THE ARAB REPUBLIC OF EGYPT

NORTH SINAI INTEGRATED RURAL DEVELOPMENT

THE MASTER PLAN STUDY

AUGUST 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

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P R E F A C E

In response to a request from the Government of the Arab Republic of Egypt, the Government of Japan decided to conduct a Master Plan Study and Feasibility Study of Priority Sub-projects on North Sinai Integrated Rural Development and entrusted the study to Japan International Cooperation Agency (JICA).

JICA sent to the Arab Republic of Egypt a study team headed by Mr. Kazunori Tamaki, Sanyu Consultants Inc., four times from April, 1988 to July, 1989.

The team held discussions with the officials concerned of the Government of the Arab Republic of Egypt and conducted field surveys in North Sinai area. After the team returned to Japan, further studies were made and the present report was 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.

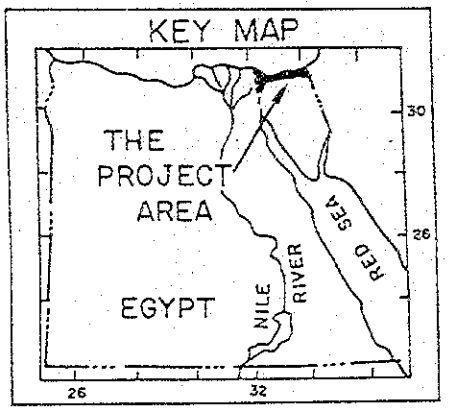
I wish to express my sincerest appreciation to the officials concerned of the Government of the Arab Republic of Egypt for their close cooperation extended to the team.

August, 1989

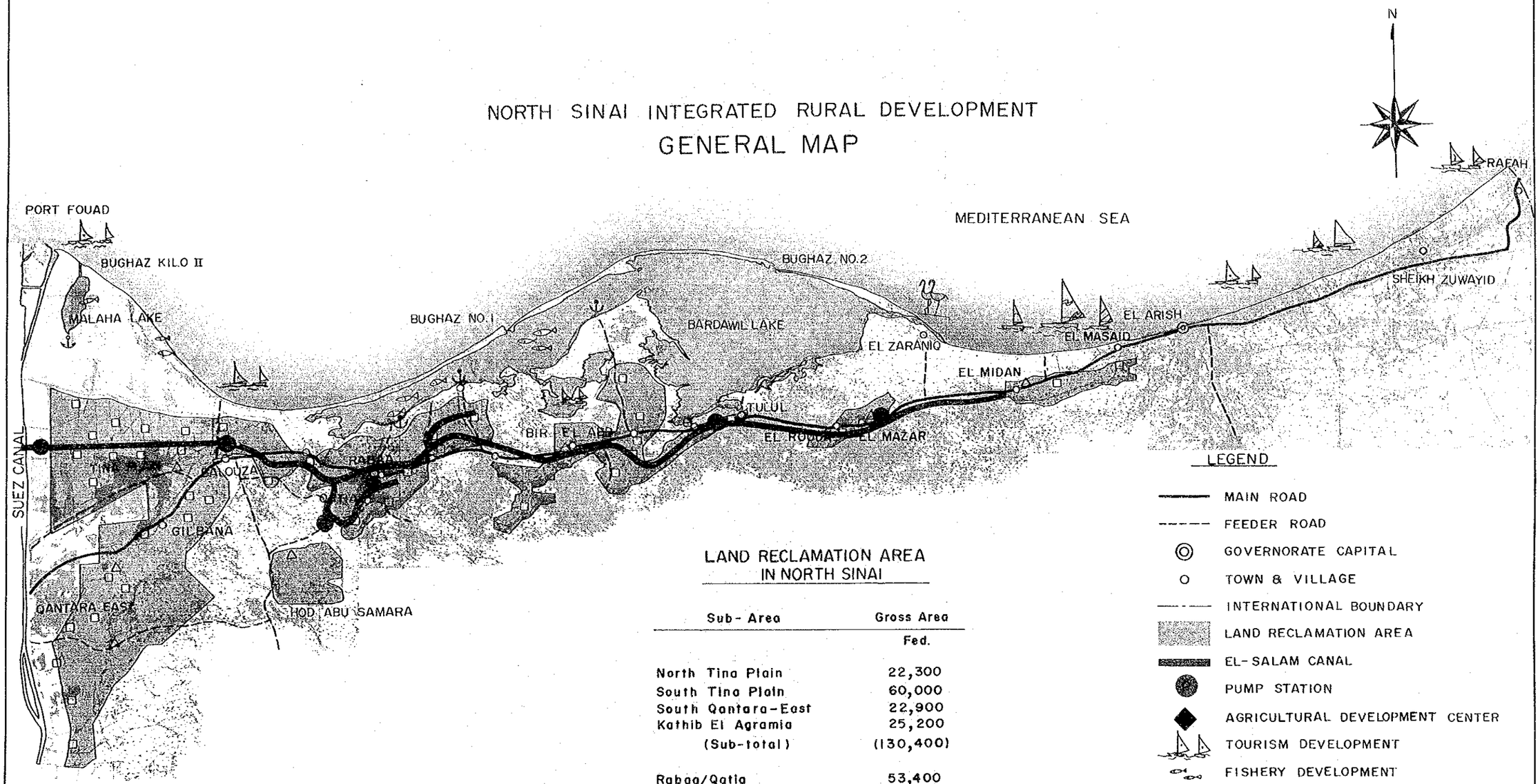
Kensuke Yanagiya

KENSUKE YANAGIYA
President
Japan International Cooperation Agency

PROJECT LOCATION MAP



NORTH SINAI INTEGRATED RURAL DEVELOPMENT
GENERAL MAP



LAND RECLAMATION AREA IN NORTH SINAI

Sub - Area	Gross Area Fed.
North Tina Plain	22,300
South Tina Plain	60,000
South Qantara-East	22,900
Kathib El Agramia	25,200
(Sub-total)	(130,400)
Rabaa/Qatia	53,400
Hod Abu Samara	14,000
(Sub-total)	(67,400)
Bir El Abd	(40,200)
El Mazar	6,700
El Midan	10,000
(Sub-total)	(16,700)
Total	254,700

LEGEND

- MAIN ROAD
- FEEDER ROAD
- GOVERNORATE CAPITAL
- TOWN & VILLAGE
- INTERNATIONAL BOUNDARY
- LAND RECLAMATION AREA
- EL-SALAM CANAL
- PUMP STATION
- AGRICULTURAL DEVELOPMENT CENTER
- TOURISM DEVELOPMENT
- FISHERY DEVELOPMENT
- FISHING PORT
- WILDLIFE SANCTUARY
- SETTLEMENT VILLAGE
- INVESTER COMPLEX

0 10 20 30 40 50 Km

SCALE

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ABBREVIATION AND UNITS

Abbreviation

CAPMAS	Central Agency for Public Mobilization and Statistics
CICCAS	Cairo International Center for Consultation and Studies
DRTPC	Development Research and Technological Planning Center, Cairo University
DRI	Desert Research Institute
EC	European Communities
EIRR	Economic Internal Rate of Return
FAO	Food and Agriculture Organization of the United Nations
GAFRD	General Agency of Fishery Resources Development
GARPAD	General Authority for Rehabilitation Projects and Agricultural Development
GDP	Gross Domestic Product
GNP	Gross National Product
GOPP	General Organization of Physical Planning
JICA	Japan International Cooperation Agency
LMP	Land Master Plan
MOA	Ministry of Agriculture and Land Reclamation
MOD	Ministry of Development, New Communities, Housing and Utilities
MOT	Ministry of Tourism
MPWWR	Ministry of Public Works and Water Resources (formerly Ministry of Irrigation (MOI))
NSG	North Sinai Governorate
PBDAC	Principal Bank for Development and Agricultural Credit
PPU/GARPAD	Project Planning Unit of GARPAD
REGWA	General Company for Research and Groundwater
RIWR	Research Institute of Water Resources
SDA	Sinai Development Authority
UNESCO	United Nations Educational, Scientific, and Cultural Organization

Unit

fed.	feddan = 0.42 ha
cu.m	Cubic meter
MCM	Million cubic meters
mS/cm	milli Siemens/centimeter = millimho/centimeter
ppm	Parts per million
sq.m	Square meter
sq.km	Square kilometer

Currency

LE	Egyptian Pound
PT	Egyptian Piastre
Yen	Japanese Yen

Exchange Rate (1988)

LE	=	100 PT
"	=	¥56
"	=	US$0.43
US$	=	LE 2.325
"	=	¥129.6

Others

F/S	Feasibility Study
M/P	Master Plan
S/W	Scope of Work

SUMMARY

S U M M A R Y

BACKGROUND

1. History of the Study

The objective of the Master Plan Study is to identify the development potentials of the North Sinai to select the priority subprojects from various development components. Priority subprojects are formulated in short-term development plan according to their urgency as well as in compliance with the Government's policy embodied under the Second Five-Year Plan (1987/88-1991/92). The integrated rural development project is proposed based on the following goals:

- To save import expenses on one hand and to promote export earnings by increasing domestic agricultural output and by improving productivity levels on the other.
- To strengthen infrastructure, including improvement of standards of living, domestic water supply, road networks, etc.
- To disperse a part of the heavily concentrated population in the Nile Valley and Delta to other areas which have agricultural and other industrial development potential;

According to the state plan to the Year 2000, reclamation of 1.26 million feddan of new agricultural land is underway, the major part of which lies on the western and eastern sides of the Suez Canal. The M/P Study Area, which is located on the eastern side of Suez Canal, encompasses the proposed area of development.

THE STUDY AREA

2. Location

The M/P Study Area comprises the low-lying Mediterranean foreshore strip extending to the northern part of the Sinai Peninsula, and the area along the eastern bank of the Suez Canal as far as the Ferdan Ferry, about 66 km south of Port Said.

The Area extends between a range of longitude from 32°20'E to 34°15'E and latitude from 30°40'N to 31°'15'N. The total area is about 3,220 sq.km, including water surface (674 sq.km in total) of Bardawil and Malaha Lakes. The Area includes Ismailia, Port Said and North Sinai governorates.

Governorate	Land Area		Lake Area	Total Area	
	(sq.km)	(%)	(sq.km)	(sq.km)	(%)
Ismailia	533	20.9	0	533	16.6
Port Said	354	13.9	24	378	11.7
North Sinai	1,659	65.2	650	2,309	71.7
Total	2,546*	100.0	674	3,220	100.0

* 606,000 feddan

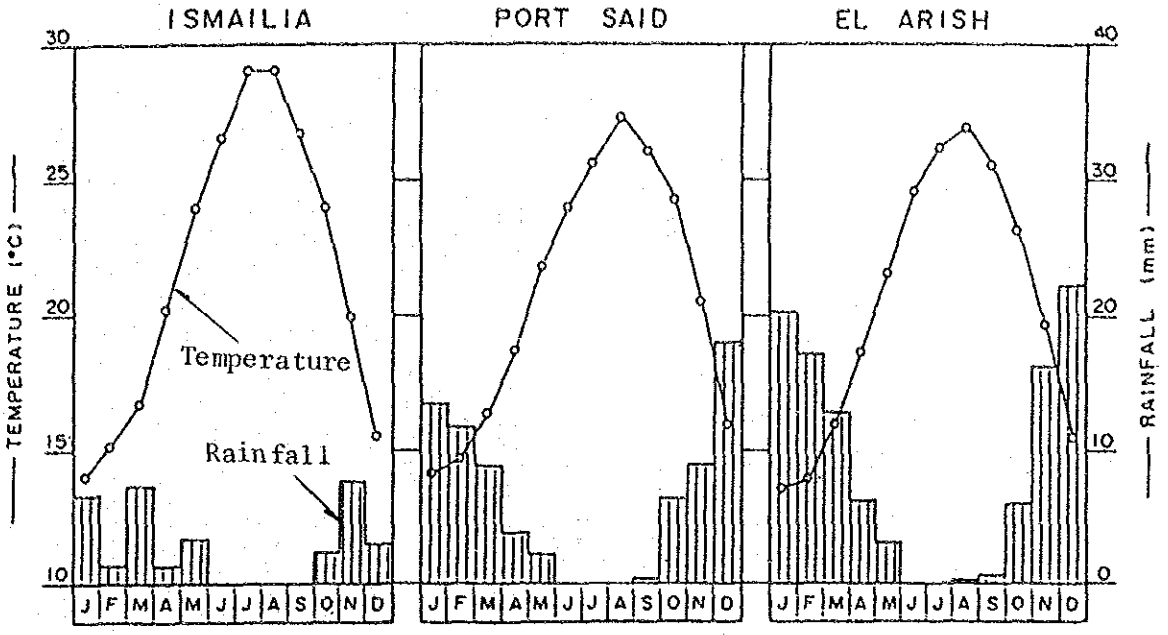
3. Population

Total population in the M/P Study Area is estimated at about 161,000 (1986). About 80 percent of the total population is concentrated in the northeastern coastal areas in and around El Arish. Agriculture is the mainstay of this area, in which 20,000 households are engaged, representing approximately 60 percent of the total number of households, followed by 3,000 households engaged in fishery.

Governorate	Markaz	Population	No. of Households
North Sinai	Bir El Abd	27,400	5,100
	El Arish	67,600	12,500
	Sheikh Zuwayid	24,400	4,500
	Rafah	34,300	6,400
	Sub-Total	153,700	28,500
Ismailia	El Qantara East	7,700	1,600
Port Said	Port Fouad	-	-
Total		161,400	30,100

4. Meteorology and Hydrology

The Mediterranean-type climate, which is comparatively mild, prevails over the Area. Hot and dusty, southern or southeastern winds locally known as "Khamseen" occasionally blow in spring. The lowest temperature occurs in January when the average monthly minimum temperature falls as low as 8°C. The highest annual rainfall was recorded at 300 mm in Rafah. It gradually decreases towards the west as low as 33 mm in Ismailia. Rainfall predominantly occurs in winter.



Groundwater is available in the areas of 1) Rafah/Sheikh Zuwayid, 2) El Arish, and 3) Rabaa/Qatia. In addition, small-scale aquifers are scattered over the sand dune zones. Rainfed-farming is practised in the area between Sheikh Zuwayid and Rafah, where small cisterns called "Harabat" are excavated to collect and store rainwater for livestock watering uses.

5. El Salam Canal Project

In the El Salam Canal Project, the water source for the Area is planned to convey the Nile water mixed with the drainage water from El Sirw drain and Bahr Hadous drain.

The reclamation area under the El Salam Canal Project had been planned to cover about 440,000 feddan, of which about 185,000 feddan in the Hussinia and South Port Said areas (western bank of the Suez Canal) and about 255,000 feddan in the Tina Plain and Mediterranean Sea coastal area (eastern bank of the Suez Canal).

6. Soils

Generally, the soils lack pedological features indicating the soil development, under arid condition. The Tina plain is a part of the Nile Delta, and the soils are derived from fluvio-lacustrine deposits of the River Nile, with poorly-drained, shallow groundwater tables, classified as Typic Salorthids with clayey or loamy texture and a salic horizon.

Sandy soils extend through southern Qantara East adjacent to the Tina Plain, and the surrounding areas of the Bardawil Lake as flat or undulating terrain. These are aeolian deposits without horizon differentiation (Typic Torripsamments). Sandy soils with shallow water table (Typic Psammaquents) are distributed in low-lying areas around the Lake and inland Sabkha between sand dunes. Wadi El Arish basin forms a broad valley, and the soils have been developed from fluvial deposits. Typic Calciorthids, as influenced from lime-stone in the upstream basin, occupy the sandy terrain to the east of El Arish.

The results of land classification of reclaimability are as follows:

Land Class	Area (feddan)	Area (%)
Class-2 (arable)	79,700	13.2
Class-3 (arable)	219,300	36.2
Class-4 (arable)	134,600	22.2
Sub-Total	433,600	71.6
Class-6 (nonarable)	167,900	27.7
Others (nonarable)	4,500	0.7
Total Land Area	606,000	100.0

According to the land classification of reclaimability, no Class-1 land was found in the Area, however, Class-2 land exists around El Arish area, the Rabaa/Qatia area and in the vicinity of the Tina Plain. Class-3 land was found in sandy terrain with gentle undulation. In addition, Class-4 land covers the area with steeper undulation. Accordingly, 71.6 percent of the total area, was found to be reclaimable.

7. Agriculture

Current farmland lies mainly in the area between El Arish and Rafah where annual rainfall reaches 200-300 mm. Fruits trees, vegetables and watermelon are cultivated by rainwater and by groundwater.

In the Rabaa/Qatia area, vegetables, watermelon, sweet melon and olive are cultivated under drip irrigation, making use of the groundwater. While sand dune areas in the northern side of the highway have not been exploited for farmland, only small scale dates palm plantations exist in the intervening depressions. Natural vegetation in the Area is fairly sparse.

8. Fisheries

The Bardawil Lake is separated from the Mediterranean Sea by a long sand bar and its water surface is 650 sq.km. The lake is hypersaline very shallow depth ranging from one to 2 m. Since the beginning of the 20th. century, openings (Bughaz I and II) have been artificially excavated, which made lake fishery possible by introducing seawater into the Lake. Gilt head seabream, gray mullets, seabass for export are caught from this lake.

The Malaha Lake consists of two hypersaline and very shallow water bodies occupying 24 sq.km in total. The lake area was formerly larger than at present, being adjacent to Port Fouad. By construction of the new by-pass of Suez Canal in 1980-81, the western part of the lake was filled with the dredged earth and sand. The water level of the lake rises by 0.5 m in winter due to the northwestern winds and gales. As the results, the depressed areas in the northern Tina Plain are widely flooded.

In both lakes, the salinity of water rises rapidly in case that water circulation between the lakes and the sea is obstructed, therefore, maintaining the seawater exchange through the openings is indispensable for keeping the salinity at safe level and for leading fish fry into the lakes.

9. Tourism

The Mediterranean Sea and the Bardawil Lake coasts, beautiful landscape, bird sanctuaries, historic legacy as well as oases in the desert are major tourism resources in North Sinai. Tourism development has so far been concentrated only in the coastal area between El Arish and Rafah, and tourism facilities have been established in this part of the North Sinai Governorate.

10. Infrastructure and Social Services

There are two sources of potable water in the Area, i.e., groundwater and Nile water conveyed by pipelines. The area extending from El Arish to Rafah mainly depends upon groundwater, and desalinization plants have been established in El Arish and El Masaid. Potable water is provided through two pipelines up to El Tulul and to El Arish. Water lorries are used to supply the water in remote settlements far from the pipelines.

A high voltage line for 22 KV was installed along the highway, covering the area between El Qantara East and El Arish. And small-scale power plants exist in the major settlements.

A two-lane highway connecting El Qantara East and Rafah via El Arish serves as an artery in the Area. This highway has enough capacity for the current traffic volumes. Feeder roads branch off towards the lake or seashore as well as inland settlement from the highway. Ferries crossing the Suez Canal, which are in a critical condition of transport, are presently operational at Ismailia, Ferdan and El Qantara. A domestic civil airport is located at El Arish and currently hosts two round-trip flights from Cairo weekly, during the summer months. Microwave telecommunication is used mainly in government offices. In 1987, about 12,000 telephone lines are operational, equivalent to 7.4 lines per 100 inhabitants.

