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Tar Contamination on Beaches of the United Arab Emirates

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The United Arab Emirates (UAE), which lies in the hot arid climate zone, has two coastal stretches of more than 800 km along the Arabian Gulf and the Gulf of Oman. The west coast facing the Arabian Gulf is more than 700 km long and the east coast facing the Gulf of Oman is about 100 km. Beaches in the southern zone along the west coast are sandy with scattered rocks. Only patches of rocky beaches can be seen in the northern area of the west coast near Al-Sham. The east coast, on the other hand, has many sandy beaches along the shore but many rocky beaches are also located along this coastal line. Due to heavy transportation of crude oil by tankers and exploration of offshore oil wells, beaches on the Arabian Gulf and the Gulf of Oman risk tar contamination. Besides affecting the fishing industry and scuba diving tourism, lumps of tar cause a destruction of living resources and reduces the recreational utility of coastal waters, especially the beaches through shore damage (Changsang 1988, Ramamurthy 1991, Shriadah 1998, 1999a). Since the measurement of beach tar has been found to be a good estimator of levels of oil contamination in offshore waters and an effective means of evaluating the potential threat of oil on coastal resources (Knap et al. 1986), the levels and distributions of beach tar along the Arabian Gulf and the Gulf of Oman coastline of the UAE are examined.

MATERIALS AND METHODS

A preliminary investigation of the UAE coastline, involving intensive driving along the shoreline as close to the beach as possible, was carried out in September 1996 to locate suitable beach stations (Fig. 1). Since it is significant that the Gulf is a naturally stressed environment (Sheppard 1993, Sheppard et al. 1992, Price et al. 1993), and has been subjected to unprecedented development pressures over the past two to three decades (Price 1993), an initiative was taken to reach as many places as possible along the shoreline of the UAE. The survey started from Al-sham, close to the border check post of Oman, to the Silia, near the Saudi Arabia border post, in the west coast. Another survey started from Kalba, close to the border check post of Oman in the south along the east coast, to Dibba Al-Hassn, near the border of Oman, in the north along the east coast, but some Attempts were futile. From these surveys, 10 beaches represented by 43 sites were chosen. The number of sites and length of each beach are given in

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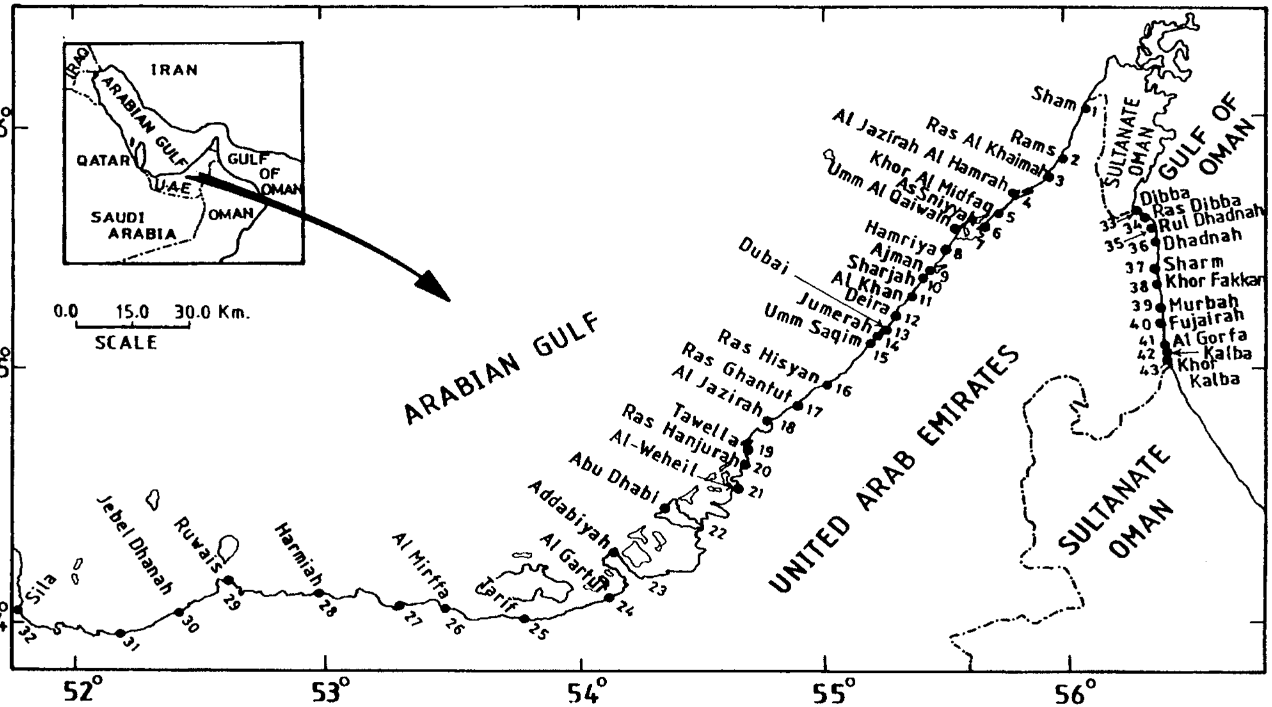


