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PREFACE

The better understanding of the changing problems facing the marine environment is a continuing goal of UNEP's Oceans programme, as it provides the necessary scientific background for formulating UNEP's policy towards the protection of the oceans.

The main sources of factual information used in the assessment of the state of the marine environment aredata published in open scientific literature, data available in various reports published as "grey literature" and data generated through numerous research and monitoring programmes sponsored by UNEP and other organizations.

Several procedures are used to evaluate critically the large amount of available data and to prepare consolidated site-specific or contaminant-specific reviews.

GESAMP, the IMO/FAO/Unesco/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on Scientific Aspects of Marine Pollution, is charged by its sponsoring bodies with preparation of global reviews. Reviews dealing with several contaminants have been already published by GESAMP and others are being prepared for publication. The first global review on the state of the marine environment was also published by GESAMP in 1982, and the second global review was published in 1990[1/].

In parallel with the preparation of global assessments, the preparation of a series of regional assessments, following the general format of the second global review of GESAMP, was initiated by UNEP in 1986, with the co-operation of the Food and Agriculture Organization of the United Nations (FAO) and the Intergovernmental Oceanographic Commission (IOC). Fifteen task teams of scientists were set up, involving primarily experts from the relevant regions, to prepare the regional reports under the joint overall co-ordination of UNEP, FAO and IOC, and with the collaboration of a number of other organizations.

The present document is the product of the Task Team for the sea area covered by the Regional Organization for the Protection of the Marine Environment (ROPME) and thus known as "ROPME Sea Area". The final text of the report was prepared by Olof Lindén, as Rapporteur of the Task Team in collaboration with Mahmoud Y. Abdulraheem, Makram A. Gerges, I. Alam, Manaf Behbehani, Mohamed A. Borhan and Layth F. Al-Kassab, whose contributions are gratefully acknowledged.

1/ Publications of GESAMP are available from the organizations sponsoring GESAMP.

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1. INTRODUCTION

1.1 Aims of the report

The ROPME Sea Area is relatively small with a total area of about 240,000 square km. It is characterized by shallow waters of high temperature with little fresh water inflow and liberal evaporation resulting in highly saline conditions in some parts of the Sea Area. It is also regarded as having one of the most fragile and endangered ecosystems with a variety of critical habitats. Although the environmental information and the database available to date do not allow a thorough investigation of the state of the marine environment in the region, this report attempts to summarize the information so far available about the state of the marine environment in the Sea Area and to highlight the major problems which arise, whether they be pollution oriented or simply lack of data or an appreciation of the causes of problems and how they can be solved most efficiently and in a cost effective manner.

1.2 Geographical coverage

The area covered in the present report includes the coastal and marine waters of the eight countries forming the Regional Organization for the Protection of the Marine Environment (ROPME). The countries are: Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia and United Arab Emirates (U.A.E.).

The ROPME Sea Area is defined as extending between the following latitudes and longitudes respectively: 16° 39'N, 53° 3'30"E; 16° 00'N, 53°25'E; 17° 00'N, 56° 30'E; 20° 30'N, 60° 00'E; 25° 04'N, 61° 25'E (See Fig..1).

1.3 Preparation of the report

This report was prepared by a Task Team consisting of the following members: Mahmoud Y. Abdulraheem, Kuwait, I. Alam, Saudi Arabia, Manaf Behbehani, Kuwait, Mohamed A. Borhan, Oman, Layth F. Al-Kassab, Iraq, Makram A. Gerges, UNEP and Olof Lindén, rapporteur.

2. CHARACTERISTICS OF THE REGION

The inner part of the ROPME Sea Area (west of the Strait of Hormuz) (Fig. 1) is an extremely shallow sea and the entire area is situated on the continental shelf. The average depth here is only some 35 metres and the deepest parts, along the Iranian coast, are 90 to 100 metres.

