

**BASIC DESIGN STUDY REPORT ON  
THE DEVELOPMENT FOR THE JABAL-AULIA  
RESERVOIR FISHERIES  
IN THE DEMOCRATIC REPUBLIC OF THE SUDAN**

**FEBRUARY 1981**

**JAPAN INTERNATIONAL COOPERATION AGENCY**

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## Preface

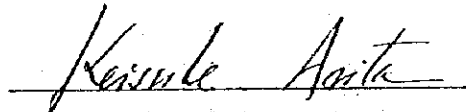
In response to the request of the Democratic Republic of the Sudan, the Japanese Government decided to conduct a study on the development of the Jabel-Aulia Reservoir Fisheries Project in the Democratic Republic of the Sudan and entrusted the study to the Japan International Cooperation Agency (JICA). This project is aimed at improving the fish marketing system and strengthening the campaign for fishermen to improve their ability, thereby improving their socio-economic status and expanding fishery production.

The JICA sent to the Sudan a study team headed by Mr. Yoshihisa Kondo, Social Development Cooperation Department, Japan International Cooperation Agency from 10 to 25 December, 1980. The team consulted with the officials concerned of the Government of the Sudan and conducted an extensive survey in the Sudan.

After the team returned to Japan, further studies were made and the present report has been prepared. I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Sudan for their close cooperation extended to the Japanese team.

February, 1981



Keisuke ARITA,  
President,  
Japan International Cooperation Agency



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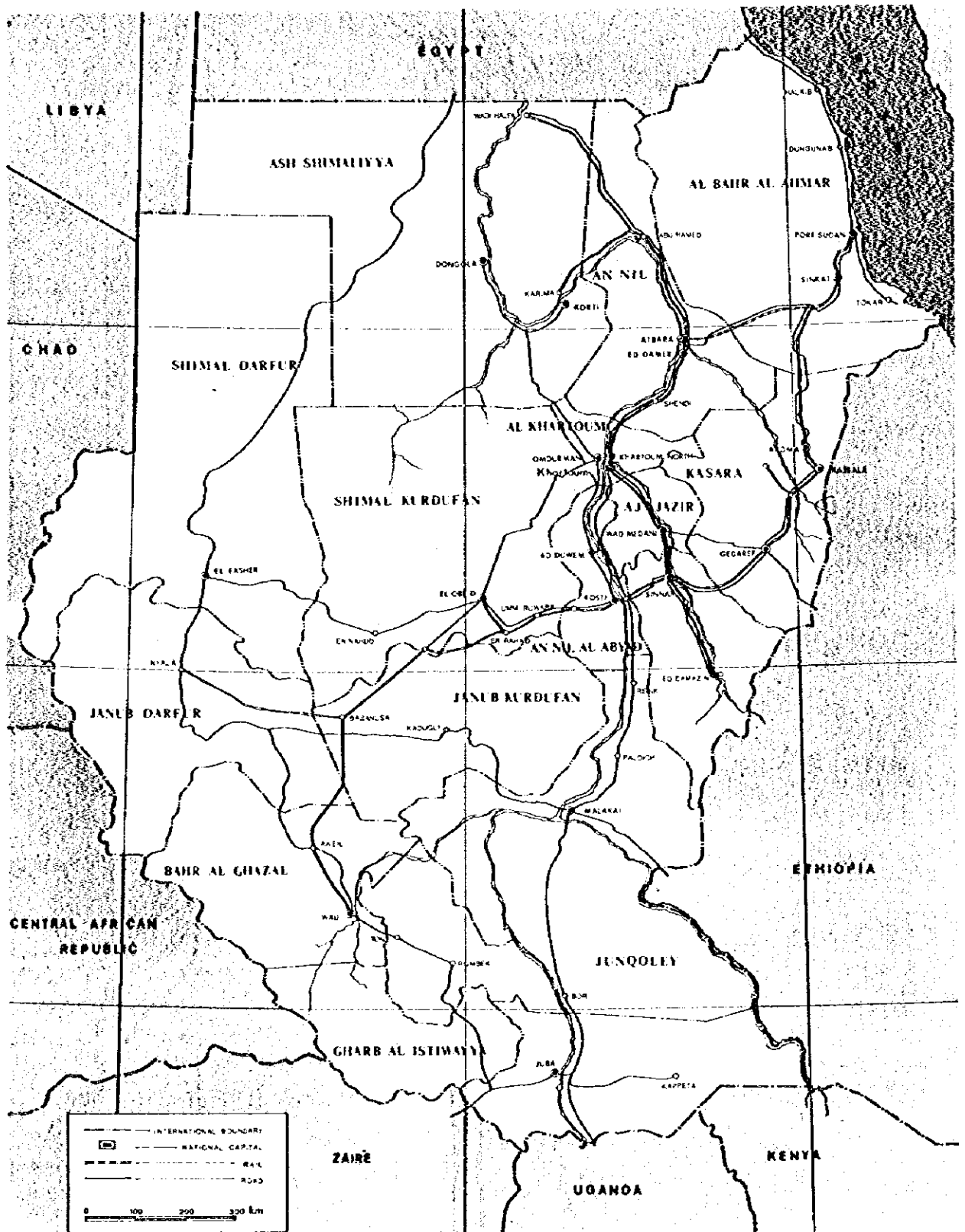
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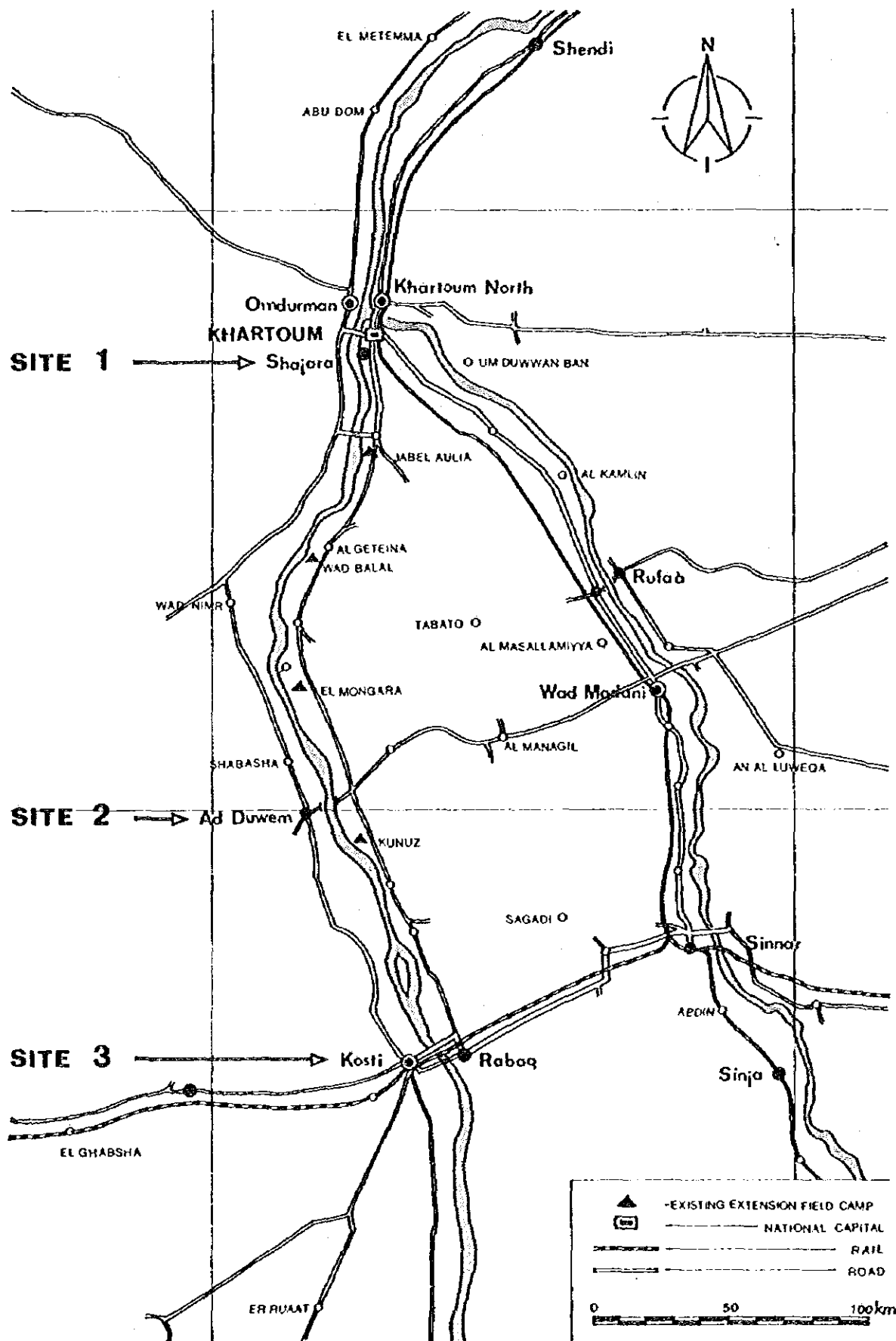
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Survey Itinerary

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## Summary

1. The Democratic Republic of the Sudan is currently engaged in a Six-Year Plan of Economic and Social Development, with 1977/78 as the base year and 1982/83 as the target year.

The share of agriculture in the Sudanese economy has traditionally been high, representing some 40% of Gross Domestic Product and 95% of total exports.

In the current Development Plan, therefore, a growth of 6.5% per annum has been set for the agricultural sector, with emphasis on the diversification of agricultural production and the development of a food processing industry.

2. In carrying out this program, the Government of the Democratic Republic of the Sudan aims, as its basic policy, not only at simply expanding the production base but at achieving a balanced income distribution as well in order to assure an equitable allocation of the benefits to be generated by the development program.

Thus, in the agricultural section, the Government is attaching major importance to the problems of distribution and storage and is attempting to introduce an appropriate distribution structure so as to raise the socio-economic status of small producers in outlying areas.

3. In the fisheries sector, the objective is to increase the annual catch to a level of 60,000 MT by the 1982/83 target year and thereby achieve complete self-sufficiency in fishery products. To this end, the Plan has set a very high annual growth rate of 11%.

The Government has selected inland fisheries development as a phase of overall development for this sector and has decided to promote fisheries development in the Jabal Awlia region, which comprises a wide area of inland waters and contains a large number of fishing population.

4. To help carry out this project, the Government of the Democratic Republic of the Sudan has asked the Government of Japan to provide a grant-in-aid. In response to this request, the Japan International Cooperation Agency dispatched a Basic Survey Mission to conduct an on-the-spot survey centered on the White Nile area from Khartoum to Kosti-- the target area for the development project.

As a result of the survey, the Mission developed a basic plan for constructing an extension training facility at Ad Duwem and process and market centers in Shajara and Kosti and concluded Minutes of Discussions, dated December 22, 1980, between the Director of Fisheries Administration, Ministry of Agriculture, Food and Natural Resources of the Democratic Republic of the Sudan and the Mission Leader, under which a report outlining the survey findings will be prepared by the Mission and submitted to the Governments of the two countries.

5. Fishery production in the Democratic Republic of the Sudan is primarily from inland waters. The inland fishery is concentrated mainly in the Nile River system. Fishing vessels are either non-motorized wooden boats or canoes. Fishing gear are mostly gill nets and seine nets. The main catch species are Tilapia, Nile Perch, Bagrus, and Alestes.

In the absence of ice and freezer facilities at the landing areas and the limited transport capability due to undeveloped roads, the only distribution channel available for fresh fish is through middlemen who come to the landing areas to assemble cargos.

Accordingly, the Government of the Democratic Republic of the Sudan has focused upon the Jabal Awlia area, located close to the major cities, for implementation of a plan to expand fisheries production, upgrade governmental services to fishermen, improve distribution via the establishment of marketing and shipping facilities, organize fishermen, and modernize fishing methods.

