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HIGH DAM SOIL SURVEY

UNITED ARAB REPUBLIC

GENERAL REPORT

UNITED NATIONS DEVELOPMENT PROGRAM
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

The Final Report as now presented by FAO consists of the following four volumes:

COMPOSITION OF THE FINAL REPORT

Volume I - General Report

Volume II - The Reconnaissance Soil Survey

It consists of 9 areas, totalling 13,618,308 acres with maps on 1:200,000 scale excepting one sheet (Sheet VIII) with 1:100,000 scale. Total 9 soil maps and 9 soil potentiality maps are enclosed with this volume.

Volume III - The Semi-detailed Soil Survey

It consists of 5 areas, totalling 1,847,627 acres with maps on 1:50,000 scale. Total of 10 soil maps and 10 soil potentiality maps are enclosed with this volume.

Volume IV - Special Subjects and Investigations

A soil survey brings up a number of questions about the characteristics of soils, their properties and origin, and about proper analytical methods which need further investigation.

This volume presents the results of complementary investigations carried out in the project. There are 11 such investigations, two of which may be indicated as examples:

- Some characteristics of the desert soils of U.A.R.

- Irrigation requirements of sandy soils.

TABLE OF CONTENTS

		Page
I.	INTRODUCTION	1
	1. The Background	1
	2. Objectives and Organization of the Project	2
	3. Execution of the Project	2
	4. Acknowledgements	3
II.	SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS	4
	1. The Area Surveyed.	4
	2. The Reconnaissance Survey.	4
	3. The Semi-detailed Surveys.	5
	4. Laboratory Work.	5
	5. Soil Classification.	5
	6. Soil Potentiality Classification.	5
	7. Accomplishments.	7
	8. Recommendations.	8
III.	GEOLOGY AND GEOMORPHOLOGY	11
	1. Geology.	11
	2. Geomorphology.	11
IV.	CLIMATE, VEGETATION AND LAND USE	12
	1. Climate.	12
	2. Vegetation.	13
	3. Land Use.	14
	4. Land Reclamation.	14
V.	THE SOILS AND THEIR CLASSIFICATION	14
	1. Soil Formation	14
	2. Principles of Soil Classification.	15
	3. Main Soil Groups of the Reconnaissance Survey.	17
	4. The Distribution of the Major Soil Groups and Associations.	18
VI.	LAND CLASSIFICATION AND POTENTIAL FOR IRRIGATED AGRICULTURE	24
	1. General.	24
	2. The Principles of the Land Classification Adopted.	24
	3. Land Classes for the Reconnaissance Survey.	25
	4. Land Classes for the Semi-detailed Surveys.	26
	5. Priorities for Land Development.	27
	6. Conclusion.	29

ANNEXES

		Page
I.	Plan of Operation.	30
II.	Project and Supporting Personnel.	41
III.	Summary, Conclusions and Recommendations of the Panel of Consultants.	44

MAPS

1. Index Maps:

   A. Areas mapped and evaluated for land development.
   B. Areas surveyed in reconnaissance and semi-detail.
   C. General orientation of areas mapped in reconnaissance (Sheets I through IX), and semi-detail.

2. Approximation of Geologic Formation According to Aerial Photo-Interpretation.
3. Simplified Soil Map of the Desert Fringes of the Nile Valley and Delta of U.A.R. (in color).
4. Simplified Soil Potentiality Map of the Desert Fringes of the Nile Valley and Delta of U.A.R. (in color).

I. INTRODUCTION

1. THE BACKGROUND

Except for a relatively narrow strip of land adjoining the Mediterranean, which receives light winter rains sufficient for the cultivation of figs, grapes, melons, date palms and some scattered fields of barley, all agriculture in the United Arab Republic depends entirely on irrigation. The population of about 29.8 millions is concentrated in the irrigated area of about 24,500 square kilometres in the Nile valley and delta, which makes this one of the most densely populated regions in the world.

The construction of the new High Dam on the Nile near Aswan is intended, among other objectives, to increase both the irrigated area and the level of agricultural productivity. With respect to agricultural development, some important consequences of the High Dam and the Lake Nasser reservoir, which will have a working capacity of 100 milliard cubic meters, are the following:

(i) As there will no longer be an annual Nile flood below the dam some 900,000 acres of "basin" land, which is now liable to inundation during four months of the year and seldom yields more than one crop, will be fully irrigated to yield two crops, or even three with pump irrigation.

(ii) The level at which the river can be maintained during the winter months will improve the irrigation supply to the higher cultivated lands.

(iii) The improved irrigation supply will be sufficient to bring another million acres of land under cultivation; with some sprinkler irrigation the figure may even be as high as 1.3 million.

This extension of irrigation has been the motive for the soil studies described in this report. The good soils of the Nile delta and valley were already fully occupied and it was known that the soils of the desert fringes were poorer quality, while the reclamation of coastal marsh land might, or might not, prove more profitable. A soil survey and classification would make it possible to evaluate these different soils, not only for costs of reclamation but in terms of productivity in relation to the cost of management and irrigation. It may be noted that the land in the desert fringe may be 40 or 60, or even 100 metres above the level of the Nile and that few of the soils are really well suited to irrigation.

In the light of these considerations the Government of the U.A.R. initiated a "High Dam Soil Survey Project" in April 1959, and later in the same year asked for help for this project from the Special Fund of the United Nations 1/. The request was accepted and the Food and Agriculture Organization was asked to act as Executing Agency. A Plan of Operation was agreed between the Government of the U.A.R., the Special Fund and FAO, and signed by the three parties in February 1960; a copy is attached as Appendix I. The Project Manager designate visited Cairo in June 1960 to help and advise in the preliminary arrangements and work on the joint U.N./ U.A.R. project began in October 1960.

1/ "The United Nations Special Fund and the Expanded Programme of Technical Assistance were merged into the United Nations Development Programme on 1st January 1966".

2. OBJECTIVES AND ORGANIZATION OF THE PROJECT

The purpose of the project was stated as comprising a soil survey and land classification of some 2 million acres in the desert fringes adjoining the existing Nile cultivation and of other areas of undeveloped land in the Nile valley. It was thus an essential preliminary step in the long-term development of agriculture made possible by the High Dam. A reconnaissance survey would first be made, using air-photo interpretation as much as possible. On the results of this reconnaissance, areas were to be selected for semi-detailed survey to make possible a classification of the land according to its suitability for irrigation development. An important part of the project was the training of Egyptian technicians in soil survey, with special emphasis on aerial-photo interpretation. The field work was to continue for three years but the Project Manager was to stay on for a fourth year to help in selecting areas for early development and deciding their relative priority, and in correlating irrigation design with soil factors.

The plan provided for a Government contribution equivalent to $ 500,000 in counterpart personnel, services, supplies, equipment and local facilities. The Special Fund contribution of $ 265,000 (subsequently increased to $ 329,700) was to cover personal services, fellowships, equipment, supplies and miscellaneous expenses. Details are given in Appendix I.

Since the High Dam Soil Survey had been initiated by the Government before the assistance of the Special Fund was requested, the Government contribution of staff, equipment, vehicles etc. had already been allocated and accomodation provided in the Soils Department building of the Ministry of Agriculture. The Co-Manager of the Special Fund Project was the Director of the Soil Survey Section of the Ministry and a Steering Committee was set up to assist relations with other government Departments. Shortly after the Project became operational it was placed under the administrative control of the newly formed Ministry of Land Reform and Reclamation, although technical supervision remained with the Ministry of Agriculture.

3. EXECUTION OF THE PROJECT

Field operations started towards the end of October 1960 and continued until the middle of June 1964, by which date an area of 12,528,500 acres had been surveyed at the reconnaissance level and a further 1,847,600 acres in semi-detail. Since the Egyptian authorities already had a sufficiently clear idea as to what areas would call for semi-detailed survey, and since the field programme had to be adjusted to the availability of photo-mosaics and to the inevitable delays caused by the illness of staff members, the reconnaissance and semi-detailed surveys proceeded concurrently throughout the period of operation rather than in the sequence originally planned.

By December 1962 it was possible, at the request of the Government, to prepare an Interim Report with tentative conclusions as to soil potentiality for the development of irrigation in the areas already surveyed. In the light of this report and the information available from the reconnaissance it was decided to reduce the area for semi-detailed survey, originally fixed at 2.6 million acres and to extend the reconnaissance of the coastal zone further to the west. Unfortunately it was not, however, practical to proceed further west than El Alamein because of the many still undetected mines from the Second World War.

The application of aerial-photo interpretation proved of very great value, particularly in the reconnaissance survey, and enabled much more differentiation of mapping units than is generally possible, although this in turn required more field work to establish the corresponding differences in soil conditions. The reconnaissance maps, even at a scale of 1:200,000, often yield little less information than the semi-detailed survey as to the soil boundaries, apart from the necessarily

smaller number of profile studies. It was for this reason that the coastal area west of Alexandria has been mapped at twice the scale of the other reconnaissance sheets. Here the prospects for agricultural development are promising and much of the detail available from the photos would have been lost at the smaller scale.

The training of local personnel in soil survey procedures, with special emphasis on photo-interpretation, was a major objective of the Project and one to which the survey programme itself had constantly to be adjusted. At first a special course of lectures and practical exercises was organized but, with frequent changes in trainee personnel and the exigencies of the survey programme, it became necessary to substitute a system of in-service training, supplemented by fellowships for further study after a period of two years on the project. Of the five fellowships awarded under the Special Fund Project, three were for instruction in soil survey procedures at an advanced institute for aerial-photo interpretation, one other was for instruction in soil surveying and one was for the study of soil physics applied to land development. (See Annexe II).

The technical problems inherent in the reclamation of the coarser sand soils in the absence of an effective ground-water table are of great importance in the interpretation of the results of these surveys and in the assignment of priorities for land development. While the preparation of such land for irrigation may be easy the resulting agricultural potential and economic justification is more doubtful. To obtain a consensus of Egyptian and international expert opinion on this important matter a Panel of Consultants was convened in March 1964. which included 12 participants nominated by the Government and 7 nominated by the Special Fund and F.A.O. (See Annexe II). The conclusions and recommendations of the panel have been of great value in the preparation of the Project reports.

4. ACKNOWLEDGEMENTS

Mention must first be made of the conscientious participation and support of the counterpart personnel of the Soil Survey, working under the leadership of Dr. A.M. Ghaith, Project Co-Manager, including engineers, draughtsmen, administrative personnel, drivers and labourers.

Special thanks are due to Dr. H.R. El Tobgy, Under-Secretary of State, Ministry of Agriculture, who was also Chairman of the Steering Committee. The help and advice of many officials of the Government and the Egyptian universities on particular technical questions is acknowledged with gratitude; the departments concerned are listed in Annexe II.

II. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

1. THE AREA SURVEYED

The area covered by the different types of soil survey and scales of mapping are summarized below:

Table 1: Survey Areas

Type of survey and scale of map		Area in acres
Semi-detailed survey (1: 50,000)		
Rosetta East		66,400
Hamul-Baltim		153,700
Qaraa-Damietta		179,600
Amiriya		141,900
Kom Ombo East		365,000
Port Said-Salhiya-Ismailya		535,100
Ismailya-Suez		395,900
		1.847,600
Reconnaissance Survey (1: 100,000)		
Alexandria - El Alamein coastal zone		625,400
Reconnaissance Survey (1: 200,000)		
Remainder of survey area		11,903,100
	Total	14,376,100

2. THE RECONNAISSANCE SURVEY

From Aswan, the site of the High Dam, to Cairo, a distance of about 800 km., the desert fringe lands of the Nile valley are generally well defined, lying beyond the cultivated land and usually separated from the desert proper by a sharp escarpment. Where the present cultivation extends to the foot of the escarpment there is of course no such desert fringe, but elsewhere it may be as much as 10 or 12 kilometres in width; or even more in tributary valleys. Around the Fayum depression and further downstream the desert fringes are less sharply defined; for the Delta area the Cairo-Alexandria and Cairo Suez roads were taken as the approxima limits of the Survey.

The reconnaissance survey has been compiled in nine map sheets, the first six of which cover the desert fringes from Aswan to the Fayum depression. The three remaining sheets cover the desert and coastal fringes of the Nile delta. All these sheets are on the scale of 1: 200,000 except sheet VIII (Alexandria to El Alamein) which because of its special interest was mapped at a scale of 1: 100,000. Sheet descriptions and a general account of the reconnaissance survey will be found in Volume II of the Project reports.

3. THE SEMI-DETAILED SURVEYS

The locations and areas of the semi-detailed surveys are shown in Table I above, all are at the scale of 1: 50,000 and cover ten map sheets. The areas selected were those considered to show the best prospects for agricultural development. These surveys are fully described in Volume III.

4. LABORATORY WORK

Chemical and physical analyses and other investigations on soil samples were carried out in the Soils Department Laboratory, the F.A.O. Soil chemist introducing a number of new procedures to meet the special requirements of the survey. These aspects of the work are dealt with in Volume IV.

5. SOIL CLASSIFICATION

For the reconnaissance survey the soils have been mapped largely at the soil association level; that is to say soils which are topographically related and which do not differ greatly in profile morphology and physical and chemical characters. The primary criteria for classification are therefore such factors as mode and environment of soil formation, geological age, profile characteristics, relief, and texture. In all, 238 mapping units have been distinguished. The main soil groups are named according to their topographical significance: soils of terraces, alluvial fans, wadis, plains etc.

For the semi-detailed surveys the soils have been mapped at the soil series level and where applicable, the series are subdivided into soil types and soil phases. A greater number of soil characteristics and properties can thus be distinguished than for the soil associations. The soil series have been given local names according to the American practice; 45 soil series, 107 soil types and 17 phases have been distinguished; or 169 mapping units in all.