The volume of the sea area west of the Straits of Hormuz is estimated at some 7,800 km^3. This area is characterized by a circulation pattern where water of normal oceanic salinity enters the area through the Strait of Hormuz at the surface, and a compensating outflowing current of high salinity water along the bottom. The river input, mainly through the Shatt al-Arab, is estimated at 37 km^3/year. About 3,100 km^3 of water is transported out of the Sea Area through the Strait of Hormuz. The lost water is replaced by an inflow from the Gulf of Oman estimated at 3,355 km^3. Using the data available, the water balance for the area was recently reviewed (Table 1, ROPME 1988).

The temperatures of the surface water normally range from 15 to 35°C although occasionally temperatures lower than 15°C may be recorded in coastal waters of the northern parts of the area. There is normally little stratification of the water as the entire water column is mixed due to strong winds. However, in the summer months a temperature stratification may develop in the central parts, the deep water being about 10°C cooler than the surface water.

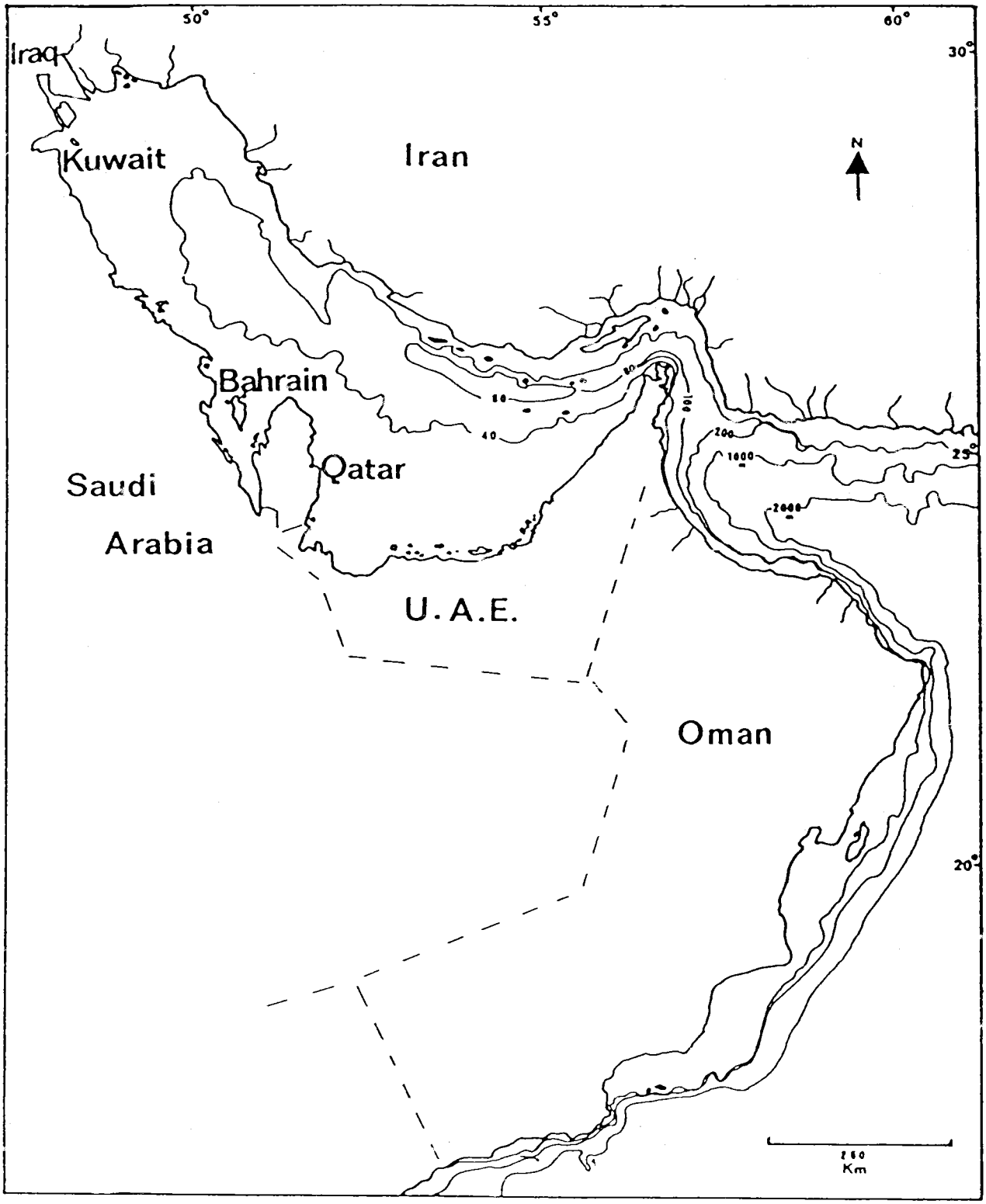

Figure 1. The ROPME Sea Area

Table 1. Water balance for the ROPME Sea Area (ROPME, 1988)

Basin	Evaporation 1/ Precipitation 2/ Runoff 3/ Total loss	-350 $km^3 yr^{-1}$ 24 $km^3 yr^{-1}$ 5 $km^3 yr^{-1}$ -321 $km^3 yr^{-1}$
Strait of Hormuz	Inflow 4/ Outflow 4/ Total gain	2696 $km^3 yr^{-1}$ 2375 $km^3 yr^{-1}$ 321 $km^3 yr^{-1}$
	Volume of basin 8400 km^3 Surface of basin 240000 km^2 Mean depth 35 m Residence time 3,5 yr	

1/ A volume of 0,4 g $cm^{-2} day^{-1}$ (equivalent to 1460 mm yr^{-1}) average of those given by Privett (1959) has been used (compare with 100 mm yr^{-1} for the Mediterranean Sea).

2/ A precipitation of 100 mm yr^{-1} has been used.

3/ Average value given by Hartmann *et al.* (1971).

4/ Computed from the water and salt balances, taking a salinity of 37 for the surface inflow and of 42 for the bottom outflow.

