow District is 0.82 hectares, in Bu'aale District 1.08 hectares, in Jilib District 2.18 hectares and in Jamaame/Kismayo Districts 1.81 hectares.

- Small-scale irrigation perimeters: these perimeters are mainly found in Bardheere District, where many of the schemes are owned by merchants or absentee landlords. Therefore, it might well be that in future, other factors than only the natural population growth would influence the rate of extension. But as such developments are difficult to predict, the population growth rate of 2 per cent has been applied here as well. An average size of farmholding of 3 hectares has been assumed.

- Medium-scale irrigation schemes: the extension of medium-scale (mainly banana) farms during the last two to three years was almost entirely done by rehabilitating former abandoned plantations rather than by clearing virgin bush land. The process of former extension is difficult to assess, because it will mainly depend on the market prospects for bananas and will be limited by the availability of irrigation water. Little information on this sector exists.

  Therefore, a 2 per cent increase per year has been used again as a basis for estimating the future extension in this sector. Under the assumption that new farmers would also have an average farm holding of 65 hectares (as the present average) and that some of the present plantations would be expanded, it is estimated that 250 hectares per year would have to be added to the existing area.

- Large-scale irrigation schemes: it has been assumed that, due to the lack of irrigation water, only the ongoing projects would expand as envisaged.

The Fanoole Rice Scheme would be extended to 7,500 hectares in 1988.
The Juba Sugar Project, where at present 5,800 hectares are under cultivation, would be extended to 7,200 hectares by 1986.
The Mogambo Irrigation Project would be developed up to 2,200 hectares in 1986.

The result of the assumed extension of agricultural land is shown in the following Table 23.

Table 23 : Assumed Development of Cultivated Land by 1992

District	Hectares presently under cultivation	Hectares under cultivation in 1992
Bardheere	1,522	1,777
Saakow	1,185	1,393
Bu'aale	2,206	2,594
Jilib	1,525	1,788
Jamaame/Kismayo		
• Desheks	7,883	9,226
• Medium-scale farms	4,940	6,950
• Large-scale projects		
•• Fanoole	350	7,500
•• Juba Sugar	5,850	7,200
•• Mogambo	-	2,200
Total	25,461	40,628

Source : Own investigations and estimates.

4.2.2.2 Crops, Cropping Pattern and Cropping Intensity

It has been assumed that no new crops would be introduced in the Juba Valley until 1992. The main crops grown at present are:

- desheks: maize, sesame, sorghum, tobacco, groundnuts, water-melons, cotton.

- small-scale irrigation perimeters: maize, sesame, onions, tobacco, bananas.

- medium-scale irrigation perimeters: bananas, maize, sesame, groundnuts.

- large-scale schemes: sugar, rice, cotton.

For the cropping patterns the following considerations have been made:

- The Juba River would not be regulated until 1992, i.e. flood damages would still occur and the emphasis of deshek farmers would still be laid on the ensurance of production of staple foods for home consumption. Low water levels in the Jilaal season would still limit the production on medium and large-scale schemes.

- Additional farmers would apply the same cropping patterns as their relatives on the neighbouring lands.

- There are no indications for a future change in the existing cropping patterns.

- Cropping patterns and intensities on the large-scale irrigation schemes have been determined by the various feasibility studies and would not be changed.

The summarized cropping intensity in desheks is 204 per cent per year, on small-scale irrigated farms 331 per cent per year and on medium-scale irrigated farms 104 per cent per year. Cropping patterns and intensities applied at present are described in detail in Ref. 19, Annex 1.

The cropping patterns on the large-scale irrigation schemes are or will be:

- Juba Sugar Project: 100 per cent per year
- Fanoole Rice Scheme: 100 per cent per year
- Mogambo Irrigation Project: 150 per cent per year for rice and 100 per cent per year for cotton.

4.2.2.3 Crop Water Requirements and Water Availability

In order to assess whether sufficient water is available for irrigation, the following steps have been taken:

- calculation of the area cultivated with each crop per season,
- determination of crop water requirements per crop, season and hectare,
- calculation of total crop water requirements per season and year.