6. SOIL POTENTIALITY CLASSIFICATION

The classification adopted for the survey, and displayed in "Soil Potentiality for Irrigated Agriculture" map sheets, is ultimately based on the soil factors which will determine the actual or potential suitability of a given soil for development under irrigation. The principles involved are discussed further in Chapter VI of this Volume and in Volume III; the classes may be summarized as follows :

Class I Soils of high potentiality, very suitable for a wide range of crops under irrigated agriculture. This class comprises the well-drained silt-loam soils of the desert fringe.

Class II Soils of good potentiality, suitable for a less extensive range of crops than Class I. This class includes the heavier soils, loamy soils with heavier sub-soils, and some coarse sandy loams.

Class III Soils of moderate potentiality, suitable for a restricted range of crops, and subject to limitations in soil management.

Class IV Soils subject to such limitations in management that they are only suitable for irrigated agriculture in special conditions, in some cases after reclamation. They may include sandy soils of fine to coarse texture, gravel by soils suited primarily to tree crops and poorly drained heavy clay and swamp soils. In general, it may be expected that the benefits of growing crops on these soils would not cover the costs of production.

Class V Soils subject to such limitations in respect of management or reclamation that their development can only be contemplated subject to further detailed investigation, and to the application of practices to improve the soils.

The total areas assigned to the different classes are summarized below:

Table 2: Areas by Potentiality Classes

Potentiality Class	Area in acres
I	88,300
II	193,800
III	569,900
Complex of I, II or III with lower categories	475,200
IV	1,759,200
V	5,714,000
Rock land	5,532,800
Urban land etc.	42,900
	Total 14,376,100

It will be seen that the area definitely suitable for development under irrigation is limited. A certain percentage of area of Soils assigned to the complex of classes may be in Classes I, II or III, also some of the land in these three classes may be too high-lying or otherwise unsuitable for development, it has been estimated that about 850,000 acres may be suitable. Large areas of gravelly sand and sand soils, assigned to classes IV and V, may be found nearer to the river and at more favourable elevations; economic and social factors must, therefore, be taken into consideration in determining whether their reclamation is to be attempted. From the point of view of a sustained agriculture, land in Classes I, II or III is definitely to be preferred even if it is more expensive to irrigate, unless the physical amelioration of Class IV or Class V soils is such as to bring their ultimate potentiality within the higher categories.

7. ACCOMPLISHMENTS

(i) The Area Surveyed. The total area surveyed during the operation of the project may be put at 14,376,100 acres allowing for a small margin of uncertainty arising from the use of uncontrolled photo-mosaics and for a small overlap between map sheets. It may be noted that in the tabulation of areas the feddan has been taken as equal to one acre (more exactly 1 feddan = 1.038 acres). Of the total area surveyed 1,847,600 acres represents semi-detailed survey in selected areas at the scale of 1 : 50,000; another 625,400 acres of reconnaissance survey in the Alexandria - El Alamein coastal zone was at the scale of 1: 100,000; the remainder, 11,903,100 acres, being reconnaissance survey at the scale of 1 : 200,000.

The potentiality classification, which was derived from the soil survey and carried out on the same scales, shows a rather limited area (852,000 acres) in Classes I, II and III, representing soils of high, good, or moderate potentiality for development under irrigation; Classes IV and V which are subject to severe limitations for development, together with complexes of land in various potentiality classes, account for a further 7,948,400 acres, while the remaining 5,575,700 acres, mainly rock land, has no development potentiality.

(ii) Photo-interpretation and Survey Procedure. An important aspect of the Project was the application of modern photo-interpretation techniques and the instruction of the counterpart personnel in the procedures involved. The material available consisted of aerial photographs, at the scale of about 1 : 40,000 for the area south of Cairo and at about 1 : 20,000 for the area north of Cairo, together with uncontrolled mosaics at a scale of 1: 50,000 for the whole area except the Alexandria-El Alamein coastal zone, for which the mosaics were on the scale of 1 : 10,000.

The survey procedure which was followed was to mark the main "land types" on the mosaics from the visual detail they revealed; sample photos for each land type were then studied under the stereoscope, the geological and physiological detail being particularly significant for their interpretation. Selected sample areas were next examined in the field using the mosaics as field maps; outside these sample areas the field work consisted in checking and elaborating the boundaries which had been sketched in on the mosaics in the light of the photo-interpretation and the sample field studies.

Some three thousand soil samples obtained during the field work were analysed in the U.A.R. Soil Department Laboratory to determine the physical and chemical characteristics of the soils. The laboratory tests included mechanical analysis, and the determination of soil moisture, pH, conductivity, soluble salts, calcium carbonate, gypsum and organic matter. The tabulated results will be found in Volumes II and III of this Report. A number of special studies were also undertaken, in the field and in the laboratory, to improve the methods of analysis and to investigate such matters of special interest as: available water and infiltration rates in desert soils, the solubility of gypsum in salt solutions and the dispersion of calcareous soils for mechanical analysis. These special studies are described in Volume IV.

(iii) Training. The counterpart personnel (listed in Annexe II) were trained in the procedures of photo-interpretation, normal soil survey operations and soil laboratory work. At one time or another, 14 U.A.R. soil technicians participated in the operation and five who had completed at least 18 months in-service training were awarded fellowships for further training abroad. They are providing a nucleus of trained personnel with the field experience necessary to carry on the soil survey work initiated under this project.

(iv) The Panel of Consultants. As already noted, a panel of local and international experts was convened in March 1964 so as to arrive at a concensus of opinion on the irrigability of the different areas, and specially the more difficult coarse sand soils, in order that the proper degree of priority can be given to their inclusion in reclamation projects. The conclusions and recommendations of the Panel covered such subjects as:

(a) Irrigation intervals in relation to soil structure and the comparative advantages of sprinkler irrigation over other methods on difficult soils.

(b) The improvement of coarse textured soil by the large-scale addition of silt and clay material, and the further investigations which should be undertaken in this connection.

(c) The reclamation of saline/alkali soils and the drainage problems which arise.

(d) Economic factors in the selection of soils for reclamation, in relation to initial costs and the ultimate potentiality of the reclaimed land.

(e) The pilot projects and experimental work that should either preceede land reclamation or be carried out concurrently with it.

(f) Priorities for land development in project areas.

(v) Soil Maps and Reports. The results of the reconnaissance survey, covering the desert fringes of the Nile valley and delta from Aswan to the sea, are presented in nine sheets of soil maps and nine sheets of soil potentiality maps, all in colour and, except the Alexandria - El Alamein sheet, on the scale 1: 200,000. The descriptions of these sheets of soil potentiality maps, at the scale of 1: 50,000 and also in colour; they are described in Volume III.

8. RECOMMENDATIONS

(i) Priorities for Irrigation Development. These may be summarized as follows (See also Chapter VI, Section 5):

(1) From the point of view of soil properties, uniformity of soils conditions, and character of terrain, the lands best suited to the extension of irrigated agriculture are the loams and silt-loams in the Amiriya and Maryut areas of the coastal zone, as far west as El Hammam. Elevations however rise to as much as 60 meters above the level of the Nile. Lands in Classes I, II, and III total some 290,000 acres, as estimated from the reconnaissance sheets.

(2) In the Kom Ombo East Plain, lying to the east of the Nile some 40 kilometres north of Aswan, the soils are fairly uniform, including fine sands, loamy sands, sandy loams, and some silts. Elevations range from 20 metres to 120 metres above the level of the river. Land in Classes I, II, and III totals some 121,600 acres, but part of this was already under reclamation at the time of the survey.

(3) Next in priority are several areas, each of which has its particular limitations. They are :

(a) A complex of many small separate parcels, along the Nile from Idfu to Luxor or Asyut, in general from 10 to 20 metres above the level of the river. With careful reclamation, parts at least can be expected to provide reasonably good land. The prospective area may be about 21,000 acres.

(b) The Kom Ombo West area, of loamy coarse sand soils in complex with gravels. They lie from 40 to 60 metres above the level of the river on its west bank. The prospective area may be about 156,300 acres.

(c) The marsh lands of the Delta, east of Rosetta, where irrigation would be relatively easy but tile drainage with pumping would be necessary, to enable leaching to improve sufficiently the saline/alkali conditions. The area, in Classes II and III, would be about 315,200 acres of which about 260,000 acres may be reclaimable.

(4) Drained lake beds, for the most part in Class III, or complexes of Classes II, III, and IV. Further details are given in Chapter VI; the total available area is uncertain.

(5) The lowest priority must be assigned to the coarse sands in the desert fringes, the majority of which are in Class IV or even V. These are of marginal or sub-marginal potentiality and can, at best, only be developed after being reclaimed or improved by special treatment. How far this may be justifiable calls for careful examination in each case, they are generally too permeable with low water storage capacity in the root zone. They may be suitable for tree crops, or possibly for other crops under sprinkler irrigation. In reclaiming them the object should be to build up a loamy topsoil of sufficient depth to provide a water-retaining capacity of about 35 mm. The making of new land is easier in Upper and Middle Egypt than in Lower Egypt, because of the abundance of loamy material in the rubble terraces.

Priorities in development should be based primarily on soil qualities, and therefore on potential productivity, rather than on considerations of the initial cost of reclamation.

(ii) Sandy Soils of the Desert Fringes. Studies should be undertaken to ascertain the best techniques for providing sufficient depths of topsoil of suitable quality in respect of plant growth, cropping, irrigation methods, and drainage; and economic appraisals should also be made. It should be investigated whether it is preferable, both technically and economically, to attempt gradual reclamation by relatively simple and inexpensive methods, or to adopt methods which, costly in the first place, will produce soils immediately for remunerative production.

Pending the results of such studies, it is recommended that further action on reclamation of these soils should be suspended.

(iii) Hydro-geology. In all investigations of the feasibility of reclamation, this aspect should be studied, and particularly the advantages and disadvantages of the various ground-water levels which are likely to occur. Pumping from the groundwater which is often available at some depth may, by lowering the water table, do more harm than good. A fluctuating water table that can be lowered by pumping or raised by surface irrigation may both maintain the moisture in the root zone, e.g. for tree crops, and allow the periodical leaching of the soil.

(iv) Reclamation of Saline-Alkali Soils. Further studies are needed in respect of :

(a) Drainage, and leaching-out of excess salts.

(b) Settlement of unripened clay sub-soils.

Both apply to the coastal belt of the Delta, and the former particularly to shaly clays and marls in Upper and Middle Egypt, as far north as the Fayum depression.

(v) Pilot Projects and Experimental Stations. In addition to strengthening the existing research institutes, it is recommended that further pilot projects and experimental stations should be set up in different parts of the country, to carry out the investigations and trials on problem soils, necessary before reclamation on a large scale begin. The work of such stations requires to be closely coordinated.

(vi) Soil Science in Land Reclamation. The actual reclamation of soils should be based on detailed soil maps, and should be guided by soil specialists, preferably as staff members of the agencies carrying out the reclamation.

(vii) Further Soil and Land Classification Surveys. In addition to the land classification system already in use in Egypt, a national soil classification system should be worked out and established. This will involve further extensive soil surveys in the various regions, coordinated with the results of pilot projects and experimental stations. The results should be recorded in semi-detailed and detailed soil maps, ultimately covering the whole country.

(viii) The Selection of Land for Reclamation. The total area of additional land in Classes I, II, and III, accessible to irrigation from the Nile, is considerably less than the area irrigable by the amount of water expected to be available when the High Dam and Reservoir come into operation. Consequently it may become necessary to reclaim marginal and submarginal lands on a considerable scale. The right policy appears to be to develop the most suitable land, and at the same time to undertake the investigations and trials necessary to evolve the most suitable methods and and means of reclaiming the lower classes of land. The technical aspects of land reclamation, particularly in relation to the retention of moisture in the coarser soils and the need for their physical amelioration, have forced themselves upon the attention of the Project soil specialists. These topics are dealt with at some length in the subsequent volumes of the Report and should not be overlooked.

III. GEOLOGY AND GEOMORPHOLOGY

1. GEOLOGY

The main geological formations of the area are shown in Map No. 2 which has been compiled from aerial photo interpretation and the available geological data, most of which can be found in the publications of Sandford and Arkell between 1929 and 1939 and in the 1928 Atlas of Egypt.

Sometime during the late Tertiary period the present Nile Valley was a sea gulf which was gradually filled with marine and terrestrial deposits during Pleistocene and recent times. The sediments were in part deposited by the Nile, but the greater part consists of fan and piedmont deposits brought down from the adjacent highlands in flash floods by steep torrential streams. The majority of these sediments consist of unconsolidated gravels, cobbles and sands, except in the coastal zone west of Alexandria where in texture they are mainly clay loams and clays. As many as five different terrace levels have been observed, both in the river deposits and in the rubble deposits of piedmont plains. In many places the terraces have been eroded or covered by fan deposits; large areas are covered by wind-blown sand.

The higher desert plateaus are geologically older, ranging in age from Cretaceous to Pliocene; these formations including sandstones, shales and limestones, and also gravel, rubble and sand deposits in various stages of consolidation. Most of the desert areas are denuded and rocky.

In Upper and Middle Egypt from Aswan to Cairo the plateau usually rises in steep, rocky escarpments to a considerable elevation above the valley floor; as much as 100 metres for the Nubian Sandstones in the Aswan-Isna area. In Lower Egypt the transition between the fringe lands and the desert is not so clearly marked and the older stony desert lands grade into the Pleistocene landscapes of the alluvial plain.