Primary schools and a few preparatory and secondary schools exist in the settlement areas. Health services are limited in the Area, where inhabitants rely mainly on a public hospital in El Arish or some other health units established in large villages.

DEVELOPMENT PLAN

11. Land Reclamation and Settlement Plan

Owing to the extension of El Salam Canal, totally 254,700 feddan of land was proposed to be reclaimed for farmland (203,800 feddan in net cultivation area) as below:

Land Reclamation Area	Area (feddan)		
	gross	net	net/gross
North Tina Plain	22,300	16,700	0.75
South Tina Plain	60,000	50,600	0.84
South Qantara-East	22,900	18,300	0.80
Kathib El Agramia	25,200	20,200	0.80
(Sub-total)	(130,400)	(105,800)	
Rabaa/Qatia	53,400	41,600	0.78
Hod Abu Samara	14,000	11,200	0.80
(Sub-total)	(67,400)	(52,800)	
Bir El Abd	10,000	8,000	0.80
Tofaha	4,100	3,300	0.80
North Salmana	12,000	9,600	0.80
South Salmana	9,100	7,300	0.80
Misfaq	5,000	4,000	0.80
(Sub-total)	(40,200)	(32,200)	
El Mazar	6,700	5,000	0.75
El Midan	10,000	8,000	0.80
(Sub-total)	(16,700)	(13,000)	
Total	254,700	203,800	0.80

The reclaimed farmland will be allocated to settlers in three categories, i.e., 50 percent of total reclaimed farmland to smallholders including Bedouin farmers, 15 percent to graduates and 35 percent to investors. And the total number of farming households will be 27,600 as shown below:

Categories	No. of Households	Population
Smallholders	24,000	120,000
Graduates	3,600	18,000
Sub-Total	27,600	138,000
Non-farming households*	4,900	24,500
Total	32,500	162,500

* : 15% of total households

In addition, the existing farmland in El Arish and Sheikh Zuwayid/Rafah areas will be improved in its agricultural productivity through rational use of groundwater etc.(vertical expansion).

12. Crop and Livestock Production Plan

The crops were selected among those which are currently grown in the Area, or gave promising results in agricultural experimental stations. Five different cropping patterns for newly reclaimed areas and one for existing farming area are proposed as follows, taking into consideration the economic viability, demand/supply balance etc.

CP-1 (Net cultivable area: 61,000 feddan)
The pattern for smallholders on flat sandy areas, by introducing olive as cash crop on 20 percent of the allocated plot, with the rest to be covered by fodders, oilseeds and vegetables.

CP-2 (Net cultivable area: 31,300 feddan)
The pattern for smallholders on flat clayey areas by introducing paddy for leaching once every three years, and the remaining two years for fodders, other grain crops and vegetables.

CP-3 (Net cultivable area: 39,900 feddan)
The pattern for graduates on undulating sandy areas in medium-size farming units. Forty (40) percent of the land is covered by fruits orchards, another 30 percent is planted with fodders and diversified crops.

CP-4 (Net cultivable area: 65,900 feddan)

The pattern for investors who establish livestock farms on undulating sandy areas. Fodder crops and oil crops are planted under a mechanized cropping system.

CP-5 (Net cultivable area: 5,700 feddan)

The pattern for investors who establish fruits orchards on highly undulating sandy areas. Fruits trees having better marketability are planted under contour method with drip irrigation.

CP-6 (Net cultivable area: 59,500 feddan)

A typical pattern recommendable to the existing farms in the area between El Arish and Rafah for improvement of productivity with a more rational use of the limited groundwater.

Farm Type	Settlement	Characteristics		
CP-1	Smallholders	Sand flats	Oil crops Goats & sheep	Sprinkler irrigation
CP-2	"	Clay flats	Food crops; Fodder crop; Cattle	Surface basin irrigation
CP-3	Graduates	Sand undulating	Oil crops; Fruits; Cattle	Sprinkler and drip irrigation
CP-4	Investors	"	Livestock	Sprinkler irrigation
CP-5	"	"	Fruits	Drip irrigation
CP-6	Existing farmers	Sand flats	Vegetables, Fruits	Sprinkler and drip irrigation

Crop production from the land reclamation area (203,800 feddan) and the area between El Arish and Rafah (59,500 feddan) in the stabilized year is anticipated as shown below:

Crop	Cropped Area (feddan)	Production (ton)
(Food Crops)		
Rice	11,000	21,000
Wheat	8,000	11,000
Maize	2,000	3,000
Other food crops	2,000	2,000
(Oil Crops)		
Sunflower	25,000	23,000
Safflower	8,000	4,000
Flax	8,000	4,000
(Vegetables)		
Tomatoes	16,000	120,000
Cucumber/Squash	12,000	86,000
Cantaloupe	3,000	18,000
French Bean	5,000	25,000
Other vegetables	12,000	79,000
(Fodder Crops)		
Alfalfa	70,000	2,107,000
Fodder Beet	37,000	1,549,000
Sordan	28,000	922,000
Napier Grass	11,000	292,000
Other fodder crops	34,000	571,000
(Perennial Crops/Fruits)		
Olive	19,000	64,000
Orange	5,000	37,000
Grapes	5,000	31,000
Apples	6,000	13,000
Other fruits	47,000	95,000

Livestock species are goats/sheep for Bedouin settlers and beef cattle for other settlers. Group tending systems are adopted as a part of livestock management, in order to save rearing costs through labour intensive management. Combination of crop and livestock enables not only to obtain high value-added agricultural products, but also to supply manure for soil improvement of farmland.

13. Irrigation Plan

The net cultivable area under the proposed land reclamation is 203,800 feddan. The projected net irrigation supply per feddan is 8,900 cu.m/year, and the peak project irrigation supply is 37.6 cu.m/day/feddan which occurs in July.

Cropping Pattern	Net Cultivable Area (feddan)	Project Irrigation Supply (MCM/annum)	Peak Project Irrigation Supply (MCM)
CP-1	61,000	499.5	68.9
CP-2	31,300	338.9	53.1
CP-3	39,900	283.3	41.0
CP-4	65,900	654.3	68.9
CP-5	5,700	37.1	5.6
Total	203,800	1,813.1	237.5 (= 88.7 cu.m/sec)

The total irrigation water requirement of the El Salam Canal including the west bank of the Suez Canal is 3,314.8 MCM/year. This water amount is available from the Nile water by mixing with the drainage water of El Sirw and Bahr Hadous drains under the condition that the salinity limit of irrigation water is set at 800 ppm.

Three irrigation methods, i.e., surface irrigation, sprinkler and drip irrigation will be applicable for the Area. Surface irrigation will be applied to the polder reclamation area (Tina Plain) which is covered with saline, loamy or clayey soils having top layer with low hydraulic conductivity.

In the desert reclamation area covered with sandy soils having low moisture retentivity, on the other hand, sprinkler irrigation will be applied for field crops and drip irrigation for orchards. Smallholders will use movable sprinklers because they are less costly than solid sprinklers. Solid sprinklers will be used by graduates and investors.

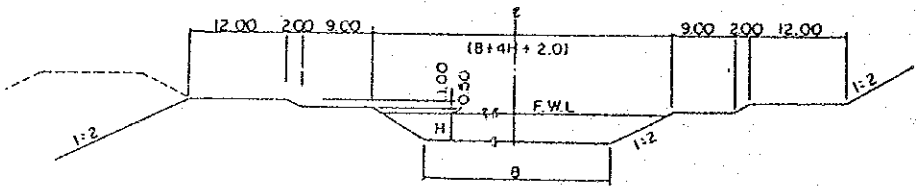
14. Drainage Plan

Saline soils in the Tina Plain require the initial leaching for land reclamation. Drainage pump will be installed to drain excess water in lowland. Open field drains with spacing of 25 m will be dug, which will be replaced by pipe drains with spacing of 50 m after the completion of reclamation stage. In sandy area, waterlogging and salinity problems may arise from irrigation practice in low-lying area near Sabkha. The field drainage system with spacing of 100-150 m will be provided.

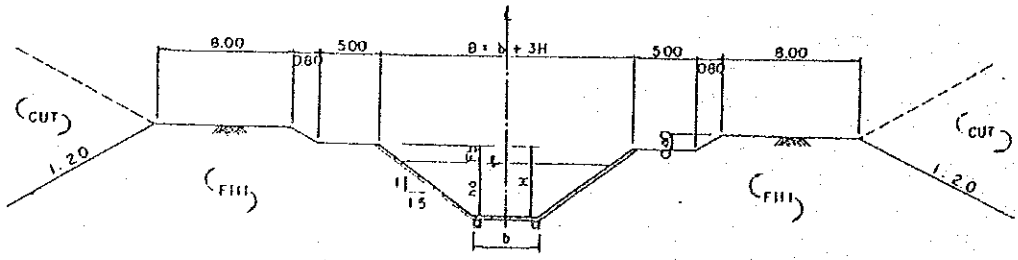
15. Water Conveyance Plan

The El Salam Canal has reached up to 300 m west from the Suez Canal. The extension of the El Salam Canal to North Sinai is intended to achieve an irrigation water supply for the proposed land reclamation area up to El Midan (203,800 feddan in net). Design of the canal section in the Tina Plain was made based on the same criteria adopted to the west bank of the Suez Canal because of its similar geographical and soil conditions. This canal section will not be lined. For the canal section in the sandy area, on the other hand, concrete lining will be provided.

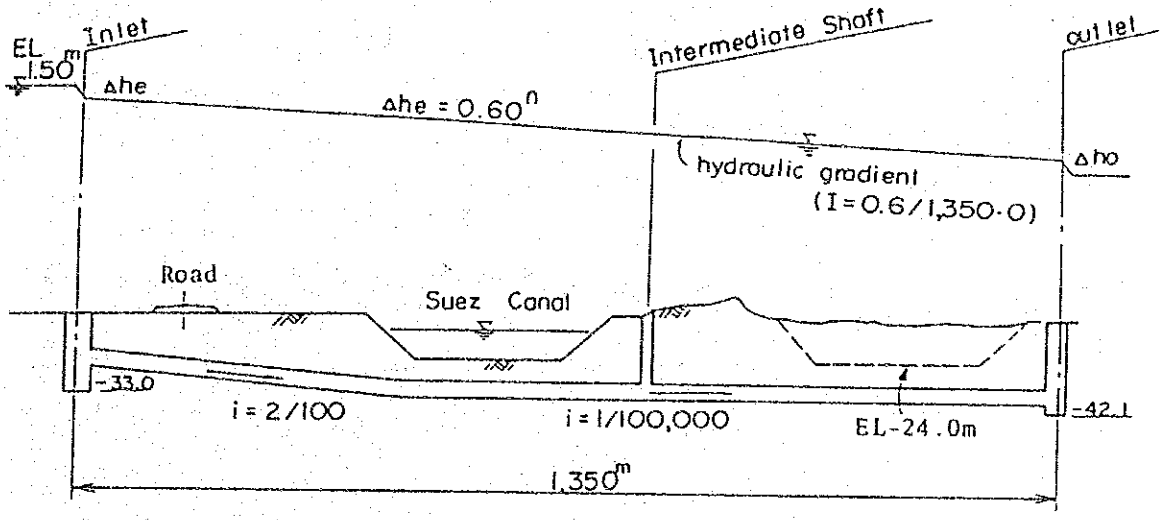
Cross Section of El Salam Canal (Tina Plain)



Cross Section of El Salam Canal (Sandy Area)



For crossing the Suez Canal, a siphon will be constructed by shield driven method. The siphon has a total length of 1,350 m. Two rows of siphon, of which diameter is 5.3 m each, was selected from the economic viewpoint.



Three pumping stations were proposed along the El Salam Canal, i.e., two stations are in the Tina Plain and one is at Tulul. In addition, a pumping station was proposed along the Rabaa/Qatia Branch Canal at El Moraiah to supply the water for Hod Abu Samara. Major appurtenant structures of the El Salam Canal are regulators and bridges which cross the highway. The sluice off-take regulator equipped with a bypass and an overflow weir was selected because of its reliability and low maintenance cost.

16. Fisheries Plan

Fisheries could be continued with proper conservation measures for Bardawil and Malaha Lakes. This can be realized by the protection of opening, which plays a key role in exchanging and circulating seawater and migrating fish fry from the Mediterranean Sea. Permanent protection structure of the openings with a breakwater and embankments to prevent the openings from sand deposit will be constructed in order to save the annual cost of dredging. For the designing of the proper

structure, tidal currents, wave conditions and siltation etc. should be further investigated.

The western part of the Bardawil Lake (about 55 sq.km) will be separated from the main body of water in order to increase fish catches by introducing the effluent from irrigated land into this confined portion. Hatchery facilities will be established to release fish fry. Landing and marketing facilities will be improved at Nigila.

In the Malaha Lake, drainage water from the irrigated land in the Tina Plain will be introduced in the lake in order to raise the productivity and to dilute the saline water. With aquaculture techniques, mullet and tilapia etc. will be raised in the fish ponds for domestic markets.

17. Agro-Industry and Marketing Plan

Oil extraction plants from olive and other oil crops, slaughterhouse with cut meat plants and ice-making plants that preserve fresh fish as well as fish meal plants will be established in the Area. Marketing facilities in the Area will be also improved in order to increase the value of products and to create the employment opportunities. These plants will be constructed at the center of raw material production area or along the highway because they require water and electricity supply as well as efficient transport system.

The following agricultural products and its values are expected in the target year.

Products	Production (ton)	Value (1,000LE)
Olive Oil	10,307	49,475
Edible Oil	8,775	26,624
Flax Oil (boiled oil)	1,010	2,301
Beef Cut-Meat	15,094	135,846
Goat/Mutton Cut Meat	7,222	54,165

18. New-Community Development Plan

At present about 161,000 persons live in the M/P Study Area and additional 270,000 persons will be settled, consequently 500,000 persons will live in the Area in Year 2000. El Arish will be continuously developed as a growth pole for the progress of the North Sinai region followed by Bir El Abd, Sheikh Zuwayid and Rafah etc. El Qantara East New Community has a role as the main base for agriculture, services and industry of the Northwest Sinai region.

Small settlements dispersed alongside the highway such as Balouza, Rabaa, Nigila, and El Khirba will play the role of service centers in the course of the land reclamation and settlement in the adjacent areas. These small settlements will function as marketing bases of agricultural and fisheries products as well as a supporting function of newly developed agriculture, fisheries, and tourism.

The scale of settlement for the land reclamation areas will be set at a population of 4,000-5,000 per village, with 750-900 households, where middle level facilities and services will be provided.

19. Infrastructure and Social Services Plan

Major social infrastructure of new community comprises domestic water supply, sewerage, electricity, telecommunications, and roads. Potable water will be supplied to all villages by means of a network of water supply pipelines and elevated tanks. Average consumption per capita is 150 litter per day. Namely, the village holding 4,000 population requires 600 cu.m of water per day. The source of the water for the Area is the Nile water. New potable water supply pipeline with 1,100 mm diameter to Rafah was proposed in addition to the existing pipelines. A water purification plant will be established at El Qantara East. For sewage treatment plant, oxidation pond method will be adopted.

Electricity will be supplied to all villages, not only for domicile but also for street lamps and agro-industry and marketing facilities etc. Average capacity per household correspond to about 1.6 KW. A thermal power generating plant will be required in line with an increase in electricity demand of the pumping stations in the agricultural development.

Road network system will be consolidated to facilitate the transportation of farm products and input-materials and to link all villages with a new road network. Although the existing highway still has sufficient capacity to absorb additional traffic, a long-term development strategy will include expanding the width and separation of counter traffic lanes for the highway. Moreover, the necessity will arise to construct a transport tunnel for crossing the Suez Canal, as the capacity of existing ferry transportation reaches nearly saturation due to the augmented traffic between North Sinai and the Nile Delta.

In addition, social service facilities such as educational, public health facilities, mosque, social welfare, telecommunication, security and community activities etc. will be provided in each community.

20. Tourism Development Plan

The previous study on tourism development in the North Sinai concluded that coastal areas of the Mediterranean Sea had a potential for tourism development owing to the favourable climatic conditions and landscape. In the M/P Study, El Ruag Bay in the Bardawil Lake was selected for the recreation resort area development because of its easiest accessibility and beautiful landscape. The Mediterranean Sea coastlines from Port Fouad to Rumana and from El Masaid to Rafah were also confirmed of its development potentials as well. These areas can be developed as a recreation resort for local people and tourists from other regions of Egypt after constructing road systems and lodging and recreational facilities. El Zaraniq lagoon at the eastern end of the Bardawil Lake is world famous for migratory birds. Ruins of the Greek and Roman era distributed in the Tina Plain etc, will be excavated and preserved. The tourism development should go simultaneously with the development of infrastructure and social services of the region.

21. Supporting Service Plan

A water users' association will be organized for maintaining terminal irrigation facilities and controlling water utilization in the Area. Existing cooperatives will be strengthened to facilitate group marketing or to help extend the more advantageous production activities for farmers. Agricultural Development Center will be established for diffusing modern irrigated farming methods among settlers.

As regards fishery, aquaculture center at the Malaha Lake and coastal fisheries development center at El Arish will be established to give a technical support, and fishermen's cooperative associations will be organized to protect fishermen's interest.

22. Environmental Impact

The implementation of the proposed subprojects would significantly alter the existing natural and socio-economic environment in the Area. Environmental impact to be accompanied with the implementation involves not only negative factors that require careful countermeasures but also positive factors. In other words, each subproject would contribute to increasing the income of inhabitants and promoting national economic activities in terms of restoration of the Area which had once been destroyed during a series of war.

An improvement is expected in micro-climatic conditions in the Area by reclamation works which make undulating topography flat and provide farmland surrounded by windbreaks. At the same time, peripheries of mobile sand dune zone will be protected by vegetation.

Prevention of water pollution in the Bardawil Lake is of critical importance. The Bardawil Lake is the only lake in Egypt which has not been polluted yet, therefore, it was appointed as the nature preserve area by the Prime Minister's Order No.1429 in 1985. Most important is El Zaraniq lagoon located at the eastern end of the lake, known as the

place where migrant birds such as flamingo fly. According to the ecological investigation conducted by Al Azhar University in association with GAFRD in 1986, useful sea fishes such as gray mullet,seabass and gilthead seabream are growing in the lake. Environmental conservation will be ensured by preventing the siltation of the openings by construction of permanent protection structure of the openings for better circulation of seawater in the lake. Agricultural effluence in the lake is only permitted into the confined western part.

Through the El Salam Canal, the Nile water mixed with drainage from El Sirw and Bahr Hadous drains will be introduced in the Area. Mixing the drainage water would worsen the quality of the canal water, especially in terms of BOD, DO, and salinity. However, this effect is estimated small unless heavy metals and toxic chemicals are contained.

