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Department of Technical Co-operation for Development

Natural Resources / Water Series No. 9

GROUND WATER IN THE EASTERN MEDITERRANEAN AND WESTERN ASIA

General Introduction and Appendices

UNITED NATIONS
New York, 1982

FORWORD

The Economic and Social Council, by resolution 675 (XXV) of 2 May 1958, requested the Secretary-General to take appropriate measures for the establishment, within the Secretariat, of a centre to promote co-ordinated efforts for the development of water resources. It also singled out ground-water problems as one of the priority subjects in the development of a programme of studies. Large-scale Ground-water Development, published in 1960, 1/ was the first study prepared in this field by the Water Resources Development Centre (now the Water Resources Branch of the Division of Natural Resources and Energy, Department of Technical Co-operation for Development).

The Advisory Committee on the Application of Science and Technology to Development, in its World Plan of Action, 2/ gave priority to ground-water exploration and development. In fact, in the course of the First and Second United Nations Development Decades, more than 100 projects assisted by the United Nations Development Programme (UNDP) and other United Nations technical co-operation programmes were entirely or partially devoted to ground-water prospecting, assessment or pilot development. (A list of ground-water projects in the eastern Mediterranean and western Asia sponsored by UNDP is contained in the annex to the present report.)

While such operational activities were developing, the need for a comprehensive review of the results of the projects and for a dissemination of relevant information became more evident. As a result, the Economic and Social Council, by resolution 1761 B (LIV) of 18 May 1973, requested the Secretary-General to take the necessary measures, within the budgetary limitations, to improve and strengthen the existing United Nations services for the analysis, evaluation and dissemination of world-wide data on natural resources, including water resources.

With respect to ground water, a first comprehensive review of the African continent was published in 1972 and 1973 under the title Ground Water in Africa 3/ as a synthesis of material available in the records and files of the United Nations. The material of the second volume in this series, Ground Water in the Western Hemisphere, 4/ was drawn from country papers which were prepared by hydrogeologists and by ground-water engineers, specialists of the countries concerned. The material of the present volume (the third in the series), Ground Water in the Eastern Mediterranean and Western Asia, has also been drawn from

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1/ United Nations publication, Sales No. 60.II.B.3.

2/ United Nations publication, Sales No. E.71.II.A.18.

3/ United Nations publication, Sales No. E.71.II.A.16.

4/ United Nations publication, Sales No. E.76.II.A.5.

country papers prepared by ground-water specialists. Due to the abundance of interesting and specialized information obtained on a country basis and to the necessarily limited format of the publication, it has not been possible to present a broad overview of ground-water occurrence and development in the whole region, as was the case with part I of Ground Water in Africa.

It is hoped that the present publication, the first to provide a comprehensive view of the ground-water resources of the eastern Mediterranean and western Asia, will contribute to their development, especially in those areas where ground water is the only source of water supply and a key factor in economic and social development.

The United Nations wishes to acknowledge the valuable assistance provided by government organizations and by consultants and specialists who assisted in the preparation of the country papers, in particular W. R. Agha, M. Bergman, S. Bezirgan, R. L. de Jong, I. M. Elboushi, J. H. Johnson, J. Karanjac, J. Khoury, D. C. Kypris, A. A. Maleh, S. Mandel, S. Omar, A. A. Shata, A. Souresfil and M. Ubaid. The final draft was reviewed by Dr. P. E. La Moreaux, Professor of Geology at the University of Alabama, Tuscaloosa, United States of America, and President of the International Association of Hydrogeologist

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INTRODUCTION

The region covered by the present publication is commonly referred to as the Middle East. Most of its boundaries are well defined (see map 1): to the north by the Black Sea, the southernmost ridges of the Caucasus Mountains and the Caspian Sea; to the west by the Aegean, the Mediterranean and the Red Seas; and to the outh by the Gulf of Aden and the Arabian Sea. Less well defined boundaries are to the west, across the Libyan desert and to the north-east and east of Iran.

The term "Middle East" does not express the fundamental character of the region in that its unique location is at the crossroads of three continents. It may be considered the fragile hinge of the eastern hemisphere, if not of the world. The cradle of monotheist religions, it is rich in culture and inhabited by a mosaic of peoples, with an eventful and turbulent history and an unstable political geography.

In the past 30 years or so, the region, which has always played a major role in world affairs, has gained a new importance owing in particular to the discovery of major oil deposits. It is estimated that two thirds of the known reserves of oil in the world are located in the region, which produced more than one fourth of the current world oil output in 1978. It is important to note, however, that most petroleum deposits are concentrated in a relatively small horseshoe-shaped area around the Persian Gulf and that only half of the countries of the region are oil producers.