6. As a result of our survey, we concluded that it would be most appropriate, for purposes of strengthening administrative services, to establish a Fisheries Extension Center in Ad Duwem, located virtually in the center of the target area, and, for purposes of improving distribution, to set up Fish Process and Market Centers at two supply points, Shajara and Kosti, situated at either end of the subject area.

A brief outline of the proposed facilities is as follows:

	Construction Area		
	Ad Duwem	Shajara	Kosti
Facility Purpose	Extension & Training Center	Distribution & Processing Center	Distribution & Processing Center
Size of Structure	Steel-frame prefabricated; one story; 260 m <sup>2</sup>	Steel-frame prefabricated; one story; 575 m <sup>2</sup>	Same as Shajara
Refrigeration	2 rooms of 15m <sup>3</sup> each--to -20 C.	2 rooms of 50m <sup>3</sup> each -- to -20C.	Same as Shajara
Ice-Making Facility	1 ton per 24-hour period; plate ice, with ice-storage bin	2 tons per 24-hour period; plate ice, with ice-storage bin	3 tons per 24-hour period; 25 kg block ice, with ice storage bin
Related Equipment	Emergency generator; vehicles; ice storage container; instructional aids	Emergency generator; vehicles; carrier boat; marketing facilities	Same as Shajara

7. Operation of the planned facilities can in all likelihood be carried out by employees of the Government of the Democratic Republic of the Sudan. However, for purposes of developing a cadre of fully qualified personnel, we would like to recommend that the Government should make use of technical training program prepared by foreign countries.

The Survey Mission made a number of calculations with regard to the cost of operating the proposed facilities, and it appears that the incremental cost of using refrigeration or ice will be quite small and can be expected to be more than offset by the benefits they bring to fish distribution.

8. The Fisheries Development Plan for the Jabal Awlia Reservoir area is aimed not only at expanding the production base but also, through improvements in the distribution system, at assuring a better balance in income distribution and more effective organization of fishermen to raise their socio-economic status. The project, accordingly, is seen to have profound significance and can be expected to yield major benefit. It certainly, in our opinion, justifies assistance from the Government of Japan in the form of a grant-in-aid.

## SECTION 1 OUTLINE OF THE SURVEY





## 1-1 Background and Objectives

The Democratic Republic of the Sudan is an agricultural nation boasting the largest land area of any country on the African continent. As shown in the Gezira irrigation scheme, irrigation-based agricultural development has been continuing space for many years. As a result, the share of the agricultural sector in the Sudanese economy has reached an extremely high level, comprising 40% of Gross Domestic Product. Five agricultural products--cotton, gum arabic, sesame, groundnuts, and sorghum--account for some 85% of total export earnings.

There is a thriving fresh-water fishery centered on the Nile River. However, owing to undeveloped marketing channels, the distribution range of fishery products is highly limited. And, since fishermen do not own the means of distribution, their socio-economic status is quite low.

The Government of the Democratic Republic of the Sudan, in its current Six-Year Plan of Economic and Social Development, is making an effort to diversify exports and, to this end, is planning to increase exports of sugar, livestock products, groundnuts, and other items. The Government, in connection with achieving its target for meat exports, is aiming to achieve 100% self-sufficiency in fishery products by the Plan's target year 1982/83. Thus, an effort is being made to expand both production and distribution of fishery products.

Close attention is also being paid to small-scale agricultural producers who up to now have been left in the shadow of the larger development programs. In this connection, a policy has been formulated to extend substantive aid to this sector and increase both its output and income levels.

With the above in mind, the Government of the Democratic Republic of the Sudan has selected the Jabal Awlia area near the capital, Khartoum, as the site of a program designed to improve distribution facilities and strengthen extension training programs as a means of raising the

socio-economic level of small-scale fishermen and so expanding fishery production.

The Government of the Democratic Republic of the Sudan has asked the Government of Japan to provide a grant-in-aid to help implement this program. In response to this request, the Japan International Cooperation Agency dispatched a survey mission to the Democratic Republic of the Sudan to conduct a Basic Design Study on the subject project.

### 1-2 Composition of the Survey Team

The survey team comprised six members under the leadership of Mr. Yoshihisa Kondo, Social Development Cooperation Department, Japan International Cooperation Agency. The members included:

Project Coordination	Mr. Yoshihisa KONDO	Social Development Cooperation Department, Japan International Cooperation Agency
Refrigeration	Mr. Katsumi IIZUKA	Fisheries Engineering Co., Ltd.
Architect	Mr. Taizo KANEKO	- ditto -
Fisheries Distribution	Mr. Naohiko NAKAJIMA	- ditto -

### 1-3 Survey Itinerary

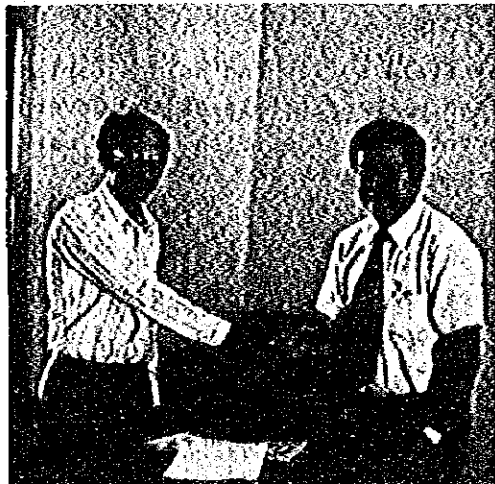
The survey was conducted over a 16-day period, extending from December 10 through December 25, 1980. A schedule of the activities of the Survey Team is provided at the end of this report.

### 1-4 Discussants

A list of discussants is provided at the end of the report.

**1 - 5 Minutes of Discussions**

Minutes of Discussions were signed and exchanged in English by and between the Director of Fisheries Administration and the Team Leader on December 22, 1980. A copy of the Minutes is shown on the following pages.



Dr. Samir Yanni Mishrigi,  
Director, Fisheries  
Administration and  
Mr. Yoshihisa Kondo,  
the Team Leader after  
signing of Minutes of  
Discussions

KHARTOUM, December 22, 1980.

MINUTES OF THE DISCUSSIONS  
THE DEVELOPMENT FOR THE JABAL-AULIA RESERVOIR  
FISHERIES IN THE DEMOCRATIC REPUBLIC  
OF THE SUDAN

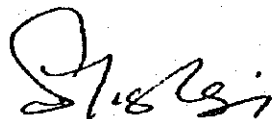
In response to the Government of the Democratic Republic of the Sudan for technical cooperation of the basic design study on the improvement project of fish supply marketing system in the Sudan, the Government of Japan sent a study team headed by Mr. YOSHIHISA KONDO, PROJECT MANAGER, Social Development Cooperation Department, Japan International Cooperation Agency to the Sudan to carry out a basic design study from December 10 to 22, 1980.

The team has conducted the field survey and held a series of discussions and exchanged views with officials of the Government of the Sudan for the improvement project of fish supply marketing system in Khartoum, Ed-Dueim and Kosti.

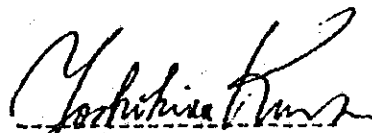
As a result of the study and the discussions, the Japanese team and the Ministry of Agriculture, Food and Natural Resources of the Sudan agreed that the team will complete the report and submit it to the two Governments for further study of the implementation of the project.

The major issues regarding the content of the minutes, confirmed by the Sudanese and Japanese counterparts, are explained in the annex attached herewith.

In confirmation of mutual agreement, we fix our signatures.



DR. SAMIR YANNI MISHRIGI,  
Director,  
Fisheries Administration,  
Ministry of Agriculture, Food and  
Natural Resources.



MR. YOSHIHISA KONDO, N.B.A  
Japanese Basic Design  
Study Team.

ANNEX I

PROJECT OUTLINE

1. Objectives of the Project are to strengthen the administrative services of Fisheries Administration for organising traditional fishermen, to provide process and market facilities for yielding better value added to the catch and eventually to improve the socioeconomic status of fishermen living along Jabal Auliya Reservoir.
2. The proposed facilities will be established at Ed Dueim and Kosti, White Nile Province and at Shagara, Khartoum Province.
3. The Fisheries Administration of the Ministry of Agriculture, Food and Natural Resources will be the executing agency for the Project and will be responsible for the administration and operation of the facilities.
4. The outlined description of the facilities is shown on Annex II.
5. The Fisheries Administration confirmed that the plan and scale of the facilities may have to be adjusted according to the budget to be allocated by the Government of Japan.
6. The Government of the Democratic Republic of the Sudan will take, at its own expense, necessary measures:
  - (1) To secure land suitable for establishing facilities;
  - (2) To clear and level the site before the commencement of the construction of the facilities and to provide to the site electricity, water supply, drainage and any other incidental facilities necessary for the construction and operation of the facilities;
  - (3) To obtain in advance all licences or permit required by the provinces for building facilities, if any;
  - (4) To ensure prompt unloading and customs clearance at the port of entry in the Sudan and the internal transportation of materials and equipment to their respective site;
  - (5) To provide all expenses necessary for the operation and maintenance of the facilities; and
  - (6) To exempt Japanese personnel concerned from taxes, duties and any other charges and fees which may be imposed on the personnel and any equipment and materials entered into the Sudan for the purpose of carrying out the services in connection with construction of the facilities.
7. The team will describe in the study report detailed function, size, quantity and specifications of facilities and equipment which are considered to be most suitable for the project.

*MKA*  
*STZ*

ANNEX II

DESCRIPTION OF FACILITIES

ED DUEIM

1. Basic Function  
Administrative center for the fishing centers established at Jabal-Auliya, Wad Balal, El Mongera and Kunuz.
2. Building:  
Office  
Store  
Workshop  
Multi-purpose space  
Utility
3. Facility  
Ice making machine  
Cold Store  
Back-up generator
4. Equipment  
Equipment necessary for strengthening the extension works carried out by the four fishing centers including vehicle, ice stocking container, fishing gears and miscellaneous equipment.

KOSTI AND SHAGARA:

1. Basic Function  
Fish process and market center positioned between the production and consumption areas.
2. Building  
Office  
Processing space  
Laboratory  
Workshop  
Store  
Utility
3. Facility  
Ice making machine  
Cold Store  
Back-up generator
4. Equipment  
Fish carrying boat, vehicle, ice stocking container and other miscellaneous equipment necessary for fish market.

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**SECTION 2 THE DEMOCRATIC REPUBLIC OF THE  
SUDAN--A BRIEF PROFILE**





The Government of Japan has already made several grants-in-aid to the Democratic Republic of the Sudan in connection with which similar profile studies were prepared. We will, accordingly, limit our remarks in this Section to such background matters as are deemed to be directly related to the subject project.

## 2-1 The Political Scene

Following the establishment of a republic in Egypt in the wake of the July, 1952 Revolution, the Sudan, which up to that time had been governed jointly by Egypt and the U.K., stepped up its demands for self-determination and autonomy. This resulted in a declaration of independence by the Sudanese Parliament in December, 1955, followed by the attainment of formal independence as the Republic of Sudan on January 1, 1956.

However, following independence, the new nation was beset by considerable political unrest, with the people of the South violently opposing the Government's Islamization policies and economic stagnation setting in as a result of poor harvests and unstable world prices for Sudan's main export: cotton. This period of political instability continued until 1969 when, following a coup d'etat led by Colonel Jaafar Nimeiry, the country's name was changed to the Democratic Republic of the Sudan and autonomy was granted to the Southern provinces. With the unification of the population and the enactment of a permanent Constitution, the country entered a period of stability. Despite occasional uprisings against the Government, as a result of assistance from the Arab petroleum producing countries and from Western Europe in the nation's development programs, Sudan's economic foundations have slowly but surely begun to solidify.