There is a well-defined seasonal pattern of the sea surface temperature. It shows a temperature increase from north to south in December, then the difference is reduced in March and they both become almost equivalent temperatures in May and a reverse trend is observed in August (Fig. 2). Temperature in the north-western part of the area, however, shows a much wider range with a maximum of 32°C in August and a minimum of about 15°C in February.

The overall pattern of surface salinity shows a gradual decrease from the inner part of the Sea Area towards the Gulf of Oman and the Arabian Sea (Fig. 3, Wooster *et al.*, 1967). Salinities exceeding 40 are reported in the north-west part of the area (Kuwait). However, much higher salinities are observed in the shallow intertidal lagoons of U.A.E. Coast and the inner Gulf of Salwah. Here salinities of 70 or above are frequently found.

The tides are basically semi-diurnal, but the heights reached by the two tides of each day often differ considerably. The tidal range is least in the centre of the area, being about 1 to 2 metres in Bahrain. In the north, at the Shatt al-Arab, tides are normally about 2.5 metres, and in the south (in the Gulf of Oman), the range is about 2 metres. In Dubai and Lengeh (Iran) ranges of 3 to 4 metres are observed.

The general circulation pattern of the water in the area is counter-clockwise. Hence there is a water movement northwards along the Iranian coast and a corresponding one southwards along the southern coast (Fig. 4). Experiments carried out from May 1983 to March 1984 with satellite tracked radio buoys (MEPA, 1984) show consistent surface drifts towards the south-east all along the tracks that covered the central inner area, with speeds ranging between 0.2 to 0.7 knots (Fig. 5).

The large input of sediments in the north-western part of the Sea Area have created highly productive tidal flats, especially in Iraq, Iran and Kuwait. In the sub-tidal zone seagrass beds cover large areas of shallow bottom.

This is one of the most extensive biotopes in terms of area as well as one of the most important in terms of its contribution to the ecology of the Sea Area. Coral reefs occur scattered throughout the area, although the low temperatures in winter fall well outside the optimum range for coral reef development. Overall some 50% of the bottom sediments in the area west of the Strait of Hormuz is mud, 40% sand. Rock-coral and gravel account for the rest.