Figure 1. The shoreline of the United Arab Emirates showing locations of sampling sites

Table (1). Sampling was conducted, over 7 days covering all beaches in October 1996 and repeated in October 1997. Repeated sampling enables analysis of variability in beach tar abundances with time and more completely assures that maximum tar abundances will be measured. Beach tar was surveyed following the guidelines of the ROPME Manual of Oceanographic Observations and Pollutant Analysis Methods (ROPME 1983). All visible solid and semi-solid tar balls on each site were collected from triplicate, 1 m wide, randomly selected transects running from the water's edge to the high tide mark. The samples were taken back to the laboratory, cleaned of non-tar material and weighed to the nearest 0.1 g. Tar balls that were heavily encrusted with extraneous matter were extracted by dissolving the ball in hexane, filtered, weighed and the debris weight subtracted. Large particles like sticks and stones were removed manually.

RESULTS AND DISCUSSION

The level of tar contamination of beaches of the UAE is given in Table (1). Tar balls collected from the whole area ranged from zero to 176 g m^{-1}. One of the important features of tar contamination on UAE coastline is that only 35 % of the 43 sites recorded no tar at any time. Another important feature is the decrease in the average amount of tar balls collected from October1996 (mean: 316.4 g m^{-1}) to October1997 (mean: 214.8 g m^{-1}). This decrease is mostly related to the decrease in the amount of oil spilt in the marine environment due to improved regulations against oil dumping and the absence of oil tanker disasters in the area during this period. The decrease in the amount of total tar balls might also be due to the breakdown of old tar balls by physical and biological processes and/or being buried by sediments (Shriadah 1998, Coles and Gunay 1989). The frequency distribution of tar contamination in the study beaches (Fig. 2) showed that 49 % of the beach sites on the Arabian Gulf side were less than 10 g m^{-1}. Of the remaining 51 %, about 7% were higher than 100 g m^{-1}. At the Gulf of Oman, about 36 % of the beach sites contained less than 10 g m^{-1}. Of the remaining 64%, none of the beach sites exceeded the 100 g m^{-1} level. Tar concentrations of greater than 150 g m^{-1} of shoreline occurred only at Abu-Dhabi-2 beach. Values in the range of >40 to < 100 g m^{-1} were common at Abu-Dhabi-1, Sharjah-2 and Fujirah. Atwood et al. (1987) indicated that when beach tar values reach 10 grams per meter, persons using the beaches commonly get tar on their feet. At values approaching 100 grams per meter, the beach becomes virtually unusable for tourist purposes. Based on the assessment of beach tar levels detected in this study, the high incidence of contamination in excess of 100 g m^{-1} at Abu-Dhabi-2 is a serious problem. Moreover; the occurrence of very fresh samples in this area during the survey of October 1997 indicates that it is a persistent problem and may have detrimental long term effects on the recreational utility of this beach. Moreover, the calculated average quantities of tar from beach sites and extrapolations of standing stock made by multiplying the appropriate average by the length of coastline measured from hydrographic charts (Table 1) indicated that there is a clear trend for increasing tar contamination from Sham to Silia and from Kalba to Dibba.

