



UNITED NATIONS ENVIRONMENT PROGRAMME



*A. Golik:*  
*Tar pollution*  
*in the Mediterranean Sea*

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IOC

## PREFACE

Sixteen years ago the United Nations Conference on the Human Environment (Stockholm 5-16 June 1972) adopted the Action Plan for the Human Environment, including the General Principles for Assessment and Control of Marine Pollution. In the light of the results of the Stockholm Conference, the United Nations General Assembly decided to establish the United Nations Environment Programme (UNEP) to "serve as a focal point for environmental action and co-ordination within the United Nations system" [General Assembly resolution 2997(XXVII) of 15 December 1972]. The organizations of the United Nations system were invited "to adopt the measures that may be required to undertake concerted and co-ordinated programmes with regard to international environmental problems", and the "intergovernmental and non-governmental organizations that have an interest in the field of the environment" were also invited "to lend their full support and collaboration to the United Nations with a view to achieving the largest possible degree of co-operation and co-ordination". Subsequently, the Governing Council of UNEP chose "oceans" as one of the priority areas in which it would focus efforts to fulfill its catalytic and co-ordinating role.

The Regional Seas Programme was initiated by UNEP in 1974. Since then the Governing Council of UNEP has repeatedly endorsed a regional approach to the control of marine pollution and the management of marine and coastal resources and has requested the development of regional action plans.

The Regional Seas Programme at present includes ten regions<sup>1/</sup> and has over 130 coastal States participating in it. It is conceived as an action-oriented programme having concern not only for the consequences but also for the causes of environmental degradation and encompassing a comprehensive approach to combating environmental problems through the management of marine and coastal areas. Each regional action plan is formulated according to the needs of the region as perceived by the Governments concerned. It is designed to link assessment of the quality of the marine environment and the causes of its deterioration with activities for the management and development of the marine and coastal environment. The action plans promote the parallel development of regional legal agreements and of action-oriented programme activities<sup>2/</sup>.

The Mediterranean Action Plan was the first one developed in the framework of the Regional Seas Programme. It was adopted in early 1975 in Barcelona<sup>3/</sup> and since then has shown a remarkable progress.

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<sup>1/</sup> Mediterranean, Kuwait Action Plan Region, West and Central Africa, Wider Caribbean, East Asian Seas, South-East Pacific, South Pacific, Red Sea and Gulf of Aden, Eastern Africa and South Asian Seas.

<sup>2/</sup> UNEP: Achievements and planned development of UNEP's Regional Seas Programme and comparable programmes sponsored by other bodies. UNEP Regional Seas Reports and Studies No. 1, UNEP, 1982.

<sup>3/</sup> UNEP: Mediterranean Action Plan. UNEP, 1985.

A centrally co-ordinated monitoring of the sources, levels and effects of pollutants, as well as research related to this monitoring (MED POL)<sup>4/</sup>, <sup>5/</sup> was organised by UNEP as one of the cornerstones of the Action Plan. The contamination of the Mediterranean by petroleum hydrocarbons was one of the early targets of MED POL.

This publication, prepared by Dr. A. Golik, was commissioned by UNEP and IOC to review the contamination of the Mediterranean basin by tar on the basis of results obtained through MED POL and other programmes.

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<sup>4/</sup> FAO/UNESCO/IOC/WHO/WMO/IAEA/UNEP: Co-ordinated Mediterranean Pollution Monitoring and Research Programme (MED POL) - Phase I: Programme Description. UNEP Regional Seas Reports and Studies No. 23, UNEP, 1983.

<sup>5/</sup> UNEP: Long-term programme for pollution monitoring and research in the Mediterranean (MED POL) - Phase II. UNEP Regional Seas Reports and Studies No. 28, Rev.1, UNEP, 1986.

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## SUMMARY

Tar balls in the marine environment are a derivate of oil or oily compounds which were released into seawater, lost their volatile fraction by evaporation and turned into soft black lumps called tar balls. Due to the relatively high intensity of oil activity in the Mediterranean Sea, tar pollution became a problem in this area. The severity of this problem is accentuated by the fact that stranded tar on the beach is a serious nuisance to sea bathers, and the Mediterranean Sea is becoming more and more attractive to coastal oriented tourism.