The results of these calculations will have to be checked against available hydrological data.

Basing on the results of research work presented in Ref. 19 and on the forecasts developed in the previous chapters, probable water use in 1992 at pump level has been estimated. The results are presented in Table 24.

In order to enable a comparison between crop water use at pump level and river discharge, the water use figures of Table 24 have been converted into m^3/s:

- Bardheere District:
  - Jilaal season 0.7 m^3/s
  - Gu season 1.2 m^3/s
  - Xagaa season 1.6 m^3/s
  - Der season 1.2 m^3/s
- Jamaame/Kismayo Districts:
  - Jilaal season 15.6 m^3/s
  - Gu season 21.1 m^3/s
  - Xagaa season 13.6 m^3/s
  - Der season 23.6 m^3/s

In addition to the figures of the Jamaame/Kismayo Districts, 1.5 m^3/s have to be added in the dry seasons of Jilaal and Xagaa. This amount of water is needed to keep a constant water level in the main irrigation canal of the Fanoole Rice Project in order to avoid cracking of the canal dykes.

Comparing the water use data with the river discharges at Bardheere and Mareerey (shown in Figures 9 and 11), the following conclusions can be drawn:

- Sufficient irrigation would be available in all agricultural seasons in Bardheere District until 1992.
- In two out of ten years there would be insufficient irrigation water from mid-December until mid-April downstream of the Fanoole weir.
- Every second year difficulties would occur at the end of February, during March and at the beginning of April downstream of the Fanoole weir.
- In only two out of ten years would there be enough water for irrigation purposes in the entire area under consideration.
- If an extension of irrigated agriculture takes place as envisaged, the production of perennial crops would be seriously hampered. Crop yields would be reduced and soil physics influenced by a lack of required leaching water.

Table 24 : Crop Water Use at Pump Level in the Juba Valley in 1992

District	Crop	Crop water use				Total in '000 m^3
		Jilaal	Gu	Xagaa	Der	
		In '000 m^3				
Bardheere	Maize	1,235	4,168	1,752	4,943	12,098
	Sesame	321	1,070	585	1,119	3,095
	Tobacco	-	466	935	-	1,401
	Onions	3,967	3,398	8,963	3,617	19,945
	Sub-Total	5,523	9,102	12,235	9,679	36,539
Jamaame/Kismayo	Bananas	58,850	52,965	58,850	54,731	225,396
	Maize	-	779	-	929	1,708
	Sesame	-	-	-	159	159
	Groundnuts	-	-	-	110	110
	Sugarcane	62,806	39,406	47,174	41,090	190,476
	Rice	-	71,219	-	83,688	154,907
	Cotton	-	-	-	2,920	2,920
	Sub-Total	121,656	164,360	106,024	183,627	575,676
	Grand Total	127,179	173,471	118,259	193,306	612,215

Source : Own Investigations and Estimates

- It would even be a risk to extend the cultivation of seasonal crops, since irrigation would partly be required until January and from the end of March onwards.

4.2.2.4 Yields and Production

It has been assumed that yields of deshek and small and medium-scale irrigated cultivation would remain as in 1984. Shortages in input supply and water availability as well as insufficient advice offered by the agricultural extension service will not allow an increase in yields. Figures as observed through field research work in 1984 (Ref. 19) are applied here for small to medium farms. About 80 tons per hectare of sugar cane are being produced at the Juba Sugar Project. For rice and cotton on the large schemes, figures estimated in the respective feasibility studies are applied here.

Total crop production in 1992 and a comparison with the present situation is shown in Table 25.

Table 25 : Comparison of Total Crop Production in the Juba Valley in 1984 and 1992

Crops	Total Production in 1984 in tons	Total Production in 1992 in tons
Maize	17,655	20,690
Sorghum	179	225
Sesame	5,679	6,653
Onions	15,392	17,971
Tobacco	277	306
Water-melons	3,642	4,617
Groundnuts	39	49
Bananas	106,677	149,800
Cotton	71	383
Rice	1,250	49,500
Sugar	42,120	51,840

Source : Own Investigations and Estimates.