The semi-detailed surveys of Rosetta East, Hamul-Baltim, and Qaraa-Damietta are wholly located within the recent Nile delta, which was built up during the Holocene and where the deposition of clay and silt in the lagoon lakes and adjacent swamps is still going on.

2. GEOMORPHOLOGY

Land forms or landscapes have been of great importance in the reconnaissance Soil Survey as they provide the major criterion for grouping the mapping units. They are also important to a lesser extent in the semi-detailed surveys.

The following are the main land forms :

(a) Rubble Terraces. These are remnants of the piedmont alluvial plains, built up by gravelly, sandy, or coarser detritus brought down from the slopes of the higher land. Subsequent uplifts of the land in relation to the level of the sea has resulted in a number of terrace levels which are distinguished according to their relative age.

(b) River Terraces. These are remnants of the old Nile deposits. In the desert fringe areas three or sometimes four different levels can be distinguished.

(c) Alluvial fans. These are accumulations of debris at the foot of the escarpments, brought down from the desert plateau by steep tributary streams descending through ravines, so that the detrital material spreads out in the shape of a fan. The fans usually consist of coarse gravelly and sandy fragments which are neither well-sorted nor rounded; sands are washed down and deposited at the base of the fan. Where these deposits cover narrower areas between higher ground they are described as outwash plains.

(d) A "Wadi" is a depression, large or small, which may or may not have been formed by stream erosion, and may carry a flow of water on occasion. The term is commonly used for natural lines of drainage, but also for any gully or elongated depression however deeply incised.

(e) Wadi bottoms are the lower parts of natural drainage ways, showing one or more stream beds.

(f) Wadi plains are wadi areas without stream beds but occasionally flooded by the run-off from higher ground. Such wadi plains have no free external drainage and the deposition of finer material is still taking place.

In the Delta the main land forms are large fluvio-marine marshlands with clay soils, lagoon lakes with swamps along their shores and, along the coast, a sandy coastal barrier plain, with some large areas of shifting sand dunes. The coastal barrier plain consists of a number of older (rocky) and more recent beach ridges marking former coast lines, with lower-lying sand plains in between which are often flooded by the sea and are generally poorly drained.

Wind-blown sand gives rise to such distinct land forms as large sand dune areas, ripple dunes and sheets of sand of varying thickness, covering other rocks.

The desert plateaus built up of the older geological formations are predominantly rocky with, in places, a thin covering of gravel, rubble or wind-blown sand. A number of "miscellaneous land types" are distinguished, mainly on the basis of the type of rock and topography; these include some swamps.

IV. CLIMATE, VEGETATION AND LAND USE

1. CLIMATE

Very little rain falls in the surveyed area. The daily minimum and maximum temperatures vary between 5°C and 42°C, the highest temperatures occurring in the interior during the summer. Humidities are low, especially in the inland deserts.

For Middle and Upper Egypt climatic data were available for the period 1900-1945, and for Port Said, Alexandria and Cairo for the period 1942-1960.

Along the Mediterranean Coast, to some 40 kms inland, the average annual rainfall is about 150 mm., while at Cairo it is no more than 30 mm., the rain falls mostly in the winter, from November through March. South of Cairo, in Middle and Upper Egypt, the mean annual rainfall varies from 1 to 7 mm. so that this zone is virtually rainless, a good rain shower occurring only once in 10 or 20 years.

During the winter months there is relatively little difference in temperatur throughout the area, whereas in summer the inland areas are considerably hotter.

Table 1 : Range of daily mean temperature (°C) in winter and summer

	November			April		
	Mean Daily	Mean Daily Max.	Mean Daily Min.	Mean Daily	Mean Daily Max.	Mean Daily Min.
Port Said	14-21	-	-	18-27	-	-
Alexandria	13-19	-	-	18-27	-	-
Cairo	14-19	-	-	24-28	-	-
El Minya - Asyut	12-19	20-30	6-15	21-29	30-37	17-22
Nag-Hammadi	13-20	22-30	5-12	24-33	35-42	16-23
Aswan	10-22	23-30	10-16	24-33	35-41	20-26

In Middle and Upper Egypt the humidities are much lower in summer than in winter. In the coastal zone there is little seasonal difference.

Table 2 : Range in relative humidity (per cent) in winter and summer.

	September - February		March - August	
	at 14.00 h	Daily mean	at 14.00 h	Daily mean
Port Said	-	69-74	-	69-74
Alexandria	-	67-70	-	65-73
Cairo	-	56-64	-	44-56
Minya-Qena	30-45	55-70	20-25	35-45
Qena-Kom Ombo	30-40	45-60	15-25	25-35
Aswan	20-30	35-45	15-20	25-30

2. VEGETATION

The vegetation of the desert fringe is extremely scanty and there is usually no vegetation at all where there is a desert pavement, which is everywhere present except in wadi bends, in areas of wind-blown sand and on the fine-textured soils of the coastal zone. On the coarse desert pavements no plant can survive the strong winds while on sandy patches seeds germinate on the moisture provided by dew, the desert vegetation consisting of widely scattered shrubs 20 to 40 cms. in height. In Upper Egypt *Colocynthis vulgaris*, bearing small fruits, is sometime found on the loamy sand soils of the wadis.

The slightly greater rainfall becomes apparent in the vegetation some 70 kms. from the coast, the sandy areas, unless they are shifting dunes, carrying a bushy desert vegetation which becomes taller and denser towards the Mediterranean.

3. LAND USE

There is very little agricultural land use in the desert fringe areas. Abandoned fields, some belonging to former monastries, may have been abandoned because of the poor soil or because of lack of water. The latter could, indeed, result from the former if there were an insufficient return to maintain the wells and water lifts.

In Upper Egypt there is some cultivation on the loamy sand soils of the youngest river terraces and in recent years the Government has undertaken larger reclamations, as for instance near Idfu and in the Kom Ombo East area.

In Lower Egypt many small areas of the desert fringe east of the Nile delta have been brought under cultivation. Grapes and melons are planted in sandy soil, in deep trenches dug in the talus to provide them with better soil moisture conditions.

4. LAND RECLAMATION

In recent years larger reclamations have been started in the Tahrir Province covering the desert fringe between Cairo and Alexandria, the first of these reclamations being on sand and gravelly sand soils in the south-eastern part of this Province. Irrigation was at first provided by Nile water brought in by canals, but now pumping from the ground-water reservoir is increasingly practised. Many kinds of crops, vegetables, small fruits and fodder have been grown, but more citrus and almonds are now being planted. Sprinkler irrigation is used in the latest reclamations. The soils are generally very coarse sandy and the water table is very deep.

Some small areas have recently been reclaimed along the road between Giza and Wadi Natrun. Sprinkler and surface irrigation are practised and the water has to be pumped from a depth of some 70 metres. Olives, citrus and grapes are the major crops. In 1959 and 1960 a considerable area of wind-blown sand soils in the Wadi Natrun was reclaimed and palms are being planted. The reclamation area of Ain Shas on the eastern side of the delta is being planted with citrus.

More recent still is the reclamation of the clay loam soils of the Maryut region, south-west of Alexandria. The main crops are cotton, wheat and maize, which do very well in spite of a certain initial salinity of the soils. During 1962 and 1963 reclamation started on the sand soils on the northern slope of Wadi Natrun, and also on the wind-blown sands of the Mollak region, south of Wadi Tumilat in the eastern desert fringe of the delta.

An extension of reclamation in the desert fringe areas west and east of the delta has also been planned. Here, the soils are almost all very coarse sands or wind-blown sands.

V. THE SOILS AND THEIR CLASSIFICATION

1. SOIL FORMATION

Under the extreme climatic conditions of Egypt soil-forming processes are very slow. Well-developed soil profiles are lacking and such profile characteristics as occur, like the reddish brown subsoils of the terrace soils, the presence of salt and gypsum accumulations in several horizons, or lime hardpans, were probably all formed in Pleistocene times under more humid conditions. The character of the parent material and the relief have been responsible for the differences in the soils. The generalised soil map accompanying this volume shows the distribution of the principle soil groups and associations.

PRINCIPLES OF SOIL CLASSIFICATION

(i) The Reconnaissance Survey. Soils have been grouped primarily according to landscape types as the survey was not sufficiently intensive to separate the soil series. The landscapes are the result of geological processes acting over longer or shorter periods, and it is the geological history of the site that accounts for the specific types of rock and sediment that build up the landscape. The soils of any one landscape, therefore usually have important characteristics in common.

In the reconnaissance soil maps the following seven main groupings according to landscape occur:

T : Soils of the Rubble Terraces
R : Soils of the River Terraces
E : Soils of the Deltaic Stage of various River Terraces
F : Soils of Alluvial Fans and Outwash Plains
W : Soils of Wadis
P : Soils of the Plains
D : Wind-blown Soils

Certain complexes comprising several landscape types have been grouped together, as for example - N: The Wadi Natrun Complex. Soils derived from limestone debris, and often underlain by limestone rocks, have been grouped together as - L: Limestone Soils.

The desert plateaus and some smaller areas, such as gypsum swamps, which have little potentiality for agricultural development are classified as - M:/ Miscellaneous Land Types.

Within these main groupings, further sub-divisions are made on the basis of age of landscapes and soils, land surface features, dissection by erosion, texture, and stoniness. These sub-divisions are denoted by a suffix following the capital letter of the main group. Thus the soils of the Rubble Terraces (T) and the River Terraces (R) are sub-divided according to the age of the terraces; e.g. the "Oldest" (Ta), "Older" (Tb), "Younger" (Tc) and "Youngest" (Td) terraces.

The soils of the Wadis (W) are sub-divided on the basis of land form and profile characteristics such as the presence or absence in the profile of a reddish subsoil. The sub-divisions are:

Wb : Wadi Bottom Soils
Wp : Wadi Plain Soils without reddish subsoils
Wq : Wadi Plain Soils with reddish subsoils.

Land forms also serve to sub-divide the main group of loose wind-blown sand soils (D) as follows :

Db : Soils of medium to high dunes
Ds : Soils of medium and low dunes
Dr : Soils of ripple dunes
Du : Soils of undifferentiated sheets of sand

Differences in texture are used in sub-dividing the soils of Farms and Outwash Plains (F):

Fg : Gravelly stony soils
Fo : Gravelly sand soils
Fs : Sand soils
Fd : Very stony debris soils.

Within the Miscellaneous Land Type, sub-divisions are made mainly in terms of relief, dissection and rockiness.

The group of soils designated by the combination of a capital and a small letter can be considered as "soil associations" comprising a number of soil series occurring in a certain type of landscape. Some soil associations may comprise the different soil series occurring in the same type of landscape. Some soil associations may comprise many different soil series, others only a few, for the wind-blown soils (D) the sub-divisions are single soil series.

Within these groups a further sub-division by phases has been made when possible, the criteria being mainly topography, texture, depth, stratification, and also terrain features such as the occurrence of terrace remnants and rock outcrops. These final sub-divisions, which are the mapping units, are designated by a number following the suffix.

(ii) Semi-Detailed Surveys. The soils have again been grouped according to landscape; the miscellaneous landtypes include the rubble terraces, colluvial slopes, wadi beds, rock land, shifting sands dunes, clay swamps, depressions, some coastal beach soils, and excavated sands.

The detail of field observation usually made it possible to define closely related soils as "Soil Series", and in many instances further to sub-divide them into "soil types" and "phases". These soil series, types and phases are the mapping units and, in all, 45 soil series, 107 types and 17 phases are distinguished. The soil series is designated by a combination of a capital and a small letter derived from its name, e.g. Nf for the Nafath soil series, Sa for the Shait soil series.

Soil types within a series are denoted by a number. Thus Nf1 is "Deep, compact, reddish silt loam soil. Subsoil fine sand", while Nf2 is "Deep, reddish, very fine sand soil. Subsoil coarse sand". The separation of soil types is mainly based on characteristics of the top soil, such as thickness, structure, texture, and drainage conditions. Phases within a series or type have an additional small letter. Thus Sf e is "eroded phase of Sf with rock outcrops", while Qa 1 s is "phase of Qa1 with very shallow, wind-blown sand topsoil".

In all, 18 Miscellaneous Land Types are also distinguished, sub-divided into 41 sub-types and 2 phases; 4 Complexes of miscellaneous land types also occur.

The mapping units of the reconnaissance and semi-detailed soil surveys are fully described in Volume II and III of the Project reports.

3. MAIN SOIL GROUPS OF THE RECONNAISSANCE SURVEY

These may be briefly described as follows :

(T) Soils of the Rubble Terraces, sub-divided into 5 soil associations, of which one (To) is not really a terrace but a very stony sloping plain at the foot of the escarpment. The other four associations represent different ages and elevations: Ta, Tb, Tc, and Td. The relief is undulating or in some cases rolling, and the terraces as a whole are gently sloping. The soils of all 5 associations have a reddish subsoil, weakly developed in the youngest terrace which is usually nearly level also.

(R) Soils of the River Terraces, sub-divided on the basis of 5 terrace levels, further division being made on textural and other profile features. The soils of the four oldest levels (Ro, Ra, Rb, Rc) form one sub-group of gravelly soils with reddish subsoils; 64 soil associations have been distinguished in this sub-group. The youngest and lowest terrace soils (Rd, Rs,) form a second sub-group. They lack the reddish subsoils and have, as a rule, little gravel, being generally sands and loamy sands; 3 soil associations have been distinguished. The relief is nearly level.

(E) Deltaic Soils of the Various River Terrace stages, pedologically younger than their river terrace counterparts, having been covered for sometime by the sea or by fresh water. The soils have little or no reddish color in the subsoil. Sands predominate and the gravel content is generally low. Two soil associations are distinguished by the presence or absence of a loamy sand topsoil and by the gravel content. The relief is nearly level.