Measurements of pelagic tar have been carried out in the Mediterranean since 1969, but mostly in the western Mediterranean. The findings show that between 1969 and 1983, mean tar concentrations in the Mediterranean ranged from 0.6 to 130 mg/m<sup>2</sup> and that, at least between 1969 and 1975, the Ionian Sea was the most tar polluted area in the Mediterranean Sea. Mean quantities of stranded tar on Mediterranean beaches were found to range between 0.2 and 4388 g/m (grams per linear metre of beach front). On the basis of geographical considerations, it seems that the areas in the Mediterranean where deballasting of oily waters and release of oily compounds into the sea were permitted until 1978 were foci for tar contamination. However, measurements of pelagic and beach-stranded tar which were conducted after 1980 indicate that there might have been a reduction in tar quantity during the last few years.

Examination of data and information relevant to oil transport rate in the Mediterranean Sea and outside of it shows that several factors combined in 1978/79 to cause a reduction in oil and as a result in tar pollution. In 1978, the 1969 amendment to the International Convention OILPOL 54 entered into force. This amendment permits release of oil only in restricted areas and even there only at certain rates and quantities. At about the same time, the oil crises of 1979 caused an increase in oil prices and a reduction in oil transport, and therefore encouraged tanker owners to reduce to a minimum the loss of oil through spillage or otherwise. The continuing grim economic condition of oil transportation facilities, high oil prices, the adoption of the Mediterranean Sea as a special area (into which no oil release with concentrations higher than 15 ppm is permitted) in the MARPOL 73/78 convention, and the enforcement of this convention caused a tighter control on oil pollution as well as development of innovative techniques and procedures aimed at preventing the waste of oil into the sea. It is suggested that these developments indeed reduced oil pollution, as indicated by a few examples of tar reduction in the Mediterranean Sea and beaches.

As it is not yet certain that reduction in tar pollution is indeed a fact, and the recent reduction of oil prices and the new discoveries and exploitation of offshore oil in the Mediterranean constitute a threat for a new wave of tar pollution, it is recommended to invest a multi-national, co-ordinated effort to determine a new baseline for tar level today in the Mediterranean. Old findings of tar pollution could be compared to this baseline to determine the present trend of this problem. In addition, it is recommended that studies related to "fingerprinting" of tar as well as tar processes should be continued to ensure means of combating this type of pollution if it persists.

## 1. INTRODUCTION

Tar in the marine environment is formed as a result of the release of hydrocarbon compounds into the sea. The sources of these hydrocarbon compounds may be natural seeps from the sea bottom, accidental or intentional release from oil tankers or ships, or release from land-based oil installations or industry. Once it is released into the marine environment, the oil loses its light fraction by evaporation and its viscosity increases, until it becomes soft, sticky brownish black material often termed tar balls or simply tar. The specific gravity of the tar is usually lower than that of seawater and therefore it normally floats on the water. The dispersal of tar is thus affected by winds and currents.

Very little is known about the effect of tar on marine organisms. In a study aimed at finding whether tar constitutes a threat to marine life, Zsolnay *et al.* (1978) examined concentrations of tar and of aromatic hydrocarbon, which is the most toxic component in crude oil, at the same stations. They found that there is no relationship between the two, presumably due to different dispersion mechanisms. However, there is no question that once tar lands on the beach, it forms a serious nuisance to bathers. It sticks to the body, ruins clothing, and it is very hard to get rid of it. Tar is therefore a serious threat to the tourist industry. This is especially so in the Mediterranean Sea, because this is a warm sea in which coastal oriented tourism is constantly growing.

Systematic studies of tar distribution in the Mediterranean started in 1969 with sampling of pelagic tar by the R/V "Atlantic II" (Horn *et al.*, 1970). Since then, pelagic tar sampling was conducted by several expeditions of various oceanographic vessels, mostly in western Mediterranean. Many studies on tar stranded on Mediterranean beaches were carried out between 1975 and 1978, most of them within the MED POL Programme (UNEP, 1980). These were conducted mostly in the eastern Mediterranean. At the same time, studies were made on the distribution of dissolved and dispersed petroleum hydrocarbons, their chemical behaviour and their effect on the biosphere. These were recently reviewed in UNEP (1986).