4.2.3 Long-Term Development with Bardheere Dam

4.2.3.1 Land Development and Land Availability

The completion of the Bardheere Dam in 1992 would have the following major effects on agricultural development in the Juba Valley:

- Flood damages would not occur any more. It has not yet been investigated in detail, whether desheks can be artificially flooded or have to be equipped with pumps for regulated irrigation.

- There would be enough water available all-year round for the irrigation of the existing perimeters and for the development of new large schemes with seasonal as well as perennial crops.

- Power generation at the dam site would allow the installation of electrical pumps for irrigation of agriculture.

In the following, it will be assessed whether bottlenecks are likely to occur in the three major fields of development resources: land, water, manpower:

As to future agricultural land use, the following considerations have been made:

- The presently highly successful small-scale irrigation perimeters in the Bardheere District would continue to develop independently, i.e. they would not be included in future large-scale irrigation schemes. The rate of extension of 2 per cent, assumed for the medium-term phase, would be retained. Thus, the total number of farmers would increase to 959 in the year 2017. Around 2,900 hectares of land would be under cultivation in this sector.

- A similar development has been assumed for deshek cultivation. After the construction of the Bardheere Dam flooding would be reduced and hence flood recession agriculture would be affected. In order to maintain this potential, desheks would have to be either artificially flooded or irrigated by pumps. In any case, deshek cultivation has to be improved. Uncontrolled flooding from tributaries and from the marine plain has to be avoided by the construction of flood protection bunds. In and outlet gates in the embankments would facilitate controlled flooding and drainage. Agricultural production would thus change from presently uncontrolled coincidental cultivation to a system under controlled irrigation.

Under these conditions, it has been assumed that the cultivated area in desheks would also grow by 2 per cent per year. The developed deshek areas per district in the year 2017 are shown in Table 26.

Table 26 : Developed Deshek Land in 2017 by Districts

District	Number of farmers	Average size of farmholding in ha	Total developed deshek area in ha
Saakow	2,792	0.82	2,300
Bu'aale	3,941	1.08	4,300
Jilib	1,345	2.18	3,000
Jamaame/ Kismayo	8,362	1.81	15,000
Total	16,430		24,600

Source : Own investigations and estimates.

- Due to the difficulties in predicting future development of medium and large-scale irrigation development, it has been assumed that this sector would grow by a constant absolute area per year. Assessments of a possible extension have been made in various reports. They vary from 1,500 to 8,285 hectares per year. A mean extension of 3,000 hectares per year, as assumed in the final design study for the Bardheere Dam Project (Ref. 34), has been applied here. This would include future extensions of existing projects (e.g. Sugar Project up to 13,500 hectares, Mogambo Project up to 6,400 hectares) as well as the development of new irrigation schemes of different sizes; medium-scale as well as large-scale perimeters may be developed. Over the 25 year period until 2017, 75,000 hectares would thus be added to the existing medium and large-scale irrigated area in the Juba Valley.

Table 27 shows the total estimated area under irrigation in the year 2017.

Table 27 : Total Irrigated Area in 2017

Schemes	Area under irrigation in 1992 in ha	Area under Irrigation in 2017 in ha
Small-scale	1,777	2,900
Desheks	15,000	24,600
Medium and large-scale	23,850	98,850
Total	40,628	126,350

Source : Own estimates

The total net area under irrigation in the Juba Valley in the year 2017 would be around 126,500 hectares.

Comparing this figure with the results of the chapter on land resources (Chapter 2.1), the following conclusions can be drawn:

- In total sufficient land is available to extend the present cultivated area to 126,500 hectares in the year 2017.
- Sufficient potential land is available to extend small-scale and deshek cultivation to about 27,500 hectares.
- Under the assumption that perennial crops would be grown on class 1 land only, about 40,000 hectares are available for that purpose.