(F) Soils of the Alluvial Fans and Outwash Plains, with little or no profile development. Four soil associations are distinguished according to textural characteristics, mainly gravel and sand content, and stoniness.

(W) Soils of the Wadis, sub-divided into the following soil associations: Wadi Bottom Soils (Wb), Wadi Plain Soils without reddish subsoils (Wp), and Wadi Plain Soils with reddish subsoils (Wq). The Wadi Bottom Soils are the gravelly or cobbly soils of the bottom parts of drainage ways and stream beds; when of a more sandy nature this is indicated. The Wadi Plain Soils are usually sand and loamy sand soils.

(P) Soils of the Plains, sub-divided into 6 soil associations, two of which form the sub-group of Residual Soils, and four the sub-group of Marine-Lacustrine Soils. Soils of the first sub-group occur mainly in Upper Egypt where they have developed over the Cretaceous rocks. The Marine-Lacustrine Soils occur in the Maryut area in the coastal zone.

(N) Soils of the Wadi Natrun Complex, including several landscape types such as the soils of rather steep slopes and of plateaus remnants in the bottom of the Wadi Natrun depression.

(L) Soils derived from Limestone, found in the coastal zone west of Alexandria where beach ridges of oölitic limestone occur. The ridges vary in age and in hardness and enclosed between them are elongated patches of fine-textured "salina" soils. The soils of the beach ridges are locally rocky.

(D) Wind-blown Soils, loose sands sub-divided into 4 soil associations according to relief, the height and type of the dunes and the thickness of the sand deposit.

(M) Miscellaneous Land Types, arranged in three main groups:

Rock Land, sub-divided into 8 landforms. These are the Tertiary and older geological formations. A distance is made between "Rock land" and "Denuded rock land", the latter generally built up of softer, more weatherable rock such as poorly consolidated sands and gravels, soft sandstones, shales and marls. The denuded Rock Lands generally have a low relief.

(S) Swamps, in which 2 soil associations are distinguished, with and without gypsum deposits.

Finally Man Made Lands are lands covered by soil brought from elsewhere.

As has already been said, the soil groups for the semi-detailed surveys are also differentiated according to landscape type. No separate description of the main groups is therefore necessary.

4. THE DISTRIBUTION OF THE MAJOR SOIL GROUPS AND ASSOCIATIONS.

(i) The Desert Fringes from Aswan to Cairo (Reconnaissance Sheets I to VI)

The cultivated land in the Nile valley is narrowest in the south where it is sometimes only 2 kilometres wide. North of Qena the valley widens considerably, to an average width of some 15 kilometres and there is a comparable variation in width of the fringe lands. Often the cultivated valley land directly adjoins the higher desert plateaus; elsewhere the fringe land may be very wide, as in the Kom Ombo west area, the Luxor-Qena-Nag Hammadi region, and between Mallawi and Cairo especially on the west bank.

In these areas the width of the fringe varies from 15 to over 50 kilometres. There are no wide fringes where the river cuts through the Nubian Sandstone and the hard Middle Eocene limestones but, where such soft rocks as the Cretaceous Isna shales and the Middle Eocene sandstones, shales, shaly clays and marls occur, their erosion and the deposition of detritus have resulted in the formation of wider fringes.

The soil parent materials were deposited during Pleistocene and Recent times, partly along former courses of the Nile, but for the greater part as fan and piedmont accumulations brought down from the rocky plateaus by torrents or by gravity; they are not well-sorted and generally very coarse in texture. Up to five different terrace levels have been distinguished, both in the river deposits and in the rubble deposits of piedmont plains. The terraces have often been removed by erosion, or covered by fan and wadi deposits.

In the Aswan - Isna region (sheet I) river terraces deposited along a former coarse of the Nile cover large areas in the Kom Ombo West plain. The soils (mainly Rb: predominantly gravel soils with reddish subsoils) are mostly coarse textured, although there are also some sandy loams, and loamy, and lie at an average height of 60 metres above the Nile in rolling country. This soil association obviously has severe limitations both as to texture and topography and has been classified as Class V. Similar river terraces, with loamy coarse sand or loam soils covering 30 to 70 per cent of the total surface in lower and flatter areas, are more promising and this soil association (Rb 7) has been shown on the potentiality map as a complex (III/V) of unsuitable and medium suitable land.

Between Aswan and Isna there are also considerable stretches covered by the gravelly soils of the rubble terraces (see Fig. 1), the remnants of the different terraces standing out in the terrain as ridges or isolated flat-topped mounds. North of Isna the rubble terraces overlie beds of sandy loam, loam and clay loam, probably late Tertiary marine sediments, which are often exposed on the surface and, containing some nitrate of ammonia, have been extensively dug as a fertilizer. These soils have no potentiality for development and the area has been put in Class V.

Between Aswan and Isna there are only a few small areas of the fringe with silty, fine sandy, and clay soils (Rs, Rx). Occurring in the nearly level lands of the youngest river terraces, they may have possibilities for development and are classified as Class III.

From Isna to Asyut (Sheets II and III) nearly all the soils of the fringe are the gravelly and stony soils of fans and outwash plains, wadis, and rubble terraces. They are not suitable for development (Class V), except for a few small areas of wadi plains and fans covered with sand soils (Wp, Fs) which may have some limited potentialities and are assigned to Classes IV 1 and IV 2.

Between Asyut and El Fayum (Sheets IV and V) the same very coarse soils of fans and wadi plains occur, again with small sandy areas of Classes IV 1 or IV 2. North of Dairut, in a narrow strip of land along the western edge of the cultivated area, medium to high sand dunes occur, with clay soils in between covering from 30 to 70 per cent of the total surface (see Fig. 2). This association of dunes and clayey depressions has been mapped as a complex of Classes II and V; it may extend over a distance of 160 kilometres with an average width of some 1.5 kilometre.

The fringe lands show the same general character as far as Cairo (Sheet VI) with coarse-textured gravelly soils of river terrace deposits, some time sloping and severely gullied (Ra, Rc, Rc1, Rc22), which have no agricultural potential. Some small areas of the sandy phases of fan deposits (Fs) and of rubble terrace deposits (Tc 10, Td 10) may have limited possibilities and have been shown in classes IV 1 and IV 2, or as a complex of classes III and IV 2.

The land surrounding the Fayum depression (see Fig. 3) offers hardly any prospects for agricultural development, being rocky and often strongly dissected and gullied.

ii) The Kom Ombo East Plain (Semi-detailed survey)

The Kom Ombo East area is a large depression in the Cretaceous Nubian Sandstone, varying in topography from nearly level to rolling, and broken by several large areas of sandstone hills. Most of the soils have developed over old and recent Wadi deposits or have formed in situ from Cretaceous sandstone and shales, although there are also some small areas of river terrace soils. The soils vary in texture from silt loam to gravelly coarse sands.

Some of the soils show possibilities for development. The deep silt loam soil types of the Kharit and Nafath soil series, and some silt and silt loam soil types of the Casel series are considered very suitable for agriculture and have been classified as Class I. The deep loam soil of the Nuqra series, overlying sandstone and shale and occurring in a nearly level terrain, is Class II, and some loamy wadi soils of the Na'ama series are Class III.

(iii) The Western Delta Fringe (Sheet VII and Semi-detailed Surveys)

The cultivated Delta plain is bordered by the soils of river terraces and the deltaic stages of river terraces, usually the "gravel soils with reddish subsoils" of the river terraces and gravelly sand soils of the deltaic terrace stages. The latter may show a thin covering of wind-blown sand and overlie clay loam subsoils rich in gypsum. The river terraces generally have an undulating relief with gravelly soils, whereas the deltaic deposits are nearly flat and have little gravel. Some areas of these gravelly and sandy soils (Eg, Eg20, Ra) show limited possibilities for development and are classified as III/IV2, IV2, or IV2 Tr.

Fig. 1: Loamy gulf-fill deposits under gravel cap of rubble terrace. (Photo J.S. Veenenbos)

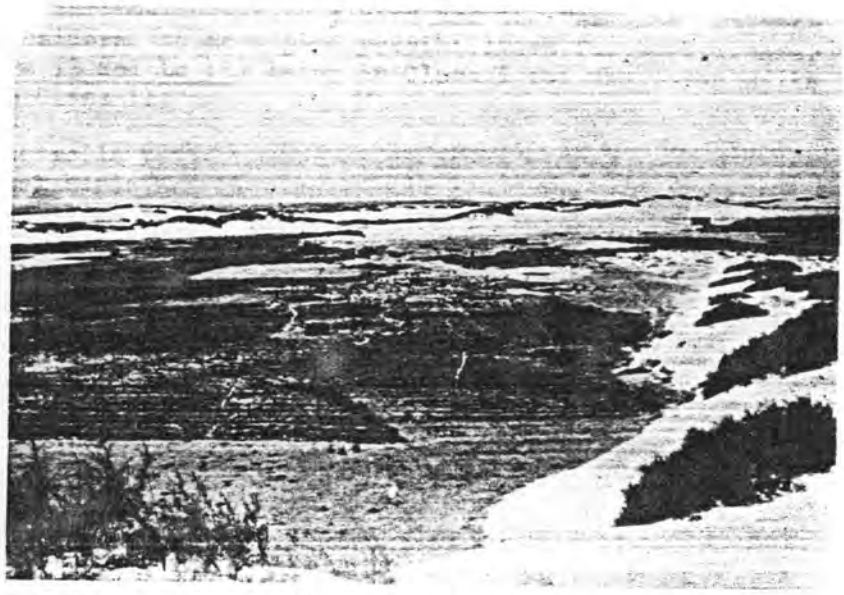

Fig. 2. Complex of sand dunes and cultivated loamy soils, El Khafug area. (Photo: J.J. Vleeshouwer)

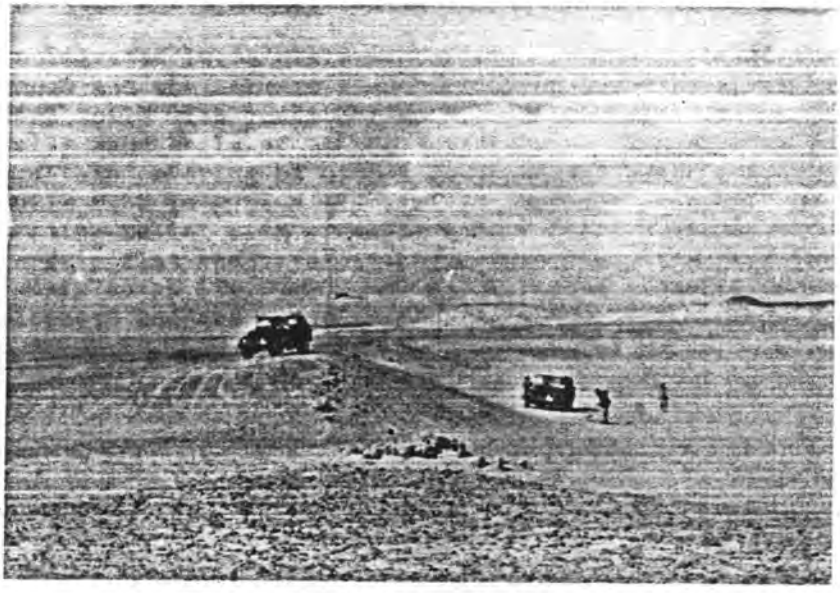

Fig. 3. Beach line of the ancient lakes of the Fayum depression (Photo J.J. Vleeshouwer)

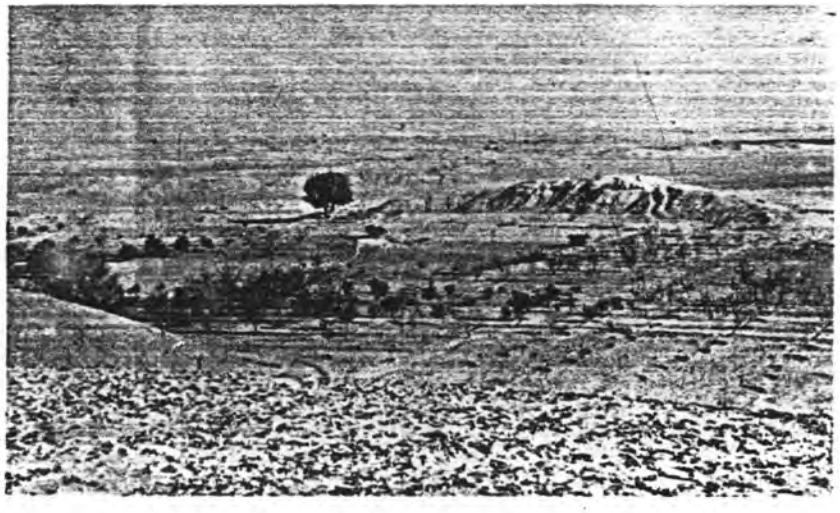

Fig. 4. Remnants of ancient settlement (Karms) between beach ridges. (Photo G.J.W. Westerveld).

To the north of the flat sand plain of the deltaic terrace deposits lies an extensive area of dunes built up of very coarse sand. Between the dunes loamy sand, loam, and clay loam soils may cover from 30 to 50 per cent of the surface. These areas are mapped as soil associations (Ds 12, Ds 11 and Db 11); other areas are entirely covered by low or high dunes (Db, Ds). In places the sandy loam soils are very rich in gypsum, having hard surface crusts. Where loamy soils occur, the dune areas have been classified as III/V or IV 1/V.

In the Wadi El Natrun depression the soils are highly calcareous fine sandy loams and coarse sands and gravels. The possibilities for development are very limited but some areas have been classified as IV 1/V, IV 1 or IV 2.