The Democratic Republic of the Sudan, as indicated by its designation as "Afro-Arab" state, maintains close relations with both the Arab and African worlds as well as friendly ties with both Western and Eastern Europe, China, India, and Japan.

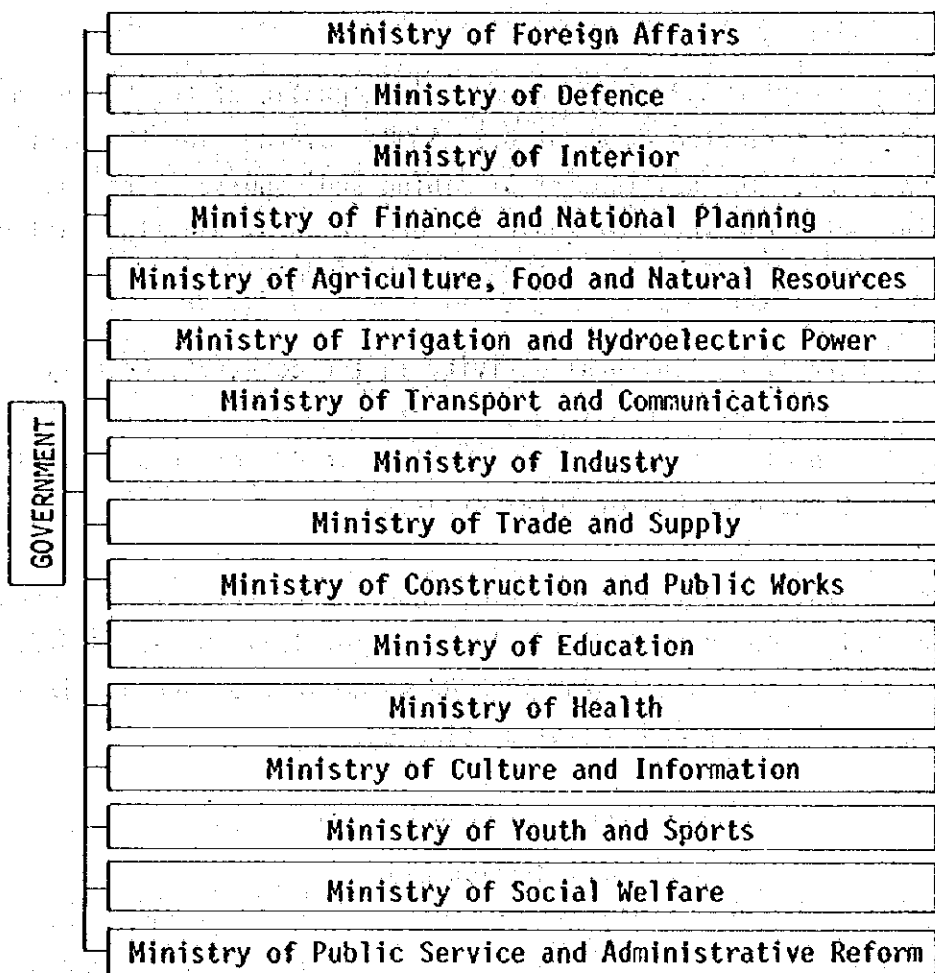
The President doubles as Chief of State and, in addition to his administrative powers, plays a legislative role as well in conjunction with the 250-seat People's Assembly.

The President's term of office is six years. He is chosen on the basis of popular vote, after nomination by the Sudan Socialist Union, the nation's sole political party.

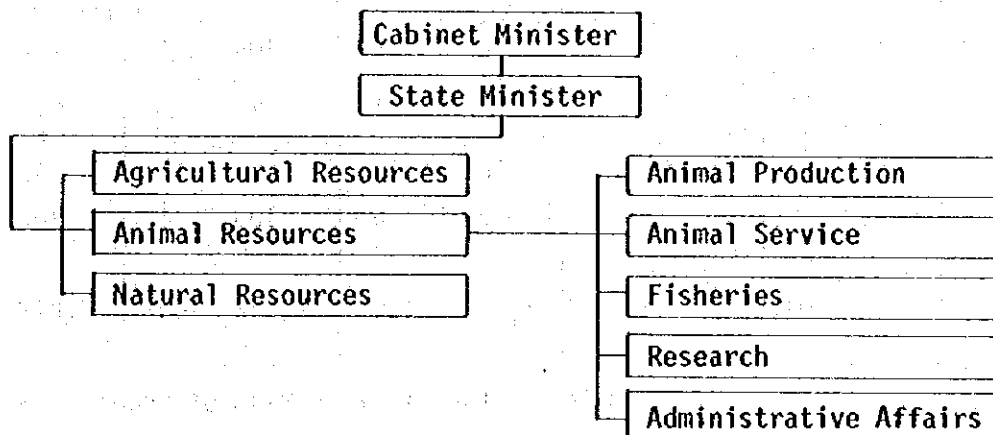
## 2-2 Government

The seat of government is in the capital city of Khartoum, while the Autonomous Government of the South is located in the city of Juba in Eastern Equatoria Province. The country is divided for administrative purposes into 18 provinces, each with its own Regional Governor nominated by the President and dispatched by the Central Government.

Following is a list of the Ministries of the Central Government along with an organization chart of the Ministry of Agriculture, Food and Natural Resources, the competent authority for this project.



**Ministry of Agriculture, Food and Natural Resources**



## 2-3 The Economy

The per-capita GNP of the Democratic Republic of the Sudan in 1977 was estimated at about U.S. \$300-- average for the African Continent. The development of mining and manufacturing has been slow, with the share of these sectors in total GNP fluctuating narrowly around a 10% level during the 1970's.

The share of agricultural activity in the country's economy has traditionally been large, as evidenced by the fact that the agricultural sector accounts for close to 40% of Gross Domestic Product and over 95% of total exports.

In the following table, we have shown the distribution of Gross Domestic Product by individual sector for 1974/75 and 1976/77 as well as the targets for 1982/83 shown in the current Six Year Plan of Economic and Social Development.

GROSS DOMESTIC PRODUCT BY SECTOR  
(In Million LS)

	1974/75	%	1976/77	%	Target 1982/83	%
Agriculture	585	39%	710	39%	1,036	37%
Mining & Manufacturing	143	9	163	9	281	10
Power and Water	21	1	23	1	36	1
Construction	65	4	79	4	132	5
Transport	89	6	106	6	164	6
Commerce, Finance, Real Estate	357	24	433	24	687	24
Government, Services	162	11	200	11	309	11
Other	89	6	108	6	167	6
TOTAL	1,511	100%	1,822	100%	2,812	100%

SOURCE: The Six Year Plan of Economic and  
Social Development: 1977/78 - 1982/83

Sudanese foreign trade is characterized by the export of agricultural products-- raw and processed-- and the import of capital, intermediate, and consumer goods. The Government has been striving to diversify agricultural exports, but the collective share of the top 4 export commodities-- cotton, gum arabic, sesame, and groundnuts-- remains quite high, comprising 78.9% of total exports in 1978 and 80% in 1979. However, in the first half of 1980, the share of these four items fell sharply to 65.4% (94,660,000 LS) from the 81% level during the first half of 1979. But we must reserve judgement as to whether this indicates a new trend or was merely a temporary phenomenon.

Following were the principal export commodities during 1978 and 1979:

**PRINCIPAL EXPORT COMMODITIES**  
(In Thousand LS)

Commodity	Unit	1978		1979	
		Quantity	Value	Quantity	Value
Cotton	Thousand Bale	787.6	104,932	998.7	151,260
Gum Arabic	M.T.	38,756	14,788	44,149	18,650
Sesame	"	75,963	19,182	16,016	6,278
Groundnuts	"	97,214	20,725	37,415	9,956
Dura	"	46,916	2,264	172,024	13,524
Vegitable Oil	"	38,265	8,734	12,359	4,016
Cattle	Head	293,715	8,310	196,419	7,102
Miscellaneous	-	-	23,406	-	21,881
<b>Total</b>			<b>202,341</b>		<b>232,667</b>

SOURCE: Bank of Sudan,  
Foreign Trade Statistical Digest  
Vol. 13, No.2

The agricultural products which comprise the bulk of Sudan's exports are far from stable. Their production is affected by weather conditions and their prices fluctuate sharply on the basis of international market conditions.

On the other hand, the drive to develop the domestic economy has increased imports of key manufactured goods and this, coupled with a rise in the prices of industrial products, has put the Sudanese balance of trade under constant pressure. The Government is attempting to replace imports with local production in various consumer product sectors, such as food products (e.g., sugar, tea, coffee) as well as textiles, but it will be some time before any improvement can be expected in the nation's balance of payments.

The following table shows trends from 1977 to 1979 in the balance of payments of the Democratic Republic of the Sudan:

BALANCE OF PAYMENTS

(In Million LS)

	1977	1978	1979
Current Accounts	-35.3	-43.7	-194.3
Trade Balance	-15.6	-74.3	-158.9
Export	230.3	216.1	227.1
Import	245.9	290.4	386
Service	-19.7	-30.6	-35.4
Capital Accounts	35.7	31.9	109.3
Errors and Omissions	-0.4	-0.1	0.8
Overall Balance	0	-11.9	-84.2

SOURCE: Bank of Sudan, Economic and Financial Statistics Review, Vol.11, No.4

The Democratic Republic of the Sudan is currently in the midst of a Six-Year Plan of Economic and Social Development that was begun in 1977. Under this Plan, investments in the public sector of 1.6 billion LS will be required by 1982/83, primarily for agriculture and irrigation projects. Since these investment funds cannot be entirely generated domestically, according to the Plan, some 50% of the target must be raised abroad. As a result, the implementation of the Development Plan has been accompanied by a steady increase in foreign debt, with the cumulative public debt as of the end of March, 1980 standing at 638 million LS. This is an exceedingly high level relative to the current annual exports (some 230-250 million LS). And when one considers that at the end of March, 1980 there was a total of some 110 million LS of undisbursed funds, it is clear that, until such time as the fruits of development lead to an actual increase in exports and the creation of import-substitution industries, an increase in the non-trade deficit, stemming from loan repayments and interest charges, is unavoidable.

Nevertheless, development in accordance with the Six-Year Plan has been proceeding apace, reflecting the political stability of the past few years and the improvement in infrastructure, which had been a bottleneck in developmental efforts to date. Also, out of a total of some 850,000 km<sup>2</sup> of arable land, less than 10% is actually been cultivated. Considerable hope is being placed also on the development of mineral resources such as iron ore, copper, gold, and chrome. Furthermore, as a result of experimental oil drilling operations in the southern part of the country in recent years, a production level of over 10,000 barrels a day has been confirmed, and additional drilling projects are scheduled.

Thus, economic conditions, when viewed from a longer-term perspective, are slowly but steadily improving.

## 2-4 The Natural Environment

The Democratic Republic of the Sudan is situated in the north-east portion of the African continent, extending from 4°-22° N. Lat. and from 24°-38° E, Long. It has many climatic zones, ranging from the hot, dry areas of the north to the tropical rain forests of the south.

