The Nowruz Oil Spill in the Arabian Gulf: Case Study of Saudi Arabia

Abdullah S. Al-Amirah

INTRODUCTION

The Arabian Gulf has suffered from hundreds of oil spills, some of them reported but most unreported. In many cases the amounts of the spills and their causes are usually undetermined. During 1978–1979, tanker captains reported to the Japan Oceanographic Data Center about 412 oil slicks in the Gulf and its approaches.1 Table 1 shows major oil spills exceeding 3,000 barrels which occurred between August, 1980, and August, 1982. Although these are relatively current, it should be noted that other significant oil spills have occurred since oil was discovered in the region by Iran in 1908.

It is almost impossible to have accurate information or data concerning oil pollution in the Gulf area since the official concern of many of the Arabian Gulf States has not existed until recent years. In some states it is difficult to obtain information about the oil spills or accidents because the facts are usually considered confidential. It is the opinion of some officials of these countries that collecting statistics or gathering information concerning oil pollution or some other similar matters affects national security.

Furthermore, oil companies do not admit or record any of the spills or slicks unless they are major accidents that might be noticed later. The Hasbah oil spill cited in Table 1 exemplifies this policy.2 During another occasion, AR-AMCO used sand to make the oil sink in very sensitive areas in order to clean the water surface in a very short period of time.

Data concerning oil pollution are usually collected by the oil companies which own or operate the facilities. Therefore, it is almost impossible to obtain this information, and if it is available, it is often misleading. Taking into consideration the sensitive nature of the Gulf, the high level of production and oil exports, and the Gulf States' wealth, it is vital that the Gulf States prepare a good environmental protection program and policies along with advanced monitoring programs and equipment. The purpose of this paper is
to analyze a major oil pollution problem with environmental and international implications.

**THE ARABIAN GULF**

The Arabian Gulf occupies an area of 226,000 square km., which is about 1,000 km. in length and 200–300 km. in width. The Gulf is characterized by its shallowness and has an average depth of 35 meters. The deepest part of the Gulf is near its entrance at the Strait of Hormuz. The Arabian Gulf has a very gentle slope on the Arabian side and a steep slope near the Iranian coast. (Figure 1).

Beginning in late May and early June, low pressure develops over Asia which produces counter-clockwise winds. The Arabian Gulf lies in the southwest edge of this pressure, and therefore it is affected by the northwestern winds. During June and sometimes in July, the velocity of the winds is very high. By mid-July northwestern wind speeds decrease until August which is the calmest month. October and November are transitional periods and the low pressure over Asia weakens. By November through February winter storms start to affect the area with a variation of speeds and directions from time to time. As the centers of the storm fronts move eastward across the Mediterranean and the Middle East and approach the Arabian Gulf, they sometimes create southeast or southern winds. March and April are transitional periods because temperatures begin to rise and some thunderstorms may occur.

The loss of sea water due to high evaporation rates, which is not compensated by rainfall and river input, causes different water levels. Consequently, the water level of the Arabian Gulf is lower.