Thus, land availability will not be a bottleneck for the envisaged development of irrigated agriculture.

4.2.3.2 Crops, Cropping Pattern and Cropping Intensity

For the outlook in this report, no major changes in the list of cultivated crops have been assumed. The cropping patterns would however be different from those which are found at present in the Juba Valley. The following crops would be grown on the different types of irrigation schemes:

- on deshek and small-scale perimeters:

  - Onions, the main cash crop at present would continue to be grown.

  - Maize and sesame: The present cropping pattern would be grown in different proportions than at present because of the envisaged higher prices for oil crops. Therefore 75 per cent of the area would be cultivated with sesame (or other oil crops) and 20 per cent with maize.

  - Sorghum would be deleted from the cropping pattern and be replaced by maize.

  - On the remaining area different types of crops would be grown such as tobacco, vegetables, tree crops.

- on medium and large-scale perimeters:

  It has been assumed that crops to be produced on these schemes would as much as possible consist of perennial crops. It can be expected that those crops would produce a higher monetary return than seasonal crops. The proportion of perennial and seasonal crops has been estimated as follows:

  - 13,500 hectares of sugar cane, as foreseen in the programme of the Juba Sugar Project.

  - 15,000 hectares of bananas. The exact extension will depend on the market prospects for this crop.

  - 11,500 hectares of tree crops, mainly citrus trees.

  - 30,000 hectares of rice as a substitute for present grain imports.

  - 10,000 hectares of cotton to supply raw material to the existing textile industry.

  - 8,850 hectares of oil crops.

Cropping intensities in the three irrigation components have been assumed as follows:

- small-scale irrigation perimeters:

  An increase of the present cropping intensities for these schemes would not be considered because:

- The existing cropping intensity has been indicated at present to be 331 per cent per year. This cropping intensity is already very high and improvement would be difficult.

- If cropping intensity were increased, the strain on labour which already exists, would be aggravated.

- Due to the assumption that 5 per cent of the cultivated area would be grown with tree crops in future, the overall cropping intensity would be slightly reduced to 319 per cent per year.

- desheks:

An intensification of the present cropping intensities in desheks would only be possible by extending the cultivated areas into the dry seasons. It has been assumed that the present cropping intensity of around 203 per cent for all desheks would be increased to 250 per cent per year.

- medium and large-scale irrigation projects:

- It has been assumed that the present cropping intensity in the medium-scale irrigation schemes (banana farms) would not change in future.

- For the large-scale irrigation projects, on which perennial crops are grown (sugar, tree crops) a cropping intensity of 100 per cent will be maintained.

- For large-scale irrigation projects where seasonal crops would be cultivated the following cropping intensities have been assumed:

  - for rice 150 per cent per year i.e. two crops on 75 per cent of the area, as with the growing length of the rice crop of around 120 days,
  - 200 per cent for oil crops and maize, because the growing period is shorter than for rice,
  - 100 per cent for cotton due to the fact that this crop needs around 160 - 180 days of growing time.

4.2.3.3 Yield Assumptions and Total Production

Under the condition that proper measures are taken to support agricultural production (extension service, input supply, credits), the following yields per hectare are considered to be realistic:

maize	4.0 t	vegetables (tomatoes)	20.0 t
sesame	1.5 t	rice	5.0 t
groundnuts	3.0 t	cotton	2.5 t
tobacco	0.8 t	sugar cane	120.0 t
onions	25.0 t	bananas	35.0 t
water-melons	35.0 t	mango trees	25.0 t
		citrus trees	25.0 t

Total production estimates have been calculated by multiplying the assumed areas in hectares grown per crop, the assumed cropping intensities and the assumed yields. Total agricultural production in 2017, compared with the figures estimated for 1984 and 1992 is shown in Table 28.