Metallic ores have been mined in the region, but the deposits are not of international importance and do not give rise to significant ore exports, with the exception of chromium in Turkey and, to a lesser extent, copper in Cyprus, Iran and Turkey.

The vast majority (two thirds) of the population is engaged in agricultural or pastoral activities which are concentrated on 5 per cent of the land, mainly along the shores of the Mediterranean Sea, the Black Sea and the Caspian Sea, in the Nile valley, in Mesopotamia (the ancient civilization lying between the lower Tigris and the Euphrates rivers, now a part of Iraq), and in the highland areas of Turkey and Iran (see map 2). About 95 per cent of the land is part of the arid or desert zone (see map 1) and includes scattered oases.

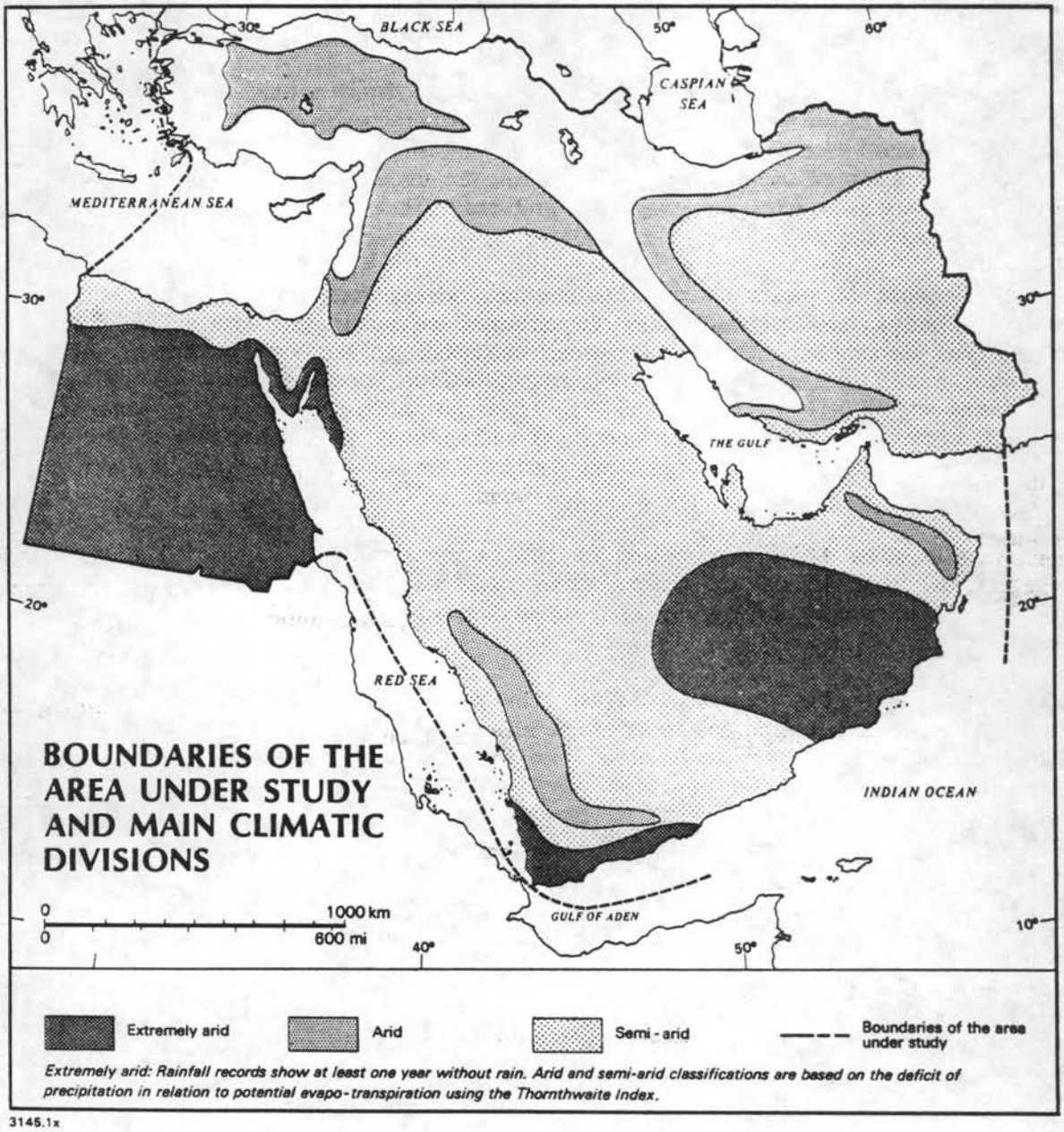
One of the main agricultural areas of the region, known as the Fertile Crescent, stretches from the Nile delta along the shores of the eastern Mediterranean to the north and then to the east and the south-east through Mesopotamia to the northern end of the Persian Gulf. The Fertile Crescent itself is at the juncture of the three subregions of the Middle East: the platforms of Egypt and Arabia to the south, the plateaux bordered by folded mountains stretching to the north in Turkey and Iran, and the transition zone of the eastern Mediterranean countries, which corresponds to the central section of the Crescent.