The Area is not infected by schistosomiasis at present. Improper maintenance of the canal would cause the stagnation which results in the spread of malaria and schistosomiasis, therefore, the careful water management under proper maintenance of the canal to control the number of snails is required, particularly in the Tina Plain.

Extension of intensive irrigated agriculture would alter ecosystem of the Area. Agricultural chemicals may necessarily be used to control pests to achieve the target yield. Organic chloric and phosphorated chemical have a strong residual toxicity and causes damages to land and water-borne lives. Utilization of chemical should, therefore, be minimized and a comprehensive pest control system should be introduced.

Mobile sand dunes are widely distributed in the Area, causing serious damage to the communities and infrastructure. Currently, sand dune fixation by means of plantation of acacia and castor bean is studied by MOA and DRI. In addition, the project envisages to contribute to sand dune fixation by expanding crop coverage with farmland reclamation and by making researches on wind and sand control methods in Agricultural Development Center.

The ancient commercial road known as "Horus Road" had been pierced in the Area and historical treasures had remained in various places such as Tel El Farma in the Tina Plain. Therefore, the detailed investigation should be conducted in close cooperation with Department of Antiquity, Ministry of Culture prior to the implementation.

23. Project Implementation Plan

Implementation of the M/P is planned in a phased manner since various development components are included as follows;

In the short-term development plan, the El Salam Canal will be extended up to El Khirba and South Tina Plain land reclamation covering 60,000 feddan and Rabaa/Qatia area land reclamation covering 53,400 feddan, which are located close to the starting point of El Salam Canal extension and expected to yield more rapid benefits, will be completed by 1997. In addition, improvement of existing agriculture in the areas between El Arish and Rafah, and improvement of fishing port in the Bardawil Lake as well as the detailed investigation for the protection of openings are included in the short-term plan.

In the medium-term development plan, land reclamation centering Bir El Abd (124,000 feddan), in parallel with the extension of the El Salam Canal will be completed by 2002. Also establishment of a fishery center at Nigila in the western part of Bardawil Lake and an aquaculture center at the Malaha Lake as well as improvement of marketing facilities are included in the medium-term plan.

In the long-term development plan, which consists of El Salam Canal extension and land reclamation in El Mazar and El Midan (16,700 feddan), as well as construction of fish ponds in a part of the shallow water in the vicinity of Malaha Lake will be completed by 2005.

To cope with the large-scale land reclamation, Agricultural Development Center will be established by the year of 1993 to give a technical support to the farmers.

Works	1988-1992	1993-1997	1998-2002	2002-2007
Agricultural Development				
El Salam Canal Extension		to Rabaa	to Bir El Abd	to El Midan
Land Reclamation (feddan)		113,400	124,600	16,700
Land Improvement (feddan)		59,500		
Land Settlement				
Fishery Development				
Bardawil Lake Opening Improve.				
Fish Landing Port Improvement				
Nigila Fishery Center				
Malaha Lake Aquaculture				
Agro-Industry & Marketing				
Oil Extraction Plant				
Slaughterhouse / Cut Meat Plant				
Agric. Product Marketing				
Fish Storage & Marketing				
Market Road Network				
Community Development				
Existing Community Improvement				
New-Community Construction				
Infrastructure				
Tourism Development				
El Ruag Recreation/Resort				
El Zaraniq wildlife Reservation				
Historical Monum. Conservation				
Supporting Service				
Agric. Extention Facilities				
Agricultulral Development Center				
Aquaculture Exptl. Center				
Natural Environ. Monitoring				
Sand Dune Fixation				

------- Preparatory Works Construction Works (Qantara East - El Arish)

Construction Works (El Arish - Rafah)

Financing preparation including those that introduce foreign currencies will be implemented during the period of the Second Five-Year Plan (1987/88-1991/92), in order to lead the whole project to success.

24. Project Cost

The total costs of the Project estimated in the M/P are as follows:

Component		Amount (million LE)
Agricultural development (including social infrastructure)	:	2,794
Fishery Development	:	50
Agro-industry Development	:	79
Total		2,923

An additional amount of 1,700 million LE will be provided for the road network, a tunnel under the Suez Canal, and new thermal power stations. On the other hand, tourism development projects will be covered by the private sector.

25. Priority Subprojects

Among the subprojects proposed for the short-term development plan, priority subprojects were selected in accordance with the urgency, importance and effect on other components based on the national development policy, i.e., 1) to increase productivity, 2) to create employment opportunities, 3) to improve living standards of inhabitants, and 4) to redistribute the dense population from the Delta to new land.

In the selection of the priority subprojects, tourism development would be excluded from the viewpoint of increase in productivity. From the aspects of balancing the regional gap and redistributing the population, the development projects in the area between El Arish and Rafah where the population density is relatively high, would be exclude. Meanwhile, fishery development is inferior to agricultural development in terms of absorbing population.

Consequently, agricultural development through extension of the El Salam Canal will have a tremendous significance on national development with anticipated effects to be brought about by increased agricultural production such as increase in food self-sufficiency, promotion of processing and marketing industries etc.

Agricultural development, i.e., land reclamation and settlement to be carried out in the short-term plan is 113,400 feddan of South Tina Plain and Rabaa/Qatia area . The feasibility study for the South Tina Plain of 60,000 feddan has been completed by PPU/GARPAD. Therefore, the feasibility study will be conducted for the land reclamation of 53,400 feddan in Rabaa/Qatia area as well as the El Salam Canal extension. Proposed also are plans for new-community development, agro-industry and marketing facilities necessary for the integrated agricultural development. All these plans will be subjected to investigation for technical and economic viability.

CHAPTER 1. INTRODUCTION

1.1. General

This is the report for the Master Plan Study on the North Sinai Integrated Rural Development in the Arab Republic of Egypt. The Government of the Arab Republic of Egypt requested technical cooperation on the master plan study and on a feasibility study for the selected priority subprojects to the Government of Japan in 1986.

In response to the above request, the Scope of Work was signed on November 2, 1987 by Mr. Mohei El Naggar, First Undersecretary of the Ministry of Development, New Communities, Housing and Utilities (MOD) and Mr. Isamu Sakane, Team Leader of the S/W mission of the Japan International Cooperation Agency (JICA) on November 2, 1987.

The Government of Egypt established the steering committee composed of members from MOD, MPWWR, GARPAD and GAFRD, etc., and Dr. Osman Badran of MOD was appointed as a chairman. Meanwhile, JICA assigned a study team to conduct the study and an advisory group composed of 4 experts from the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan to follow up the study team and Mr. Isamu Sakane was chosen as leader of the advisory group.

The study comprises the master planning and the feasibility study, and the field survey for preparing the Master Plan was conducted during the periods, as shown below;

Phase I Survey	April 8, 1988	- May 4, 1988
Phase II Survey	June 27, 1988	- August 18, 1988
Phase III Survey	October 12, 1988	- December 28,1988

The Study Team prepared the Master Plan after reviewing and analyzing the results of the field survey and the data collected.

The Master Plan covers the whole area from Suez Canal to Rafah in North Sinai and aims at the comprehensive development in the region consisting of various components. Major development components are as follows;

1) Agricultural development
2) Agro-industry and supporting services
3) New-community development for settlers
4) Inland fishery development
5) Tourism development

In the course of the Master Plan Study, the development potentials for the respective component were identified by mainly reviewing the existing data and information. Furthermore, the impact on environment was qualitatively assessed based on the existing data. Finally, the implementation programme of the development plans was formulated considering the priority of the subprojects of each component.

The Interim Report on the Master Plan Study was prepared by the Study Team and submitted to the Government of Egypt in October, 1988. After discussion with the steering committee, the Study Team selected the following package of components as priority subprojects to be studied on its technical and economic feasibility.

- El Salam Canal extension up to El Khirba including a siphon crossing the Suez Canal
- Land reclamation of the Rabaa/Qatia area, which includes new-community development, agro-industry and supporting services.

1) Steering Committee

Name	Present Post
Prof. Dr. Osman Badran	Chairman of the Steering Committee, MOD
Eng. M. Abdel Fatah Mohsen	Advisor and member in the Advisory Committee for Reconstruction (ACR), MOD
Eng. Mohei El Naggar	First Undersecretary, MOD
Dr. Salah El Zarka	Fishery Consultant, MOD
Mr. Ibrahim Nagib	Advisor of the Steering Committee, MOD
Eng. M. Tag El Sahley	Chairman of the Studies and Researches Organization, MOD
Eng. Salah Abou El Ezz	General Director of Central Organization for Development, MOD
Eng. Amina Maher	Chairman of the General Organization of Physical Planning (GOPP), MOD
Dr. Fathy Sakr	Economic Consultant, GOPP, MOD
Eng. Helmy Ibrahim	First Undersecretary of Ministry of Public Works and Water Resources (MPWWR)
Dr. Samir Nagmoush	First Undersecretary of General Authority for Rehabilitation Project and Agricultural Development (GARPAD), Ministry of Agriculture and Land Reclamation
Eng. Tawfik El Mahruky	Undersecretary of Central Agency for Mobilization and Statistics (CAPMAS)
Eng. M. Abdel Monem El Kotoury	Chairman of Sinai Development Authority (SDA)
Eng. Roshdy Fahim	Undersecretary of Sinai Development Authority (SDA)
Eng. Taher Yossef	Chairman of General Organization of Fisheries
Eng. Medhat Seif	Undersecretary of Ministry of Tourism (MOT)
Mr. Anwar Salama	Egyptian General Petroleum Corporation
Prof. Dr. M. Khairy Moursy	Prof. Food Technology, Faculty of Agriculture, Cairo University
Mr. M. El Hafer Karim	North Sinai Governorate (NSG)
Mr. Fouad Zatun	Port Said Governorate (PSG)
Eng. Hanan Akel	Rapporteur

2) JICA Study Team

Name	Field
Mr. Kazunori Tamaki	Leader
Mr. Kazuo Nakabayashi	Soil & Land Use (Deputy Leader)
Mr. Hiroshi Moriyama	Irrigation & Drainage
Mr. Toshihide Shibata	Agronomy
Mr. Masamichi Watanabe	Facility Design
Mr. Hironori Takahashi	Meteorology & Hydrology
Mr. Yutaka Nozaki	Regional Planning
Mr. Kazumi Iida	Fishery
Mr. Michimasa Umesato	Tourism
Mr. Mitsutomo Anai	Agro-Economy/Project Evaluation

1.2. Social and Economic Background

1.2.1. Population and Agricultural Land

It is fair to say that the largest problem that Egypt faces now is the population increase. Any social and economic problem can be cited in connection with the population.

According to the statistical data by CAPMAS, population in 1977 was 38.8 million which had increased to 51.3 million by 1987. Average annual rate of increase is estimated at 2.8 percent (refer to Table 1.2-1). However, working away from Egypt to the Arab countries have been reduced year by year.

Meanwhile, the existing cultivated area in Egypt is only about 3 percent of the total land, which is developed exclusively along the River Nile. Looking into the ratio of population to cultivated land, which is an important index for studying on demand and supply of food, cultivated land per capita in 1986 was 0.12 feddan and has been decreasing year by year (Table 1.2-2). This figure indicates that land reclamation has not kept up with high population increase including home-coming population from Arab countries. It is considered that shortages in cultivated land in proportion to the population will become more critical in the future.

1.2.2. Food Self-Support

Basically, Egypt is an agricultural country. About 56 percent of the population lives in rural area and 34 percent (1983/84) of the labour force is engaged in agriculture. However, the ratio of food self-support has shown a downward trend.

The staple food of Egyptian is wheat of which annual consumption is reaching 180 kg per capita. On the other hand, domestic production of wheat was only 53 kg per capita in 1987,

resulting in an annual increase in the amount of imports for wheat, maize, dairy products and meat. Thus, dependence on foreign countries for food supply has increased against a background of rapidly increasing population.

1.2.3. Agriculture in Egypt

Agricultural production accounted for 31 percent of GDP in 1974, but decreased by 17 percent in 1984/85, which is the lowest growth rate compared to other sectors because agricultural production has not been increased in Egypt. Agricultural exports accounted for 12.5 percent of the total value of export in 1987, up from 6 - 8 percent before 1987.

Meanwhile, food imports accounted for 30 percent of the total imports (Table 1.2-3). In 1987, the amount of food imported was 3.1 million LE while 0.38 million LE of agricultural export (Table 1.2-4), which indicates a large gap despite Egypt being an agricultural country. The trade balance for the latest 10 years has shown a consistent deficit.

1.2.4. Agricultural Production

Change in cultivated area for the principal crops are shown in Figure 1.2-1, which indicate that there have been no remarkable changes since 1974. Production of the seven major crops has been stagnant or even decreased. However, a gradual increase in planted area for fruits should be noted. The Government of Egypt has controlled to planting area for selected crops such as cotton, sugarcane, wheat, etc., in order to secure a certain amount of production. The governmental control is not applied for fruits production, accordingly the farm gate price of fruits is higher than other crops, resulting a gradual increase in the cropped area in recent years, as well as vegetables (Table 1.2-5).

Change in the number of livestock is stagnant as shown in Table 1.2-6 and the number of sheep which is the most important meat for Egyptian has been decreasing. The reason why the number of livestock has not increased is the competition between crop production and animal raising on the limited agricultural land.

1.2.5. Five-Year Plan

The new series of Five-Year Plans began in 1982/83 and the Second Five-Year Plan (1987/88 - 1991/92) is proceeding at present. The principles are outlined below:

(1) Raising the capacity of the Egyptian economy
(2) Strengthening the physical and social infrastructure
(3) Achieving population - location balance

Item (1) includes an increase of production and productivity in each sector and raising the Egyptian economy is planned by means of an increase in agricultural production and exports.

As for item (3), it is recognized that population growth has become of critical importance, and a strategy is planned to redistribute population into more spacious area where agricultural and other industries can be established.

Table 1.2-7 shows public sector investment in the Second Five-Year Plan as compared with that in the First Five-Year Plan. As for the agricultural sector, investment is increased by 100 million LE but unchanged for irrigation and drainage sector. Table 1.2-8 indicates the target planting area and production for the main crops and Table 1.2-9 shows the expected food self-support, in which 43 percent of wheat demand is expected to be domestically produced while 57 percent will depend on imports.

Table 1.2-1. Change in Population

	Population (1,000)	Remarks
1977	38,794	
1978	39,767	
1979	40,889	
1980	42,126	
1981	43,322	
1982	44,506	
1983	45,755	
1984	47,191	
1985	48,503	
1986	49,897 (100)	Urban (44%), Rural (56%)
1987	51,329	

Annual increase from 1977 to 1986: 2.8%
Total Egyptian abroad in 1986: 2,250,000 person
Source: Statistical Yearbook, 1988, CAPMAS

Table 1.2-2. Cultivated Area per Capita

	1961	1965	1969	1970	1976	1980	1986
Cultivated Land (1,000 ha)	2,568	2,672	2,835	2,843	2,862	2,855	-
Population (1,000)	26,579	29,389	32,316	33,053	36,627	42,126	-
Cultivated Land per Capita (ha)	0.096	0.091	0.088	0.086	0.078	0.068	-
" (fed)	0.23	0.22	0.21	0.20	0.19	0.16	0.12 1/

Source: Cultivated Land; production Yearbook, FAO
Population; Statistical Yearbook, CAPMAS
Note: 1/ Second Five-Year Plan

Table 1.2-3. Import of Agricultural Products

(unit: 1,000 LE)

	1980	1981	1982	1983	1984	1985	1986	1987
Livestock Animals and its Products	210,194	417,530	386,068	404,949	529,836	493,072	476,023	794,492
Vegetable Products	545,117	1,145,995	1,069,377	862,665	994,376	865,530	1,041,654	1,440,255
Fat. Oils, and its Products	152,606	198,034	191,066	214,245	146,817	170,731	428,155	255,170
Prepared Foodstuffs, Beverage and Tobacco	200,623	363,391	322,170	365,994	426,945	374,087	489,994	641,283
Sub-total	1,108,540 (33)	2,124,950 (34)	1,968,681 (31)	1,847,853 (26)	2,097,974 (28)	1,903,420 (27)	2,435,826 (30)	3,095,200 (27)
Other Commodities								
Total Import	3,401,999 (100)	6,187,486 (100)	6,354,517 (100)	7,192,657 (100)	7,536,068 (100)	6,973,061 (100)	8,051,432 (100)	11,357,837 (100)

Table 1.2-4. Export of Agricultural Products

(unit: 1,000 LE)

	1980	1981	1982	1983	1984	1985	1986	1987
Livestock and its Products	11,900	14,493	21,816	11,830	10,685	10,695	14,137	15,183
Vegetable Products	116,866	122,433	123,639	150,647	147,988	129,007	120,322	328,538
Fat Oils and its Products	767	1,427	1,176	1,028	1,887	2,786	2,214	2,597
Prepared Foodstuffs, Beverage and Tobacco	23,910	32,914	26,271	21,639	16,700	16,791	20,445	33,242
Sub-total	153,443 (7.2)	171,267 (7.6)	172,902 (7.9)	185,144 (8.2)	177,260 (8.1)	159,279 (6.1)	157,118 (7.6)	379,560 (12.5)
Other Commodities								
Total Export	2,132,178 (100)	2,262,982 (100)	2,184,122 (100)	2,250,295 (100)	2,197,933 (100)	2,599,941 (100)	2,053,959 (100)	3,046,010 (100)