Table 28 : Total Estimated Agricultural Production in the Juba Valley and Comparison at Different Development Stages

Crop	Total production 1984	1992	2017
Maize	17,655	20,690	145,828
Sorghum	179	225	-
Sesame	5,679	6,653	98,567
Onions	15,392	17,971	85,550
Tobacco	277	306	1,147
Water-melons	3,642	4,617	25,830
Groundnuts	39	19	207
Bananas	106,677	149,800	404,250
Cotton	71	383	25,000
Rice	1,250	49,500	225,000
Sugar ca[illegible] (2)	42,120	51,840	162,000
Tree c[illegible]s	-	-	287,500

Source : Own estimates.

4.2.3.4 Water Requirements and Water Availability

Crop irrigation water requirements were claculated during a survey carried out in 1984 (Ref. 19). Project irrigation requirements were calculated by using an overall irrigation efficiency of 60 per cent. The average project irrigation requirements for the different crops would then be (all figures at pump level, per hectare and per season):

- maize (90 days)	: 8,300 m^3
- sesame (90 days)	: 5,500 m^3
- tobacco (90 days)	: 8,900 m^3
- onions (120 days)	: 10,750 m^3
- water-melons (120 days)	: 18,200 m^3
- groundnuts (90 days)	: 9,700 m^3
- cotton (120 days)	: 20,500 m^3
- rice (110 days)	: 19,500 m^3
- bananas (perennial)	: 33,500 m^3
- sugar cane (perennial)	: 33,500 m^3
- tree crops (perennial)	: 29,500 m^3

Based on these figures and the area cultivated per crop, together with the cropping intensities, the total annual water requirements for the 126,500 hectares of irrigated land in 2017 would be around 3,000 x $10^6 m^3$.

Comparing the requirement with the water availability, it can be concluded that water would not be a bottleneck for the envisaged development of irrigated agriculture.

4.2.3.5 Labour Requirements and Labour Availability

The increase of the cultivated area from presently around 27,000 hectares to 126,500 hectares in 2017 would imply a considerable increase in labour requirements. In order to measure requirements against availability, the following considerations have been made:

- Labour requirements for the cultivation of crops in small-scale irrigation perimeters would be covered by family members of the farmers concerned and tenants, (the present prevailing system), who would come from the farming community of Bardheere District, where this type of irrigated agriculture would be concentrated.

- Labour requirements for the cultivation of irrigated crops in desheks would come from family members of the farmers concerned, as is presently practised. At times of peak labour demands, farmers who would cultivate small farmholdings would go as hired labourers to larger farmholdings.

- Labour requirements for the cultivation of irrigated crops in medium and large-scale irrigation projects have been assumed as follows:

  - labour requirements on banana farms have been assessed during a field survey in 1984 (Ref. 19) with the result that on average two Labour Units (LU) per hectare of irrigated banana fields are required over the year. This would imply that for an area of 15,000 hectares in 2017 a total of 30,000 LU would be needed per year,

  - sugar cane: 0.75 LU per hectare, i.e. 10,125 LU for a total of 13,500 hectares,

  - tree crops: 1.0 LU per 1.5 hectares, i.e. 7,700 LU for a total of 11,500 hectares,

  - rice: under fully mechanized conditions 1.0 LU per 4.0 hectares, i.e. 11,250 LU for a total of 45,000 hectares; under semi-mechanized conditions 1.0 LU per hectare, i.e. 45,000 LU for a total of 45,000 hectares,

  - maize and oil crops: under fully mechanized conditions 1.0 LU per 10 hectares, i.e. 3,770 LU for a total of 18,850 hectares, under semi-mechanized conditions 1.0 LU for 2.0 hectares, i.e. 9,500 LU for a total of 18,850 hectares,

  - cotton: 1.0 LU per 3.0 hectares, i.e. 3,500 for a total of 10,000 hectares.

Total labour requirements for irrigated agriculture in the Juba Valley in the year 2017 would be around 150,000 LU. If the production of rice, maize and oil crops on new irrigation perimeters would be fully mechanized (90 per cent of the work would be done by machines), this figure would be reduced to around 110,000 LU.