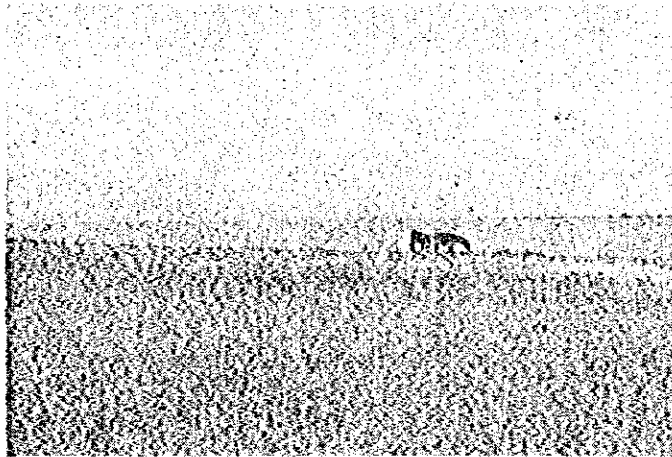
With the exception of the hill country along the Red Sea, rainfall in the north is less than 100 mm per year and so not amenable to the growth of vegetation. South of 16° N., Lat., rainfall rises to some 400 mm. At rainfall levels of over 500 mm, grasslands and bush become evident, which are used as grazing lands. However, over the bulk of the nation's area, the volume of transpiration exceeds that of precipitation, so that the amount of land suitable for year-round rain-fed agriculture is really quite limited. Forests became predominant in vegetation only below 6° N., Lat. in the southern part of the country.

The Nile River basin covers a vast area of some 28.6 million km<sup>2</sup>, comprising about 1/10 of the entire African continent. The White Nile rises in Tanzania, a full 6,700 km from the point at which the river empties into the Red Sea. The source of the Blue Nile is in Lake Tana on the Ethiopian Plateau. These source areas receive rainfall from wet monsoons coming in from the South Atlantic and Indian Oceans, which cause significant seasonal variations in the Nile water level. During August and September, the water level of the main Nile channel reaches a peak, at which time the composition of water flow is: 10% White Nile, 68% Blue Nile, and 22% Atbara. Peak volume is 16 times that of the low-water period, which is reached in May.

However, as a result of various development programs undertaken in recent years, dam construction is being accelerated to mobilize



the Nile waters for irrigation and hydro-electric power production. The resulting regulation of water levels through these dams is tending to narrow the range of fluctuations in these levels.



Width of the White Nile varies depending on seasons but sections with 4km - 5km width are not uncommon

Topographically, the areas North from the line connecting the hill country along the Red Sea in the Northeast (maximum altitude 2,100m) and the Marra Range in the West are dry plains bordering on the Northern Libyan and Sahara Deserts. As this area narrows into the mountain ranges of the far south, swamp lands begin to widen. These swamp lands and the areas that are submerged during high-water seasons receive solar energy and photo-synthesis, so it is not difficult to appreciate the intimate interaction between primary production and the fishery resources of the Nile water system.



### SECTION 3 THE FISHING INDUSTRY



### 3-1 Outline of the Fishing Industry

The nation's fish catch during 1979/80 was estimated at some 28,000 MT, but only 2.5% of this (700 tons) was accounted for by the marine fishery.

Whereas the Democratic Republic of the Sudan has only about 550 km of coastline along the Red Sea, its inland water area-- including lakes and marshes, inundated areas, and swamplands-- covers an area in excess of 30,000 km<sup>2</sup>. There are a number of programs for developing the marine fishery along the Red Sea, but at the present time, viewed from the standpoint of catch volume, catch value, and the number of persons engaged in fisheries, the role played by the inland fisheries in the nation's economy overshadows by far that of the seawater sector.

It would be no exaggeration to say that the entire inland water fishery in the Democratic Republic of the Sudan depends on the Nile water system. However, one must bear in mind that the land area of the country is a vast 2.5 million km<sup>2</sup>, with a very low population density of only 6.5 persons per km<sup>2</sup>. Also, some 35% of the total population is concentrated in the central areas of Khartoum, Blue Nile, and White Nile Provinces, whereas the inland water areas that form the basis of fisheries production are heavily skewed toward the southern regions of the country. In addition, there is a total lack of roads and railways required to transport fishery products as well as a dearth of freezing and refrigerating facilities to preserve freshness. Given all these problems, it is probably not feasible at this stage to institute a development program that would utilize all of the latent fishery resources.

Although statistical evidence is not available, it may be assumed that the share of fisheries in the nation's economy is still quite small. In reality, though, fishing does play a most important role in sustaining the livelihood of many Sudanese, particularly those living in the inland water areas.

The number of persons commercially engaged to some extent in fisheries is said to be 7,000, but some 70% of this total lives in the central Khartoum, Lake Nubia, and Red Sea Coastal Districts. These areas, in contrast with the vast swampy area of the south have only a relatively small water area, but since they are logistically well situated to consuming areas, resource utilization conditions are favorable. Inasmuch as fishery activity is not yet organized along industrial lines, society's interest in fisheries, as opposed to agriculture, is still quite low. Also, traditionally, since the factors of fishery production, such as vessels and nets, have been in the hands of middlemen, fishermen have been accorded an unreasonably low position on the Sudanese social scale.

As a result of these conditions, the Sudanese Government has determined that, in an effort to develop fisheries, it is absolutely vital to raise both the economic and social position of the fishermen and has been formulating policies to achieve this goal through better training programs and improved marketing methods.

### 3-2 Species and Catch Volume

The fishing industry in the Democratic Republic of the Sudan, particularly the river fisheries which comprise the most important segment, is still conducted largely on a subsistence level. Also, owing to the country's vast area and its long river length of some 3,000 km along the White and Main Niles, collection of fishery data has been extremely difficult. As a consequence, there is little reliable data on either species or catch volume.

Based on data for 1979/80, the total fishery catch of the Sudan, including the 700 tons of catch in marine fishery, is estimated to have totaled 28,000 tons, but the basis for this estimate is not known.

There are said to be about 200 species of fish in the Nile, of which some 30 species can be caught commercially. Some of these are as follows:

<i>Tilapia nilotica</i>	<i>Barbus bynni</i>
T. <i>galilaea</i>	Family <i>Mormyridae</i>
T. <i>zillii</i>	<i>Citharinus spp</i>
<i>Labeo spp</i>	<i>Alestes spp</i>
<i>Bagrus bayad</i>	<i>Hydrocynus spp</i>
B. <i>docmac</i>	<i>Gymnarchus niloticus</i>
<i>Lates niloticus</i>	<i>Tetradon fahaka</i>
<i>Synodontis spp</i>	<i>Clarias spp</i>
<i>Distichodus spp</i>	

The most important species are: *Tilapia*, *Labeo*, *Bagrus*, *Lates*, and *Synodontis*. Of these, the largest catch species is *Tilapia*, which is sold as a 2nd-grade species. This fish seeks out areas on the river bottom fed by mud rich in organic materials. The bottom soil of the Nile River owes much to the humus of vegetation supplied from the extensive swamplands of the South, which contain the upper reaches of the river.

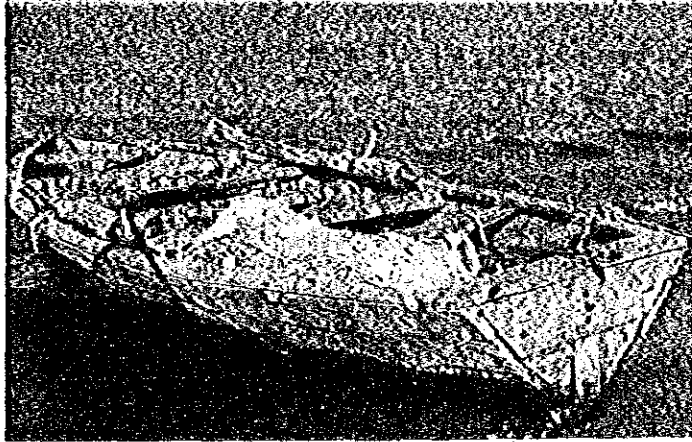
Three varieties of *Tilapia* are found in the country, but the most common is *Tilapia nilotica*.

*Lates niloticus* is known as Nile Perch. This is a large fish, with weights in excess of 50 kg not uncommon. In addition, it is considered a premium variety, selling at the highest price of any species, and so is quite important.

### 3-3 Fishing Vessels; Gear; Fishing Methods

All fishing vessels are non-motorized wooden boats or canoes. Hull lengths of the former range from 5-7 meters and widths from 1.2-1.4 meters, with oars providing motive power. Hull construction uses

mainly planks of the local Acacia genus, called Sounot. This tree is hard and durable but very heavy and so considerable effort is needed to row back and forth to the fishing grounds.



Wooden boat of L.O.A.  
6m - 7m made of hard  
wood without motor

These wooden vessels are built on the basis of the experience and instinct of the ship carpenters, and the levels of milling techniques are none too satisfactory. In addition, the vessels are built with hand tools. As a result, construction quality falls far short of that found in the developed countries.

For caulking materials, ordinary pieces of cloth are employed. Hull materials are used without any coal-tar or paint coating.

Wooden boats normally carry a crew of 3-5 and remain in the fishing grounds for a maximum of 10-12 hours.

Canoes are much smaller and lighter than the wooden vessels. They are planked-type, with an overall length of 3-4 meters and a width of 0.5-0.7 meter and are manned by 1-2 persons. They are quite widely used in the south and among immigrants from Nigeria.

The main types of fishing gear are gill nets, seine nets, and cast nets, with occasional use of long-lines. In the case of the subsistence fisheries, spears, harpoons, and baskets are also used.



The construction of gill and seine nets is essentially the same, with a difference only in application. Their material is most often nylon twine but, in some areas, nylon monofilament is also seen.

Mesh size is in most cases about 10 cm, presumably because this is the smallest size permitted by the fishing regulations. Net materials are in the main hand-woven by the fishermen themselves, and construction is 20-30 meshes high and 100-200 meters long. Float lines are weighted by styrofoam floats and the sinkers with lead plates. Net construction is characterized by heavy shrinkage. The nets are believed to be used also for large fish, such as Nile perch.

Operations are usually conducted at night or in the early morning hours. The portion of the Nile from the Jabal Awlia Dam to Kosti has many sections with widths of 3-4 km during the high-water period in December. Currents are gentle and so pose almost no problems to the use of gill or seine nets.

In the case of gill nets, the nets are usually taken in daily to retrieve the catch but, in some cases, are left on the grounds for a period of 2-3 days.

In the case of seine nets, the usual practice is to attach one end of the net to the river bank. After the net is spent out, the seining is done from land (i.e., beach seining). These nets are effective in catching Tilapia, Bagrus, and other species living in coastal shallow area.

### **3-4 Number of Fishermen and Boat**

According to data supplied by the Fisheries Administration, the number of fishermen and boats in the Democratic Republic of the Sudan are as follows:

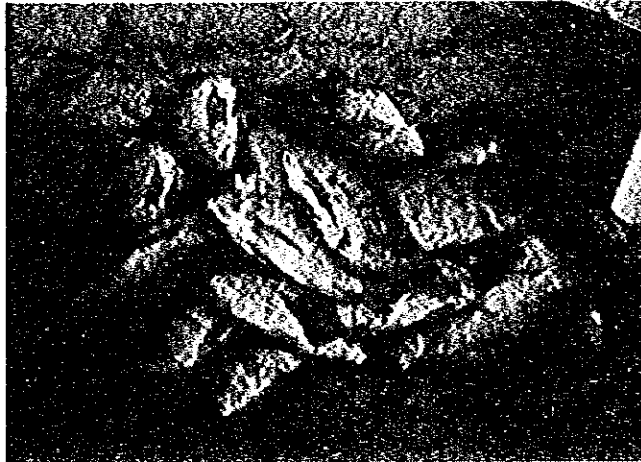
### NUMBER OF BOATS AND FISHERMEN

PROVINCE/ZONE	NO. OF FISHERMEN	NO. OF BOATS	
		WOODEN BOAT	CANOE
Blue Nile (Roseires Reservoir)	878	48	500
Sennar Reservoir	171	64	38
Khashim El-Girba	110	15	20
Lake Nubia	150	40	-
North of Jabal Awlia Dam	58	24	-
North of Khartoum	222	116	-
Jabal Awlia Reservoir	2,594	485	382
Southern Region	2,000	250	1,000
Red Sea	810	270	0
<b>Total</b>	<b>6,993</b>	<b>1,312</b>	<b>1,940</b>

Based on the previously noted 28,000-ton estimated annual catch, the average catch per individual comes to about 4,000 kg, while the average catch per fishing vessel (including canoes) is 8,610 Kg. The average size of crew per fishing vessel works out to about 2.15 persons.