Source: Statistical Yearbook, CAPMAS

Figure I.2-1 Planted Area of Main Crops

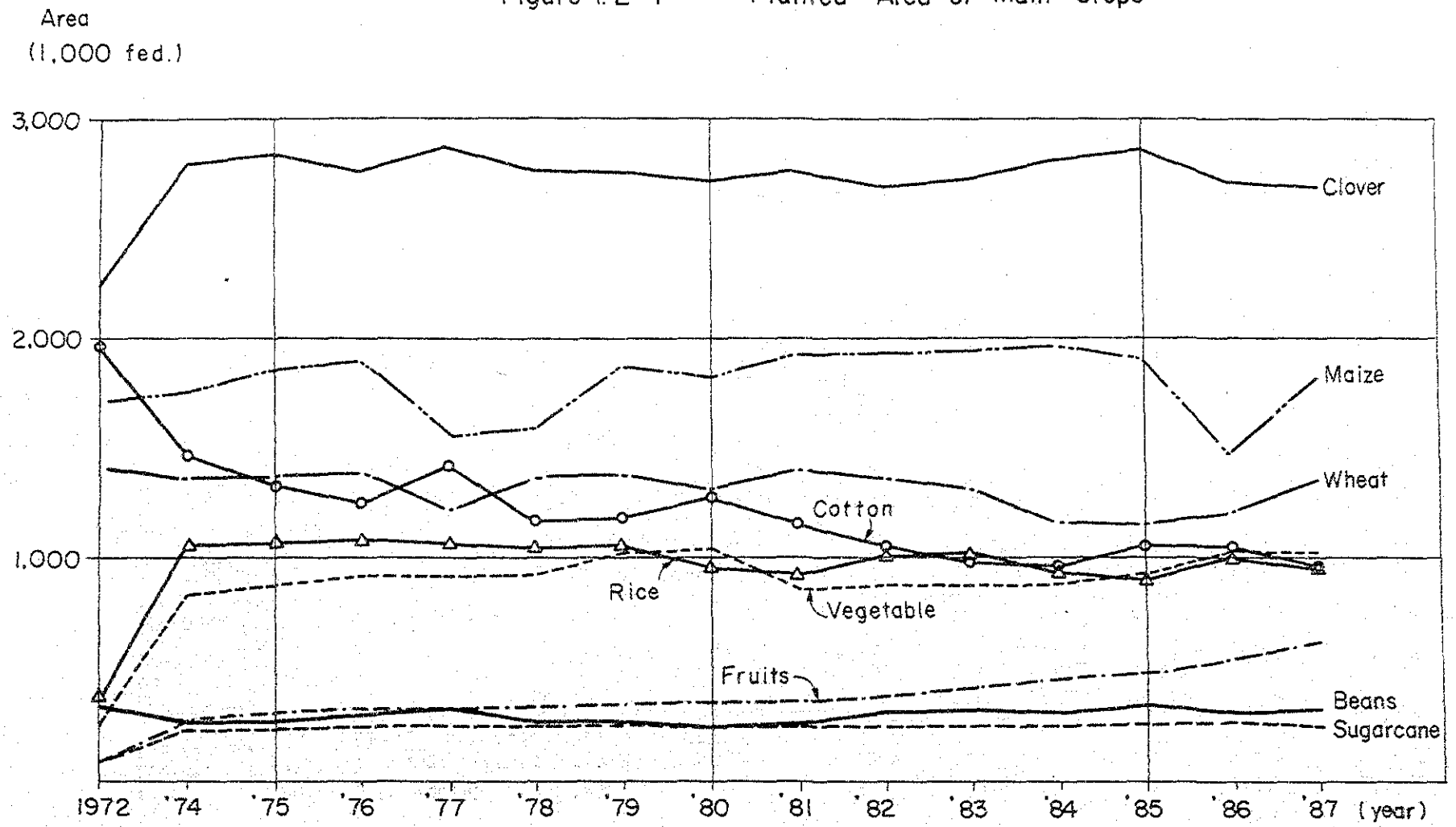


Table 1.2-5. Cropped Area

(unit: 1,000 feddan)

	1952	1982	1983	1984	1985	1986	1987	1987/1982	Change (%)
Winter Crops[1/]	4,364	4,963	4,983	4,945	5,038	4,944	5,098	1.03	2.7
Summer Crops[2/]	3,026	5,007	4,830	4,818	4,845	4,787	4,842	0.96	3.3
Nile Crops[3/]	1,824	821	880	845	880	890	854	1.04	4.0
Orchards	94	390	404	435	457	549	616	1.58	57.9
Total	9,308	11,181	11,097	11,043	11,220	11,170	11,410	1.02	2.0

Note: 1/ ... November to May
2/ ... March to April to September
3/ ... May to October to November
Source: Statistical Yearbook, 1988, CAPMAS

Table 1.2-6. Number of Livestock

(unit: 1,000 Head)

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1986/1977
Buffaloes	2,266	2,542	2,321	2,347	2,370	2,393	2,412	2,430	2,447	2,502	1.10
Camels	97	93	88	84	80	76	72	68	68	68	0.70
Cows	2,048	2,587	1,954	1,912	1,852	1,826	1,772	1,743	1,709	1,855	0.91
Goats	1,375	1,440	1,427	1,451	1,475	1,498	1,520	1,542	1,563	1,583	1.15
Pigs	15	15	15	15	15	15	15	15	15	15	1.00
Sheep	1,821	2,554	1,679	1,593	1,498	1,394	1,280	1,157	1,149	1,149	0.63

Source: Statistical Yearbook, CAPMAS

Table 1.2-7. Public Sector Investment

(unit: Billion LE)

Economic Sectors	First Five-Year Plan Value	First Five-Year Plan %	Second Five-Year Plan Value	Second Five-Year Plan %
Commodity Sector	13.0	47.8	14.6	52.4
Agriculture	0.8	2.8	0.9	3.1
Irrigation & Drainage	1.4	5.1	1.4	5.1
Industry & Mining	6.1	22.3	5.8	20.8
Petroleum	1.4	5.1	1.1	4.9
Electricity	2.6	9.7	4.8	17.1
Construction	0.7	2.8	0.6	2.3
Production Services Sectors	8.4	30.9	5.5	19.9
Transport, Communication & Storage	7.2	26.6	4.7	16.9
Suez Canal	0.4	1.4	0.3	0.9
Commerce	0.4	1.6	0.2	0.8
Finance & Insurance	0.1	0.3	0.1	0.5
Tourism	0.3	1.0	0.2	0.8
Social Infrastructure Sectors	5.2	19.2	7.7	27.7
Housing	0.3	1.0	0.2	0.6
Public Utilities	2.9	10.7	4.0	14.4
Education	0.7	2.7	1.6	5.9
Health	0.5	1.7	0.8	2.9
Other Social Services	0.8	3.1	1.1	3.9
Total	26.6	97.9	27.8	100.0
Investment Expenditure & Unallocated Reserve	0.5	2.1	0.7	-
Grand Total	27.1	100.0	28.5	-

Source: Summary of the second Five-Year Plan (1987/88-1991/92)

Table 1.2-8. Areas Targeted for Most Important Crops

(unit: 1,000 fed, 1,000 tons)

Crop	Expected (1986/87)		Target (1991/92)		Annual Growth	
	Planted Area	Production	Planted Area	Production	Planted Area	Production
Wheat	1,294	2,188	1,540	3,120	3.5	7.3
Barley	170	193	175	215	0.6	2.2
Maize	1,632	3,206	2,562	6,291	9.4	14.4
Fine Maize	403	639	100	161	24.4	3.0
Rice	1,144	2,667	1,139	3,257	0.1	4.1
Fava Beans	335	364	370	451	2.0	4.4
Lentils	27	19	105	77	31.2	32.3
Other Legumes	74	56	79	63	1.3	2.4
Cotton	1,055	1,097	1,180	1,413	2.2	5.2
Flax	45	130	46	139	0.4	1.3
Groundnuts	38	26	55	50	7.7	14.0
Sesame	29	12	45	20	9.1	10.8
Soybeans	115	137	160	198	6.8	7.6
Sugarcane	280	10,358	267	1,161	1.0	1.5
Sugarbeet	52	835	58	1,023	2.2	4.1
Vegetables	1,405	11,936	1,177	11,236	3.5	0.5
Onions	54	744	82	1,153	8.7	9.3
Permanent Clover	2,102	NA	998	NA	3.6	NA
Feed Clover	1,000	NA	301	NA	0.4	NA
Other Fodder	267	NA	700	NA	1.6	NA
Fruit	50	3,163	60	4,450	5.2	7.1
Dairy	-	2,475	-	2,820	-	2.5
Meat (Livestock)	-	406	-	470	-	2.9
Meat (Poultry)	-	223	-	281	-	4.7
Eggs	-	143	-	175	-	4.1
Fish	-	236	-	350	-	8.2

Source: Second Five-Year Plan

Table 1.2-9. Quantitative Foods Balance

(unit: %)

	1986/87		1987/88		1991/92	
	Domestic	Import	Domestic	Import	Domestic	Import
Wheat	31.0	69.0	33.0	67.0	43.0	57.0
Barley	97.0	3.0	100.0	0.0	100.0	0.0
Maize	63.0	37.0	75.5	24.5	90.0	10.0
Rice	100.0	0.0	100.0	0.0	100.0	0.0
Lentil	25.0	75.0	27.0	73.0	88.0	12.0
Cotton	100.0	0.0	100.0	0.0	100.0	0.0
Groundnuts	100.0	0.0	100.0	0.0	100.0	0.0
Sesame	37.0	63.0	38.0	62.0	49.0	51.0
Sunflower	100.0	0.0	100.0	0.0	100.0	0.0
Soybeans	100.0	0.0	100.0	0.0	100.0	0.0
Sugarcane	100.0	0.0	100.0	0.0	100.0	0.0
Sugarbeets	100.0	0.0	100.0	0.0	100.0	0.0
Fresh Vegetables	100.0	0.0	100.0	0.0	100.0	0.0
Onions	100.0	0.0	100.0	0.0	100.0	0.0
Fruits/Dates	100.0	0.0	100.0	0.0	100.0	0.0
Fresh Milk	100.0	0.0	100.0	0.0	100.0	0.0
Fish	75.0	25.0	77.0	23.0	85.0	15.0
Meat (Red/White)	75.0	25.0	74.0	26.0	70.0	30.0
Dairy Products	76.0	24.0	79.0	21.0	84.0	16.0
Refined Sugar	58.0	42.0	58.0	42.0	60.0	41.0
Edible Oil	24.0	76.0	25.0	75.0	28.0	72.0

Source: Second Five-Year Plan, 1988

1.3. Existing Development Plans and Surveys

Several master plans either for comprehensive development or for particular sector development have been already prepared by various agencies and have presented the development potentials, while most plans have not been practically realized. In this M/P on integrated rural development in North Sinai, the development potentials were identified by reviewing the existing data and information and by field survey on the following components:

- Agricultural development
- Inland fishery development
- Agro-industry and marketing
- New-community development
- Tourism development

Table 1.3-1 Existing Development Plans & Surveys

1) General

- Sinai Development Study (Phase I), Dames & Moore, ACR/MOD, 1985
- Sinai Development Plan, DRTPC/Cairo Univ. & MIT, 1982

2) Agriculture

- Preliminary Feasibility Study for Reclamation, Cultivation and Reconstruction of Lands in North Sinai, REGWA/GARPAD, 1984
- The Overall Plan for Development of Coastal Strip, El Arish-Sheikh Zuwayid-Rafah, CICCAS/GARPAD, 1984
- Land Master Plan, Euroconsult-Pacer/GARPAD, 1986
- Tina Plain Development Project Feasibility Study, PPU/GARPAD, 1988

3) Fishery

- Bardawil Lagoon Development Programme, France Agriculture, GAFRD, 1983
- Ecology of Bardawil Lagoon, GAFRD, 1985
- Study of Bardawil Lake, CPI, 1988

4) Water Resources

- Water Master Plan, MOI (MPWWR)
- El Salam Canal Project, F/S Report, MOI (MPWWR)
- North Sinai Water Resources Study Report, RIWR/MPWWR, 1988

5) City Development

- Structure Plan for El Arish City Report, GOPP/MOD, 1987
- Planning Projects of Bir El Abd, Nakhel, El Hassana and Related Areas, NSG, 1982

6) Tourism

North Sinai Structural Plan & Tourism Study, EGYPTEAM/MOD, 1987

CHAPTER 2. THE STUDY AREA

2.1. Location and Topography

2.1.1. Boundary of the Study Area

The Study Area comprises the low-lying Mediterranean Sea foreshore strip and the area lying along the eastern bank of the Suez Canal up to the Ferdan ferry which is located 66 km south from Port Said. The area further south of the Ferdan ferry comes within the East Bitter Lake Project. A narrow belt 3 km in width along the eastern bank of the Suez Canal is excluded from the Study Area because it falls within the jurisdiction of the Suez Canal.

The Study Area extends in 32°20' - 34°15'E of longitude and 30°40' - 31°15 N of latitude. The total extent of the Study Area is 3,220 sq.km including 674 sq.km of Malaha and Bardawil Lakes. The Study Area extends over three governorates as follows;

Governorate	Land Area		Lake Area	Total Area	
	(sq.km)	(%)	(sq.km)	(sq.km)	(%)
Ismailia	533	20.9	0	533	16.6
Port Said	354	13.9	24	378	11.7
North Sinai	1,659	65.2	650	2,309	71.7
Total	2,546*	100.0	674	3,220	100.0

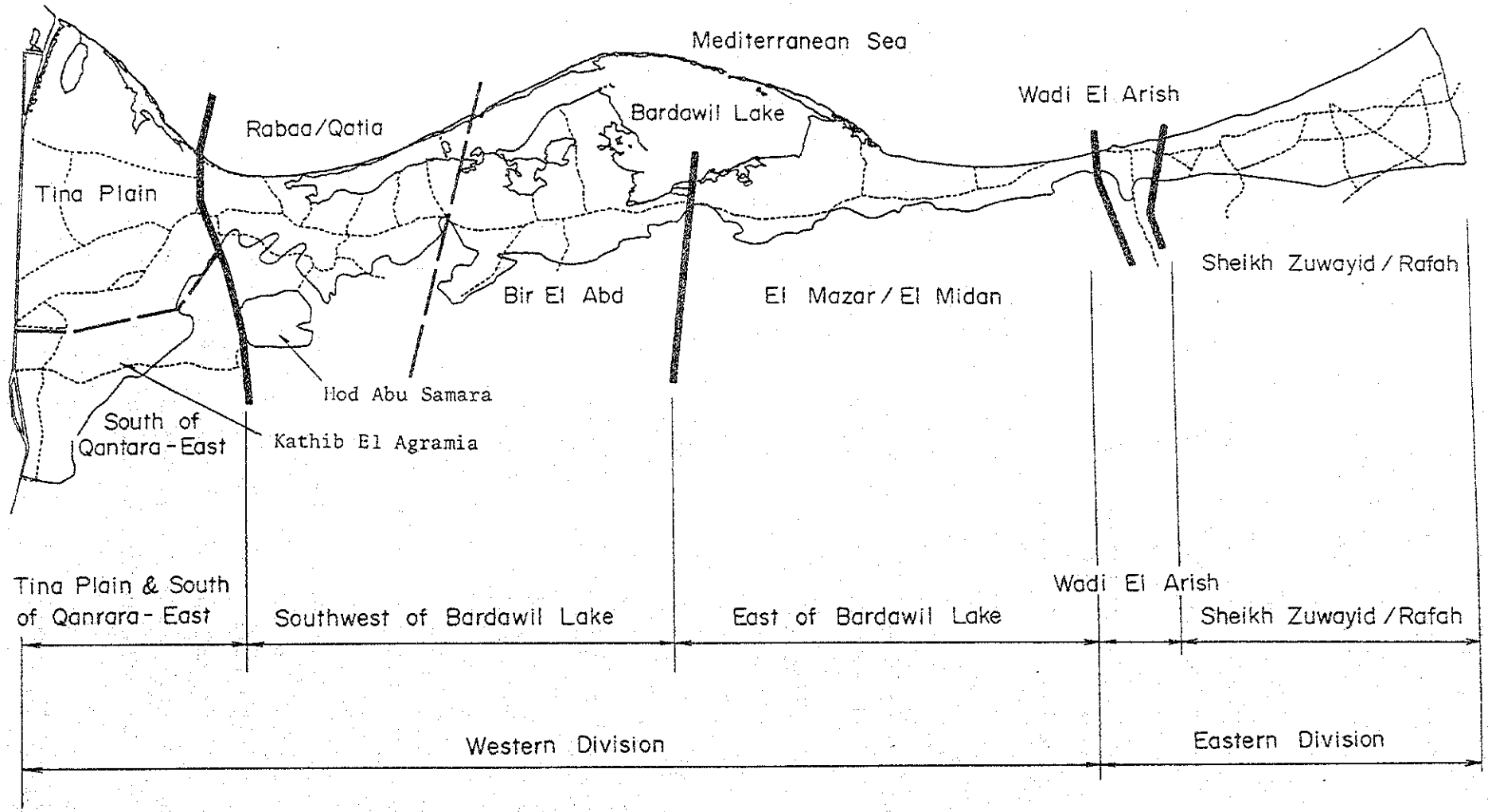
* 606,000 feddan

The Study Area can be divided into the following two divisions by the natural and socioeconomical conditions (Figure 2.1-1).

1) Western Division

The elevated area higher than EL.25 m is generally comprise of undulating sand dunes and has no important water resources, so that it is excluded from the Study Area. However, the areas of Hod Abu Samara and Kathib El Agramia with an altitude in the range of EL.25 m to EL.40 m are included in the Study Area because of their favourable gently undulating topography.

Figure 2. I – I. Area Division Map



2) Eastern Division

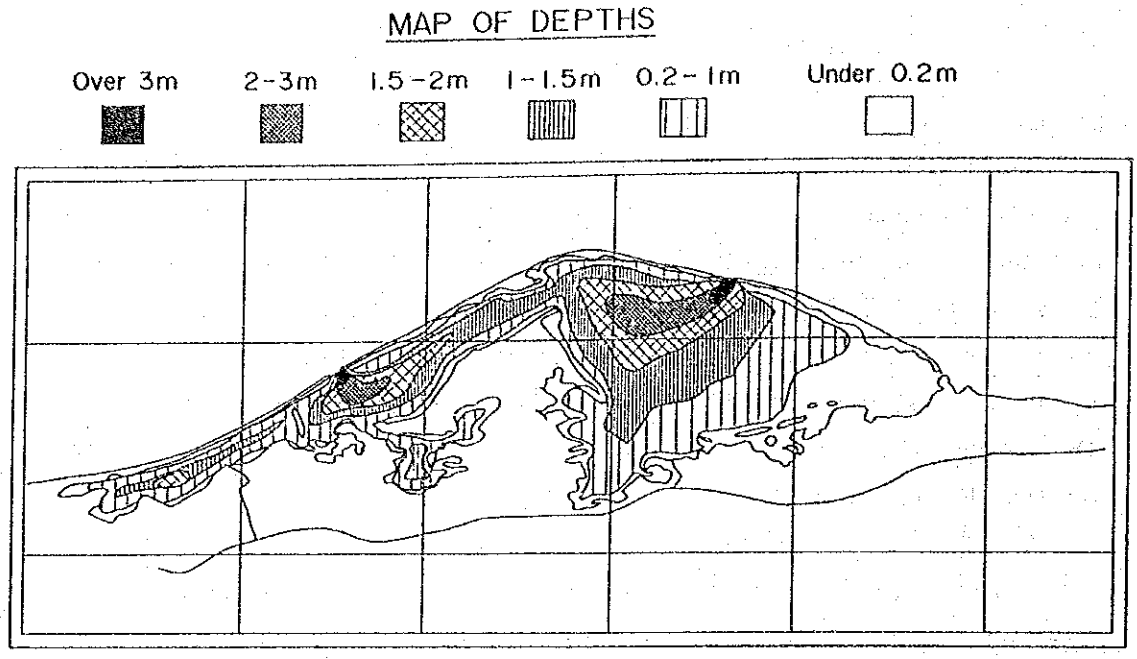
The land lying along Wadi El Arish, where irrigated agriculture is practised, is included in the Study Area. Wadi El Arish, with a catchment area of about 22,000 sq.km, is the largest dry arroyo in the Sinai Peninsula, however, most of the catchment area is located outside of the Study Area. Although there are several storage dam sites in the catchment area, the storage dam project to convey water to the El Arish area seems to be economically unfeasible as the potential dam sites are located too far from the El Arish area. Therefore, the storage dam projects are not considered in the course of the Master Plan study.