In addition to the above figures it has been estimated that for the running of the irrigation schemes another 10 per cent of skilled labour and management personnel would be necessary which would increase the requirements to 165,000 and 121,000 LU respectively.

It has to be noted that these figures give an impression only for the average labour requirements. Labour peaks which would occur in certain seasons of the year would require a higher number of workers.

According to the population estimate in Chapter 2.3, the number of people depending on agriculture would come to 184,000 persons in 1984. It has been estimated that by 2017 this population will have reached a number of around 345,000 persons, using an overall population growth rate in the agricultural sector of 2 per cent over the 33 year period.

Under the assumption that an average family would consist of seven persons, a total of 50,500 families would be engaged in crop production. Assuming furthermore that each family would have three persons engaged in agricultural work and these three persons would equal 2.5 LU, the total number of available labour units would amount to 126,000.

Comparing the average number of LU needed and the available LU for the year 2017, the following conclusions can be drawn:

- Should fully mechanized large-scale schemes be developed, the available number of LU would be just sufficient to cope with the average agricultural activities. Labour peak requirements would not be covered. Assuming that labourers working on large-scale schemes would still cultivate their own plot for food crops, this would aggravate the situation in certain seasons. Those labourers would not be available at times of crop planting, weeding and harvesting.

- If large-scale projects were divided into small units managed by single farm families, the available labour force would not be sufficient to cope with the necessary agricultural work. In this case also, the situation would be aggravated in times of peak labour requirements.

- Thus, if only the natural growth of the agricultural population is considered as a labour force reservoir, labour would be a bottle-neck for agricultural development. As has been explained in Chapter 2.3, it is expected that the earning conditions in irrigated agriculture would certainly attract people from other sectors and regions. Whether or not this would be sufficient, cannot be determined at the present stage of information.

4.2.3.6 Development Costs

To get an overall impression of possible development costs for the 126,500 hectares of irrigated land in the Juba Valley, estimates on investment costs per hectare have been made. These costs are shown in Table 29. The estimations of the costs have been made under the following considerations:

- Small-scale irrigation perimeters, desheks and medium-scale irrigation perimeters would be constructed and managed by individual farmers and their families.
- Large-scale irrigation schemes would be constructed as large projects.
- Land preparation (clearing and levelling) has been assumed to be carried out manually at a rate of 65 man days per hectare and So Sh 100 per man day for small and medium-scale irrigation schemes and desheks.
- Costs for earth work, canal structures and drain structures have been estimated on the basis of feasibility studies for Juba Valley projects.
- Costs of pumps are own estimates. It has been assumed, that desheks and banana farms would have large pump units and small-scale irrigation farmers each have their own pump units.
- For buildings (sheds, stores, huts) So Sh 12,000 have been estimated for small-scale irrigation schemes and desheks; for medium-scale irrigation schemes a figure of So Sh 13,000 has been used.
- No costs have been assumed for on-field structures, since they are carried out each year on small-scale irrigation schemes, desheks and banana farms.
- Roads have not been calculated for small-scale irrigation schemes and desheks.
- Engineering costs would not occur in desheks, small and medium-scale irrigation schemes. It has been assumed that this would be done by the extension service.
- The conversion rate of December 1984 of 1 US $ = So Sh 26.3 has been used to arrive at US $ prices for small-scale irrigation schemes, desheks and banana farms.
- Investment estimates for different types of irrigation schemes are shown in Table 30.

Table 30 : Estimated Investment Cost per ha for Various Irrigation Schemes in the Juba Valley in Phase 2

Description	Small-scale irrigation perimeter in US $ per ha	Desheks in US $ per ha	Medium-scale irrigation perimeter in US $ per ha	Large-scale irrigation projects in US $ per ha
Land preparation (clearing, levelling)	250	250	575	1,490
Earth work (canals and drains)	65	65	100	2,740
Canal structures	85	85	100	1,470
Drain structures	40	40	50	860
On-field structures	-	-	-	420
Pumps	400	175	175	660
Roads	-	-	200	110
Buildings	450	450	500	1,615
Water and power supply	-	-	-	310
Engineering costs	-	-	-	750
Total	1,290	1.065	1,700	10,425

Source : Own estimations and calculations.