(iv) The Western Coastal Zone (Reconnaissance Sheet VIII)

To the west and north-west of the sand dune and sand plain landscapes described above lies a marine-lacustrine plain extending for some 60 kilometres east and west and with an average width of 15 kilometres. The soils are silt loam with clay loam subsoils; the silt loam topsoil may be very shallow (Pn) or moderately thick (Pn 13). Other areas are covered by very deep silty clay loams (Pm) sometimes with thin coverings of wind-blown sand (Pm 20). Locally the silty clay loams are shallow and overlie hard rock (Pm 4/20).

Further north, the marine-lacustrine plain is bordered by a zone with rocky beach ridges running parallel to the coast, between which flat stretches (salinas) show soils similar to those of the marine-lacustrine plain. These are very shallow silt loam over clay loam subsoils (Lc), or locally where the silt loam topsoil is thicker (Lc 13). In places there are outcrops of the underlying limestone (Lc 8/13).

The marine-lacustrine plains and the "salinas" between the beach ridges are considered to have good possibilities for agriculture, the deeper silt loam (Pm 13 and Lc 13) being in Class I and the other soils (Pm, Pm 20, Lc 8/13) in Class II.

The soils between the recent beach ridges in the coastal zone between Alexandria and El Alamein may also have possibilities for agriculture (see Fig. 4). They are shallow silty clay loams overlying hard rock with thin (Lr 20), or thick (Lr 21) sheets of sand on the surface. Other possible soils are the periodically flooded saline sandy clay loams (Lc), and the sandy soils (Ls 8, Ls, Lb, Ds 4/18) where patches of good deep soil alternate with shallow and rocky patches. These areas have been classified as III/m, IV/M and III/V.

(v) The Eastern Delta Fringe (Sheet IX and Semi-detailed Surveys)

These lands, between Cairo and the Suez Canal, show only very limited possibilities. Apart from extensive rock lands, the fringe includes very coarse fan and wadi deposits and sand dunes of no agricultural potentiality, but fairly extensive areas are considered to have some possibilities in spite of serious limitations. Such are the gravelly deltaic terrace soils which are loamy in the top 20 cms (Eg), gravel soils with reddish subsoils of younger river terraces (Rc), gravelly coarse sands of the younger river terraces (Rc 10, Rd), and the phase of the river terrace soils with loamy topsoil to a thickness of from 20 to 50 cms (Rc 7/10). These lands are classified as Class IV 1 and IV 2; the Rc soils are considered to have possibilities for tree crops only (Class IV 2 Tr).

(vi) The Coastal Zone of the Delta (Semi-detailed Surveys)

The clay soils of the delta plain are bordered towards the coast by a zone of low dunes and flooded sandy plains, from 1 to 10 kilometres in width, or separated from this coastal sandy zone by lagoon lakes like Burullus and Manzala.

Deposited in the brackish waters of lagoon-lakes and swamps inland of the sandy coastal barrier zone, the clay soils of the fluvio-marine marshlands contain little lime but much salt and gypsum. The exchangeable sodium and magnesium percentages are high and the soils are therefore saline/alkali; they are all heavy clays, but locally loam subsoils may provide better drainage.

The reclamation of the marshlands will need careful drainage and the correction of the saline/alkali conditions. Irrigations will be relatively easy, but tile drainage with pumping will be necessary to enable leaching of the soils.

These clay soils are generally classified as of medium suitability but subject to serious management limitations (Classes IIIB and IIIC).

Along the shores of lagoon-lakes there are swamps with clay soils which are younger phases of the fluvio-marine clays. The reclamation of these swamps, and the lake bottoms, will require major drainage works and the area has been classified as IVB, i.e. unsuitable except under special conditions and involving excessive reclamation costs.

VI. LAND CLASSIFICATION AND THE POTENTIAL FOR IRRIGATED AGRICULTURE

1. GENERAL

Although sprinkler irrigation has been introduced in recent years, only flood irrigation was formerly practised in Egypt and until about 1960 the maximum elevation to which water could economically be lifted for irrigation was considered to be 20 metres above the level of the Nile.

When it became apparent that the extension of agriculture in the desert fringes would involve the irrigation of coarse sands and gravelly sands, relative priority was given to the saline/alkali clay soils of the coastal marshes. Plans were also made to lift water 60 metres or more above the level of the Nile (to utilize areas of finer textured soils in the desert fringes) and to place more emphasis on sprinkler irrigation to economize the use of water on the coarse soils.

2. THE PRINCIPLES OF THE LAND CLASSIFICATION ADOPTED

In the light of these general considerations the land classification adopted for the Project surveys was essentially an "arability" classification; being based on the anticipated capacity of the land to produce a crop, given adequate irrigation and a good standard of management. The classification is not, therefore, an "irrigation suitability" classification as defined in the U.S. Bureau of Reclamation Manual (Vol. 5), although the two systems of classification have much in common. Further engineering, hydrological and economic studies and more detailed soil surveys would be needed to distinguish the irrigation classes and define priorities for development according to the procedure laid down in the U.S. Manual.

The present "arability" classification may be regarded as a first step in this direction and, particularly for the marginal and sub-marginal land in Classes III and IV, consideration has been given to the limitations imposed by cost of reclamation and special management requirements. Thus some soils may only be productive if high-value crops are grown by special methods, as for instance where the land can only be made remunerative by mixing the soil with large quantities of soil brought from elsewhere to provide a more favourable texture and better soil-water conditions. This mixing of coarse sandy soils with loam or clay loam is already practised locally.

The system of classification adopted follows closely the system introduced by Dr. A.M. Ghaith, Director of the Soil Survey, and described in Ministry of Agriculture Bulletin No. 283, "Aims and Methods of Soil Survey and Land Classification in Egypt" (1958), which in turn follows the general principles of the U.S. Bureau of Reclamation classification. Some modification of Dr. Ghaith's classification was necessary since his was intended primarily for land already irrigated and the availability of irrigation water forms an important criterion, whereas the present studies are concerned only with uncultivated soils.

It must be emphasized that all land has been classified on the assumptions that irrigation water is available and that standards of farming are adequate. Before any area can be developed, an economic study will, therefore, be necessary, and in many cases an engineering study and a more detailed soil survey also, in order to assess the feasibility of the project. The approximate area in each of the Land Classes is set out in Table 2 of Chapter II.

3. LAND CLASSES FOR THE RECONNAISSANCE SURVEY

The classes shown on the reconnaissance survey soil potentiality map sheets at the scale of 1 : 200,000 and 1 : 100,000 are defined below; some areas have been mapped as a complex of two or more classes.

Class I - (Very Suitable). Soils which are very suitable for the development of irrigated agriculture, and which are expected to be capable of producing sustained and relatively high yields from a wide range of crops. There are no soil limitations. This class comprises the well-drained silt loam soils of marine lacustrine plains and older beach ridges in the Alexandria-Cairo and Alexandria-El Alamein areas (sheets VII and VIII) and of Wadi plains and "youngest" river terraces in the Aswan-Isna area (sheet I).

Class II - (Suitable). Class II soils are expected to have a measurably lower productive capacity and are adapted to a somewhat narrower range of crops when irrigated. Some soil limitations may be present. Class II includes the following: silty clay loam soils with thin coverings of wind-blown sand; shallow silt loam soils in the marine-lacustrine plains and on older beach ridges; some stretches of saline sandy clay loam soils of "salinas" in the Alexandria-Cairo and Alexandria-El Alamein areas (sheets VII and VIII); very deep coarse sandy loam soils, locally with thin coverings of wind-blown sand, in the Alexandria-Cairo area (sheet VII); silt loam soils of the "youngest" river terraces in the Cairo-Suez area (sheet IX); and residual deep loam and clay loam soils of the plains in the Aswan-Isna area (sheet I).

Class III -(Medium Suitable). Class III comprises soils expected to be of moderate potentiality for irrigation farming. The range of crops is appreciably smaller than in Classes I and II. There are rather serious soil limitations, such as shallowness of the soil over rock, local coverings of wind-blown sand, coarse texture or very fine texture, stratification in the profile, gullying, and water-tables at depths of less than 150 cms. Class III includes: very shallow silt loam soils with local thin coverings of sand in the marine-lacustrine plains and on older beach ridges in the

Alexandria-El Alamein area (sheet VIII); shallow loam and clay loam soils with a high water table; gravelly loamy sand soils in "deltaic" river terraces and "younger" river terraces; some Wadi plain soils with alternating gravelly and sandy loam layers in the Cairo-Suez area (sheet IX); undifferentiated loose sands and gravelly soils with reddish subsoils of the "oldest" river terraces in the Alexandria-Cairo area (sheet VII); loamy sand soils of "younger" and "oldest" river terraces in the Isna-Nag Hammadi, Samalut-El Fayum, and El Fayum-Cairo areas (sheets II, V, VI); some Wadi plain and river terrace soils in the Aswan-Isna area (sheet I) comprising loamy sands and loamy coarse sands, gullied fine sands, and compact heavy clay loam and clay soils; some denuded rock land in the El Fayum-Cairo area, with patches of old alluvial clay and fine sand soils, is also included.

Class IV - (Suitable only under special conditions). Class IV comprises soils of limited use for irrigation agriculture. There are usually more severe soil deficiencies, mainly because of the texture and discontinuities in the profile which will create problems of water and plant nutrient availability or problems of drainage. It is certain that the yields of the traditional crops, under present conditions, will not cover the cost of production. Special measures of soil amelioration, such as mixing with other soils, will be required.

According to the severity of the soil deficiencies, two sub-classes (IV1 and IV2) have tentatively been distinguished , to establish their priority should lands in Class IV be considered for reclamation. Class IV includes: gravelly sands and coarse sand soils of fans and outwash plains; Wadi plain and wadi bottom areas; younger rubble terraces and river terraces; the deltaic stages of river terraces; the loose sands of ripple dunes and of medium to high dunes; some sandy soils in marine-lacustrine plains and in the Wadi Natrun complex; and some areas of coarse sands with rock outcrops in denuded rock land.

Small areas of Class IV 1 and IV 2 land are considered to have some possibilities for tree crops after irrigation has been established; these are distinguished as IV 1 Tr and IV 2 Tr and occur in the Alexandria-Cairo and Cairo-Suez areas. The soils are "gravelly soils with reddish subsoils" of the "oldest" and the "younger" river terraces, with undulating or nearly level relief.

Class V - (Suitability to be determined after further detailed investigations and with reference to special soil amelioration practices). Class V soils present such serious management and reclamation limitations that further investigations will be needed to assess whether, and to what extent, they are suitable for development under irrigation.

Class M - (Miscellaneous Land Types). Only very limited areas within this class may have some agricultural potentialities.

4. LAND CLASSES FOR THE SEMI-DETAILED SURVEYS.

The land classification for the semi-detailed soil potentiality maps, (1: 50,000) differs only in detail from the reconnaissance survey, the following classes and sub-classes being used:

Class I - Very suitable land
Class II - Suitable land
Class III- Medium suitable land, tentatively sub-divided into:

A - Moderate management limitations
B - Serious management limitations
C - Severe management limitations.

Class IV - Unsuitable Land, except under special conditions, with two sub-divisions:

A - Excessive annual costs of management to be expected
B - Excessive reclamation costs to be expected

Class V - Suitability to be determined after further detailed investigations and with reference to special soil amelioration practices.

Class VI - Rock Land

In some instances areas have been mapped as Complexes of two or more classes.

The above classes and sub-classes, their characteristics, expected potentialities, management and reclamation requirements are fully described in Volume III.

5. PRIORITIES FOR LAND DEVELOPMENT

1) From the point of view of soil properties and the character of the terrain, the lands considered best suited to the extension of irrigated agriculture are the Class I and Class II lands of the Maryut Region south-west of Alexandria, lying some 60 metres above the level of the Nile. The soils included are:

Class I (about 74,000 acres)

Soils of salina flats
Lc 13: Silt loam over clay loam

Soils of marine-lacustrine plains
Pn 13: Silt loam over clay loam

Class II (about 170,000 acres)

Soils of "salinas" between beach ridges
Lc 8/13: Silt loam over clay loam with local rock outcrops

Soils of marine-lacustrine plains
Pn : very shallow silt loam over clay loam
Pm : very deep silty clay loam
Pm 20 : very deep silty clay loam with thin sheets of wind-blown sand

2) Next in priority is the area in the Kom Ombo East Plain, lying to the east of the Nile some 40 kilometres north of Aswan and at elevations of 20 to 120 metres above the river. The lands are in Classes I, II and III and include the following soils :

Class I (about 14,000 acres)

Soils of the plains
Kharit series: Kr 1: Deep, reddish, compact silt loam
Nafath series: Nf 1: Deep, compact, reddish silt loam; subsoils fine sand
Nf 2: Deep, reddish, very fine sand, subsoil sand.

Soils of River Terraces
Casel series: Ca 1: Deep, dark silt soil
Ca 3: Shallow, dark silt loam over sand subsoil

Class II (about 14,000 acres)

Nubian Sandstone soils
Nuqra series: Nq 1: Deep loam over desintegrated rock; nearly flat.

Class III (about 93,000 acres)

Soils of Wadis
Na'ama series: Nm 1: Deep stratified loam
Nm 2: Deep stratified sand and loam

3) Below these two in priority, are several areas each of which has its own particular limitations. They are:

3.1) Small parcels of Class III land, and complexes of III and V, to an area of about 30,000 acres in the western fri ge between Idfu, Isna and Asyut, and generally from 10 to 20 metres above the level of the Nile. The soils included are:

Class III

Soils of River Terraces
Rx : Complex of fine sand, silt and clay soils.