Most of the land in Egypt, in the Arabian Peninsula northwards to the Euphrates River and in central and eastern Iran, is a desert, sparsely populated

Map 1

Boundaries of the area under study and main climatic divisions

MAP 1



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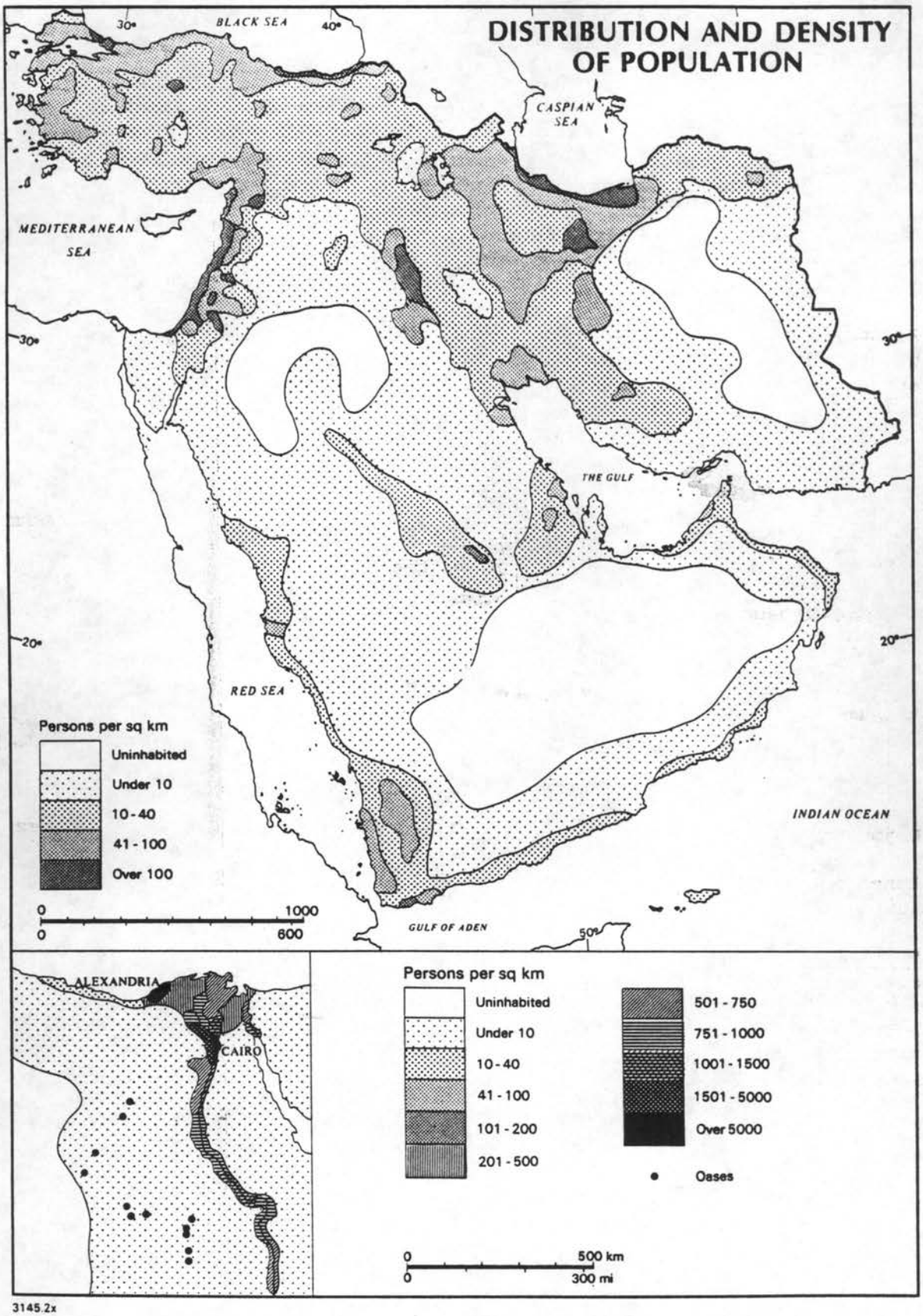
Map 2

Distribution and density of population

MAP 2



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except in some mountain areas, valleys and oases. The total population is about 170 million, more than 55 per cent of which are Arabs. In the past 40 years, many movements of population have taken place, dramatically at times, which have affected millions of people; for instance, the movement of Jews to Israel and of Palestinians to various Arab countries, and the influx of manpower (including workers and professionals from countries outside the area, such as India, Pakistan and the Sudan) into oil-producing areas.