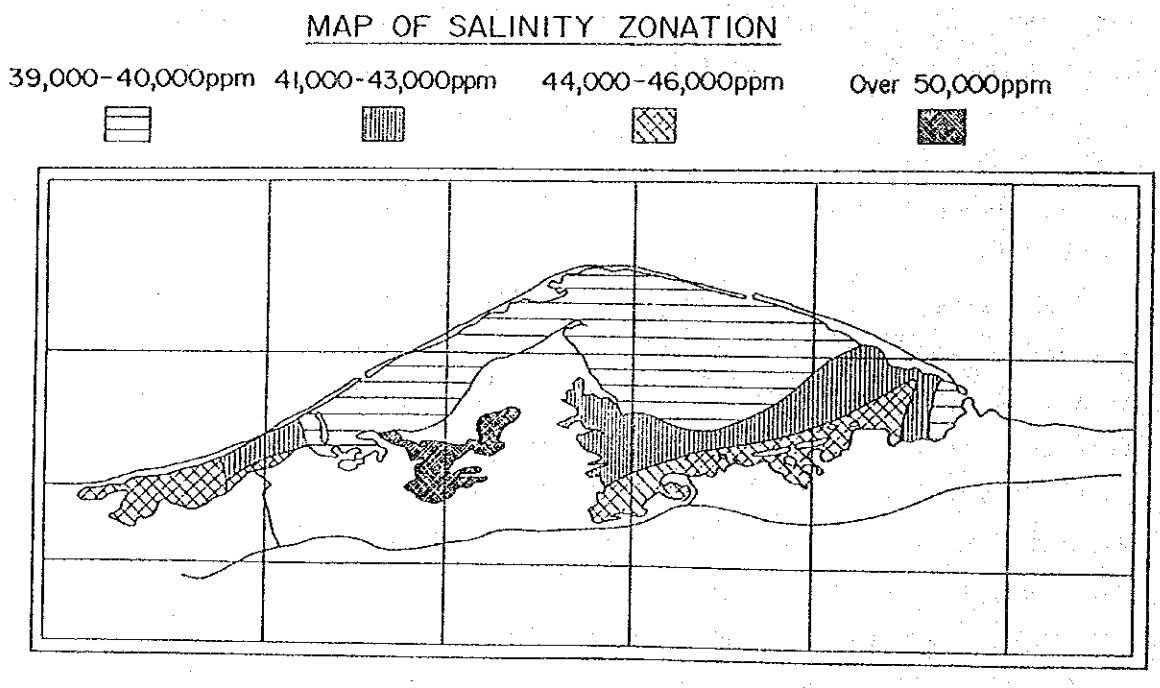
In the coastal strip of the El Arish-Rafah area, there is agricultural land in progress utilizing groundwater for irrigation. The annual rainfall amounts to between 100 mm and 300 mm and rainfed agriculture which is characterized by orchard fruits such as peach and almond is practised at the south of the irrigated farmland. Rainfed farmland in the El Arish-Rafah area, where the maximum ground elevation is around EL.80 m, is included in the Study Area.

2.1.2. Bardawil Lake

The lake is separated from the Mediterranean Sea by a long sand bar and is about 80 km long with a maximum width of 21 km. It's area is approximately 650 sq.km and the depth is generally 1 - 2 m (Figure 2.1-2). No river or drains flow into the lake. The average annual rainfall in the lake is about 80 mm while the mean evaporation is assumed to be 1,500 mm per year. Formerly, the lake was a natural depression covered with salt crusts for centuries. And it is assumed that from time to time the sea waves broke the sand bar and flooded the depression during storms. The breaks of the bar were silted up rapidly and the depression dried up again. Early this century, people made openings in the bar to flow seawater into the depression and commenced fishing in the lake.

Figure 2.1-2. Outline of Bardawil Lake





Source : Bardawil Lagoon Development Programme Interim Report.

Currently, the lake has two man-made openings (Bughaz I and Bughaz II) to promote seawater exchange. The openings are about 300 m wide with a maximum depth of 5 - 6 m. The salinity in the lake is kept at 40,000 - 45,000 ppm. It rises easily when the openings are narrowed by silting. In 1971 and 1979, one of the openings was silted. The salinity rose up to 70,000 ppm, and 120,000 ppm in particular sections of the lake. Consequently, the quantity of fish production in the lake drastically decreased.

2.1.3. Malaha Lake

Malaha Lake consists of two hypersaline and very shallow water bodies occupying 24 sq.km totally in the northern part of the Tina Plain. The northern water body, (the North Lake) has an area of approximately 14 sq.km with an extremely shallow depth of 1.0 - 1.5 m. The southern water body, (the South Lake) has an area of approximately 10 sq.km and is also extremely shallow with a depth of 1.0 - 1.5 m.

The area of Malaha Lake was formerly larger than at present, being adjacent to Port Fouad, with flood-prone areas of approximately 110 sq.km. By construction of the new Suez Canal by-pass in 1980 - 1981, the west part of the lake was filled with the dredged earth and sand. In 1982, an opening (Bughaz Kilo II) was made to the remaining part of the lake in order to connect it with the Mediterranean Sea and to promote the circulation of seawater. This is the water body which is now called the North Lake. The man-made opening is about 30 m wide and 2 km long with a depth of 2 m. The South Lake was made by flooding through an opening (Bughaz Kala) excavated on the shore in 1983. This man-made opening is about 50 m wide and 300 m long with a depth of 2 m.

No river or drains flow into the lakes. The annual rainfall is about 60 mm while the evaporation in the area is assumed to be around 1,600 mm per year. Under these natural conditions, the salinity of the lake water rises rapidly in case that water

circulation between the lake and the sea is obstructed. Therefore, maintaining the seawater exchange through the openings is indispensable for keeping the salinity of the lake water at safe level and for leading fish fry into the lakes.

The water level of the lake fluctuates about 0.5 m between summer and winter, caused by northwest winds from April to November and gales occurring in winter. Due to the rise in water level, the depressed areas of the northern Tina plain are flooded and the area of water surface of the lakes is expanded several times beyond the above-mentioned area.

2.2. Administrative Boundary, Population and Social Conditions

2.2.1. Administrative Boundary

The Study Area consists of three governorates, namely, Ismailia, Port Said and North Sinai. The North Sinai Governorate, which occupies about 65% of the total land area is divided into Bir El Abd, El Arish, Sheikh Zuwayid, and Rafah districts (Markaz) as shown in Figure 2.2-1. Important settlements in the Study Area are El Arish and Bir El Abd in North Sinai Governorate, and El Qantara East in Ismailia Governorate.

2.2.2. Population

The population density in the Study Area is relatively low (3.3 persons per sq.km in Sinai, 1986 CAPMAS). Population is concentrated in the settlements distributed along the highway between El Qantara East and Rafah. The rest of the area has only sparse population apart from some temporary Bedouin settlements around wells.

Approximately 161,000 people live in the Study Area (estimated in 1986) which is about 0.3 percent of the total population of the country, 49.9 million (Table 2.2-1). The largest settlement is El Arish which has approximately 68,000 people. About 78 percent of the total population are living in the northeast coastal area of the North Sinai Governorate (the Eastern Division). On the other hand, small settlements are distributed along the highway between El Qantara East and El Arish. Population of the small settlements is concentrated in the zone between Balouza and Bir El Abd, due to the settling of Bedouin coming from the southern area.

Figure 2.2-1. Administrative Boundary

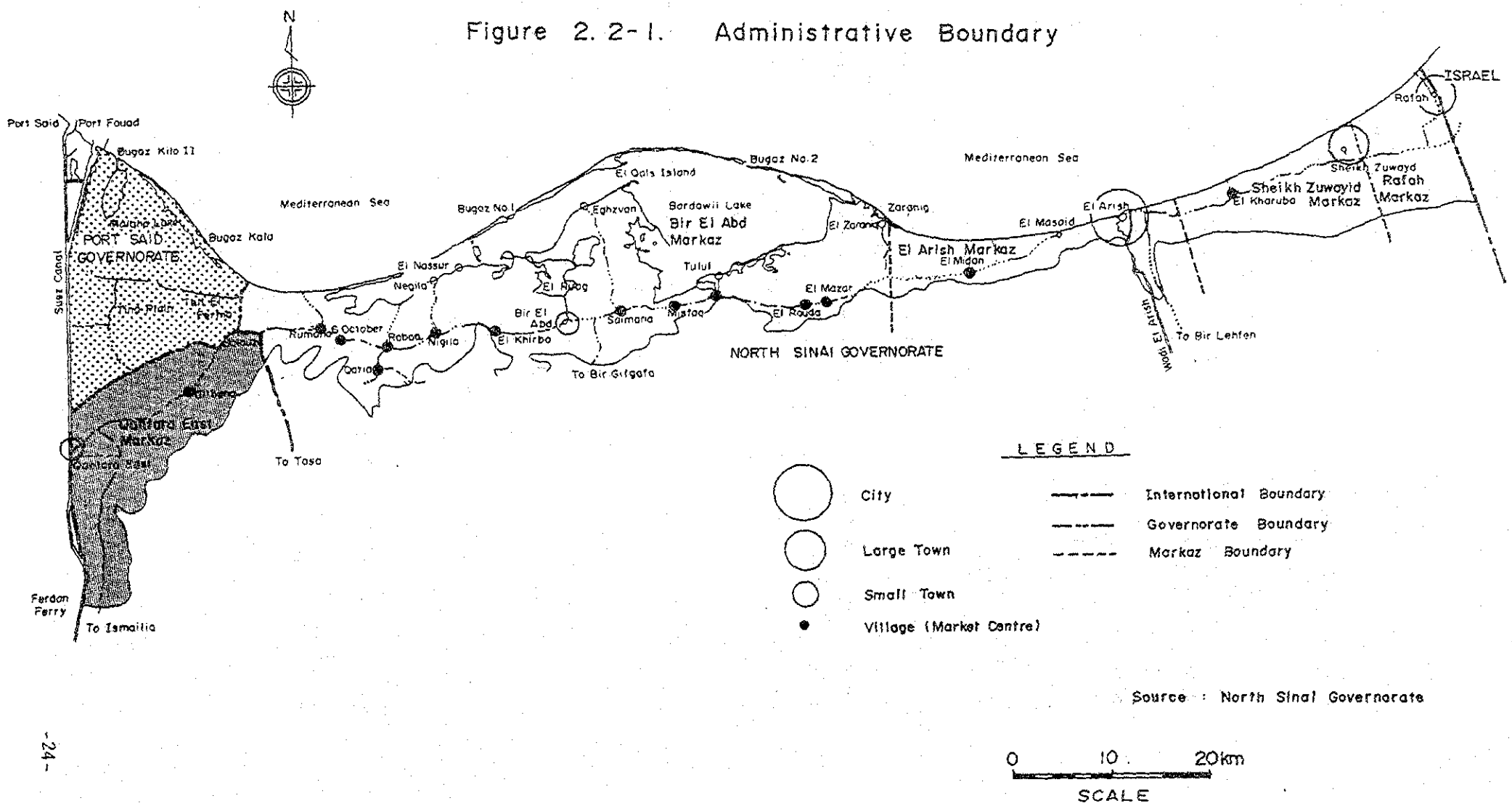


Table 2.2-1. Demography of the Study Area (1986)

Governorate	Markaz	Population*1 (1,000 persons)	No. of Households*2 (1,000 Household)
North Sinai	Bir El Abd	27.4	5.1
	El Arish	67.6	12.5
	Sheikh Zuwayid	24.4	4.5
	Rafah	34.3	6.4
	Sub-total	153.7	28.5
Ismailia	El Qantara East	7.7	1.6
Port Said	Port Fouad	0	0
	Total	161.4	30.1

Source: *1 ... CAPMAS, Population Census, 1986.
Note : *2 ... estimated

The rate of population growth in the North Sinai Governorate is estimated to have been approximately 25 percent between 1982 and 1986, an average annual growth rate of 5.8 percent. Remarkable population growth is found in the districts of Rafah (47%), El Arish (39%), and Bir El Abd (32%). This annual growth rate is higher than that of the national growth rate of 2.8 percent (1977-1986), because of returned and migrant population from the west bank of the Suez Canal. Average family size is 5.4 persons per family in the North Sinai Governorate.

2.2.3. Economic Situation

Agriculture is the major industry of the Study Area, and 6,600 households out of the total households of about 30,000 were landowners or owner farmers in 1984. The average farming acreage is 8.3 feddan. It suggests that landless farmers have been permanently or temporarily employed for running the farms in the Area.

The total number of agricultural households in the Study Area, including those of landless farmers, can be estimated at 20,000 based on the average level of farm income and labour demand, which accounts for about 60 percent of the total households. Fishing households come next to farm households with 3,000. The information

on the remaining households of approximately 10,000 is not available but it can be assumed that these households earn their income as public servants, manufacturers, transporters, wholesalers, tourist agents, etc.

In the Eastern Division, which is blessed with an annual maximum rainfall of 300 mm, intensive agricultural production has been carried out, through use of groundwater and rainfall. The area between El Arish and Rafah is being prepared for tourism. El Arish is a fishing port which enjoys the second largest fishing catch in the region.

On the other hand, the Western Division has extremely low annual rainfall ranging from 10 mm to 100 mm. It is thinly populated with irrigated farming practised on groundwater. Such irrigated farming, however, can be considered a type of subsistence agriculture such as sheep and goat grazing or dates production by the Bedouin. The farming in this part, therefore, can be said to be extensive farming with extremely low labour intensity. Bardawil Lake is the largest fishing site, however, the fish catch in the lake has hit a peak recently.

2.2.4. Settlement Pattern

Among the major settlements distributed along the highway, El Qantara East and Gilbana belong to the Ismailia Governorate. Balouza, Rumana, Nigila, Bir El Abd, El Arish, Sheikh Zuwayid, and Rafah belong to the North Sinai Governorate. Rural communities of various scales are currently under rehabilitation, expansion, or construction.

The settlements in the Study Area are classified according to the following population scales:

Category	Population	1986 Census
City	Over 50,000	El Arish
Large Town	25,000- 50,000	Rafah
Small Town	5,000 - 25,000	Sheikh Zuwayid, El Qantara East, Bir El Abd
Village (Market Center)	under 5,000	Others

The settlements in the Study Area are divided into five groups from the viewpoint of their linkages, as follows;

1) El Qantara East

El Qantara East is located on the east bank of the Suez Canal and has closer economical relations with Ismailia, Port Said and Suez than Central Sinai region. The main economic activities are small in scale, such as manufacturing, commerce and trade. There are also governmental offices and some public services. A new community is under construction, about 6 km east of the old town, which is to be a major agricultural, service, and industrial center to serve the northwest Sinai region.

2) Balouza - Tulul

A series of small and medium-scale settlements are found along the highway. The inhabitants are mainly Bedouin. Two hundred housing units were built at Balouza, Rabaa and Nigila and 73 housing units at Rumana during the First Five-Year Plan. In addition, a new community is under construction near the Six October village at present. The largest settlement is Bir El Abd which is a commercial and trade center. There are also governmental offices in Bir El Abd. This town also functions as a livestock center for the surrounding area and there are some irrigated farms using groundwater. A new-community is under construction at the north of this town. Economic activities of Balouza, Rumana, Rabaa, Nigila and El Khirba are limited, since these villages act only as small bases for grazing and date palm production. In some villages, a high percentage of households is occupied in fishing in the Bardawil Lake. There is some local tourist accommodation at Rumana.

3) El Rouda - El Midan

In the east of Bir El Abd, settlements are smaller and scattered. A small fishing community with 100 housing units together with facilities for fish cold storage has been established at Tulul, in which improvement project has been carried out by grant aid of EC.

4) El Arish

El Arish is the principal population center for economic activities in the whole of Sinai, particularly, in North Sinai. This city is the largest and most rapidly expanding city in the Study Area and serves a variety of economic activities. About 40 percent of the the total population of the Study Area is concentrated in this city. Irrigated agriculture is practised in 1,200 feddan in Wadi El Arish basin and extensive rainfed agriculture is also practised in the east part of the city. There is an olive oil extracting plant. Fishing is also an important activity. A large-scale fishery port is now consolidated and a part of it is already used. There are governmental offices, important educational institutions, health services and commercial centers. Tourism in the city is very active and a full range of accommodation has been provided totaling 2,000 beds in hotels, chalets, or beach cabins (1984). Satellite villages are being built in El Masaid and El Salam (new-communities). These are mainly residential or commuter type new communities.

5) Sheikh Zuwayid - Rafah

Rafah is the second largest town in the Study Area, located on the eastern border. Rafah and Sheikh Zuwayid are two urban centers where the administration units and services are centralized. Around these towns, different population settlements are located in close proximity to each other. The main economic activities in this area

are agriculture and livestock. Fruit orchards of olives, apricots, peaches, figs, etc., have been developed around Rafah. There are also commerce and industrial activities. On beaches between Sheikh Zuwayid and Rafah, tourist camps and bungalows are provided.

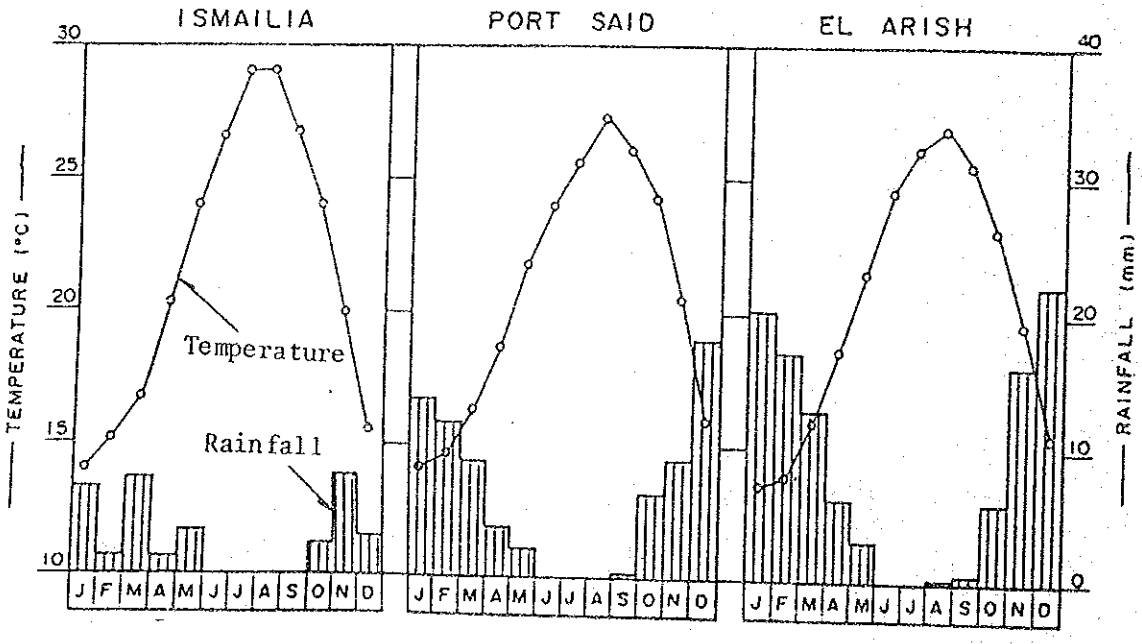
2.3. Meteorology and Water Resources

2.3.1. Climate

The climate in the Study Area is generally known as the Mediterranean type which is characterized by a relatively rainy winter with cool air temperature and a dry hot summer. In spring the weather is unstable with hot and dusty winds, known locally as "Khamseen", which blow occasionally from the south and southeast.