Class (III+V)

Wind-blown sand areas
Ds : Loose sand soils of low-medium dunes, and clayey soils between dunes occupying from 30 to 70 percent of the surface.

3.2) A complex in the Kom Ombo West area north of Aswan, west of the Nile and from 40 to 60 metres above the level of the river:

Class (III+V) (156,000 acres)

Soils of river terraces
Rb 7: Gravelly soils with reddish subsoils and loamy coarse sand or loam soils, in flat and low-lying positions and covering from 30 to 70 percent of the surface.

3.3) Clay lands in the coastal areas of Rosetta East, Hamul-Baltim, Qaraa-Damietta, Salhiya-Port-Said, and Ismaeliya-Salhya. Irrigation would be relatively easy but tile drainage with pumping would be necessary, to enable leaching to improve the saline-alkali conditions. These clay lands comprise:

Class III A

Soils of the fluvio-marine marshes
Burullus series: Bu 1: Very poorly drained clay soils
Bu 2: Poorly drained clay soils, topsoil not cracked
Bu 3: Poorly drained clay soils, topsoil cracked

Buto series: Bo 1: Moderately well-drained clay soils
Bo 2: Well-drained clay soils. Locally low clay dunes.

Khashaa series: Kh 1: Clay or loam soil, moderately deep over sand
Kh 2: Clay or loam soil, shallow over sand

Class III B

Soils of the fluvio-marine marshes
Manzala series: Ma 1: Moderately well-drained clay soil
Ma 2: Well-drained clay soil; locally low clay dunes
Ma 3: Well-drained clay soil; locally medium high clay dunes

Class III C

Soils of the fluvio-marine marshes
Port-Said series: Ps 1: Very poorly drained clay soil
Ps 2: Poorly drained clay soil; topsoil not cracked
Ps 3: Poorly drained clay soil; topsoil cracked

4) Below these three priority categories, mention should be made of two further possibilities, but both present such serious limitations that their development must be subject to a detailed study of the technical and economic problems involved.

4.1) The reclamation of the swamps bordering the lagoon lakes of the delta: Maryut, Idko-Burullus, Manzala etc., and of the lake bottoms themselves, might be expected to provide soils of similar productivity to those of the fluvio-marine marshes mentioned in priority (3.3). At present they are heavy saline-alkali clays with poor drainage. The swamps have been classified as miscellaneous land types in Land Class IV B, that is to say, suitable for development only under special conditions and subject to excessive reclamation costs.

4.2) The sands and gravelly sands of the desert fringes will be costly to reclaim and will require careful management. Some areas may however be suitable for three crops, using large planting holes filled with well prepared soil from elsewhere. Other areas may be made suitable for a wider range of crops by building up a topsoil, suitable in depth, texture and retentivity of moisture, by the addition of large quantities of loam and clay loam. Such material is more abundant in the substrata of the rubble terraces between Isna and Cairo. To economize in water use, sprinkler irrigation will usually be advisable after reclamation.

These areas have been mapped as Class IV or even Class V.

6. CONCLUSION

The last paragraph, in setting out the priorities for development in terms of soil types and land classes, amplifies the first and most specific of the recommendations made in Chapter II. This has in fact been objective of the Special Fund High Dam Soil Survey Project in the UAR throughout its period of operation: a soil survey and land classification of the desert fringes of the Nile valley and delta as an essential preliminary step towards the long term development of agriculture made possible by the construction of the High Dam.

ANNEXE III

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS OF THE PANEL OF CONSULTANTS

1. The Government of UAR, the Food and Agriculture Organization of the United Nations and the UN Special Fund agreed to call a meeting of the Panel of Consultants to advise them in the final stages of the execution of their joint project on the High Dam Soil Survey. The objectives of the Panel are to advise on the:

a) Suitability of soils surveyed during the project for irrigation from the High Dam, and give recommendations on allocation of priorities for actual development.

b) Technical and economic aspects of irrigation and reclamation of suitable areas as well as of marginal and less suitable areas as follow-up activities by the Government.

2. Such a Panel Meeting was held at Cairo between March 11-21, 1964. It consisted of 6 days discussions and 4 days of field excursions. The participants consisted of five FAO and twelve UAR consultants in the field of: soils, irrigation engineering, land reclamation, drainage and land development, and agro-economy. The FAO Project-Manager and the Government Co-Manager took very active and leading parts in the discussions. UNSF and FAO Project officers from their respective headquarters in New York and Rome, also participated. The detailed list of participants is given on page 45.

3. A large number of papers and documents all related to the main theme of the Panel Meeting were presented or distributed.

4. A four-day excursion was organised by the Government in order to afford the opportunity to the Consultants to see the project area and to discuss the problems in the field. In addition, several of the members of the Panel made extensive field trips in selected areas to form their views to give recommendations expected of them.

5. In order to give views on the various aspects of the project, six topics were discussed in the Panel. These topics are:

a) Correlation of irrigation and drainage design to soil types.

b) Making of new lands.

c) Economic consideration on reclamation of land including development of marginal and sub-marginal lands.

d) Soil survey and land classification.

e) Priority for land development in the project area.

f) Follow-up of the project.

6. The Meeting gave the following conclusions and/or recommendations:

a) The meeting fully endorsed the soil maps prepared by the project, both reconnaissance and semi-detailed, and which used aerial photo-interpretation techniques.

b) The meeting suggested some modification in the definition of classes which should be called soil potentiality classes rather than land classes. These changes do not affect any boundaries in land classification maps prepared.

The conclusions and/or recommendations on each of these topics are given below.

7. On correlation of irrigation and drainage design to soil types, the conclusions are:

a) For irrigation design, conclusions are:

i) Irrigation intervals from 1 to 6 days can be expected depending upon the daily water-use rates, the water holding capacity of the soil and the effective root zone depth of the sandy soils.

ii) Sprinkler irrigation will be needed on these sandy soils.

iii) Deeper rooting crops will afford longer irrigation intervals. Tree crops should offer satisfactory intervals between water applications.

iv) The 4 mm per day and 5 mm per day consumptive use areas would require frequencies from 1-4 days, with most of the frequencies falling between 1 and 3 days.

v) The 3 mm per day water use areas would allow 2-6 day irrigation intervals on soils similar to that shown in item iv.

vi) The total amount of water used for sprinkler and surface irrigation, sprinkler efficiency at 70% and surface efficiency 50%, for 300 days of use is shown below.

	5 mm/day	4 mm/day	3 mm/day
Sprinkler	8,820 m^3	7,180 m^3	5,418 m^3
Surface	12,600 m^3	10,080 m^3	7,560 m^3

Recommendations are:

The soil texture needs to be changed, in order to increase the water-holding capacity by one or more of the following:

i) Addition of organic matter.

ii) Addition of silt or clay in the irrigation water.

iii) Addition of silt or clay separate from the irrigation water.

iv) Expand crop possibilities over present.

v) Sprinkler irrigation improvement should be a continuous process.

b) On drainage, recommendations are:

i) Continue observation of water tables in Tahrir North projects and similar projects, in order to remedy any ill-effects of the building up of a water table through the construction of an appropriate drainage system.

ii) Maximum use should be made of the experience accumulated in the Ministry of Public Works for the procedure of detailed designs for drainage systems.

iii) Reclamation of saline/alkali soils to be continued in the same way as at present. Consideration might be given to adopt a closer spacing for these reclamation projects in the first initial years.

iv) It is desirable to do more studies on the unripe clay soils both in the field of profile development and in the field of anticipated subsidence.

8. On the subject of "Making New Lands" the following conclusions were agreed:

a) For reclamation of new lands preference should be given to procedures with higher initial capital investment and lower annual costs over procedures with lower initial capital investment and higher annual costs.

b) Investigations should be carried out in pilot schemes in order to properly assess difficulties, possibilities and economics of procedures for making new land through the addition of silt and/or clay material.

c) Additional investigation as to soil improvement measures like the use of green manure crops, crop residues, compost and composted town refuse should also be conducted.

Special attention should also be given to the required depth of this man-made top layer and ways and means to come to a homogeneous formation of this.

d) The effect of making plant holes on the development of the root system of tree crops needs to be studied in order to find out whether root development is limited to this plant hole. The results of these studies could have a bearing on tree spacings and consequently on the number of trees per feddan.

e) These man-made soils will undoubtedly result in a better irrigation efficiency, thus economising in the use of water, whereas also a wider variety of crops can be grown on these soils.

f) It was suggested that the possibilities and feasibility of conveying silt-laden water between two curtains of air bubbles was to be studied further in Lake Nasser.

9. Economic consideration on land development including reclamation of marginal and sub-marginal lands were discussed and the following recommendations were given:

a) Continue the emphasis on reclaiming the soils of relatively more suitable potentiality, while carrying out pilot schemes and other studies, including a more synthesized study (economic, engineering, irrigation, agronomy and soils) on less suitable and problem soils. As a first step in this synthesis, a committee representing these various fields of interest might be appointed to study the presently proposed reclamation projects, based upon their "Soil Potential" classes developed from this Soil Inventory Project, and indicate their relative position on such factors as:

i) "Expected physical productivity" (High, Medium or Low, etc.)

ii) "Reclamation costs"

iii) "Irrigation costs"

iv) "Farm operation costs"

v) "Management ability required"

and such other factors as would help to arrive at the relatively net returns from each project. The work of the committee might also form the basis for developing a land classification map.

b) Continue studies of crop suitability to soil potential classes and compare these with gross returns from the current "same three-year rotation" used on the several different kinds of lands. Review the kinds of crops, according to the kinds of soils and new methods and practices. With increased supplies of water and commercial fertilizer becoming available, a critical review of the current crop rotation practices on certain soil areas might be in order.

c) Place great emphasis on cost-benefit ratios as a means of resource allocation and developing reclamation project priorities. Improved estimates of expected yields, gross crop values, and farm production costs on each crop as a means of determining gross and net returns per feddan by crops, will assist in improving these cost-benefit estimates. Studies of production on farms and areas in similar reclaimed soil areas would be especially helpful.

d) Develop and utilize market studies, which would indicate consumer needs and foreign market possibilities as to food and fiber products and synthesize these findings with production specialists as to soil areas (and location) best suited to meet these individual crop needs.

10. On soil survey and land classification it was agreed to limit the definition of the land classes to the physical and chemical characteristics of the soil with no reference to economics. It was also agreed to publish both the soil survey and land classification (soil potentiality) maps.

The Panel recommended that other factors being equal, first priority for development be given to those projects that have the best soils with classes I, II and III. The projects with a high percentage of class IV should have a low priority and with class V a still lower priority for development.

11. The priority for land development in the project areas were discussed. A provisional list was presented by the Government. It was concluded that the priority list be considered only as first approximation based on soil factors and on their potentiality for the development of irrigated agriculture. It was recognised that economic, social and other factors may modify the priority to be given finally by the Government. The Panel recommended that:

a) Further studies be made especially on classes of land with lower potentiality: both cost-benefit studies as well as pilot projects for irrigated agriculture, in order to assess their rating of priority of actual development.

b) Soil studies be conducted of some lake bottom and other areas not included under the joint High Dam Soil Survey Project.

12. With respect to the follow-up of the project, the aspects of a financial advisory service and additional advisory technical assistance were discussed.

Under the second aspect there was the agreement that, pilot projects should be considered in particular for problem areas, whereas for other development areas experiment or development farms and the strengthening of existing research stations seemed preferable.

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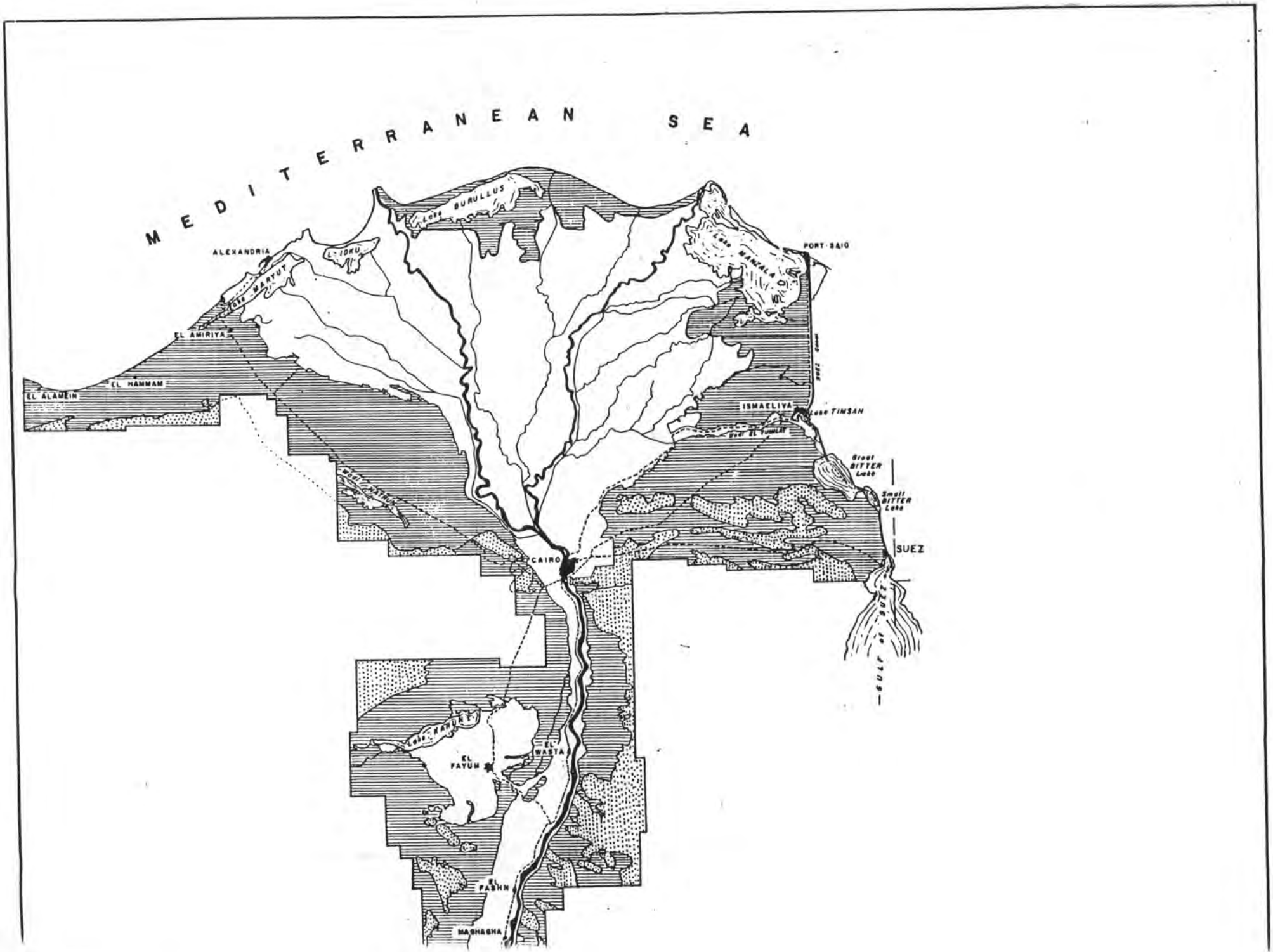