The development of industrial and urban areas, the need to increase agricultural production and, more generally, the over-all drive of the Governments and peoples of developing countries towards better socio-economic and living conditions, have resulted in a rapidly increasing demand for water, especially ground water, which is the only source of water supply in most of the region. In some countries, ground-water exploration and development, financed by the income from oil production have reached spectacular levels, but in many cases have proved costly.

A summary of the over-all natural conditions, that is, climate, morphology and geology, to which the occurrence of ground water is related, is given hereafter for the region, except for the desert areas of Egypt, the interior of the Arabian Peninsula and central and eastern Iran.

Climate

To the west, the climate is by and large of the Mediterranean type, with a rainy season in the winter and a dry season in the summer. Areas with the most rainfall are those facing the Black Sea and the Mediterranean Sea, the annual amount averaging 1-2/m. In the interior, rainfall is 250 mm or less (see map 3). Sharp contrasts in temperature on a daily or seasonal basis are experienced in many areas. Winters are cold in the mountains and the highlands of Turkey and Iran, but generally mild elsewhere. The Gulf area is extremely hot during the summer, with temperatures exceeding 40° C.

Physiography

Major relief features are shown in map 4.

Based on the physiography and morphology, the area is divided into the following main units:

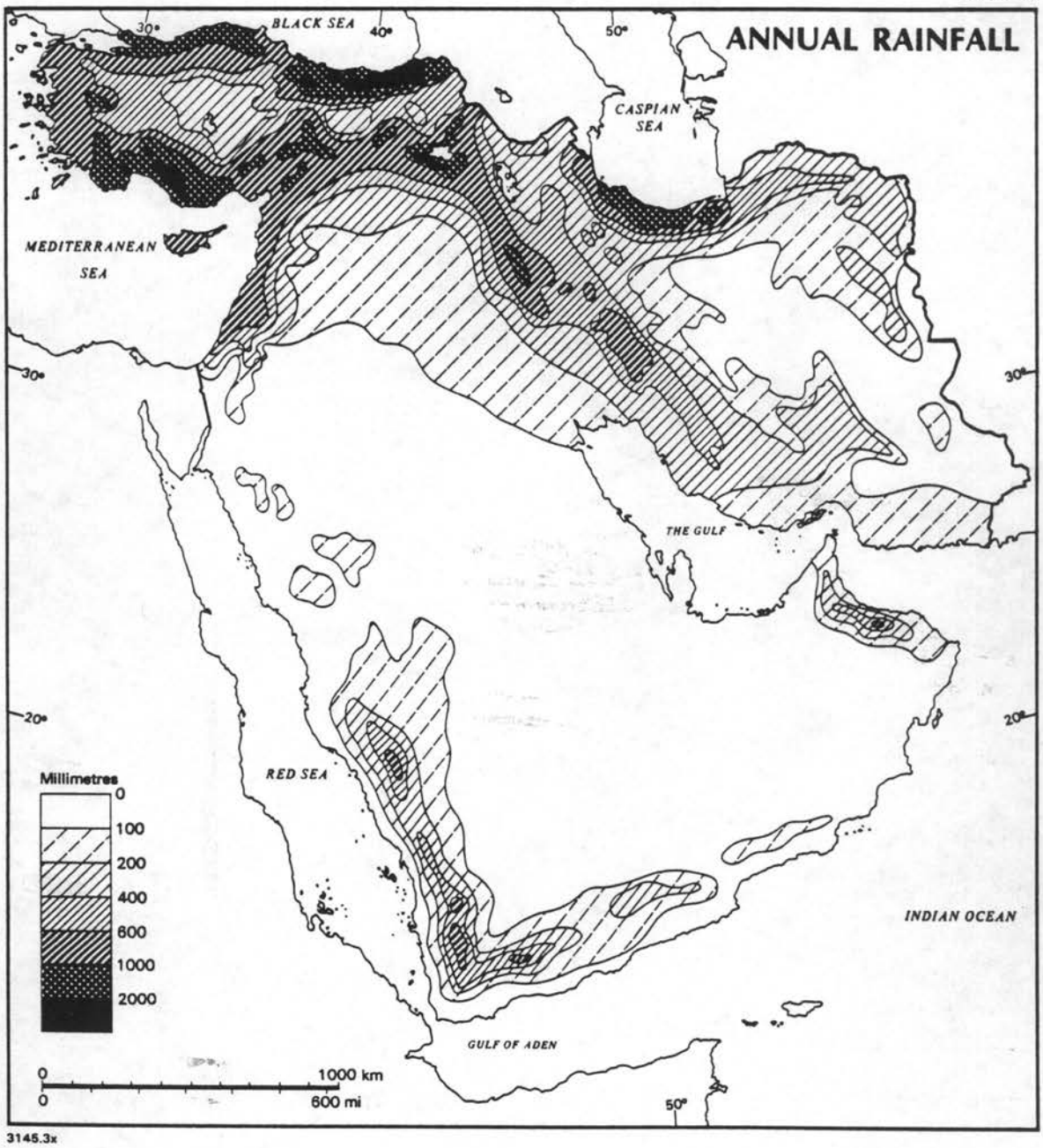
Mountains The Taurus mountains (3,700 m) and Pontine mountains (2,500 m to the west; up to 3,900 m to the east) in Turkey; the Alborz (up to 5,600 m) and Zagros (4,500 m) mountains in Iran; the ridges bordering the Red Sea in Egypt (up to 2,100 m); the Arabian Peninsula (2,500 m to the north near the Gulf of Aqaba; 3,200 m to the south, 2,500 m in the Hadramaw and 2,000 m in Oman) and the Lebanon mountains (3,000 m).