The lowest temperatures occur in January when the maximum average temperature is 20°C, and the minimum average temperature is 8°C. In August, the maximum and minimum average temperatures in the coastal area are 31 and 22°C, respectively. The maximum average temperature increases further inland, reaching 36°C in Ismailia. The minimum average temperature in Ismailia is 20°C in August.

Figure 2.3-1. Mean Monthly Temperature and Rainfall



The mean monthly temperature and rainfall at Ismailia, Port Said and El Arish are shown in Figure 2.3-1. The relative humidity is 70 percent on the average in the coastal area and 50 percent in Ismailia. The annual average windspeed is around 14 km/hr and the prevailing wind directions are north, northeast and northwest.

The annual rainfall is highest in Rafah at the eastern end of the Study Area. It amounts to 300 mm at Rafah but decreases to the westward and inland to 33 mm at Ismailia (Figure 2.3-2). Rainfall occurs mainly during the winter season and occasional rainfall occurs during the transitional seasons of spring and autumn. During the four months of June, July, August and September, there is virtually no rain.

2.3.2. Water Resources

The sources of water available in the Study Area are as follows;

(i) Groundwater

(ii) Nile water mixed with drainage water, which will be conveyed by the El Salam Canal

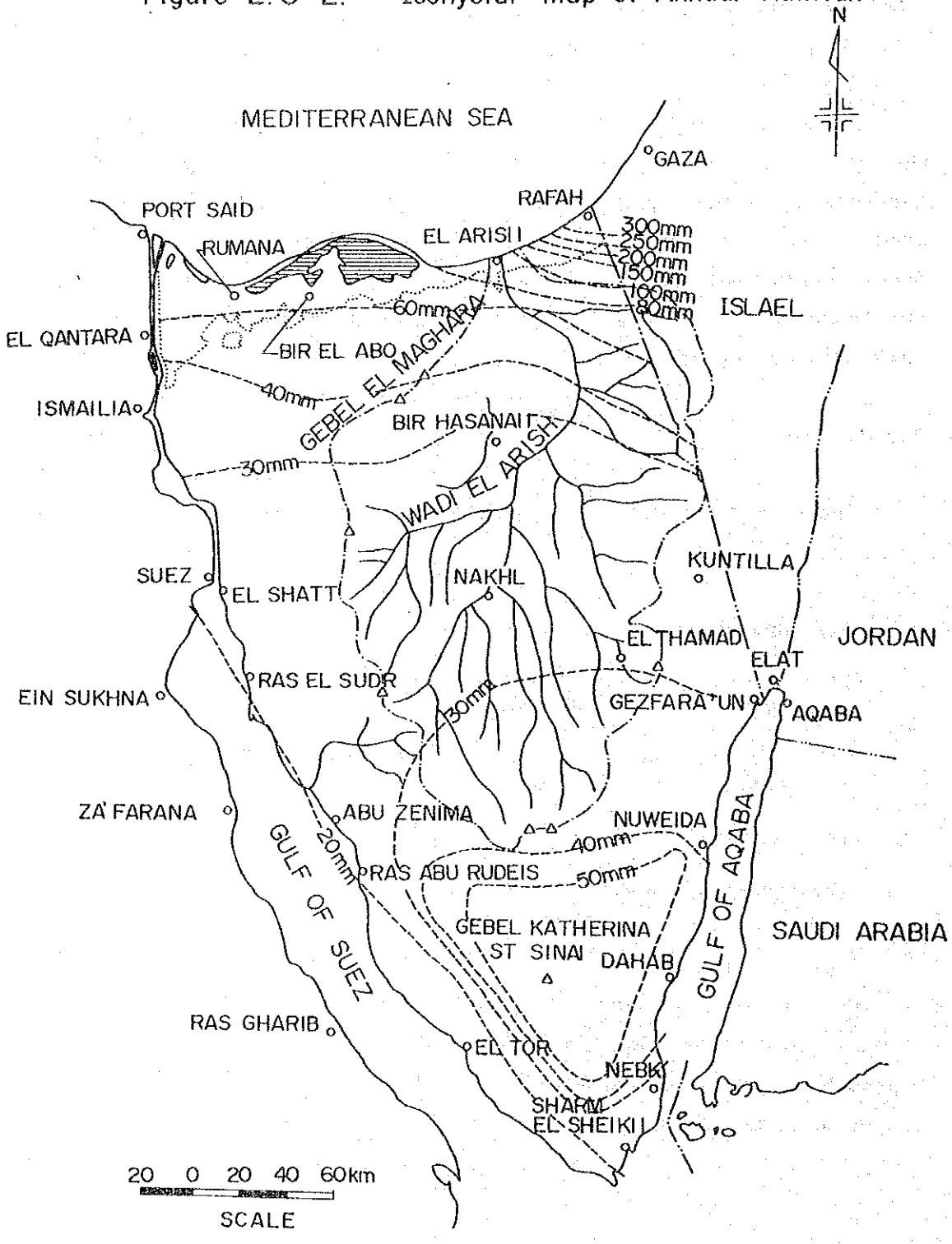
(iii) Surface water which will be available by provision of storage dams

(iv) Rainfall

(v) Desalinated brackish water

The use of desalinated brackish water for irrigated agriculture is not feasible because of high costs. Meanwhile, there is an irrigation development plan to irrigate approximately 600 feddan through the re-use of water effluent from the sewage treatment plant to be provided in the area of El Arish.

Figure 2.3-2. Isohyetal Map of Annual Rainfall



Source : Sinai Development Study (Phase I), 1985

Accordingly, the sources of water available in the Study Area are limited to (i), (ii), (iii) and (iv) listed above. However, the amount of water available from each source varies considerably. The El Salam Canal can supply about 7.4 MCM of water per day on an average, while the average groundwater recharge in the Study Area is estimated to be 0.14 MCM/day in total (Research Institute of Water Resources).

1) Groundwater

According to the study by the Research Institute of Water Resources, there are three important groundwater sources in the Study Area as below:

Area	Aquifer	No. of Wells	Estimated Ave. Recharge (cu.m/day)	Estimated Withdrawal (cu.m/day)
Rafah-Sheikh Zuwayid	Quaternary coastal aquifer	280	48,000	43,000
El Arish	Quaternary coastal aquifer	145	50,000	52,000
Rabaa	Pleistocene	290	38,000	14,000

Most of these aquifers are unconfined aquifers and the groundwater is extracted by drilled wells with submerged pumps. Other than these major aquifers, there are small sand dune aquifers scattered between Rumana and Rafah. The aquifer is shallow and hand-dug wells have been constructed. The water is used for both irrigation and drinking purposes.

The groundwater conditions of the areas listed in the above table can be summarized as follows;

(a) Rafah - Sheikh Zuwayid Area

This area seems to have limited possibilities for further groundwater development. Over-pumping of aquifers is likely to occur in the near future, so that groundwater monitoring and management will be required to prevent the deterioration of groundwater quality.

(b) El Arish Area

Over-pumping of aquifers is beginning to occur in this area. It is assumed that about half of the withdrawn groundwater is used for drinking water supply. Significant increase in the salinity of the groundwater has been observed and there is one area where salinity exceeded 5,000 ppm. In this area, several desalination plants for brackish groundwater are operating for supply of drinking water. Judging from such conditions, pumping control should be immediately instituted for this area, in addition to groundwater monitoring and general management of groundwater use.

(c) Rabaa/Qatia Area

In the area of Rabaa and Qatia, irrigated agriculture through drip irrigation of groundwater has been carried out by the settlers of Bedouin. This area seems to have high potential for groundwater development because the estimated average groundwater recharge is considerably greater than the amount of water withdrawal. However, detailed analysis of the groundwater conditions will be required before commencement of groundwater development, for the following reasons:

- The estimated average groundwater recharge cannot be judged accurately to permit groundwater development because it is based on a water balance study performed by using incomplete rainfall and evapotranspiration data.
- It must be confirmed that seawater intrusion does not occur as a result of groundwater development.

2) The River Nile and Drainage Water

The El Salam Canal project is planned to convey irrigation water, (which will be obtained after mixing the Nile water from the Damietta barrage, drainage water from the El Sirw drain by gravity, and drainage water from the Bahr Hadous drain by pumping), to newly reclaimed lands.

According to the MPWWR, the reclamation area of the project, planned in 1979, was about 600,000 feddan. About 200,000 feddan in the areas of Hussinia Valley and South Port Said located at the west bank of the Suez Canal was planned to be developed under Phase I of the project. And about 400,000 feddan in the Tina Plain and coastal area along the Mediterranean Sea was planned for development under Phase II. At present, the El Salam Canal between the Damietta barrage and the Suez Canal (87 km long) is under construction as Phase I.

The area to be reclaimed in Phase I will actually be about 185,000 feddan because the reclamation area in North Hussinia planned in 1979 has been reduced. The location of about 400,000 feddan to be reclaimed in the area of North Sinai under Phase II development has not been fixed so far. The area and location of the land to be reclaimed under Phase II will be defined in the present Master Plan.

The outline of the El Salam Canal Project planned by the MPWWR in 1979 is as follows;

(a) Reclamation area	600,000	feddan
(b) Irrigation water	4,450	MCM/annum
	(7,420	cu.m/fed)
(c) Water source		
- Nile water	2,110	MCM/annum
- El Sirw drain	435	"
- Bahr Hadous drain	1,905	"
Total	4,450	MCM/annum

The results of studies on the re-use of drainage water from the El Sirw drain and Bahr Hadous drain carried out by the MPWWR in 1984 are as follows;

(a) Maximum Amount of Water Available for El Salam Canal

- Nile water	2,110 MCM/annum
- El Sirw drain	569 "
- Bahr Hadous drain	1,391 "
Total	4,070 MCM/annum

(b) Salinity of Mixed Water

- Average 810 ppm
- Maximum 1,060 ppm

The annual amount of water available for the El Salam Canal is estimated below when the salinity of Nile water is 370 ppm and the upper salinity limit for irrigation is 900 ppm or 800 ppm.

Water Source	900 ppm	800 ppm
Nile water	2,110 MCM/annum	2,110 MCM/annum
El Sirw drain	569 "	569 "
Bahr Hadous drain	1,180 "	821 "
Total	3,859 MCM/annum	3,500 MCM/annum

The maximum quantity of water available for the Study Area through the El Salam Canal was discussed at a meeting with the Steering Committee on July 10, 1988. This meeting decided the maximum should be 2/3 of the maximum amount of water available for the El Salam Canal derived from the study carried out in 1984. Consequently, the maximum amount of water available for the Study Area through the El Salam Canal is 2,714 MCM/annum as follow;

$$4{,}070 \text{ MCM/annum} \times 2/3 = 2{,}714 \text{ MCM/annum}$$

3) Surface Water

Although rainfall occurs in Sinai, most of the water is lost through either evaporation or percolation into the subsoil of Wadi El Arish, which has the largest catchment area (22,000 sq.km) in the Sinai Peninsula. Wadi El Arish is the only river from which surface runoff is observed once in several years in the Study Area.

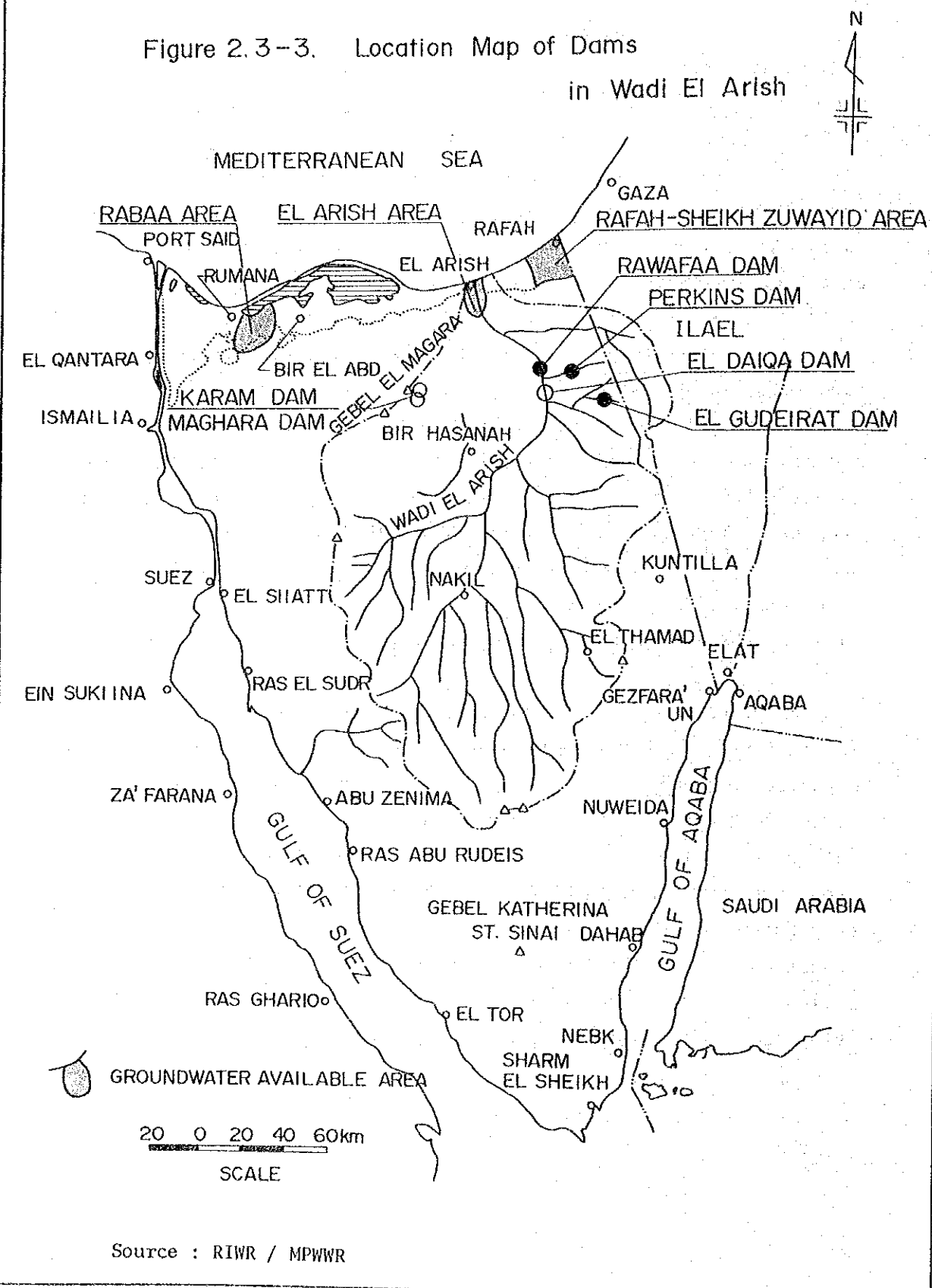
However, most of the catchment area is located outside the Study Area.

Several methods have traditionally been employed in Wadi El Arish to store or conserve runoff water for use as drinking water or for agriculture. One of these is spreader dykes in the wadi bed. The effect of the dykes is to slow the passage of water downstream by spreading and storing some runoff water. Cultivation is carried out just upstream from the dyke. This method is continuously utilized by Bedouin on a small scale.

As for storage dam projects for development of surface water resources, careful studies will be required before implementation because of sporadic and irregular runoff, high evaporation losses and rapid siltation of reservoirs. As there is great variability of annual rainfall, regular water supply from the storage dam cannot be expected. Therefore, as proposed in the Maghara project, the storage dam projects should be planned in combination with the development of groundwater resources, from which reliable yield of water can be expected under conditions of adequate pumping control.

Existing dams and potential damsites are shown in Figure 2.3-3. As mentioned in "Sinai Development Study, Phase I", El Daiqa dam was expected to supply water of about 4 MCM/annum to the recharge basins in the El Arish area at the lowest water cost of 0.4 LE per cu.m. This water cost estimate is based on the assumption that the live capacity of 30 MCM will be filled once every three years. However, at present, the construction of El Daiqa dam is considered economically unfeasible because the reservoir is assumed to be filled once every seven to ten years as the result of calculation using the newly available data.

Figure 2.3-3. Location Map of Dams in Wadi El Arish



Source : RIWR / MPWWR

The storage dam projects with beneficiary areas not far from the damsites are planned in combination with the development of groundwater resources. But the storage dam projects to convey water to the El Arish area will be economically unfeasible because potential damsites are located too far from the El Arish area.

4) Rainfall

The annual rainfall in the El Arish-Rafah area amounts to 100 - 300 mm such that rainfed agriculture flourishes in this area. Cisterns, which are known locally as "Harabat", are being used to collect and store rain water for livestock and drinking purposes.

Rainfed agriculture is not as profitable as irrigated agriculture because the cost of water stored in Harabat, which is estimated at 4 - 5 LE/cu.m, is too high. However, rainfall is still an important water resource in this area as there is no other available water source.

Cost of Water Stored in Harabat

Water Cost = Annual Cost / Annual Storage Capacity

(a) Annual Cost = C x CRF + O/M

$$= C \times \frac{i \times (1 + i)^n}{(1 + i)^n - 1} + O/M$$

$$= 140 \text{ LE}$$

where,

C: Construction cost = 1,800 LE
CRF: Capital recovery factor
i: Interest = 6%
n: Life span = 30 years
O/M: O/M cost = C x 0.5%

(b) Annual Storage Capacity : 30 cu.m
Catchment area : 100 sq.m (10 m x 10 m)
Annual Rainfall: 300 mm

2.4. Soil and Land Use

2.4.1. Soil

Reconnaissance and a semi-detailed soil survey for the Study Area had been carried out by GARPAD. Based on these maps, furthermore, GARPAD prepared Land Master Plan to assess the potential of land reclamation in this region. These soil maps were extensively checked by auger boring during the M/P study period.

1) Landforms

The following landforms are recognized in the Study Area:

(a) Coastal Sand Dunes, Ridges and Hummocks

Along the coast line of the Mediterranean Sea and the Bardawil Lake, a narrow belt of sandy beach is located. Adjoining the sandy beach, low-lying Sabkha are distributed in the Tina Plain and the south of Bardawil Lake area. On the other hand, a high ridge of coastal sand dune of 40 to 50 m high runs in parallel with the coast line in the Sheikh Zuwayid/Rafah area.

(b) Foreshore Plain Comprising Sabkha and Deflated Sand Terrain

The Tina Plain, which is the eastern edge of the Nile Delta, is clay flat consisting of fluvio-lacustrine deposits of loamy and clayey texture. The Tina Plain is flat or very gently undulating, low-lying land with scattered hummocks and is submerged by tidal water seasonally. Poor drainage and shallow saline water table have induced the salt accumulation, resulting the formation of patches of thick salt crust on the surface. Because of extremely saline soil, the Tina Plain is mostly barren or covered with sparse halophitic vegetation.