MEDITERRANEAN SEA
ALEXANDRIA
L. IDKU
Lake BURULLUS
Lake MANZALA
PORT SAID
L. MARYUT
EL AMIRIYA
EL HAMMAM
EL ALAMEIN
ISMAELIYA
Lake TIMSAH
Great BITTER Lake
Small BITTER Lake
SUEZ
CAIRO
Lake KARUN
EL FAYUM
EL WASTA
EL FASHN
MAGHAGHA
GULF of SUEZ

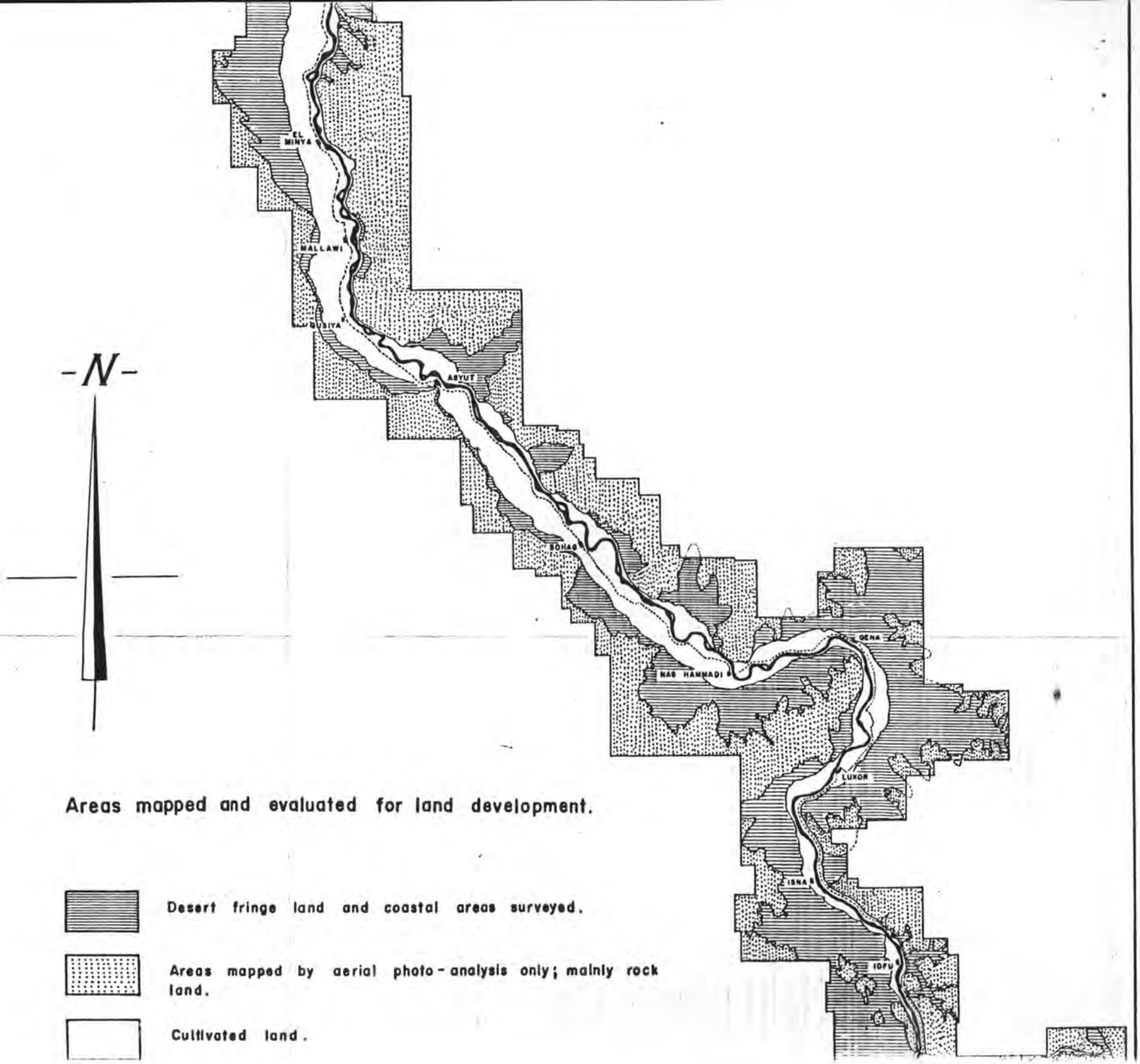


Fig. 1.a Areas mapped and evaluated for land development.

Desert fringe land and coastal areas surveyed.

Areas mapped by aerial photo-analysis only; mainly rock land.

Cultivated land.

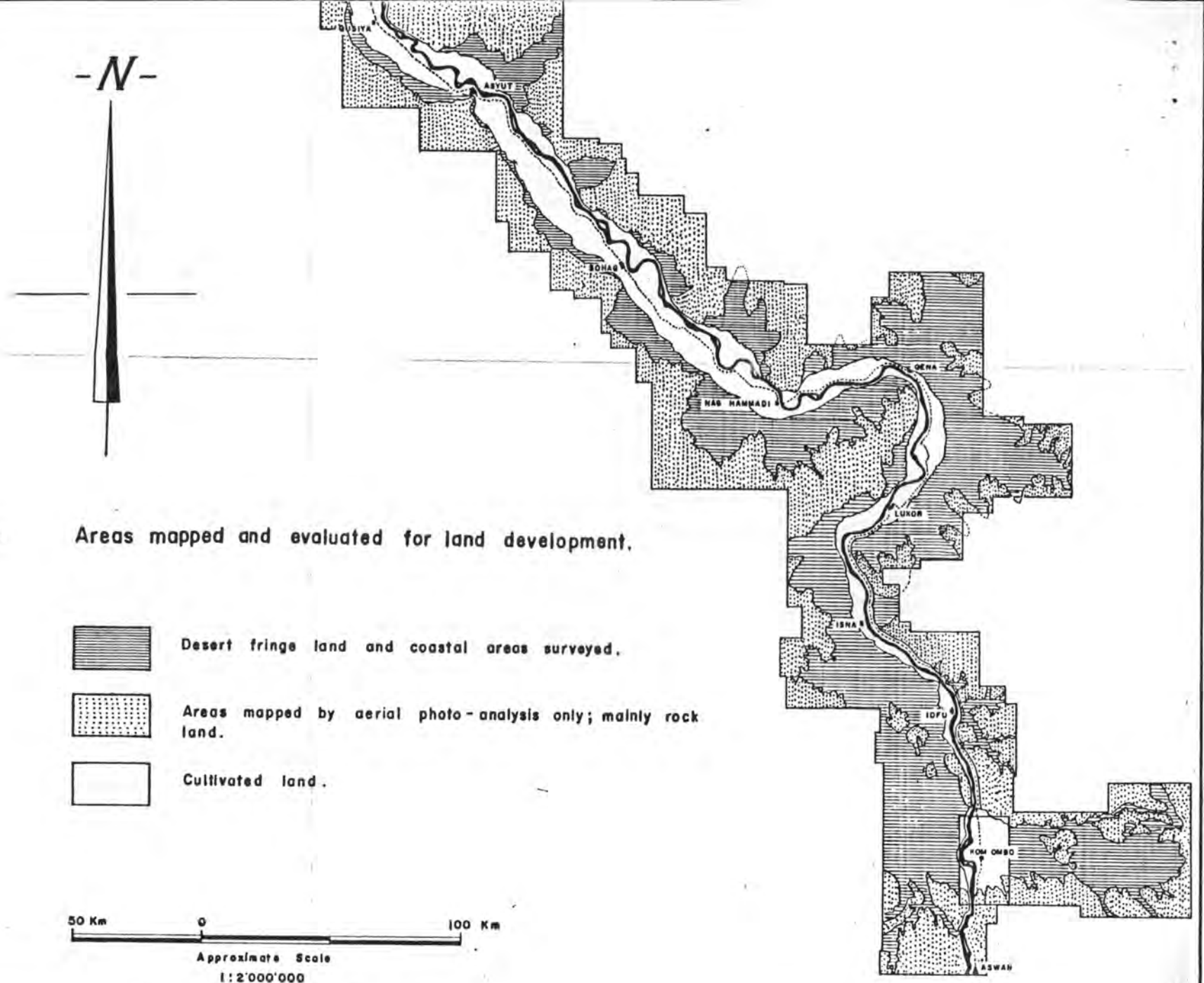


Fig. 1.a Areas mapped and evaluated for land development.