Table 1. Tar balls (g m^{-1}) at beaches surveyed along the coastline of the UAE.

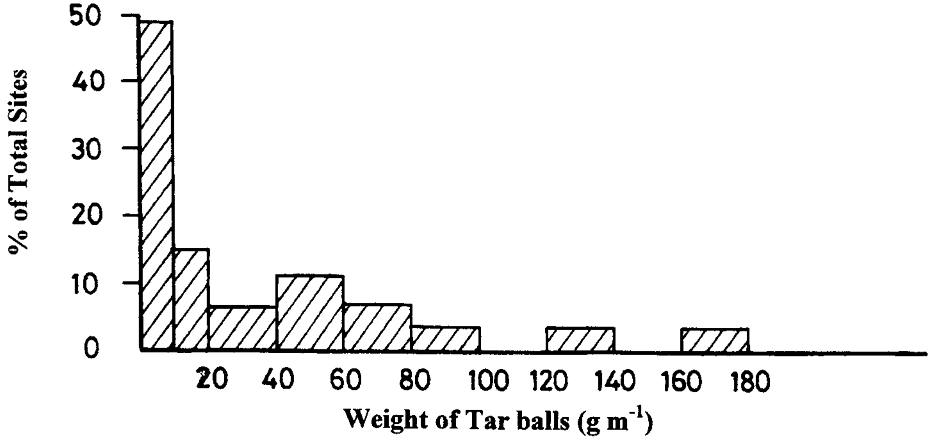
Beaches surveyed	No. of Sites	Beach tar (1996)	Beach tar (1997)	Range and mean of beach tar	Beach length (km)	Standing stocks (Kg)**
A. Arabian Gulf:						
1. Ras al-Khaimah :	5	0-2 (0.4)*	0-1 (0.2)*	0-2 (0.3)*	82	24.6
2. Umm al-Quwain:	3	0-3 (1.2)*	0-2 (0.8)*	0-3 (1.0)*	47	47.0
3. Ajman :	1	0-2 (0.7)*	0-1 (0.3)*	0-2 (0.5)*	18	9.0
4. Sharjah-1:	2	0-3 (0.9)*	0-1 (0.3)*	0-3 (0.6)*	26	15.6
5. Dubai:	6	0-4 (3.2)*	0-2 (1.2)*	0-4 (2.2)*	79	173.8
6. Abu-Dhabi-1:	7	12-97 (75)*	0-65 (55)*	0-97 (65)*	218	14170
7. Abu-Dhabi-2:	8	18-176 (140)*	0-116 (100)*	0-176 (120)*	240	28800
B. Gulf of Oman:						
8. Sharjah-2:	6	4-41 (34)*	0-21 (20)*	0-41 (27)*	49	1323
9. Fujirah:	3	7-49 (43)*	0-32 (23)*	0-49 (33)*	31	1023
10.Sharjah-3:	2	0-25 (18)*	0-22 (14)*	0-25 (16)*	12	192

* Mean value of six measurements.

** Standing stock (Kg) = average concentration of beach tar × beach length.

This distribution pattern of tar contamination is consistent with to spatial and temporal influences. The high values measured, particularly in the beaches of Abu-Dhabi were more related to oil spills from offshore oil wells, various refineries and transportation of crude oil by tankers (Golob and Brus 1984, Khodagui 1991, Shriadah 1998, Shriadah 1999b). Any spilled oil in this area