Flat sandy terrain (Sand flat) is formed of aeolian sand deposits and is very gently undulating. The soils are non-saline deep sandy textured, and the water table is moderately shallow but fluctuates depending upon the elevation.

Undulating sandy terrain (Sand undulating) has the same origin as above but is gently undulating to undulating and susceptible to wind erosion. The groundwater table is very deep and the drainage is excessive, resulting very low available moisture.

Inland Sabkha is located in the hollow between sand dunes. The soils are sandy textured, which have very shallow water table, and are covered with salt crusts or submerged by saline water being percolated from sand dunes.

(c) Wadi El Arish Basin

Wadi El Arish shows a wide valley in the downstream area. The soils in Wadi river bed have been formed of calcareous fluviorine deposits and are loamy texture with moderate drainage.

In the area between Sheikh Zuwayid and Rafah, calcareous sandy terrace is located. The terrace is gently undulating and fairly deflated and stable. The soils are fine sand or loamy sand texture and have moderately deep water table.

(d) Active Dune Complex

Generally, mobile sand dunes are located along the southern boundary of the Study Area as shown in Figure 2.4-1. Undulating and rolling dunes are of coarse sandy texture and shifted by strong winds like Khamseen. The sand dunes are barren or partly covered with sparse desert shrubs.

Among them, the factors restricting land reclamation are lowland Sabkha and mobile sand dunes, the distribution of which are shown in Figure 2.4-1.

2) Soils

The soils are in general lacking pedological features indicating the soil development. The soils have been derived from the following parent materials;

- Nile alluvium and lacustrine deposits of the Tina Plain.
- Aeolian sand deposits of the active dunes, sheets, and hummocks.
- The calcareous loam of Wadi El Arish

Only two diagnostic horizons have been developed, namely calcic and salic horizon. The following Suborders have been classified, according to the Soil Taxonomy of USDA:

Entisols :	Torripsamments
	Torriorthents
	Hydraquents
	Psammaquents
Aridisols:	Salorthids
	Calciorthids

The soil distribution is closely related to the landforms and restricts the land use. The relationship among them are schematically illustrated in Figure 2.4-2. The distribution of major soils in the Study Area is briefly described below

- In the flat low-lying Tina Plain, Typic Salorthids (Gleyic Solonchaks in FAO/UNESCO) which are so-called salt-accumulated soils having a salic horizon. These soils, which consist of fluvio-lacustrine deposits, are loamy or clayey textured and poorly drained having a shallow saline groundwater tables.

  In a transitional belt between the Tina Plain and the sandy terrain, non-uniform texture soils with alternately stratified

sand and clay layers occupy. These soils are identified as Typic Hydraquents or Typic Psammaquents having shallow water table.

- In the south of El Qantara East area and the southwest and east of Bardawil Lake areas, flat or undulating sandy soils are distributed. These soils have been derived from the aeolian sand deposits and have no horizon differentiation, therfore, they are classified into Typic Torripsamments (Eutric Regosols in FAO/UNESCO).

  Sandy soils having a shallow water table cover Sabkha in the lowland surrounding the Bardawil Lake and the depression between sand dunes. These soils are identified as Typic Psammaquents.

- Soils in the Wadi El Arish basin have been derived from fluviorine deposits. Because no diagnostic horizon have been observed, these soils are classified into Typic Torriorthents.

  The sandy terraces located in the east of El Arish and the area between Sheikh Zuwayid and Rafah are covered with Typic Calciorthids (Calcaric Regosols in FAO/UNESCO), which have a calcic horizon derived from the limestone mountains in the upstream of Wadi El Arish.

Furthermore, the soils were divided according to texture in the REGWA's semi-detailed survey as below:

- Coarse-textured soils (Sandy soils)
- Medium-textured soils (Loamy soils)
- Fine-textured soils (Clayey soils)

And they were subdivided by the groundwater table as below;

	Water table below the surface
- Shallow	less than 50 cm
- Moderately shallow	50 - 75 cm
- Moderately deep	75 - 100 cm
- Deep	more than 100 cm

Figure 2.4-1. Present Land Condition

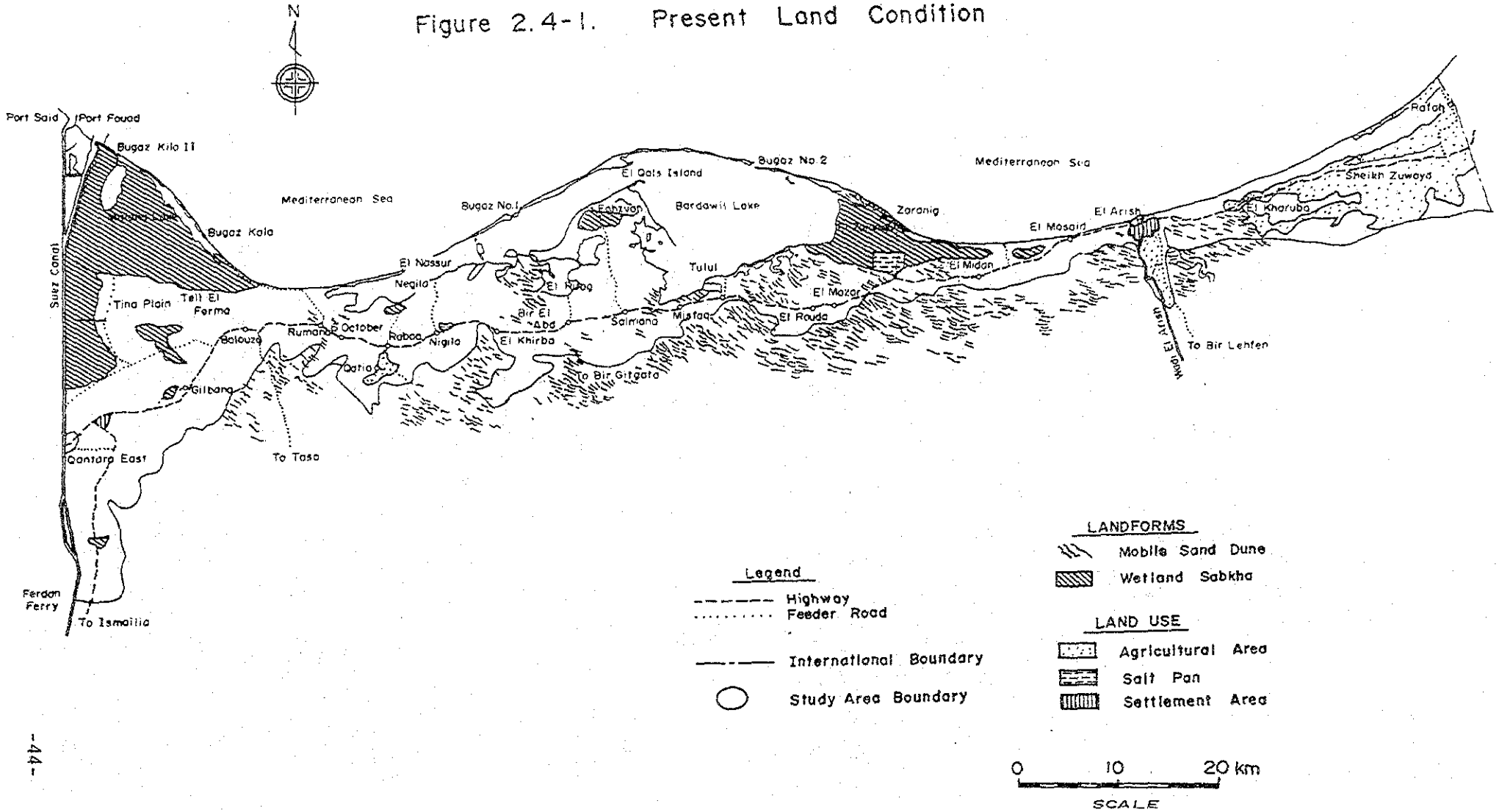
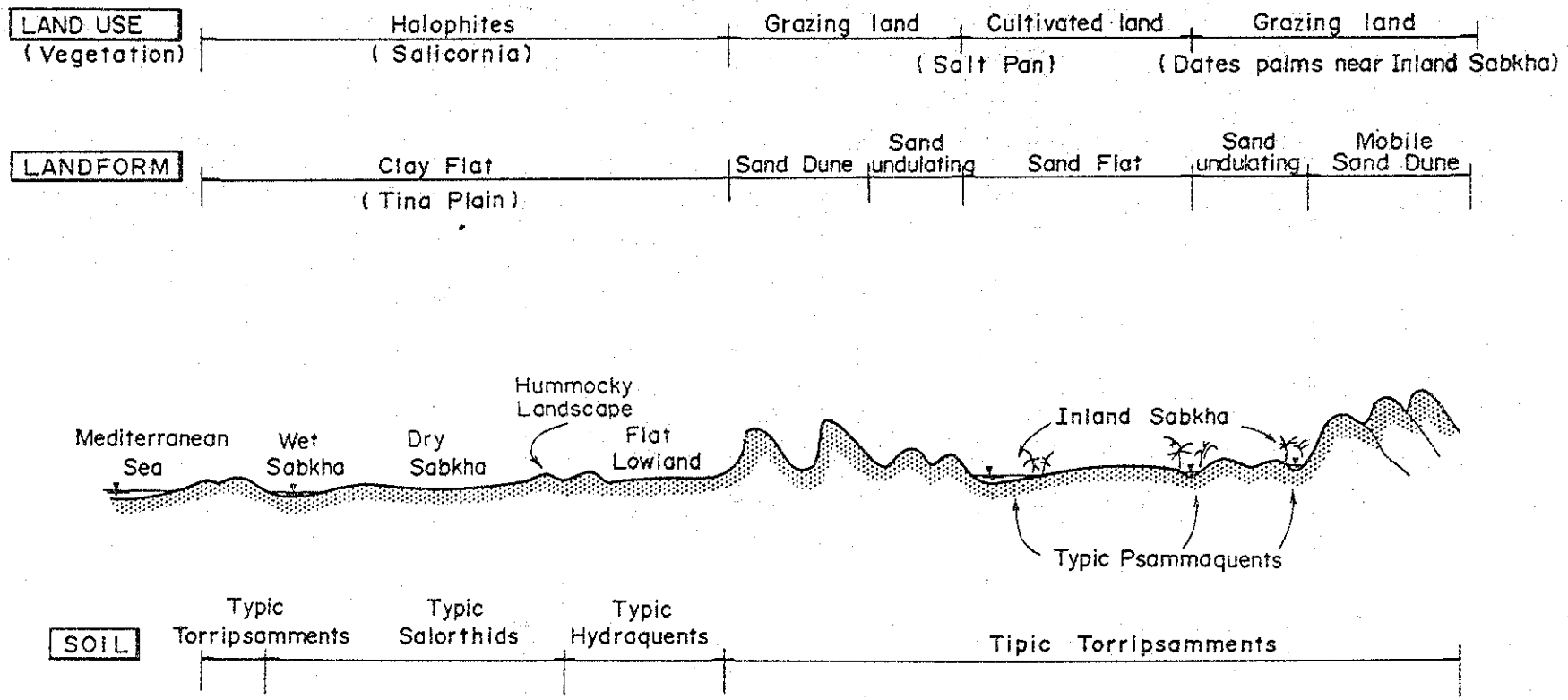


Figure. 2·4-2 Relationship between Landform - Soil - Land Use (Vegetation)



3) Land Classification

The land classification systems which were adopted in the previous studies are summarized as follows;

Semi-Detailed Soil Survey (REGWA/GARPAD)	:	USDA Land Capability Classification
Land Master Plan (GARPAD)	:	USBR Land Classification for Irrigation
Sinai Development Study (Phase I)	:	"Land Resource Unit (LRU)" based on the USDA Land Capability Classification

In addition, GARPAD proposed the recommended agricultural land use according to each Land Management Category in the Land Master Plan (refer to APPENDIX-B).

In the land classification system of the U.S. Bureau of Reclamation, land classes are separated into "arable", i.e., Class-1 to Class-4 and "non-arable", i.e., Class-6 (Table 2.4-1). The most suitable land is Class-1 land which does not have limitations as to reclamation. The limitations are categorized into soil condition (s), topographical condition (t), and drainage condition (d). According to the severity of single or combined limitations, arable land is classified into Class-2 to Class-4 land. Class-6 land is economically non-arable land including mobile sand dunes and Sabkha.

Land classification specifications for surface irrigation and for sprinkler/drip irrigation were prepared for the North Sinai region in accordance with the system of the U.S. Bureau of Reclamation and are shown in Table 2.4-2.

In the LMP, whole area of the Tina Plain was classified into Class-2 (good arable land), i.e., fine-textured soils of lacustrine and Nile alluvium origins. It maybe restored to fertile cultivated land after intensive leaching under an adequate drainage system. According to the field check by the Study Team, however, the low-lying depressions in the northern part of the Tina Plain were classified into Class-6 (non-arable land), because a thick salt crust which covers the surface, moreover, pumping out of drainage water should be required for salt leaching.

For the sandy area, on the other hand, land was generally classified into Class-4 (limited arable land) in the LMP. However, considering the introduction of the sprinkler or drip irrigation method in the Study Area, sandy terrain with smooth surface were classified into Class-2 to 3 (arable land) by the Study Team.

The land classification map is shown in Figure 2.4-3 and acreage of each land class is given in Table 2.4-3. Class-1 land is not found in the Study Area. Class-2 land is located near Rabaa/Qatia and Wadi El Arish area. Gently undulating sandy terrain, i.e., Class-3 land (3st) occupies major part of the Study Area, followed by undulating sandy terrain; Class-4 land (4st). Class-6 land consists of mobile sand dunes and Sabkha, which should be excluded from the M/P land reclamation area.

Finally, the relationship between landform, soil and land reclaimability is shown in Table 2.4-4, and the land suitability for cropping by landforms is summarized in Table 2.4-5.

Table 2.4-1. Land Classification for Irrigated Agriculture (Sprinkler/Drip Irrigation or Surface Irrigation)

Class 1 - Arable: Land that is highly suitable for irrigated farming, being capable of producing a sustained and relatively high yield of climatically adapted crops at reasonable cost. This land has a relatively high payment potential.

Class 2 - Arable: Land that has moderate suitability for irrigation. These are usually either adaptable to a narrower range of crops more expensive to develop for irrigation, or less productive than Class 1. Potentially this land has only intermediate payment potential.

Class 3 - Arable: Land that has only marginal suitability for irrigation. It is less suitable than Class 2 land and usually has either a serious single deficiency or a combination of several moderate deficiencies in soil, topography, or drainage properties. Although greater risk may be involved in farming this land than that of Classes 1 and 2, it is expected to have adequate payment potential under the proper management.

Class 4 - Limited Arable: Land that is adaptable to only a very limited range of crops. For example, land suited only to such single crops as rice, pasture, or fruit.

Class 6 - Nonarable: Land that is nonarable under the existing or projected economic conditions associated with the proposed project development. Generally, Class 6 comprises steep, rough, broken, rocky, or badly eroded land, or land with inadequate drainage, or other marked deficiencies.

Table 2.4-2. Land Classification Specifications

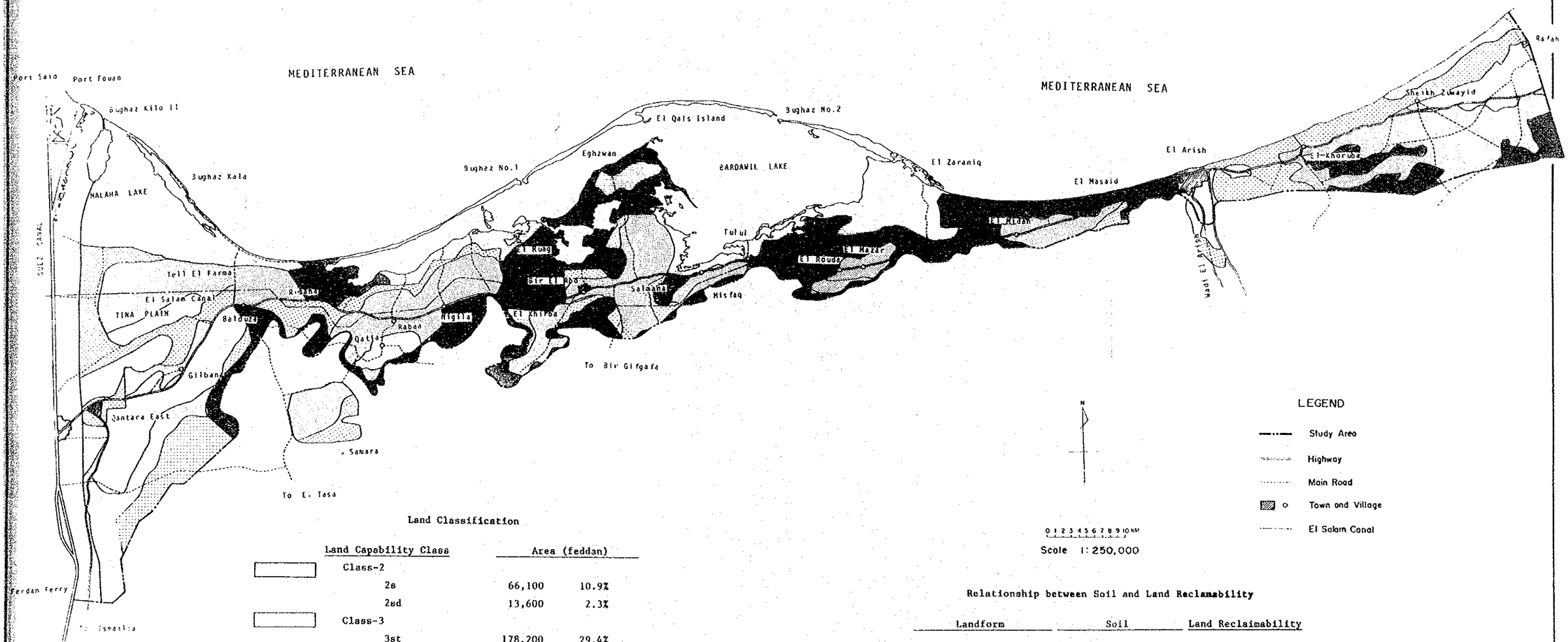
(1) For Sprinkler and Drip Irrigation

Limitation	1	2	3	4	6
Soil (s)					
Texture	loam to clay loam	sandy loam to fine sand	loamy sand to medium sand	coarse sand	loose coarse sand
Depth (cm)	> 200	> 200	> 100	> 100	< 100
Available moisture (cm/m)	> 15	> 15	5 - 10	2 - 5	< 2
Salinity	none	none to slight	slight	strong	very strong
Sodicity	none	none	slight	strong	very strong
Topography (t)					
Slope (%)	0 - 3	0 - 3	3 - 8	8 - 15	> 15
Relief	flat	flat - gently undulating	gently undulating - undulating	undulating - rolling	hilly
Erosion hazard	none	none	slight	moderate to severe	severe
Drainage (d)					
Drainability	good	good to moderate	moderate	excessive or poor	very excessive or very poor
Permeability	moderate	moderate	moderate to high	high to very high	very high
Water table (cm)	> 150	100 - 150	100 - 150	60 - 100	< 60