From Table 30 it can be noticed that investment costs per hectare for the various irrigation schemes have been estimated at the following 1984 US $ prices:

- small-scale irrigation perimeters : 1,300 US $
- desheks : 1,000 US $
- medium-scale irrigation perimeters : 1,700 US $
- large-scale irrigation schemes : 10,500 US $

An estimation of the total investment costs for the development of 126,500 hectares in the Juba Valley by 2017 is shown in Table 29.

Table 29 : Estimated Total Development Costs for Irrigated Land in the Juba Valley

Irrigation Scheme	Area in ha per scheme	Investment costs per ha in US $ in 1984 prices	Total investment costs in US $ in 1984 prices
mall-scale	2,900	1,300	3,770,000
esheks	24,600	1,000	24,600,000
anana farms	15,000	1,700	25,500,000
arge-scale	83,850	10,500	880,425,000
otal	126,350	-	934,295,000

ource : Own investigations and estimates, Juba Valley projects' feasibility studies.

om this table it can be noticed that the total investnt costs, without physical and financial contingencies, sts for extension service and processing industries anana packing centres, rice mills, maize and oil mills) uld come to around US $ 935 million in 1984 prices.

4.2.4 Long-Term Development with Interim Storage Works

Alternative possibilities of storing water from the Juba River for irrigation purposes are presently being investigated. The aim of an interim storage solution would be to supply irrigation water in the dry season of Jilaal to the medium and large-scale irrigation schemes in the Lower Juba Region (banana farms, Sugar Project, Mogambo Project) for an undetermined period. The construction of the Bardheere Dam would be postponed. Since the year of commissioning of the Bardheere Dam would depend on the results of further studies, it can at this stage only be assessed what development would be possible after completion of the interim storage works.

Following the recommendations of the World Bank (Ref. 8a) it is assumed that an interim storage reservoir would have a storage capacity of around 250 x $10^6 m^3$ of water. The reservoir would be filled during the Der season from the river. Making time allowances for planning and infrastructural works which would have to precede the construction of a reservoir, it is assumed that water would not be available before the possible completion date of the Bardheere Dam, i.e. 1992.

By the end of the year 1992 the following areas of medium and large-scale irrigation schemes are assumed to be under cultivation in the reaches downstream of the Fanoole diversion weir:

- medium-scale irrigation perimeters : 7,000 hectares
- Juba Sugar Project : 7,200 hectares
- Mogambo Irrigation Project : 2,200 hectares

For the calculation of the projects' irrigation requirements at pump level the following assumptions have been made:

- In one out of five years a water deficiency would occur for 120 days (mid-December to mid-April).
- Water from the interim reservoir would be released with a constant flow over 120 days.
- The number of days during which irrigation water would be needed is
  - for bananas 120 days,
  - for sugar cane 120 days,
  - for rice 45 days (mid-December to end of January),
  - for cotton 45 days (mid-December to end of January).

Based on the above and on the assumptions on crop water requirements and irrigation efficiency described in Chapter 4.2.3.4, the total water demand for the 120 day period would be 232 x $10^6 m^3$. Taking into account that the water flow remaining in the river bed downstream of the Fanoole weir is necessary for ecological and drinking water purposes, the storage capacity of 250 x $10^6 m^3$ would just be sufficient to irrigate the medium and large-scale perimeters in 1992.

However, it would not be possible to establish new irrigation schemes from 1992 onwards. The planned extension of the Juba Sugar Project and the Mogambo Irrigation Project would have to be postponed. Moreover, since an interim storage solution would not provide for flood protection, the existing projects would either have to construct their own protection bunds, or produce under the risk of inundations in one out of five years and of catastrophic floods in one out of nine years. It would not be possible to install electro-pumps for irrigation.

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