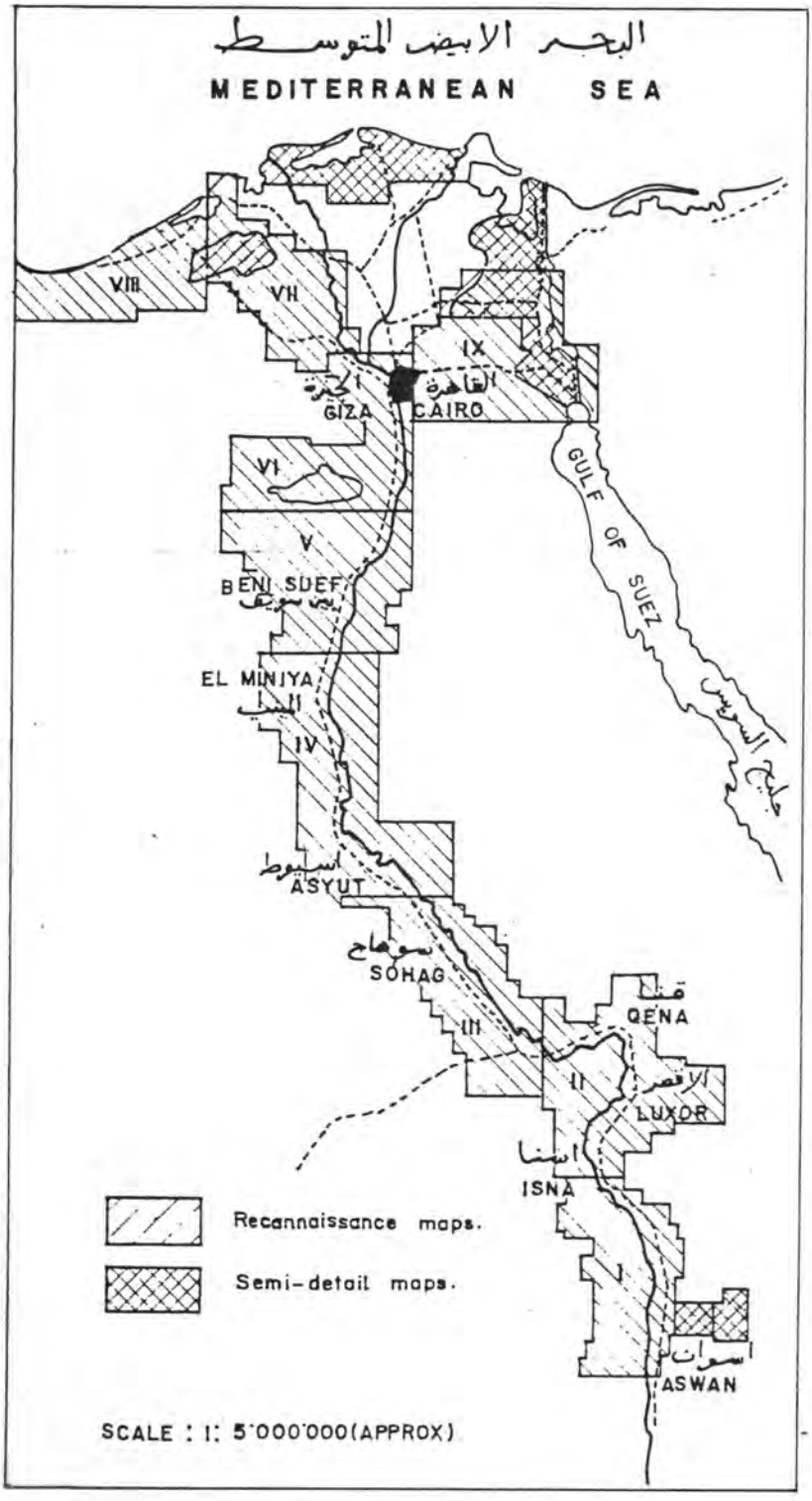
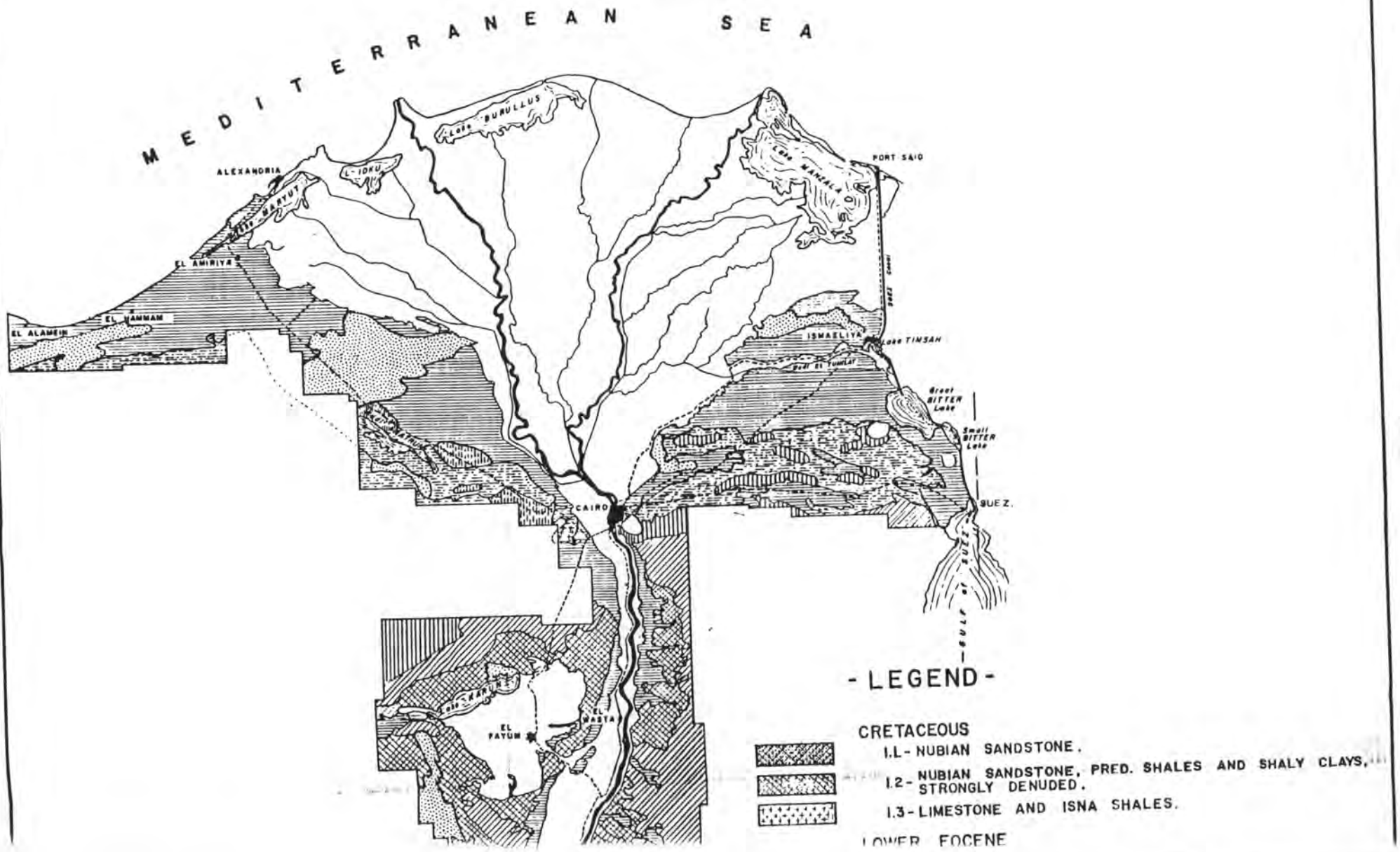


Fig. 1.c General orientation of areas mapped in reconnaissance (sheet I through IX) and semi - detail

APPROXIMATION OF GEOLOGIC FORMATION ACCORDING TO AERIAL PHOTO INTERPRETATION



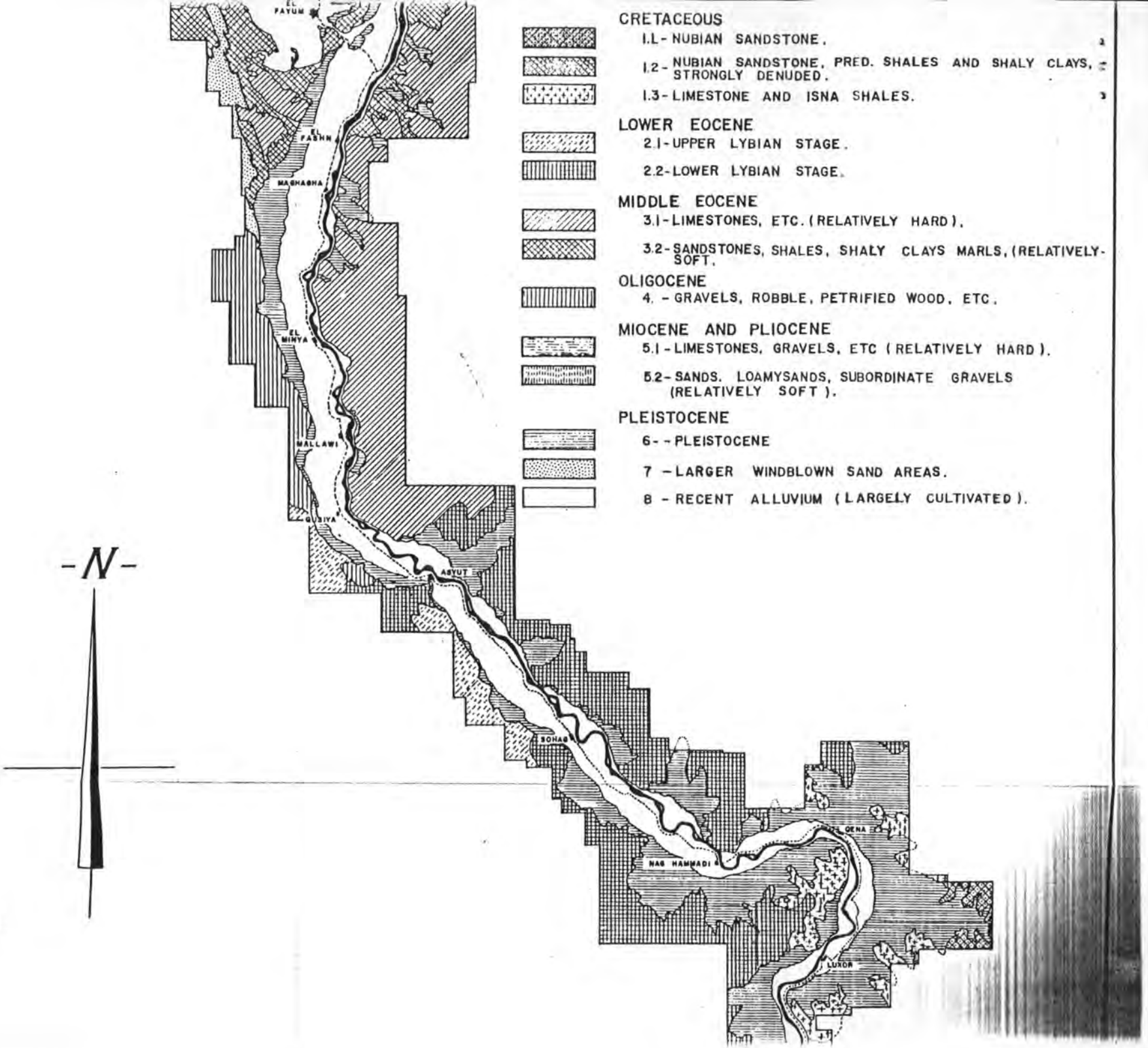

CRETACEOUS
1.1- NUBIAN SANDSTONE.
1.2- NUBIAN SANDSTONE, PRED. SHALES AND SHALY CLAYS, STRONGLY DENUDED.
1.3- LIMESTONE AND ISNA SHALES.
LOWER EOCENE
2.1- UPPER LYBIAN STAGE.
2.2- LOWER LYBIAN STAGE.
MIDDLE EOCENE
3.1- LIMESTONES, ETC. (RELATIVELY HARD).
3.2- SANDSTONES, SHALES, SHALY CLAYS MARLS, (RELATIVELY-SOFT.
OLIGOCENE
4. - GRAVELS, ROBBLE, PETRIFIED WOOD, ETC.
MIOCENE AND PLIOCENE
5.1 - LIMESTONES, GRAVELS, ETC (RELATIVELY HARD).
5.2- SANDS. LOAMYSANDS, SUBORDINATE GRAVELS (RELATIVELY SOFT).
PLEISTOCENE
6- - PLEISTOCENE
7 - LARGER WINDBLOWN SAND AREAS.
8 - RECENT ALLUVIUM (LARGELY CULTIVATED).
-N-
EL FAYUM
EL FASHN
MAGHAGHA
EL MINYA
MALLAWI
QUSIYA
ASYUT
SOHAG
QENA
NAG HAMMADI
LUXOR

Fig. 2

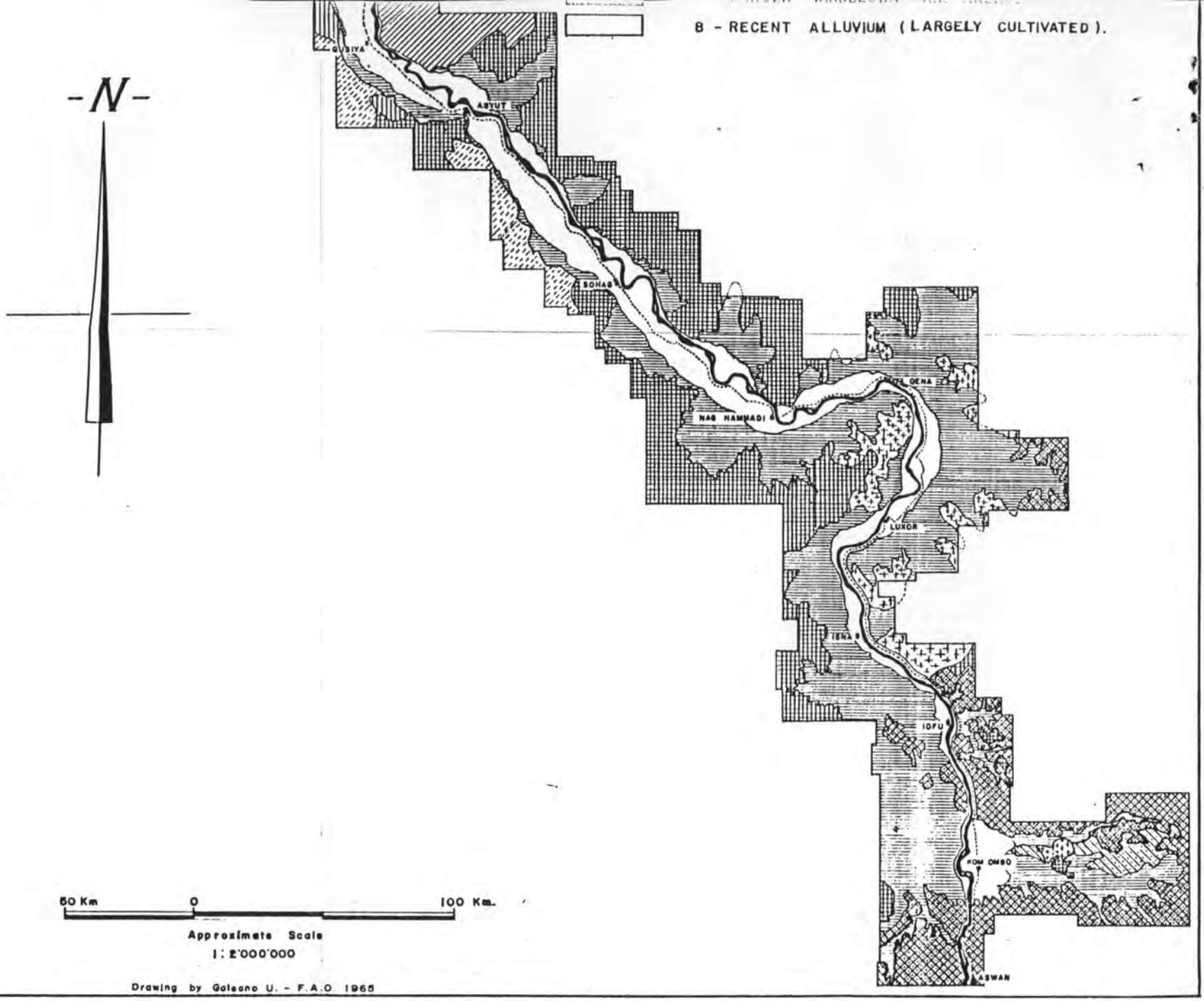

B - RECENT ALLUVIUM (LARGELY CULTIVATED).
-N-
ASYUT
SOHAG
NAG HAMMADI
QENA
LUXOR
ISNA
IDFU
KOM OMBO
ASWAN
50 Km
0
100 Km.
Approximate Scale
1 : 2'000'000
Drawing by Galeano U. - F.A.O 1965

Fig. 2