The Mediterranean Sea was considered to be the most oil polluted sea in the world (U.S. National Academy of Sciences, 1975). This was because of the heavy oil traffic on it relative to its size, and because it is an enclosed body of water with very restricted passages to other oceans. During the last three decades, efforts were made, at national and international levels, to reduce the input of oil into the Mediterranean. There are signs that these, together with the increase in oil prices in 1979, have indeed caused reduction of oil and tar pollution in the Mediterranean.

The purpose of this document is to review the available information on tar pollution in the Mediterranean Sea and its shores, to assess the magnitude of this pollution in terms of space and time, to examine the methods for monitoring this pollution, and to evaluate the feasibility of assessing oil pollution of the Mediterranean through monitoring tar contamination.

## 2. THE MEDITERRANEAN SEA

Surrounded by Europe, Asia and Africa (see Figure 1), the Mediterranean is an enclosed sea, extending over an area of  $3.7 \times 10^6$  km<sup>2</sup> with an average depth of 1,500 m and maximum depth of 5,092 m. Its passages to other oceans are restricted: through the Straits of Gibraltar (320 m deep and 20 km wide) to the Atlantic Ocean and through the man-made Suez Canal to the Red Sea and Indian Ocean. In addition, it is connected through the Bosphorus to the Black Sea. The time required to exchange the water of the Mediterranean is estimated at eighty years, implying that the average residence time of substances in the water in the Mediterranean is about eighty years.