(2) For Surface Irrigation

Limitation	1	2	3	4	6
Soil (s)					
Texture	loam to clay loam	clay loam to light clay	light clay to clay	clay	heavy clay, soft immatured
Depth (cm)	> 200	> 200	> 100	> 100	< 100
Salinity	none to slight	slight to strong without salt crust	strong without salt crust	very strong with salt crust	extremely strong with thick salt crust
Sodicity	none	none-slight	slight	strong	very strong
Carbonate (%)	0 - 10	0 - 10	> 10	> 10	> 10
Gypsum (%)	0 - 5	0 - 5	5 - 10	10 - 15	> 15
Topography (t)					
Slope (%)	0 - 2	0 - 2	2 - 5	2 - 5	> 5
Relief	flat	flat - very gently undulating	flat - gently undulating	flat - gently undulating	flat - undulating (depression, EL 0 m)
Erosion hazard	none	none	none	slight	severe
Drainage (d)					
Drainability	good	slightly poor	poor	poor to very poor	very poor
Permeability	moderate	low	low	low to very low	impermeable
Water table (cm)	> 150	100 - 150	60 - 100	30 - 60 periodically water logging	30 permanently water logging

LAND CLASSIFICATION



Land Classification

Land Capability Class		Area (feddan)	
Class-2			
	2s	66,100	10.9%
	2sd	13,600	2.3%
Class-3			
	3st	178,200	29.4%
	3sd	41,100	6.8%
Class-4			
	4st	124,400	20.5%
	4sd	10,200	1.7%
Class-6			
	Sabkha	96,700	16.0%
	Mobile Sand Dune	71,200	11.7%
	Others	4,500	0.7%
Total		606,000 (2,545 sq.km)	100.0%

Relationship between Soil and Land Reclamability

Landform	Soil	Land Reclaimability
Coastal Sand Dune	Typic Torripsamments (Typic Psammaquents)	4st, 6st
Clay Flat (Tina Plain)		
Wet & Dry Sabkha	Typic Salorthids	4sd, 6sd
Flat Lowland	Typic Hydraquents	3sd
Sand Flat	Typic Torripsamments	2s, 3st, 3sd
Sand Undulating	"	3st, 4st
Inland Sabkha	Typic Psammaquents	4sd, 6sd
Mobile Sand Dune	Typic Torripsamments	6st

Table 2.4-3. Land Classification

Land Capability Class	Area (feddan)	
Class-2 (Arable)		
2s	66,100	10.9%
2sd	13,600	2.3%
Class-3 (Arable)		
3st	178,200	29.4%
3sd	41,100	6.8%
Class-4 (Limited Arable)		
4st	124,400	20.5%
4sd	10,200	1.7%
Class-6 (Non-arable)		
Sabkha	96,700	16.0%
Mobile Sand Dune	71,200	11.7%
Others	4,500	0.7%
Total	606,000 (2,545 sq.km)	100.0%

Table 2.4-4. Relationship between Soil and Land Reclaimability

Landform	Soil	Land Reclaimability
Coastal Sand Dune	Typic Torripsamments (Typic Psammaquents)	4st, 6st
Clay Flat (Tina Plain)		
Wet & Dry Sabkha	Typic Salorthids	4sd, 6sd
Flat Lowland	Typic Hydraquents	3sd
Sand Flat	Typic Torripsamments	2s, 3st, 3sd
Sand Undulating	"	3st, 4st
Inland Sabkha	Typic Psammaquents	4sd, 6sd
Mobile Sand Dune	Typic Torripsamments	6st

Table 2.4-5. Suitability for Cropping

Landform	Description
Tina Plain (Clay Flat)	Flat to very gently undulating, 0 - 2 percent slope, low elevation, scattered hummocks, loamy to clay textured, extremely saline, salt crust on the surface, shallow water table, poorly drained, tidal and seasonal flooding, barren or sparse halophitic vegetation. Suitable for polder reclamation with surface irrigation after intensive leaching with drainage, salt tolerant crops during land reclamation.
Sabkha	Flat or depression, 0 - 2 percent slope, very low elevation (surface at below sea level), sandy textured, extremely saline, thick salt crusts or submerged, very shallow saline groundwater, very poorly drained barren or sparse halophitic vegetation (Salicornia, Tamarisk). Not suitable for reclamation in general, some portions are used as salt pans.
Flat Sandy Terrain (Sand Flat)	Flat to very gently undulating, 0 - 3 percent, slope sandy textured, low salinity, moderately shallow water table, low available moisture content, poor drainage in some places, date palm plantation in depressions. Suitable for desert reclamation with sprinkler or drip irrigation.
Undulating Sandy Terrain (Sand Undulating)	Gently undulating to undulating, 3 - 8 percent slope, sandy textured, no salinity, deep water table, low available moisture, excessive drainage, susceptible wind erosion, desert shrubs and date palm plantation in hollows between sand dunes. Suitable for desert reclamation in gently undulating terrain. Fruit trees can be planted and fed by drip irrigation in undulating portion.
Mobile Sand Dunes	Undulating to rolling, 8 - 30 percent slope, coarse sandy textured, moved by strong winds like Khamseen, extremely low available moisture content, excessive drainage, barren. Not suitable for reclamation.
Wadi El Arish Basin	Flat to gently undulating, 0 - 2 percent slope, loamy textured, calcareous, moderate drainability. Fruit trees and vegetables irrigated by groundwater, and rainfed wheat and fodder crops.
Calcareous Sandy Terrace (El Arish - Rafah)	Flat to undulating, 0 - 8 percent slope, fine sand to loamy sand texture, calcareous, moderately deep water table, good drainage. Cultivated fruit and nut trees under rainfed conditions and some fruit trees and vegetables irrigated by drip irrigation using groundwater.

2.4.2. Land Use

The present land use in the Study Area is also shown in Figure 2.4-1. The land-use pattern in the Sinai Peninsula has been greatly changed by the war. Road networks, communities and agricultural land have been developed along the highway connecting El Qantara East and El Arish since 1982.

Based on the topo-maps scaled 1:100,000 and the LANDSAT imagery, the present land use in the Study Area has been studied by field observation. For the area between El Arish and Rafah, in addition, aerial photographs taken in 1982 were interpreted.

1) Agricultural Land

In Sheikh Zuwayid/Rafah area, where annual rainfall is from 200 to 300 mm, about 35,000 feddan are used for agriculture of fruit and nut trees and watermelon. In the coastal sand dunes along Bardawil Lake, rainfed watermelon and fig trees are found in limited areas.

Irrigated agriculture is fully dependent upon groundwater. In Rabaa/Qatia and Bir El Abd, vegetables, watermelon, melon and olives are cultivated under the drip irrigation system. The irrigated area in the Study Area was estimated as below;

Rabaa/Qatia Area	1,300	feddan	(approx.)
Bir El Abd Area	200	"	(")
Wadi El Arish Area	1,200	"	(")
Sheikh Zuwayid/Rafah Area	4,000	"	(")

Small-scale date palm plantations are sparsely scattered in hollows between sand dunes.

2) Grazing Land

Natural vegetation in the Study Area is very poor. Grazing sheep, goats, and camels by the Bedouin is a major activity in the Area. Due to the expansion of settlements along the highways, pastureland is decreasing with over-grazing as a result.

3) Sand Dunes

Large and small-scale mobile sand dunes occupy a considerable area especially in the northwest and southeast of Bir El Abd. The sand dunes between El Arish and Sheikh Zuwayid consisting of calcareous fine sand are relatively stable and sand dune fixation by the planting of castor beans and acacia is currently underway.

4) Coastal Beach and Sabkha

Along the coastal beach, which extends from El Masaid to Rafah, many villas are constructed for tourists. Some of the low-lying areas of Sabkha are presently used for salt pans.

5) Villages and towns etc.

Existing communities are concentrated along the highway and are surrounded by settled Bedouin farmers. Infrastructure such as pumping stations for potable water supply and power generating plants are also distributed along the highway.

2.5. Agriculture and Livestock

2.5.1. Main Features of Agriculture in North Sinai

Agriculture in North Sinai is limited by the availability of irrigation water. The Study Area covers three governorates, that is, North Sinai, Ismailia, and Port Said, however, the latter two governorates have virtually no agricultural activities in the Study Area. Therefore, present agricultural situation in North Sinai Governorate will be regarded as that of the Study Area. Of the six Markaz in the governorate, El Hassana and El Nekhel are located in the remote desert with nearly depleted water resources which limit any significant farming activities.

Agriculture in El Arish, Sheikh Zuwayid and Rafah can be grouped into two types: (1) rainfed cropping of barley, watermelon and fruits or nuts trees relying on the expected rainfall of 200 to 300 mm per annum, and (2) drip-irrigated cropping of fruits orchards and vegetable gardens using groundwater. The latter is heavily dependent upon outside markets so that the production of vegetables during the period from winter to spring occupies a high share in the cropping area targeting the high demand of outside markets. This period coincides with lower temperature, and this is why plastic houses are used in this area. During summer, the plastic cover is removed and summer vegetables are raised as a second crop. This type of farming indicates a commercial style of agriculture, though smaller in size rather than a subsistence style of cereal or leguminous production. Farmers in North Sinai are in a weaker bargaining position than those in the Delta area since they have to pay 9-12 LE per ton to deliver their produce to the markets outside the governorate. They must compensate this by a higher level of cropping techniques.

Meanwhile, agriculture in Bir El Abd has shown a positive trend for years as the settled Bedouin farmers dig more shallow wells in the desert. However, the availability of groundwater will restrict this trend in near future.

2.5.2. Agricultural Land, Household and Production

According to the data bank of North Sinai Governorate, total agricultural land and numbers of farm households in the Study Area are shown in Table 2.5-1. Total production in the Study Area has centered on fruits and vegetables, where winter vegetables are economically important and 25 to 50 percent of these products are marketed outside the governorate. Cereal crops have low profitability and poor yield levels. They are only cropped in rainfed conditions for self-consumption along with rainfed watermelon. The majority of cash crops are produced in Markaz El Arish and farther to the east (refer to Tables 2.5-2 and 2.5-3)

Table 2.5-1. Agricultural Land and Number of Households

(unit: feddan, household)

Item	El Arish	Sheikh Zuwayid	Rafah	Bir El Abd	Total
Cropped acreage*	6,690	13,185	15,266	19,544	54,645
Percentage of cultivated land	12	24	28	36	100
Number of household	774	1,474	2,462	1,893	6,603
Holding size/farm	9	9	6	10	8

Note : * ... including rainfed, occasional cropping
Source: North Sinai Governorate (NSG), 1987

Table 2.5-2. Current Crop Production Acreage

(unit: feddan)

Season	Crop	El Arish	Sheikh Zuwayid	Rafah	Bir El Abd	Total
Winter	Barley*	1,681	5,640	4,779	6	12,106
	Lentil*	0	742	13	-	755
	Wheat	14	16	119	-	149
Winter	Vegetables	423	2,953	1,625	491	5,492
Summer	Vegetables	388	407	470	470	1,735
Nily	Vegetables	219	330	106	273	918
Perennial Fruits		2,891	14,139	12,763	1,475	31,268

Note : *... mostly rainfed cropping
Source: same as above

Table 2.5-3. Estimated Total Crop Production

(unit: tons)

Season	Crop	El Arish	Sheikh Zuwayid	Rafah	Bir El Abd	Total
Winter	Barley	2,500	8,370	7,090	0	17,960
	Lentil	0	350	10	0	360
	Wheat	10	10	60	-	80
Winter	Vegetables	3,810	26,570	14,630	4,420	49,430
Summer	Vegetables	3,800	4,500	5,200	4,700	18,200
Nily	Vegetables	1,800	3,600	1,100	2,500	9,000
(Fruits)	Almond	10	3,640	5,100	20	8,770
	Olive	1,940	360	320	270	2,890
	Peach	0	9,600	2,400	10	12,010
	Fig	300	640	30	420	1,390
	Grape	40	450	30	40	560
	Others	300	280	3,320	3,600	7,500

Source: NSG, 1986-87

2.5.3. Farming Conditions and Practices

As far as arid or desert farming is concerned, yields and quality of produce are heavily dependent on how water sources with acceptable water quality are secured, and also depend on ways to increase soil-water holding capacity, to select the best planting period and to prevent high evaporation or wind erosion. In North Sinai, farmers have solved such problems by digging shallow wells, using drip irrigation, enclosing farm plot with fences made from reeds, applying organic manure and cropping under pipe-framed plastic greenhouses or plastic tunnels for winter vegetables, etc. Due to lower capacity of nutrient retention in sandy soils, poultry or goat manure are generally used. Particularly, application of organic manure in deep pits prior to fruit tree planting has become popular among farmers.

Fruits are main crop in the area between El Arish and Rafah where flat terrain with loamy sand soils develop. These soils are somewhat water-retentive. Recent trends show a sharp decrease in olive, lemon, and almond harvests and an increase in acreages under peach, apples, and figs owing to higher market demand. The farm economy in this area relies upon summer orchard produce and winter vegetables such as sweet melon, cucumbers, and tomatoes. In

this context, early harvesting is economically profitable even with hired-labour because of attractive unit prices. The labour demand peaks during periods of harvesting greenhouse raised vegetables from late winter to early spring, and for fruits from summer to autumn. Technical levels of the farmers are high.

As to agricultural problems, water shortage is the most acute. The pressing need for domestic water has increased as a result of the population growth in urban areas between El Arish and Rafah, which has caused an adverse effect on water sources for irrigation in terms of both quantity and quality, because water sources are the same and competitive. Consequently, some water sources show the salt concentration ranging from 3,000 to 5,000 ppm during to summer months.

As far as soil and plant protection are concerned, there are two major practical problems. One is the unbalanced availability of trace elements, notably iron deficiency and phosphorous absorption hindrance. The other is the rapid prevalence of soil schistnematodes over the vegetable areas.

In case of vegetable producers, a great difference arises in both yield levels and prices of cash crops according to marketing seasons and producing areas. However, acceptable incomes can be secured in the long run, say for five years, taking into account the additional incomes from animal husbandry, etc. It will take 3 years for fruits orchards to have the first harvest and 7 years to reach the economically viable stage. Until this target stage, subsistence should be sustained through vegetable intercropping.

2.5.4. Agricultural Mechanization

Agricultural machinery has not been popular due partly to the sandy soils easy for hand ploughing, to the small holdings (1-5 feddan/farm) and to the labour intensive nature of the small-scale

drip irrigation system. Yet, an increasing tendency is now observed among rich farmers to mechanize deep ploughing, pest control and supplementary water supply. On the other hand, machinery is still costly for farmers, although they have assess to privately or government-owned machinery for rent. Farmers do not keep draught animals in North Sinai.

2.5.5. Livestock Production

Typical animal husbandry in North Sinai Governorate has been traditionally sustained by the Bedouin. They have made use of natural grasses emerging from the surface of sand dunes after occasional rainfall, such as salt brush for grazing of goats and sheep. They also have used camels and donkeys as means of transport and carriage across the sandy desert. Total heads of livestock kept by farmers are shown in Table 2.5-4, and the slaughtered livestock and meat production in the NSG in 1987 are given in Table 2.5-5.

Table 2.5-4. Total Head of Livestock

(unit: head, 1,000 birds)

Species**	El Arish	Sheikh Zuwayid	Rafah	Bir El Abd	Total
Meat cattle	142	77	477	1	761*
Dairy cows	371	475	1,402	2	2,382*
Steer buffalo	153	40	270	0	691*
Calves	60	130	250	0	485*
Total Cattle	726	722	2,399	3	4,326*
Sheep, goats (1,000)	44	59	18	40	242
Poultry (1,000)	1,600	1,280	225	315	3,420
Egglayers (1,000)	1,250	0	1,250	0	2,500

Source: NSG, 1987
*... including (NSG) Livestock Prod. Station
**... Camels and donkeys are kept, but numbers not available

Table 2.5-5. Slaughtered Livestock and Meat Production

Species	Sheep	Goats	Buffalo	Camels	Cattle	B.Males+B	Heifter
Slaughtered*	273	463	223	124	159	109	413
Produce (kg)	4,914	5,550	44,120	31,950	31,950	19,620	78,470
Meat/head (kg)	18	12	198	100	201	180	190

Source: NGS, 1987-1988 * head

Distributions and amounts of natural grasses which are palatable and nutritious for grazing animals have a close relationship with annual rainfall, with a general tendency of denser plant population in the areas near the northeast coast. Carrying capacity of natural sand dunes amounts to approximately 2 feddan per adult sheep in grass ranges with the species Atriplex Nummlaria, Kochia Indica, or Acaccia Saligna. A herd of animals kept by a Bedouin family in North Sinai is estimated to average 17 head of goats or sheep, and one of camel or donkey. The herd is mainly used for domestic consumption.

Recent very rapid extension of the poultry industry has brought 164 broiler production units (with 3.5 million fowls) and two layers units (with 2.5 million fowls) to El Arish and further eastern parts of the governorate. Local population still relies for its meat consumption on traditional goats and sheep slaughtering. Slaughtered adult animals are marketed in the form of carcass and distributed from slaughterhouses to butcher retailers and restaurants.

Meat production and head slaughtered are shown in Table 2.5-6. Furthermore, the North Sinai Governorate established a livestock farm in El Arish to cope with the strong demand for meat, and also to supply milk and milk products. This farm keeps 350 friesian cows, 140 friesian beef yearlings, 9 bull stocks, and 200 beef buffalo heifers and steers. It supplies beef cattle to

slaughterhouses, and milk to a milk plant in Rafah for white cheese production and provides cattle-breeding services to those who keep Baladi cattle for mating.

2.5.6. Feeds, Livestock Economy and Animal Health

The critical key factor limiting livestock development in North Sinai is feed security, followed by limited supplies of good quality water. There is very little space left for cropping fodders under the current agricultural system where orchards and winter vegetables are predominant in cropping patterns. Even the governorate livestock farm purchases high-priced concentrates and hay from the Nile Delta region.

According to the farm survey, their standard ration gives 1 kg of the total digestable nutrient (TDN) for every 50 kg of live weight for maintenance feeds, equivalent to 0.5 - 0.6 LE. In North Sinai, feed supply becomes very tight during the winter leading to higher feed prices.

Buffaloes fattened as a source of red meat will be marketed at the yearling stage with dressed weight of from 200 to 250 kg at farm gate prices ranging 3 - 6 LE/kg. Limited marketing of live animals with average price levels: 100 - 120 LE for adult goats, 150 LE for adult ram, 1,000 LE for culled camel and 3 - 5 LE for a hen.

Settled Bedouin still keep a few goats and sheep. Average numbers of head retainable with crop residues and wild grasses are less than 3 heads per family. The North Sinai area is still free from water-borne diseases such as foot and mouth disease (FMD), rinder pest and haemologic septicaemia.