Plateaux are the morphological units prevailing in Turkey and Iran and the western part of the Arabian Peninsula. Most of these regions have little or no drainage to the sea. As a result, they contain a number of lakes, some of sizable proportions (in Turkey and Iran), sometimes with saline waters; in the arid desert areas of Iran, vast dry salt lakes can be observed.

Map 3

Annual rainfall

MAP 3



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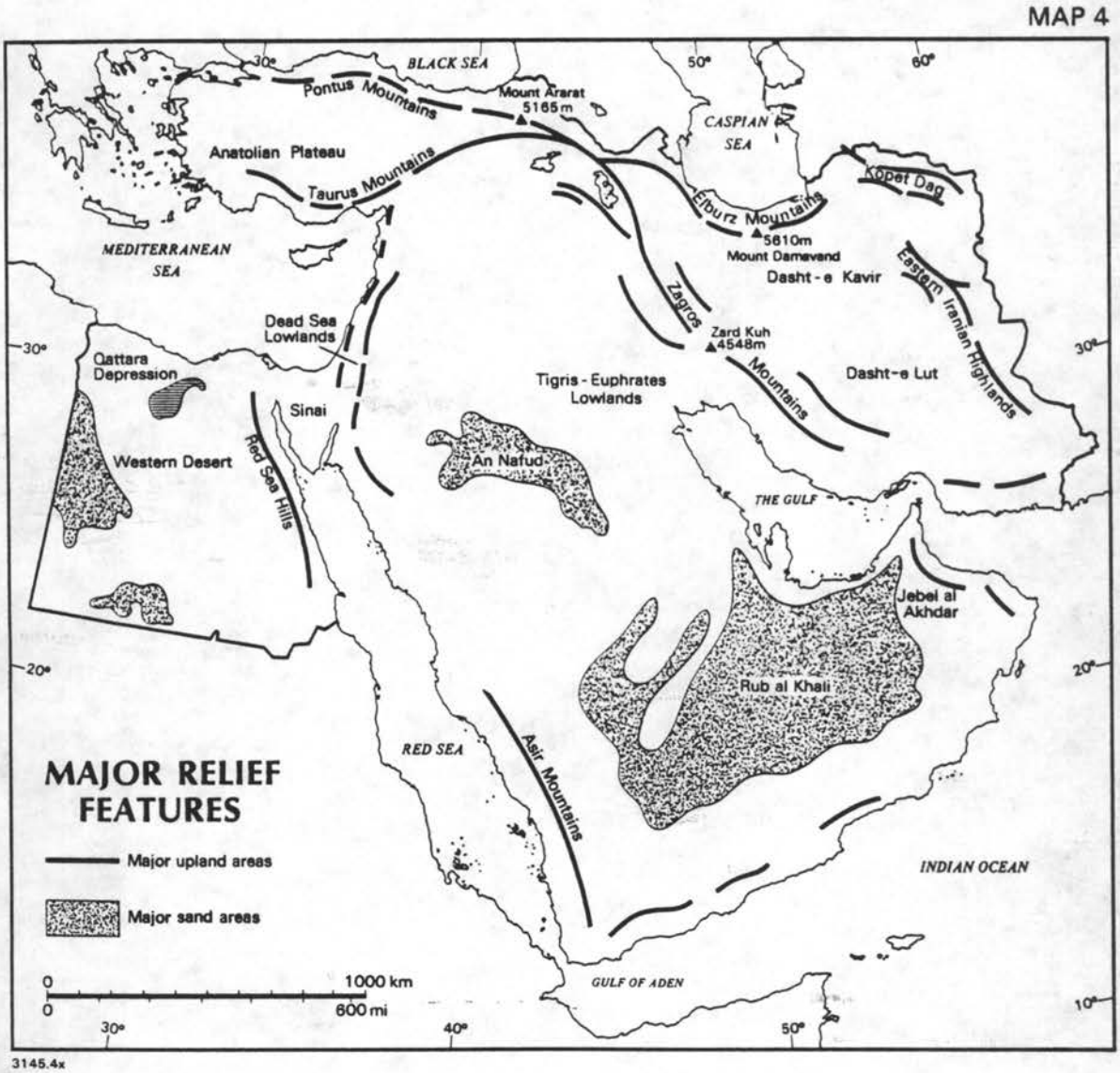
Map 4