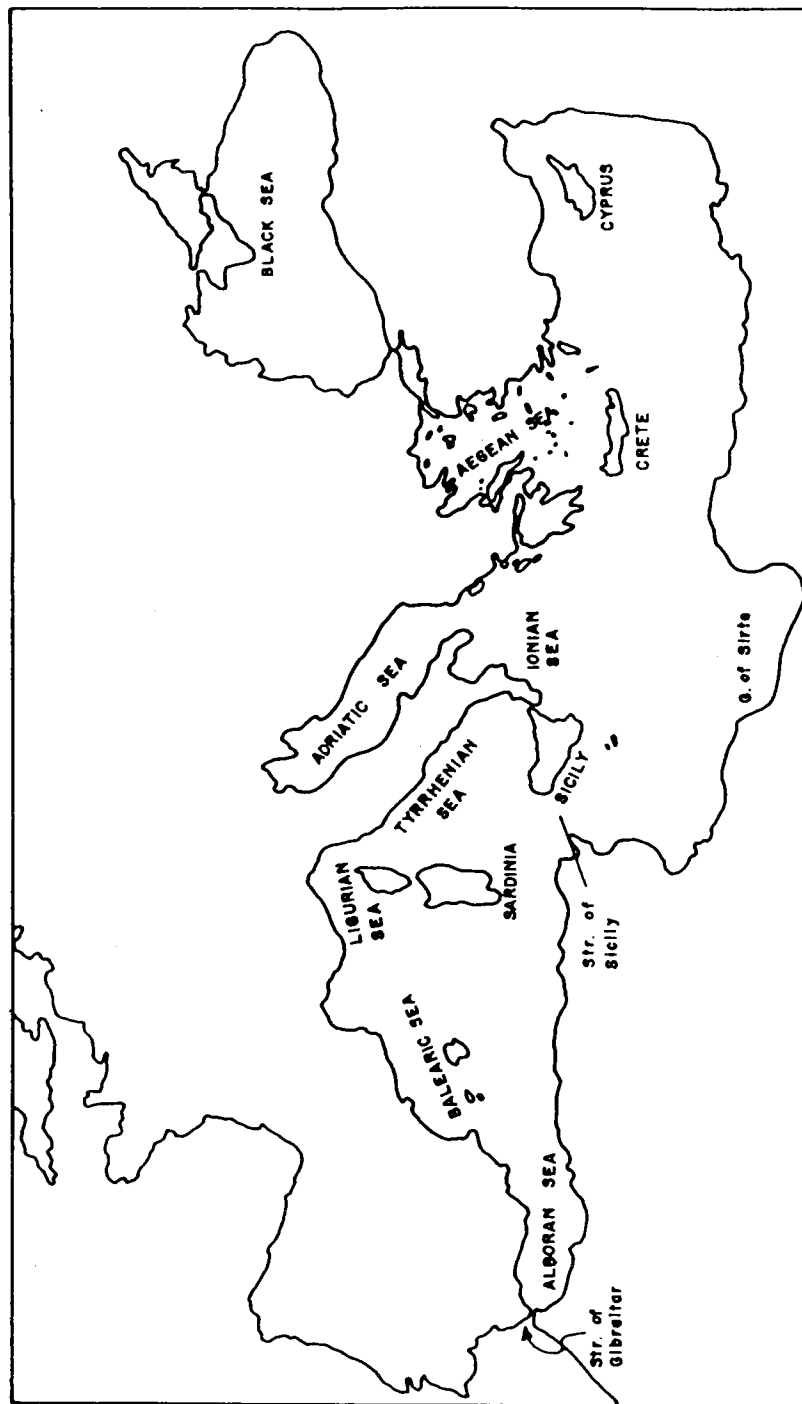


Figure 1. The Mediterranean Sea.

The Straits of Sicily, with a 400 m deep sill, divide the Mediterranean into western and eastern basins. These basins are further divided into quasi-natural internal basins: the Alboran, Balearic, Ligurian and Tyrrhenian Seas in the western basin and the Adriatic, Ionian and Aegean Seas in the eastern basin. Many islands are found in the Mediterranean; the larger of them are Sicily, Sardinia, Cyprus, Corsica and Crete. In addition, many small islands are found in the Aegean Sea. The major rivers that empty into the Mediterranean are the Ebro, Rhone and Po Rivers, and until the activation of the Aswan Dam, the Nile River as well. These rivers created large alluvial plains and deltas on the Mediterranean shores.

The water circulation in the Mediterranean (see Figure 2) is determined by its geographical shape, evaporation-precipitation ratio, and wind system. Surface Atlantic water enters the Mediterranean through the Straits of Gibraltar and flows eastward along the coast of North Africa. Some of the water is deflected northward to form circulation in the Ligurian and Tyrrhenian Seas, where its density increases because of evaporation and cooling, and it sinks to form a deep water layer. The remaining water continues eastward through the Straits of Sicily, where again part of the water participates in a counterclockwise circulation in the Ionian and Adriatic Seas and the rest continues to the eastern part of the Mediterranean. There, the salinity and temperature of the water increase due to the excess of evaporation over precipitation and runoff. The water becomes denser and sinks. The outflowing water from the Mediterranean goes through the deeper part of the Straits of Gibraltar and sinks in the Atlantic Ocean to a depth of about 1,000 m. It spreads in the Atlantic Ocean but is still distinct, by its high salinity and temperature, at large distances from Gibraltar, towards the west and north.

### 3. FACTORS CONTROLLING TAR CONCENTRATION IN THE MEDITERRANEAN

Any discussion on tar ball concentration in the sea or the beaches must be related to the quantity and distribution of petroleum hydrocarbon discharge into the Mediterranean Sea. This subject has been described and discussed in a recent publication (UNEP, 1986). The following is a short summary based on this as well as other publications.

Figure 3, taken from Le Lourde (1977), shows the locations of the various activities in the Mediterranean which are related to oil. Although this map needs updating, its basic elements are still valid today. Middle Eastern oil, which reaches the eastern shores of the Mediterranean via pipelines and the Suez Canal, is shipped from there westward. North African oil is shipped from the southern part of the Mediterranean to its northern shores. Concentrations of refineries are found in the northwestern part of the sea, with a smaller concentration in its southwestern part. Offshore oil discoveries were recently made in Algeria, Tunisia, Libya, Egypt, Greece, Italy and Spain.

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