**TABLE 1**

Selected Oil Spills in the Arabian Gulf

<table>
<thead>
<tr>
<th>Date</th>
<th>Source</th>
<th>Location</th>
<th>Barrels Spilled</th>
<th>Type of Oil</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug 80¹</td>
<td>Gremona, Spanish-92, 345 DWT</td>
<td>26°12'N, 50°38'E Bahrain</td>
<td>7,000</td>
<td>bunker oil</td>
<td>open valve</td>
</tr>
<tr>
<td>6 Aug 80¹</td>
<td>unknown</td>
<td>26°06'N, 50°30'E</td>
<td>up to 19,250</td>
<td>undetermined</td>
<td>undetermined</td>
</tr>
<tr>
<td>2 Oct 80¹</td>
<td>Hasbah 6 well Arabian American Oil</td>
<td>27°50'N, 49°40'E Hasbah field, Saudi Arabia</td>
<td>up to 98,000</td>
<td>crude</td>
<td>blow-out</td>
</tr>
<tr>
<td>June-Oct 81²</td>
<td>Production, storage, &amp; refiner facilities</td>
<td>Southwestern Iran Southwestern Iraq</td>
<td>23,800</td>
<td>crude &amp; refined petroleum products</td>
<td>attacks during war Iran/Iraq fire</td>
</tr>
<tr>
<td>20 Aug 81²</td>
<td>storage tanks, Kuwait National Petroleum Co.</td>
<td>29°02'N, 48°10' E Sharaybah, Kuwait</td>
<td>742,000</td>
<td>naphtha, kerosene &amp; heavy diesel</td>
<td>military attack, explosion &amp; fire</td>
</tr>
<tr>
<td>12 Jan 82²</td>
<td>Annabelle, bulk carrier, GR—38,001 DWT</td>
<td>30°25'N, 49°02'E off Bandar Khomeini, Iran</td>
<td>3,738</td>
<td>fuel</td>
<td>military attack, explosion &amp; fire</td>
</tr>
<tr>
<td>20 Aug 82²</td>
<td>Corinthian L1-89,194, Arab Emirates DWT</td>
<td>25°23'N, 57°05'E off Fujairah, United Arab Emirates</td>
<td>9,000</td>
<td>fuel, diesel &amp; lubricating</td>
<td>military attack, explosion &amp; fire</td>
</tr>
</tbody>
</table>


than it is in the Gulf of Oman. These differences of water levels cause the water to rush through the Strait of Hormuz to the Arabian Gulf causing anticlockwise surface currents parallel to the Iranian side. These currents start to weaken as they flow north along the Arabian side. Also, subsurface currents occur in the Gulf because the fresh water input is not equal to the evaporation rate. As density of the water increases, it sinks and flows back to the Gulf entrance through the Strait of Hormuz beneath the less dense inflow (Figures 2 & 3).

The temperature of the surface water varies from winter to summer. It is down about 16 degrees centigrade in winter, up to 36 degrees centigrade in summer. Salinity of the Arabian Gulf waters is about 40 parts per thousand and over 70 parts per thousand in some shallow coastal areas that are exemplified by restricted bays and lagoons.

The Arabian Gulf is characterized by two factors. First, it has high salinity due to a high evaporation rate when compared with little fresh water input. Saline conditions are also attributed to the slight exchange of water with the Indian Ocean because of the narrow passage at the Strait of Hormuz. Second is the temperature fluctuation. The high salinity and the wide range of temperature control and limit the occurrence and distribution of marine life in the Gulf.

THE PHYSICAL AND BIOLOGICAL STRUCTURE OF THE SAUDI COASTAL ZONE IN THE ARABIAN GULF:

The Saudi coastal zone is characterized by its shallowness, its extensive system of bays and lagoons, and its
sandy beaches. The most important features in this coastal zone are the coral reefs, coral islands, coastal inlands, coastal wetlands and sea grass beds. Among the reefs in the Arabian Gulf, Saudi reefs are considered to be the best developed. These have at least 50 species of reef forming corals and many hundreds of species of associated organisms. This type of reef can be seen surrounding six nearby coral islands. They are important for young fish and open sea commercial fish as shelter and feeding stations.

There are several coral islands located in off-shore Saudi waters which are flat and sandy (Figure 4). The names, sizes and vegetational features of the island are shown in Table 2. All of these islands are used as breeding sites by sea birds and by two species of marine turtles, viz., the green turtle and the hawksbill turtles. The latter are generally considered to be less in number than the green turtle.

The coastal islands are composed of sand and rock. They are breeding sites for rare and endangered bird species. Also, they support many bird colonies. An example of these islands are Tarut, Abu Ali and al-Btinah, which are the largest and now connected by a road causeway; and the smaller islands of Zakhuniyah and Ummas-samamik.