Major relief features



Plains The region includes two vast flat areas. In Egypt, the elevations decrease from 500 m in the south over a distance of nearly 1,000 km to the shores of the Mediterranean Sea, with depressions below sea level; and in the Arabian Peninsula, the elevations decrease from 1,000 m in the west (the mountain ranges parallel to the Red Sea) in an easterly direction through the An Nafud and the Ad Dahna to the Gulf, over distances of 400-600 km.

Shore-lines in general are rugged and dominated by cliffs. Main coastal plains are around the Caspian Sea and along the Gulf.

From the above general descriptions, it can be observed that with regard to climate, especially rainfall, and topography, (the mountain valleys and piedmont areas excepted), natural conditions are not favourable to the recharge of ground water by direct infiltration of rainfall or run-off for the following reasons:

(a) Direct infiltration of rainfall in flat areas under hot climates does not occur as water evaporates before it can infiltrate;

(b) Run-off occurs only during short periods; it is lost to the sea in coastal mountainous areas (Lebanon) or in saline depressions inland on the plateaux.

Geology

The geology of the area is shown in map 5.

In general, the main ground-water bearing formations are as follows:

(a) River alluvium in the Nile valley and delta, in the Tigris-Euphrates valley, in the Hadramaw valley and in various intermontane valleys, and in wadis of the Arabian Peninsula;

(b) Karstic Mesozoic limestones in the Mediterranean area (Turkey, the Syrian Arab Republic and Lebanon) and Iran;

(c) Extended and thick Mesozoic and Cenozoic sandstone aquifers in Egypt and the Arabian Peninsula. In the latter, a thick complex mass of sediments contains several aquifers, mostly confined, and sometimes wells flow at the surface when drilled.

The main problems experienced are those related to:

(a) The depletion of non-renewable ground water in artesian aquifers;

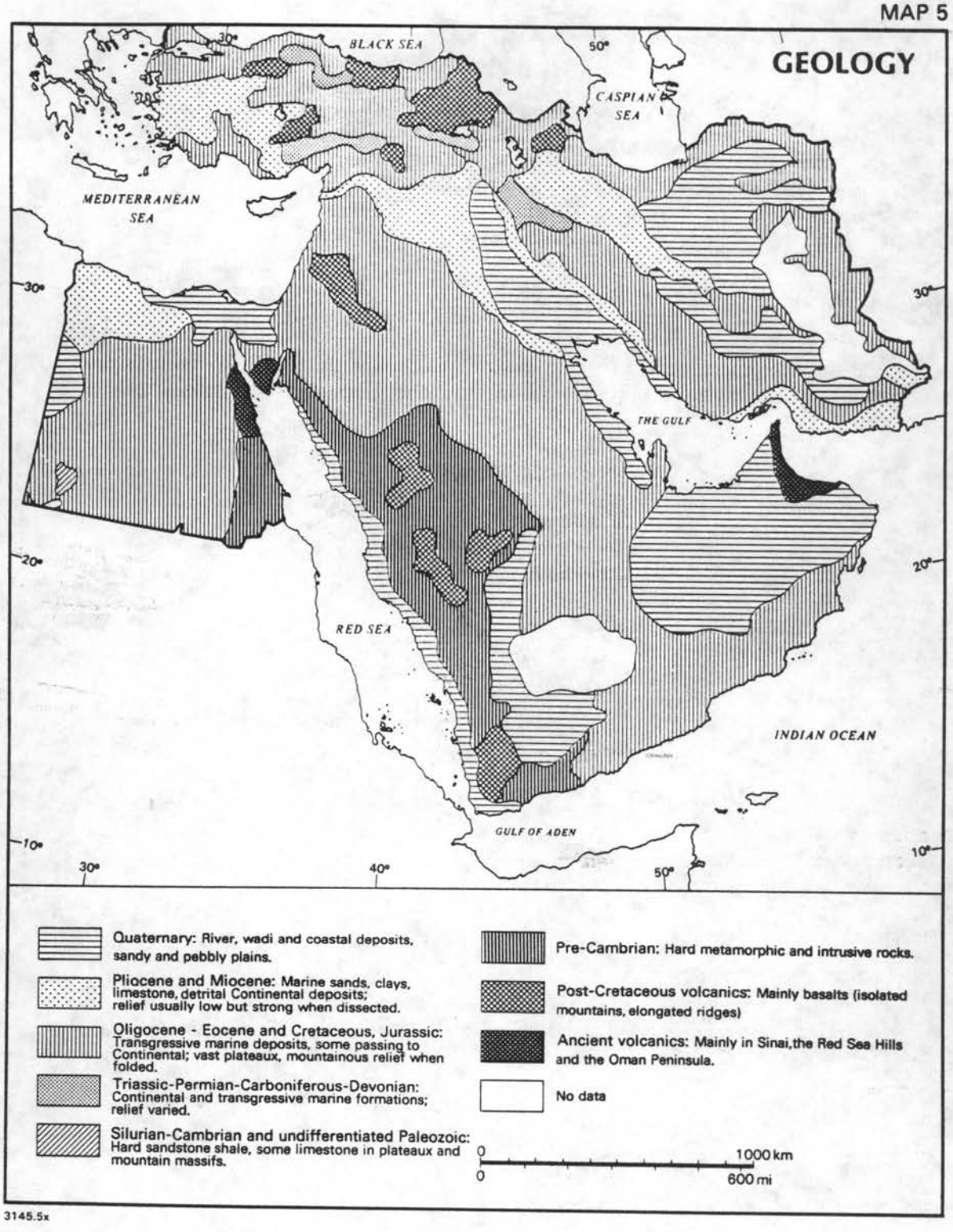
(b) The high dissolved solids of deep waters and shallow ground water in desert areas, including Mesopotamia; sea-water intrusion in coastal areas due to over-pumping;