### 3-5 Distribution and Processing

Catch landed from the fishing vessels is purchased on the spot by middlemen. In the total absence of storage facilities, such as ice or refrigeration, and in view of the limited transport capability owing to the lack of roads, virtually the only sales channel for fresh fish is via the middlemen who come to assemble cargos.



Fresh fish is channeled for market by middlemen immediately after landing

Fish bought up by the middlemen is usually trucked to the consuming areas, but ice is rarely used during transport. In the case of Khartoum, fresh fish is brought in from the Jabal Awlia area and from as far away as Kosti. There is a central market in Khartoum, on which the fish delivered in the early morning is promptly wholesaled. After gilling and gutting and filleting, the fish is moved into retail outlets.

The fish landed in the Lake Nubia area is handled by the Animal Production Public Corporation and is retailed in Khartoum through retail outlets operated by this Corporation. Thus it does not go through the public market.

Prices paid by middlemen at the landing areas vary widely, depending on location and season. At Lake Nubia, the prices paid to fishermen by the Animal Production Public Corporation for premium fish (Nile Perch, Bagrus) is 20 Pt/ kg (Pt: Piaster= 1/100 LS); for second-grade fish (Tilapin)-- 15 Pt/kg; and for third-grade (Labeo, Barbus, etc.)-- 10 Pt/kg.

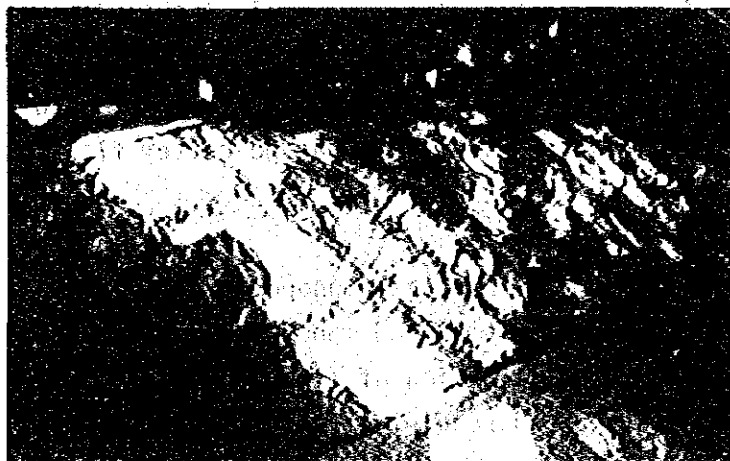


Fish being retailed  
in Khartoum

Retail prices are controlled by the Government. For premium fish, 1.2 LS/kg; for second-grade, 0.8 LS/kg; and for third-grade, 0.6 LS/kg. However, prices in the free market are generally far above the controlled prices. In February, 1980, based on a survey by the Fisheries Administration, the wholesale prices in the free market were: Nile Perch/ Bagrus--- 9 LS/5 kg. (1.8 LS/kg); Tilapia-- 9 LS/10 kg. (0.9 LS/ kg ; Labeo-- 6 LS/5 kg (1.2 LS/kg); Synodontis-- 4 LS/5 kg (0.8 LS/kg); and Alestes-- 2 LS/5 kg (0.4 LS/kg).

There are only three basic processing methods: sundrying, salt-drying, and wet-salting. Wet-salting is used mainly for the process of Alestes. The technique is to mix salt in a proportion of about 25% of round fish weight, and leave it for 5-10 days; then, after eluting the moisture, the fish is pressure packed (from above) into a can and shipped.

Salted Alestes is sold in the cities at a price of about 50 Pt/kg and is also said to be exported to Egypt, though we could not verify export volume or value from Customs statistics.



Wet salted  
Alestes

### 3-6 Fishing Administration

Fishing administration is centralized in the Central Government within the Animal Resource Division of the Ministry of Agriculture, Food and Natural Resources. There are also fishery bureaus in many of the Provinces, including the southern autonomous government.

The Fisheries Administration of the Central Government extends cooperation largely in the form of guidance. It is subdivided into the following sections: Marine Fisheries, Training Institute, Fish-culture Extension Unit, Provincial Extension Services and Management Unit, and Statistics and Marketing.

The Provincial Extension Services administer the various fishing areas, such as Jabal Awlia Reservoir, Sennar Reservoir, Roseries Reservoir, Lake Nubia, and Riverine Fisheries.

In the Jabal Awlia Reservoir Area, an effort is being made to train and organize the local fishermen. Fishing centers (essentially camps) have been set up at four locations from

Khartoum to Kosti. Two personnel of the Fisheries Administration along with 4 full-time fishermen have been assigned to each of these camps to blend in with the traditional societies of the fishing communities and propagate better fishing techniques among the local fishermen.

In an effort to forestall monopolization of the factors of production by the middlemen and moneyed classes, there is a system of compulsory registration of fishing vessels. A regulation has also been passed requiring each fishing vessel to secure an annual fishing permit issued by the Fisheries Administration. These regulations are designed to assure full utilization and prevent a concentration of ownership of the factors of production.

With regard to gear, mesh-size regulations have been developed which prohibit the use of mesh sizes of less than 10 cm., with the exception of a 4 cm mesh for seine nets used in catching *Alestes*. In addition, there are regulations on minimum permissible body length by individual species.

## **SECTION 4 THE PROJECT CONCEPT**





#### 4 - 1 Project Background

The Democratic Republic of the Sudan is currently in the midst of a Six-Year Plan of Economic and Social Development, with 1977/78 as the base year and 1982/83 as the target year.

This Plan anticipates an annual economy growth rate of 7.5% over its life. However, given the fact that, in the starting year, the agricultural sector accounted for some 40% of Gross Domestic Product, with 80% of the population engaged in agriculture or related pursuits and with 90% or more of foreign exchange earnings generated by four basic or processed agricultural products, even the industrial and transportation sectors are keyed in the Plan to the targets set for agriculture.

The target annual growth rates by sector are:

... agriculture--	6.5%
... mining and manufacturing--	9.5%
... power & water--	9.0%
... construction--	7.5%
... transport--	7.5%
... commerce, finance, real estate--	8.0%
... government and services--	7.5%

A relatively high growth rate has been set for mining and manufacturing, but even this rate is considered to be a function of the growth of agricultural production, with particular emphasis on developing the food processing industry.

In the previous "Five-Year Plan" (extended to 1977), priority was also given to agriculture, with emphasis on increased production of edible grains, oil seed, livestock, and fisheries.

The self-sufficiency ratios achieved for grain products by the previous Plan's concluding year were: wheat--50%; rice--67%; and sorghum 100%, but target fulfillment for the agricultural sector as a whole was only 76%. Nevertheless, considering the drought that developed in the Sahara region during the early 1970's, this result was perhaps acceptable.

In the livestock sector, the actual growth of production fell far behind the targets envisaged in the previous Five-Year Plan. For example: beef-- 2%, vs. a targeted 3.6%; milk-- 2.4%, vs. 7.9%; eggs-- 1.3% vs. 7.1%.

It is generally recognized that the previous "Five-Year Plan" led to an absolute growth in production but did not boost productivity. This is attributed to the inadequacy of the basic social infrastructure and the lack of suitable governmental guidance.

The current Six-Year Plan has given serious consideration to these factors. For example, in the agricultural section it puts a high priority on both the development of a production base and distribution and storage.

In the livestock area as well, the intent is to channel surplus production from subsistence operations into the market economy through the development of an appropriate, efficient distribution mechanism. In particular, 100% self-sufficiency is targeted for 1982/83 in fish, milk, and eggs. The ambitious production targets are shown in the following table:

TARGETS FOR ANIMAL PRODUCTS (In Thousand M.T.)

Product	Actual 1974/75	Target 1982/83	Annual Increase %
Beef	151	305	9.2
Mutton	92	169	6.5
Goat	21	36	6.3
Camel Meat	21	30	4.5
Poultry Meat	12	25	8.9
Fish	24	60	11.0
Total Meat	321	625	8.1
Milk	1,081	1,730	5.2
Eggs	19	52	11.5

SOURCE: The Six Year Plan of Economic  
and Social Development

With regard to Plan implementation, the Government of the Democratic Republic of the Sudan has drawn up a basic policy comprising seven planks, one of which places strong emphasis on "equitable distribution". In order to assure that the benefits from development are spread as equitably as possible among the people, a renewed effort is slated to develop the traditional small-scale sector of the primary economy. The need is also recognized to distribute, over as broad an area as possible, a budget for cooperatives, education, and health and welfare.

#### 4 — 2 The Fishery Development Plan

As explained above, an ambitious commitment has been undertaken to raise fishery production by target 1982/83 to 60,000 tons for a projected growth rate of 11% per annum.

The target program for the marine fishery is still not entirely clear but, assuming on the basis of present situation, a 95% share

for the fresh-water fishery, the production target for the latter in 1982/83 would come to 57,000 tons or more.

This production level should, in our view, be quite compatible with resource size. The total inland water area of the Democratic Republic of the Sudan is estimated to be at least 30,000 km<sup>2</sup>. Various estimates have been made of MSY in these inland waters but, even at a conservative 50 kg/hectare/year, a latent production potential of 150,000 tons/year is indicated. Of course, the resource is not evenly spread over the entire area and many fishing grounds are still inaccessible. Even so, there is little likelihood of a resource bottleneck standing in the way of a catch level of 60,000 tons per year.

In order to attain this target, a total of five fishery projects are planned over the life of the current Six-Year Plan. They cover:

- ... fresh-water fishery development
- ... marine fishery development
- ... development of fishery statistics
- ... establishment of fishery school
- ... extension training programs

With respect to the fresh-water fishery development project, the Government of the Democratic Republic of the Sudan has decided to concentrate on the Jabal Awlia Reservoir area. It has in fact already established four field stations in this area for extension training purposes.

The reason for focusing on the Jabal Awlia area for fishery development is that, during high-water periods, this area contains a water area of some 1,500 km<sup>2</sup> and constitutes the country's largest reservoir. There is also a long history of small-scale fishery operations in this area. It is, in addition, a convenient location from which to supply fish to the main consuming areas of Khartoum, Wad Madani, and Kosti.

The basic policy of the Government in implementing the Fresh-water Fisheries Development Project is to give first consideration to providing a full range of governmental services to fishermen via the present field facilities and then to improve fish distribution by establishing process and market facilities incorporating ice-making equipment and cold-storage. Through modernization of catch methods and organization of the fishermen themselves the plan seeks to expand production and assure that the increased fisheries revenues are properly redistributed to the fishermen.

#### 4-3 The Basic Plan

The basic plan of the Jabal Awlia Developmental Project is firstly, to construct facilities for strengthening administrative services to fishermen in the White Nile area from Jabal Awlia to Kosti and secondly, to increase the value-added of the fishery catch, improve distribution, and raise the socio-economic status of the fishermen.

The target project area extends a full 270 kilometers from the capital, Khartoum, to Kosti. The four extension training sites in this area, as mentioned above, are located at Jabal Awlia, Wad Balal, Mongara, and Kunuz. Facilities at these field camps consist presently of only 1-2 temporary tents, manned by employees of the Fishery Administration who have been posted there. However, the necessary facilities for extension training are sadly lacking. Nor is there any organic communication among the four locations, owing to the lack of transportation.