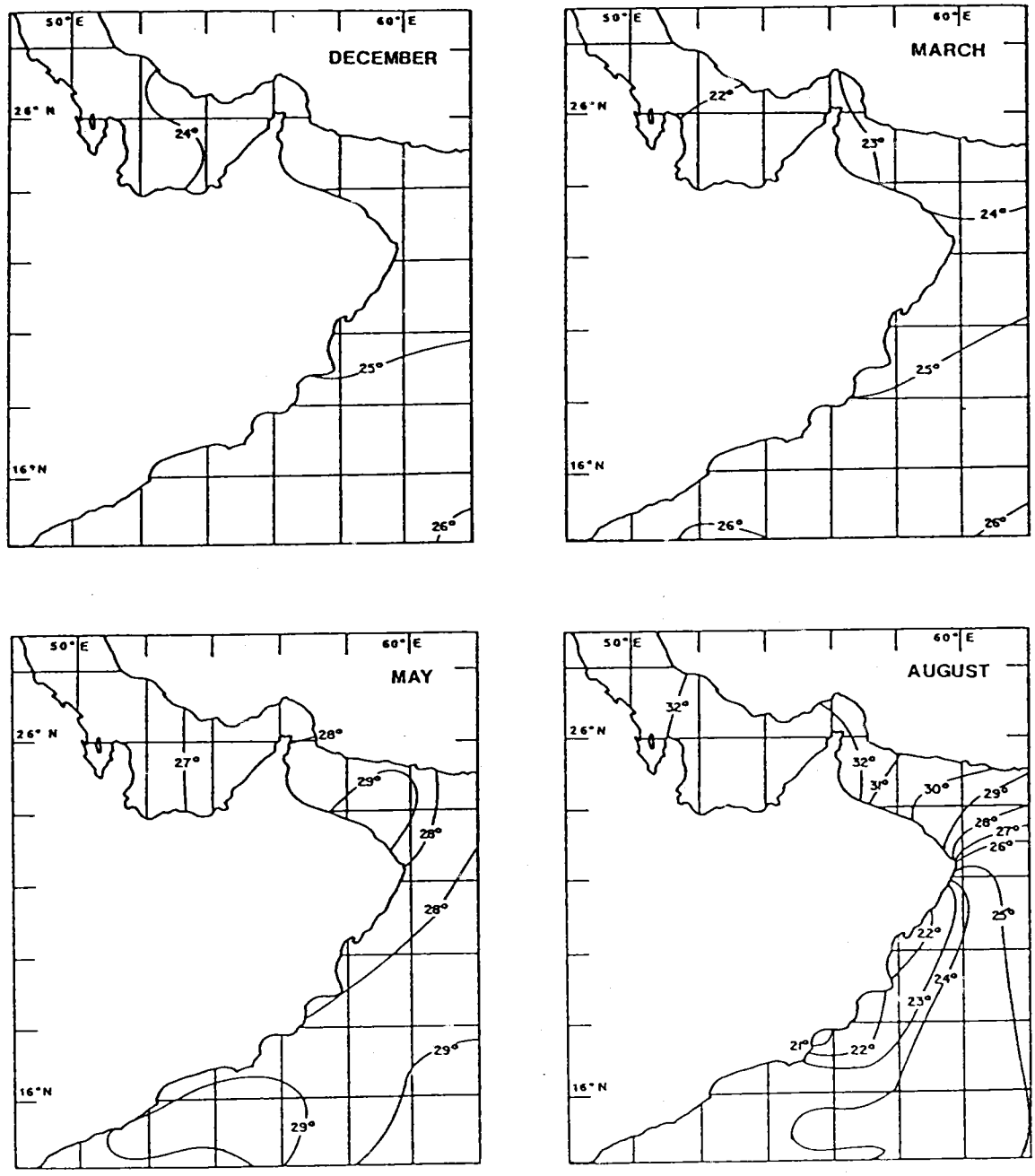

Figure 2. Sea surface temperature (°C) during December, March, May and August (KNMI, 1952)