(c) The irregular and low recharge in alluvium valleys and, in general, the disproportion existing between steadily increasing water needs and ground water availability.

Map 5

Geology

MAP 5



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For a time it was thought that desalinated water would help alleviate water shortages in some areas, especially the Gulf. Some large-scale desalination plants were built which used natural gas, the value of natural gas at that time being considered neglible. However, the cost of these large plants, their relatively short life, related high cost of amortization, and the value of exportable liquefied natural gas resulted in unit costs of desalinated water that precluded its use for irrigation.

Proper development and management of ground-water resources in this part of the world, more than in any other region appears, therefore, to be a matter of priority in socio-economic development, including the production of food and the improvement of living conditions, of a population that has strived for centuries, to survive against adverse natural conditions.

Ground-water projects in the eastern Mediterranean and western Asia sponsored by the United Nations Development Programme

Country and project	Symbol	Agency	Duration	Ground-water component		
				Exclusive or major	Substantial (30-50 per cent of project)	Minor
Cyprus						
Survey of mineral and ground-water resources	CYP 2	United Nations	1963-1969		x	
Surveys, demonstration and planning of water resources utilization	CYP 66-506	Food and Agriculture Organization of the United Nations	1966-1974	x		
Feasibility study for irrigation development in the Morphou-Tyllizia area	CYP 71-513	Food and Agriculture Organization of the United Nations	1971-1974		x	
Paphos irrigation project	CYP 75-016	Food and Agriculture Organization of the United Nations	1976-1980	x		
Democratic Yemen						
Soil and water irrigation and conservation in the Wadi Tuban watershed area	PDY 71-508	Food and Agriculture Organization of the United Nations	1971-1979			x
Development of Northern areas (Hadramaout)	PDY 72-R40	United Nations	1972-1980		x	

Country and project	Symbol	Agency	Duration	Ground-water component		
				Exclusive or major	Substantial (30-50 per cent of project)	Minor
Egypt						
Pilot project for ground-water utilization, New Valley, Western Desert	EGY 71-561	Food and Agriculture Organization of the United Nations	1972-1978			
Master plan for water resources development	EGY 73-024	International Bank for Reconstruction and Development	1977-1982			
Iran						
Geological survey institute	IRA 1 and 28	United Nations	1962-1968			x
Co-ordination of water resources development	IRA 73-015	United Nations	1974-1978			x
Water resources development	IRA 77-029	United Nations	1978-1979		x	
Iraq						
Rural water supply programme Phase I	IRQ 71-527	World Health Organization	1971-1973			x
Rural water supply programme Phase II	IRQ 73-016	World Health Organization	1974-1979			x
Israel						
Experimental ground-water coastal collectors	ISR 3	Food and Agriculture Organization of the United Nations	1960-1965	x		
Underground water storage study	ISR 9	Food and Agriculture Organization of the United Nations	1962-1969	x		