a- The Arabian Gulf side



b- The Gulf of Oman side

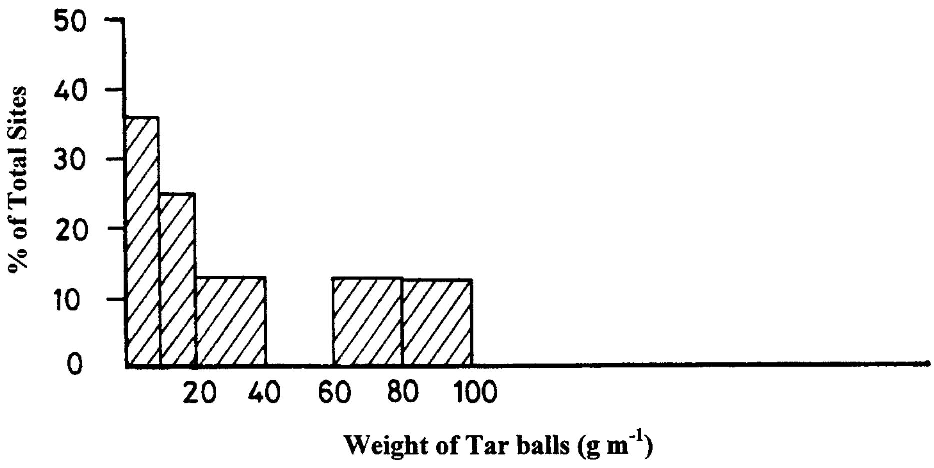


Figure 2. Distribution percentages of tar balls in beaches of the United Arab Emirates along the Arabian Gulf and the Gulf of Oman.

eventually loses most of its volume mainly through evaporation due to the exceptionally high ambient temperature of the Gulf (sometimes reaching 35 °C during the summer season), the high rate of photooxidation due to the long duration of daylight and the high salinity of the seawater in this area (Khodagui 1991, Shriadah and Al-Ghais 1999), resulting in the formation of tar balls. As a result of the circulation patterns of seawater in the Arabian Gulf (Hunter 1983,1986), tar balls are transported by waves and currents and become stranded on the shoreline, concentrating near or above the hightide line. The tar contamination observed on the Gulf of Oman side of the UAE, particularly in the area from Khor Fakkan to Fujirah, is due only to oil spills from some oil carrying vessels. These sources of contamination do not appear to affect other beaches in the Arabian Gulf side of the UAE like Ras al-Khaimah, Umm al-Quwain, Ajman, Sharjah, and Dubai where beach tar was nearly absent during the period of investigation.

Comparing the tar concentrations measured in the present study with the previously reported value for the UAE (Fowler 1988), one can notice that tar ball contamination from even the most heavily contaminated sites are relatively lower (Table 2). This decrease is probably due to improved regulations against oil dumping and replacement of older tankers with ships equipped with a separate ballast system or mechanisms for reducing release of oil with ballast water. This is consistent with broad agreement that oil spills and beach tar concentrations have decreased substantially in the past decade at many locations in the world (GESAMP, 1990, Coles and Al-Riyami, 1996).

Table 2. Comparison of the UAE beach tar contamination per m of beach front with adjoining areas and other world regions.

Region	Tar weight (g m^{-1})	References
United Arab Emirates	0-176	Present study
Kuwait	34-1941	Al-Harmi and Anderlini, 1979
Bahrain	14-858	Fowler, 1988
United Arab Emirates	4-233	Fowler, 1988
Saudi Arabia (Arabian Gulf)	0-28750	Coles and Gunay, 1989
Oman (full coast)	5-2325	Burns et al., 1982
Oman (full coast)	1-906	Fowler, 1988
Oman (full coast)	1-480	Badawy and Al-Harthy, 1991
Oman (full coast)	47-145	Badawy et al., 1993
Oman (Muscat area)	0-5230	Coles and Al-Riyami, 1996
Israel	384-4388	Golik, 1982
Sudan	45-170	Oostdam, 1984
Jamaica	0-11940.1	Jones and Bacon, 1990

Moreover, comparison of the range of beach tar with data from the adjoining regions and other areas of the world (Table 2) indicates that the contamination by tar balls determined in this study was much lower than reported elsewhere.

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