Field station for extension training service

An Extension Center is to be established at Ad Duwem and equipped with the necessary facilities and materials to coordinate and assist the present field camps. Ad Duwem is the central administrative city of the White Nile Province, with relatively convenient access to the four existing facilities.

Fish Process and Market Centers are to be constructed at Shajara, close to the major Khartoum consuming area, and at Kosti, in the heart of the White Nile fishery area and an important supply base for the areas in the southern part of the country. These Centers are to be equipped with cold-storage (refrigerators), ice-making equipment, and processing areas. A steady improvement is expected to take place in the fish distribution structure, which has hitherto been dominated by middlemen.

#### 4 - 4 Outline of Facilities

The various facilities are to be equipped as follows:

##### 1) The Extension Center at Ad Duwem:

- |              |  |
|--------------|--|
| Office --    | for 3-4 regular employees  |
| Warehouse -- | to store and administer training materials   |
| Workshop --- | for maintenance and repairs on machinery and equipment, vehicles, and outboard motors attached to the Center |

Refrigerators-- 2 units of 15m<sup>3</sup> (-20° C.) each--  
to store small quantities of fish on  
request from fishermen at Ad Duwem and  
the four extension training camps.

Ice-making

Equipment-- 1 ton/ 24 hour period; plate-ice,  
with ice-storage unit; to produce  
ice for use in demonstrations at the  
various training camps.

Utility Room-- Area for giving lectures to and  
communication among fishermen

Equipment-- emergency generator, four-wheel drive  
vehicle, ice-storage container, cold-  
storage vehicle, FRP boat, outboard  
motors, fishing gear, tools

2) The Process and Market Centers at Shajara and Kosti;

Office-- for 2-3 regular employees

Laboratory-- for simple quality inspections and  
processing-related experiments

Warehouse-- for fishing boxes and packaging materials

Workshop-- for repair and maintenance of  
machinery and equipment and vehicles  
attached to the Centers

Processing Area-- for primary processing, based on  
filleting and evisceration; this is to  
be a hand-processing operation involving  
8-10 workers

Refrigerators-- 2 units of 50m<sup>3</sup> (-20° C.) each; 10 days' cold storage, based on a daily intake of 3 tons of product.

Ice-making  
Equipment--

Kosti-- 3 tons/ 24 hr period; 25 kg. block ice, with ice-storage unit.

In the case of Kosti, in order to meet the demand for ice from a wide area to the south, we have specified block ice for its advantages in preservation.

Provision has been made for receipts of about 3 tons of roundfish per day, after allowance for ice loss.

Shajara-- 2 tons/ 24 hr. period; plate-ice, with ice-storage unit.

Since Shajara is located close to both production and consuming areas, transport time is short. So we have specified plate-ice for ease of handling.

Provision has been made for receipts of about 3 tons/day of roundfish.

Utility Room-- for lectures to and conversation among fishermen

Equipment-- Emergency generators, 4-wheel drive vehicles, refrigeration truck



## SECTION 5 THE BASIC DESIGN



## 5 - 1 Basic Specifications

This plan has been developed on the basis of the following specifications:

- 1) The basic design plan is based on the survey items in the basic design study carried out in December, 1980. It is in conformity with the basic concepts and requirements of the Government of the Democratic Republic of the Sudan and has been approved by this Government.
- 2) With regard to the selection of construction sites, we surveyed several prospective areas from the standpoint of three criteria: ability to accommodate a building site of 1,500- 2,000 m<sup>2</sup>; properly equipped with trunk facilities-- roads, water and sewage, and power; and offering logistical support for the operation of the various facilities.

Based on this survey, we found suitable sites on publicly owned land in Shajara and Ad Duwem. In Kosti, however, there was not enough time during the survey period to find a specific location. It was, therefore decided that a suitable site fulfilling the above conditions would be selected on the joint responsibility of the Fishery Administration of the Ministry of Agriculture, Food, and Natural Resources and the municipal authorities of Kosti.

- 3) The various regulations pertaining to facilities construction in principle follow British practice while taking into account local conditions. The Government of the Democratic Republic of the Sudan will be responsible for all necessary procedures and filings.

- 4) The materials which can be readily procured locally for the construction program include: sand, gravel, and blocks. Those that can be obtained on an irregular basis include: cement, reinforcing bar, and first stage milled products. As a consequence, the bulk of the necessary building materials will have to be brought in from Japan.
- 5) While some slight differences were noted between Shajara and Kosti, in general, the local climatic conditions for the subject areas are characterized by high heat and low humidity and low rainfall. At times, there are sand storms with strong winds.

Climatic data for Khartoum, Ad Duwem and Kosti are given below:

KHARTOUM

Month	Mean Pressure (mb)	Air Temperature (°C)				Relative Humidity (%)	Rainfall			Wind	
		Mean Temperature	Mean highest in each month	Highest in each month	Lowest in each month		No of Days with Rainfall	Maximum in One Day (mm)	Prevailing Wind Direction	Wind Speed (m.P.H)	
											0.1
January	966.0	23.9	31.7	40.1	7.0	0	0	0	N	10	
February	965.3	24.9	33.2	43.3	7.6	0	0	0	N	10	
March	963.5	28.5	37.0	44.9	11.6	0	0	0	N	9	
April	962.1	31.5	40.1	47.2	12.7	0	0	0	N	10	
May	961.9	34.1	41.9	46.7	18.5	1.4	1.2	0	N	9	
June	962.4	34.5	41.6	47.2	20.2	1.3	1.2	0.2	S	9	
July	963.3	31.5	38.1	46.3	20.0	6.3	5.6	1.7	S	10	
August	963.8	30.5	36.2	43.3	18.2	7.2	6.6	2.3	S	9	
September	963.0	32.0	38.4	44.7	19.4	3.1	2.6	0.7	S	7	
October	962.8	32.3	39.3	43.0	18.7	1.2	1.1	0.1	N	8	
November	964.3	28.5	35.8	42.0	12.8	0	0	0	N	9	
December	965.9	24.6	32.3	39.0	6.0	0	0	0	N	9	
Means	963.7	29.7	37.1	47.2	6.0			**100			
Total	-	-	-	-	-	205	183	5.1			
No. of years' observations	30	30	30	30	30	30	30	30	10	10	

- 1) \* indicates highest or lowest during a year
- 2) 12:00 is the observation time for mean pressure and 18:00 for relative humidity

AD-DUWEM

Month	Mean Pressure (mb)	Air Temperature (°C)				Relative Humidity (%)	Rainfall			Wind		
		Mean Temperature	Mean highest in each month	Highest in each month	Lowest in each month		No of Days with Rainfall	Maximum in One Day (mm)	Prevailing Wind Direction	Wind Speed (m.P.H)		
January	9658	24.3	32.1	40.0	8.8	0.1	1.0	10.0	0	0	NE	4
February	9651	25.2	33.3	44.8	6.0	0	0	0	0	0.7	NE	6
March	9633	28.5	37.3	45.2	11.2	0	0	0	0	-	NE	6
April	9623	30.9	40.0	46.0	12.1	0.2	0.2	0.1	0.2	57.0	NE	6
May	9622	32.7	41.1	45.7	16.3	1.1	1.0	0.2	0.2	47.6	NE	6
June	9634	32.0	39.6	45.4	14.5	2.8	2.7	0.8	0.8	54.0	SW	5
July	9645	29.7	36.0	44.3	14.2	6.3	5.8	2.6	2.6	64.4	SW	5
August	9649	28.3	34.0	43.6	14.6	8.1	7.7	3.4	3.4	88.6	SW	5
September	9640	29.3	35.9	41.4	13.0	4.3	4.1	1.6	1.6	78.0	SW	3
October	9632	30.5	37.9	41.6	16.5	1.3	1.1	0.2	0.2	43.6	NE	3
November	9645	28.3	35.9	41.2	10.7	0	0	0	0	5.3	NW	4
December	9657	24.9	32.7	39.6	5.4	0	0	0	0	0	NE	4
Means	9641	28.7	36.3	46.0	5.4	2.41	2.26	8.9	8.9	88.6		
Total												
No. of years' observations												

- 1) \* indicates highest or lowest during a year.
- 2) 12:00 is the observation time for mean pressure and 18:00 for relative humidity.

KOSTI

Month	Mean Pressure (mb)	Air Temperature (°C)				Relative Humidity (%)	Rainfall			Wind	
		Mean Temperature	Mean highest in each month	Highest in each month	Lowest in each month		No of Days with Rainfall	Maximum in One Day (mm)	Prevailing Wind Direction	Wind Speed (m.P.H)	
						0.1	1.0	10.0			
January	9653	248	329	402	103	0	0	0	N	6	
February	9646	259	345	422	106	0	0	0	N	6	
March	9629	287	373	448	124	0.1	0.1	0	N	6	
April	9621	315	405	453	144	0.6	0.6	0	N	5	
May	9625	327	405	460	170	2.8	2.4	0.7	N	5	
June	9641	315	381	442	184	6.1	5.2	1.1	SSW	6	
July	9651	289	346	415	189	11.7	10.1	3.4	SSW	6	
August	9654	275	324	402	189	14.0	12.6	4.3	SSW	5	
September	9645	285	345	408	190	7.1	6.2	2.1	SSW	5	
October	9633	301	372	416	182	3.5	2.9	0.5	N	4	
November	9639	286	362	408	131	0.3	0.2	0	N	6	
December	9654	255	333	396	101	0	0	0	N	6	
Means	9641	257	360	* 460	* 101						
Total						462	403	111			
No. of years observations											

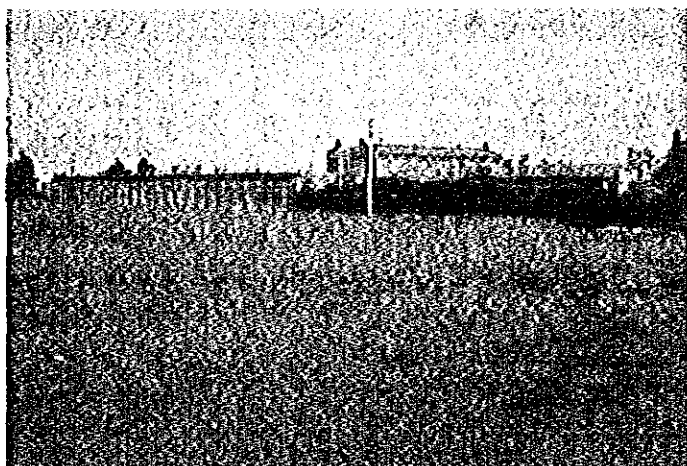
- 1) \* indicates highest or lowest during a year
- 2) 12:00 is the observation time for mean pressure and 18:00 for relative humidity

## 5 - 2 Site Descriptions

### Shajara:

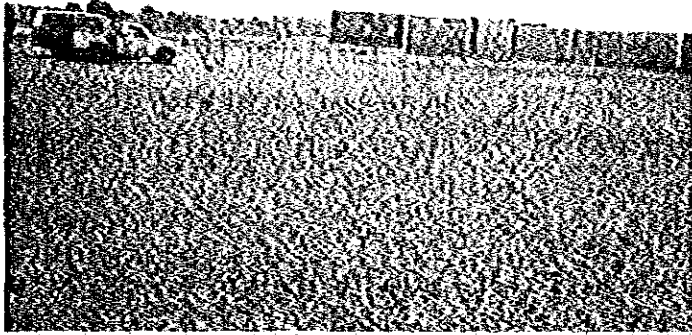
Shajara is located about 15 kilometers south of Khartoum. The site is roughly a 20-30 minute drive from the center of the city. A Government Fisheries Training Institute is located here on a large site. This institute contains facilities required to accommodate trainees, such as dormitories, school buildings, and fish ponds. Accordingly the basic power, water, and communication facilities are already present, while the site is on public land. The institute is directly administered by the Fisheries Administration of the Ministry of Agriculture, Food, and Natural Resources.