Country and project	Symbol	Agency	Duration	Ground-water component		
				Exclusive or major	Substantial (30-50 per cent of project)	Minor
Jordan						
Ground-water survey of the Azraq area	JOR 4	United Nations	1961-1964	x		
Investigation of the sandstone aquifers of East Jordan	JOR 9	Food and Agriculture Organization of the United Nations	1965-1970	x		
Investigation and use of ground-water resources of East Jordan	JOR 71-525	Food and Agriculture Organization of the United Nations	1971-1976	x		
Ground-water irrigation of East Jordan	JOR 74-004	Food and Agriculture Organization of the United Nations	1975-1978		x	
Lebanon						
Ground-water survey	LEB 7	United Nations	1962-1969	x		
Adviser in ground-water and connected subjects	LEB 70-014	United Nations	1970-1974	x		
Hydro-agricultural development of Northern Lebanon	LEB 71-524	Food and Agriculture Organization of the United Nations	1972-1978		x	
Irrigation of Khoura Zgharta	LEB 73-004	Food and Agriculture Organization of the United Nations	1973-1978		x	
Hydro-agricultural development of Central Bekaa	LEB 74-001	Food and Agriculture Organization of the United Nations	1974-1977		x	

Country and project	Symbol	Agency	Duration	Ground-water component		
				Exclusive or major	Substantial (30-50 per cent of project)	Minor
Oman						
Water Resources Centre	OMA 73-009	Food and Agriculture Organization of the United Nations	1974-1978		x	
Soil and water management	OMA 73-010	Food and Agriculture Organization of the United Nations	1974-1978		x	
Qatar						
Hydro-agricultural resources surveys	QAT 71-501	Food and Agriculture Organization of the United Nations	1971-1976		x	
Integrated water and land use planning	QAT 73-007	Food and Agriculture Organization of the United Nations	1974-1978		x	
Saudi Arabia						
Land and water survey in the Wadi Jizan	SAA 1	Food and Agriculture Organization of the United Nations	1961-1964		x	
Irrigation development in Wadi Jizan	SAA 66-518	Food and Agriculture Organization of the United Nations	1966-1981			x

Country and project	Symbol	Agency	Duration	Ground-water component: Exclusive or major	Ground-water component: Substantial (30-50 per cent of project)	Ground-water component: Minor
Syrian Arab Republic						
Survey of ground water resources of the Jezireh	SYR 8	Food and Agriculture Organization of the United Nations	1959-1964	x		
Turkey						
Strengthening ground-water capability of DSI Phase I	TUR 74-042	United Nations	1975-1977	X		
Phase II	TUR 77-015	United Nations	1977-1980	X		
Assistance for utilizing isotopes in hydrology	TUR 74-053	International Atomic Energy Agency	1975-1979		X	
Training and support for DSI personnel	TUR 77-006	United Nations	1977-1980	X		
United Arab Emirates						
Water resources management for agricultural purposes	UAE 73-008	Food and Agriculture Organization of the United Nations	1973-1982		X	
Yemen						
Water supply of Sana'a and Hodeida	YEM 70-507	World Health Organization	1971-1976		X	
Rural water supply	YEM 73-017	World Health Organization	1974-1980		X	

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Efficiency and Distributional Equity in the Use and Treatment of Water: Guidelines for Pricing and Regulations
Natural Resources/Water Series No. 8

English. Sales No. 80.II.A.11

A Review of the United Nations Ground-water Exploration and Development Programme in the Developing Countries, 1962-1977
Natural Resources/Water Series No. 7

English, French, Spanish. Sales No. 79.II.A.4

Report of the United Nations Water Conference, Mar Del Plata, 14-25 March 1977

English. Sales No. 77.II.A.12

River Basin Development: Policies and Planning (vols. I and II)
Natural Resources/Water Series No. 6

English. Sales No. 77.II.A.4

Guidelines for Flood Loss Prevention and Management in Developing Countries
Natural Resources/Water Series No. 5

English. Sales No. 76.II.A.7

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The Demand for Water: Procedures and Methodologies for Projecting Water Demands in the Context of Regional and National Planning
Natural Resources/Water Series No. 3

English. Sales No. 76.II.A.1

Management of International Water Resources: Institutional and Legal Aspects
Natural Resources/Water Series No. 1

English, French, Spanish. Sales No. 75.II.A.2

Ground-water Storage and Artificial Recharge
Natural Resources/Water Series No. 2

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Second United Nations Desalination Plant Operation Survey: A Technical and Economic Analysis of the Performance of Desalination Plants in Operation

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Integrated River Basin Development

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Water Resources Planning: Experiences in a National and Regional Context

English. Reference No. TCD/SEM.80/1

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