If a Process and Market Center were to be built in a corner of this area, there would be many advantages in terms of facility operation. The major consumer market Khartoum, is close by. And there is a paved road to the Jaba Awlia Dam 35 kilometers to the south, so transport will not be much of a problem. We have located the prospective construction site in a flat area on the north side of the Training Institute grounds.



Proposed Site  
in Shajara





Proposed site  
in Ad Duwem

#### Ad Duwem:

Ad Duwem is the administrative center of the White Nile area as well as the Provincial Seat. By land it is 224 kilometers from Khartoum and 118 kilometers from Kosti and is situated on the left bank of the White Nile. A ferry connects the city with Abhehela on the opposite bank.

The proposed site is relatively convenient to the four extension training camps already established along the White Nile and is considered appropriate as a location for basing core facilities for supervision and support of the camp activities. There were several possible sites within the city of Ad Duwem, but we finally decided upon a location not far from the Nile contiguous to the north-east quadrant of the city. At present, the only structure in the vicinity is a stadium, but power and water can be brought in from the closest point within the city limits.

Kosti:

Kosti is linked to the capital, Khartoum, by a highway via Wad Madani and Sinnar. This road is now paved with the exception of a portion about 2/3 of the distance from Kosti to Sinnar. (As of end 1980)

Improvements are also being made to the highway on the right bank of the White Nile from Jabal Awliya to Rabaq. When the above projects are completed, they will immeasurably improve land transport to Khartoum.

From Kosti south to Juba, capital of the Autonomous Government, there is regular boat service along the White Nile, with Kosti serving as a supply base for the southern part of the country.

Kosti has been developed in accordance with a master city plan. A prospective site for this project is located within a section being developed as heavy industrial area. However, based on the plans of the Power and Water Public Corporation of Kosti City, it will clearly take considerable time before water and power can be brought to the site. The area then has not merit as a potential construction site.

We were told by the city that, since time did not permit us to search for an alternate site, they, together with the Fishery Administration, would take the responsibility for selecting a prospective site.

### 5-3 Description of the Facilities

Following is a description of the main facilities planned on the basis of the project concept. The facilities will differ as between the Shajara and Kosti locations, designed to function as Process and Market Centers, and Ad Duwem, which is to function as an Extension Center.

#### Shajara and Kosti:

##### 1) Ice-making facilities:

Kosti is favored by well-developed transportation-- highway, rail, and river-- and is the key distribution center for the southern part of the country. The fishing grounds and consuming areas are both dispersed over a wide area, so that block ice is desirable from the standpoint of having to preserve fish over relatively long periods.

With regard to the size of the ice-making facilities, this would have been best determined on the basis of an accurate distribution survey. But, since such a survey is not yet feasible, facility size has been determined on the basis of the estimated 5 MT daily average fish landings at Kosti.

Assuming for the present that 60% of the receipts will be handled as fresh catch using ice, and after allowing for ice loss during transport, preservation and crushing, we have set a ratio of 1:1 against fresh catch for ice requirements viz., that the amount of ice required will be 3 tons per day. In other words, the ice-making capacity of the block-type ice-making unit has been set at 3 tons per 24 hour period. The capacity of the ice-storage unit has been set at 5 days' storage taking into consideration the peak demand for fish as well as demand other than for fish use.

Considering the high outside temperatures and the need for some period of storage, we have incorporated a freezing

unit in the ice storage unit with a view to maintaining temperatures therein at a continuous level of about 0° C. This should permit an adequate ice supply regardless of variations in demand.

Since Shajara is close to the capital, Khartoum, we may assume that almost all of the fish moving through this facility will be shipped to Khartoum. However, in comparison with Kosti, road conditions from Shajara to Khartoum are good and transport time is short, so ice consumption should be lower than for Kosti.

The capacity of the ice-making equipment is assumed on the basis that daily average receipts at the present Khartoum Central Market will be 10 tons, of which some 50% will originate from the facilities at Shajara and Kosti to be built under this Plan.

Assuming that 60% of this target volume is handled by the facility at Shajara, the fish catch handled at Shajara should be 3 tons/day. At 0.7 tons of ice requirements per 1.0 ton of fish catch, the required ice-making capacity should be in the order of 2 tons per day.

Considering the short distance between fishing grounds and consuming areas and the small amount of ice capacity required, we have specified a plate-type ice maker for Shajara, which is convenient for both operation and maintenance.

## 2) Refrigeration:

It is difficult at this stage to anticipate the range of annual variation in catch volume to be handled at the subject facilities. Accordingly, with a view to avoiding an increase in operating costs during periods of low catch volume, we have designed a refrigerator with two independent sections.

There are various ways of estimating a suitable refrigeration capacity but, considering the small volume of fish receipts per day, we have postulated a capacity sufficient to handle 10 times the daily throughput volume-- i.e.,

$$3 \text{ tons/day} \times 10 \text{ days} = 30 \text{ tons}$$

Figuring 80% usable space within the refrigeration chamber and a factor of 0.4 for the ratio of fish to cubic volume, the required capacity works out to:

$$30 \text{ tons} \div 0.8 \div 0.4 = 93.75 \text{ m}^3$$

Hence  $50 \text{ m}^3$  for each of the two refrigeration chambers in the facility.

Temperatures inside the refrigerator should be maintained at a level of minus  $20^\circ \text{C}$ ., somewhat lower than the normal inside refrigeration temperature of  $0^\circ \text{C}$  to minus  $10^\circ \text{C}$ . This takes into account the perpetually high external temperatures, the considerable time needed to move the fish to the final consumer, and the fact that there is almost no hope of being able to keep the fish at low temperatures during the distribution stages.

One of the two refrigeration chambers will contain a freezing unit for freezing fish, the other will be used as an auxiliary unit in case of freezer breakdown, unusually large receipts of fish at one time, or to permit slow freezing when receipts are small. Thus, there will always be an extra freezer beyond the requirements for normal operations.

Freezer types and capacities have been kept basic enough to permit interchangeability.

**3) Processing and Research Division:**

The processing operations of the facilities will, for the time being, be directed at primary processing, such as gutting and filleting. Each facility has been designed so that, at an estimated 3 tons/day of processing volume, it can be operated by a complement of 10-15 persons. This facility will permit fish storage over long periods of time and so help to compensate for the production instability that is a characteristic of fishing activity. The processing unit will also have an important role in establishing product standards and in raising value added. It will also be most helpful in ensuring sanitary conditions.

The lab will have the key functions of performing quality control checks on frozen products, making bacterial checks, and conducting experiments in the processing of waste material from the processing line. It will be important also in improving fishing gear and fishing techniques.

**4) Maintenance and Services:**

This section will be responsible for maintaining the Center facility and will also serve as a channel for providing technical guidance to the fishermen. An office area has been provided for a 3-4 man staff.

**5) Other Facilities:**

To facilitate the operation of the above Centers, we have provided for a warehouse containing all sorts of equipment and spare parts; a workshop for equipment maintenance; and a utility room for communicating technical information to the fishermen.

## Ad Duwem

### 1) Ice-making Equipment:

This facility is intended to administer and support the four extension training camps already located along the White Nile. Thus, the purpose of the ice here is mainly for demonstration to the fishermen at the various field locations. For this reason, the rated capacity of the ice-making equipment has been set at a very low 1 ton/24 hour period. The unit is to be of standard plate-ice design.

The ice-storage unit, as in the case of Shajara and Kosti, is to hold five days' production. Cold storage containers are also to be placed at each field station to permit temporary storage of both ice and fish.

### 2) Refrigeration:

Refrigeration facilities will be used not only for cold storage of the catch brought in by the fishermen at Ad Duwem but also for purposes of demonstrating to the fishermen the use of refrigeration in preserving fish after temporary storage in the ice cabinets located at the field camps and during times of exceptionally heavy catches.

The basic specifications governing the design of the refrigerator are the same as for Shajara and Kosti, but interior capacity has been set at about 15 m<sup>3</sup>.

### 3) Maintenance and Service

This section will serve the same basic purposes as those at Shajara and Kosti. However, whereas the latter two facilities are geared to supplying the consumer market, that at Ad Duwem is intended more as a center for transmitting

technical and product assistance directly to the fish producers. We have accordingly, provided office space for some 4-5 regular employees.

**4) Other Facilities**

A workshop has been planned for equipment maintenance along with a warehouse including equipment for extension training and a utility area for giving lectures to the fishermen.

The following chart summarizes the planned facilities at Shajara, Kosti, and Ad Duwem.



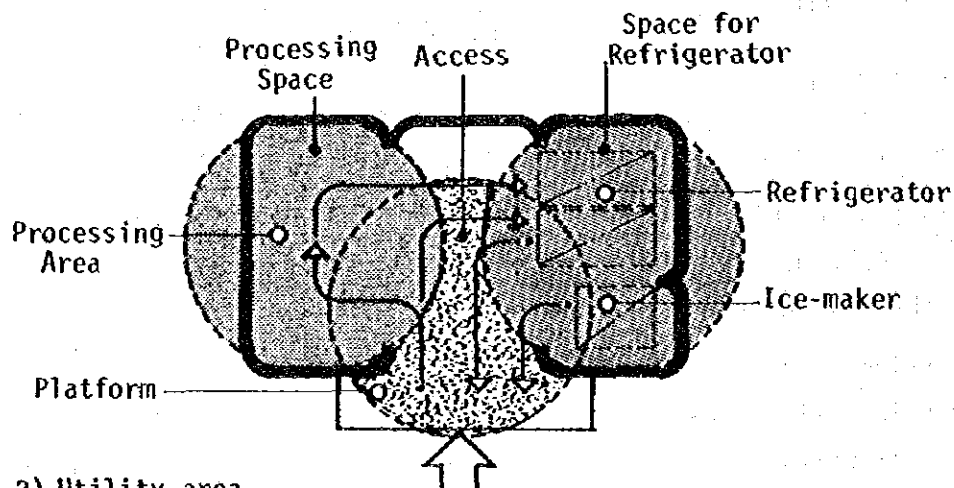
	Shajara	Kosti	Ad Duwem
<b>Building (in m<sup>2</sup>)</b>			
Refrigerator	80.0	80.0	36.0
Ice-making equipment	35.0	68.0	16.0
Access space	52.0	52.0	39.0
Processing space	60.0	60.0	-
Laboratory	30.0	30.0	-
Office	38.0	38.0	50.0
Workshop	30.0	30.0	35.0
Warehouse	30.0	30.0	15.0
Utility Room	166.0	162.0	50.0
Other	49.0	20.0	34.0
<b>Total Area</b>	<b>570.0 m<sup>2</sup></b>	<b>570.0 m<sup>2</sup></b>	<b>260.0 m<sup>2</sup></b>
<b>Ice-making &amp; Refrigeration Equipment</b>			
<u>Ice-making</u>			
Type of unit	Water-cooled plate	Water-cooled block	Water-cooled plate
Ice-making capacity	2 tons/day	3 tons/day	1 ton/day
No. of units	1	1	1
<u>Ice-storage bin</u>			
Storage capacity	30 m <sup>3</sup>	30 m <sup>3</sup>	15 m <sup>3</sup>
Number of units	1	1	1
<u>Refrigerator</u>			
Refrigeration capacity	50 m <sup>3</sup>	50 m <sup>3</sup>	15 m <sup>3</sup>
No. of units	2	2	2
<b>Related Equipment:</b>	Emergency generator, 4-wheel drive vehicle, freezer vehicle, insulated box, fish carrying box, scale, carrier boat, tools	Same as at Shajara plus ice-crusher	Emergency generator, 4-wheel drive vehicle, insulated truck, ice storage containers, FRP boat, outboard motor, fishing gear, tools

## 5-4 Building Plan

We have developed the following construction plan, giving consideration to the functions of the above facilities and the size of facilities and buildings.

### (1) Floor Plan:

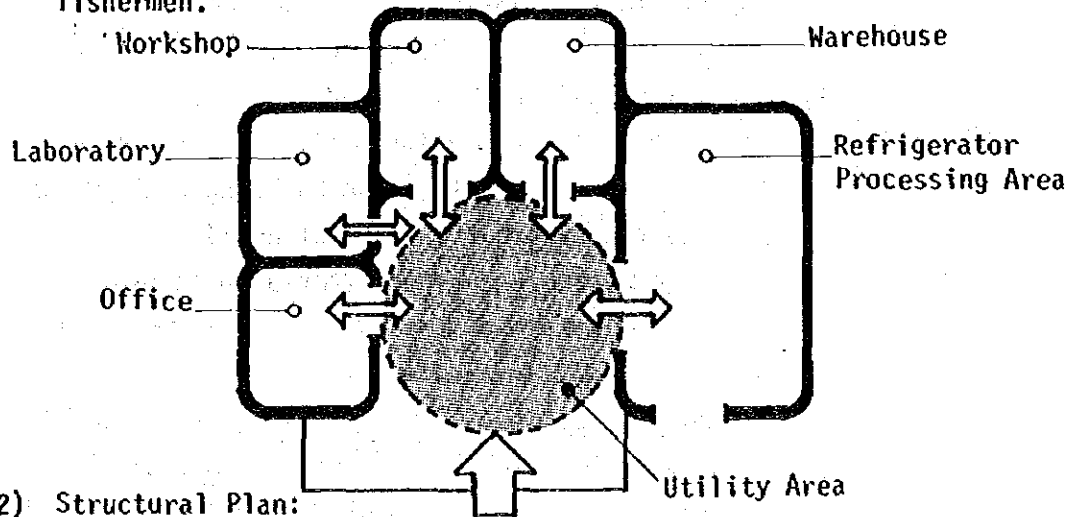
- 1) Careful attention must be paid to the access space required for the processing room, ice-making equipment and the in-and-out movement of fish. By concentrating the access space for entering fish into the processing area, storing fish in the refrigerator, and removing ice and fish from the ice-maker and refrigerator, we have sought to achieve effective use of the space as well as efficiency in the flow of materials. And by raising the floor level of this section, in-and-out movement of vehicles will be facilitated.



### 2) Utility area

In most buildings in the Democratic Republic of the Sudan, buildings are built around a courtyard. We have designed the subject facilities in such manner that this courtyard space becomes a utility area. By locating the workshop, warehouse, offices, and processing area around it, the courtyard can be used as an auxiliary workshop and warehouse

for repairs on fishing nets and other equipment and for various other jobs. The courtyard area can also serve as a community core for the entire Center or for visting fishermen.



The materials which can be procured locally with relative ease are limited to sand, cement, reinforcing bars, and bricks. But even with respect to these items, we are frankly concerned about the ability to secure the needed quantities on a stable basis. Also, taking into account the quality and efficiency of local labor, we have adopted the basic policy of bringing in from Japan as many fabricated components and materials as possible so as to minimize local fabrication and content. For this reason, with a view to incorporating the maximum degree of fabrication and assembly, we have specified that the structure be steel framed, one-story, and prefabricated to the maximum possible extent.

Concerning the foundation no pilings will be required. However, care must be taken with respect to the special properties of the so-called black soil. During dry periods, this surface soil tends to reduce considerably, but, once moisture is received, it expands tremendously and becomes very soft. It is, therefore, necessary to excavate to an

adequate depth the area under the foundation and underground beams and spread sand on the surface in order to avoid upward pressure on the foundation area due to this surface soil expansion.

(3) Specification Plan:

In deciding on materials and building methods, we have adopted the same policy as that outlined for the structure and have worked up a specification plan geared to local natural conditions. The main specifications are as follows:

Main structure--	heavy steel frame, prefabricated
Foundation/slab--	reinforced concrete
Roof --	insulated corrugated steel plate
Exterior walls--	insulated colored steel plate
Interior walls--	lath-mortar, steel trowel, vinyl paint coated; plywood foundation, oil paint coating
Interior floors--	mortar steel trowel finish; mortar steel trowel foundation, vinyl tile finish
Ceiling --	aluminum spandel finish, asbestos slates, oil paint coating

5 - 5 Equipment Plan

(1) Ice-making/refrigeration facilities:

In all three locations-- Shajara, Ad Duwem, and Kosti--, the average annual temperature high is 36-37°C (dry bulb). During April to July, there are days when the temperature reaches 45°C (dry bulb) or more. In contrast to the very high dry bulb temperatures, relative humidity is exceedingly low, averaging 20-30% (12:00 AM).

In light of these climatic conditions, despite its relative ease of operation, an air-cooled freezer cannot be recommended from a technical standpoint. Also, operating costs would be increased, owing to its large capacity motor. It is, thus, preferable that the freezer which is to be used with the ice-making unit and refrigerator be water-cooled, with a water cooling tower.

In order to forestall problems with the freezer during the Habubu (sand storms) peculiar to the Democratic Republic of the Sudan, the cooling tower will be of sealed type. However the freezer unit with small cooling capacity will be air-cooled type.

#### Ice-making machine

For the ice-making units at Shajara and Ad Duwem, we have specified the relatively easy-to-operate plate type. They are of section steel construction, with the ice-making unit located in the upper part of the ice storage cabinet. The production and crushing of ice as well as ice storage will all be automatic. Removal of ice from freezing plate will be done by raw water-- a process that is relatively service-free and reliable.

The ice storage cabinet will be of prefabricated panels with sandwiched insulation. A air-cooled freezer unit will be installed for exclusive use in cooling the storage bin, with temperatures inside the cabinet to be held at about 0°C.

With respect to the ice-making unit at Kostf, the congealing can, the freezing tank, freezer and circulating pump will comprise a unit assembly, for production of block ice. Attached to the ceiling of the freezing tank, will be a simple lifting device for ice to ease handling of ice.

The ice storage cabinet, like the plate-ice maker, will be equipped with a air-cooled freezer unit for exclusive use in the cabinet.

#### Refrigerator

The refrigerator is intended to preserve the iced catch from the various fishing grounds. Construction is to be prefabricated panels of 100 mm thickness, with sandwiched insulation. A basket will be provided to permit simple stacking. A drain board will be placed on the floor to facilitate operations within the refrigerator.

After considering the structure of fish prices and operating costs under the existing distribution system, we decided that quick freezing should more properly be left to the next stage of the project. However, so long as the quantity of fish is not too large, on the basis of a  $-20^{\circ}\text{C}$  temperature within the refrigerator, slow freezing will be possible with the reserve freezer unit.

The freezers in the refrigerators at Shajara and Kosti will be of unit water-cooled construction, with compressor, condenser, and cooling fan. At Ad Duwem, since capacity is small, a air-cooled type unit freezer will be sufficient.

#### Auxiliary equipment

An ice crusher will be attached to the Kosti block ice maker so that crushed ice can be supplied when necessary.

The Ad Duwem Extension Center will be provided with ice storage containers of unit construction, with insulation, for installation at the local fishing camps in the area. The cubic capacity of these containers will be about  $5 \text{ m}^3$ ;

they will not be equipped with freezers in consideration of the power conditions at these camps.

(2) Electrical Equipment:

Power

With respect to power for the ice maker, refrigerator, and other motive equipment and lighting, the Government of the Democratic Republic of the Sudan will be responsible for bringing in power lines as far as the main panel board at each facility-- Kosti, Shajara, and Ad Duwem. Electrical work beyond the main panel board will be done by Japanese side.

The power requirements at each location will be as follows:

Location	Power Application	Required KVA
Kosti	1. Power circuits	54.5
	2. Lighting circuits	3.5
		Total 58 KVA
Ad Duwem	1. Power circuits	21.5
	2. Lighting circuits	2.5
		Total 24 KVA
Shajara	1. Power circuits	43.5
	2. Lighting circuits	3.5
		Total 47 KVA

Motor power: 3  $\phi$  415 V 50 Hz

Power equipment

At all locations, power from the power distribution board to the ice making unit, refrigerator, and other motive equipment will be separately controlled by individual

switches, so that, in the event of an emergency, separate power cut-off in the affected area will be feasible.

Fluorescent light will mainly be used in the office and other interior areas. But, for outside illumination, incandescent lighting will be used.

Lighting fixtures will be built in the office and suspended by pipe in the other areas.

Outlets will be provided in sufficient numbers to meet the needs of the various areas.

#### Emergency generator

An emergency generator will be provided as back-up in case of a power failure. The generator load will be sufficient to permit operation of one of the refrigerator chambers in the event of such failure. The generator will be started by manual operator as soon as a stoppage of power occurs and will feed power to the refrigerator via a manual switch-over.

The capacities of the various emergency generators are as follows:

Location	Generating Capacity (KVA)
Kosti	45 KVA
Ad Duwem	20
Shajara	45

Note: 415 V 50 Hz



**(3) Water Supply and Drainage:**

**Water supply facilities**

With respect to the water requirements for the ice maker and processing area at each location, the Government of the Democratic Republic of the Sudan is to bring in water mains up to the on-site meter; beyond this point, all on-site water supply construction and equipment will be the responsibility of Japanese side.

Water will be drawn from the respective cities in which the facilities are to be located. After being piped in, the water will be distributed directly to each receiving area. After giving close consideration to water stoppages and changes in water pressure, we have decided to specify a special reserve tank for exclusive use in the ice-making operation. Water will be pumped from this tank to the ice-making unit.

We have analyzed the quality of the municipal water supply at each location and have found the chemical properties to be extremely good.

In the tables on the following page, we show water requirements by facility type along with the quality analysis data.

**Drainage Facilities**

Drainage facilities at each location will be of three types: for processing use, for lavatory use, and for disposal of other waste water.

### WATER SUPPLY REQUIREMENTS

Location	Application	Requirements (MT/day)
Kosti	1. 3-ton ice-maker	4
	2. Reserve water supply for cooling tower	12
	3. Processing room, other	7
	Total	23 M/T
Ad Duwem	1. 1-ton ice-maker	1.3
	2. Reserve water supply for cooling tower	3
	3. Other	4.7
	Total	9 M/T
Shajara	1. 2-ton ice-maker	2.6
	2. Reserve water supply for cooling tower	12
	3. Processing room, other	7.4
	Total	22 M/T

### WATER QUALITY ANALYSIS

	Shajara	Ad Duwem	Kosti	Japan Standard
Lead (mg/ltr.)	( N o t D e t e c t e d )			0.1 or less
PH	7.9 (19°C)	7.7 (19°C)	7.5 (19°C)	5.8 - 8.6
Copper (mg/ltr)	0.02	Not detected	0.01	1.0 or less
Zinc (mg/ltr)	0.31	0.04	0.26	1.0 or less
Iron (mg/ltr)	0.23	1.12	0.17	0.3 or less
Manganese (mg/ltr)	0.12	0.03	Not detected	0.3 or less
Chlorine ions (mg/ltr)	8	7	7	200 or less
Turbidity (degree)	5	10	2	2 or less
Hardness (mg/ltr)	121	58	54	300 or less

Individual septic tanks will be used for disposal of water from the processing area and lavatory. For other waste water, we have specified a seepage pit for disposal via evaporation and seepage. The septic tanks will be to WHO standards.

**(4) Air conditioning**

At each facility, window type air conditioners are to be installed in the offices and labs. Ceiling fans will be used in the processing areas and workshops, while ventilating fans will be installed in the lavatories.