The Saudi shoreline in the Arabian Gulf has a gentle slope combined with large tidal ranges that have created extensive tidal flats. They are rocky, sandy or muddy according to their location. These tidal flats are a very important source of food for many marine animals and a very suitable environment for mangroves. The mangrove swamps are considered to be very productive and

Figure 2
much of their production is exported to the marine eco-systems. The coastal flats provide a good source of food for many of the shore and water bird species at the low tide and at the high tide they provide the same for fish, shrimp and other marine animals.

The sea grass beds occupy a large part of the shallow subtidal area up to a depth of 10 or 12 meters from the shoreline. Sea grass is the principal source of food for the green turtle and the only source of food for the dugong. Sea grass is considered to be a very important feeding site for the juvenile stages of the Arabian Gulf pearl oysters. Also, it plays an important role in the energy input into the Gulf fishery sources. The Gulf of Salwa, Gulf of Bahrain and Tarut Bay are known to have an extensive occurrence of sea grass beds. Tarut Bay is also known to be the nursery of the southern Saudi Arabia Shrimp stock due to the large areas covered by sea grass beds which extend over two-thirds of the bay.

NOWRUZ OIL SPILL: CASE STUDY OF SAUDI ARABIA

In early 1983, a ship collided with a well platform at 29° 33'N, latitude 49° 25'E, longitude in the Iranian Nowruz oil field about 250 km. north of Jubail. This collision caused the well to cease production. On February 27, 1983, during high winds and seas, the well blew-out causing a spill of 1,500 to 2,000 barrels of heavy crude oil per day. On March 2, another two wells were started on fire following an Iraqi attack on the Nowruz
oil field. The estimated amount of burned oil was 16,000 barrels per day. On the 12th and 19th of April, Iraq attacked two wells of the Ardeshire Oil Field 53 km. south of the Nowruz Oil Field. This action produced a fire at these two wells and caused a small spill. The amount of spill and the number
TABLE 2

Sea Islands in the Arabian Gulf

<table>
<thead>
<tr>
<th>Name</th>
<th>Length x Width</th>
<th>Vegetation Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hargus</td>
<td>259 × 79 meters</td>
<td>none, high seas sometimes wash over.</td>
</tr>
<tr>
<td>Arabiah</td>
<td>488 × 267 meters</td>
<td>low bushes only, frontier forces base.</td>
</tr>
<tr>
<td>Karan</td>
<td>2024 × 632 meters</td>
<td>dense cover of bushes up to one (1) meter high.</td>
</tr>
<tr>
<td>Kurayn</td>
<td>312 × 251 meters</td>
<td>scattered bushes only.</td>
</tr>
<tr>
<td>Jana</td>
<td>1105 × 300 meters</td>
<td>dense cover of bushes up to one (1) meter high.</td>
</tr>
<tr>
<td>Jurayd</td>
<td>732 × 282 meters</td>
<td>dense cover on about two-thirds of the island.</td>
</tr>
</tbody>
</table>

Source: John E. Burchard, Preservation of Arabian Gulf Islands (unpublished paper).

of damaged wells was not well-known because it was impossible to conduct aerial surveillance over the source or nearby due to the war situation between Iraq and Iran. Also, the contradictions in information from different sources made it difficult to gain a clear picture of the situation. By March 8, some sources estimated that there were 10 damaged wells spilling about 5,000 to 7,000 barrels of oil daily into the Gulf. But on April 12, an Iranian report to the Expert Committee Meeting in Kuwait, concerning the Nowruz Oil Spill, claimed that only three wells were damaged with only 2,000 barrels spilling into the Gulf per day.

The Regional Organization of the Protection of the Marine Environment (ROPME) has been conducting many meetings in Kuwait and Bahrain among the ministers of health and experts from the Gulf nations. ROPME representatives tried to reach a political solution to cap the wells, to design a plan for a clean-up operation, and to protect areas which have a potential risk from oil spills. ROPME did not succeed in reaching a ceasefire agreement between Iraq and Iran. Iraq was using the Nowruz blowouts to request a general ceasefire in the entire war area between Iraq and Iran, instead of a limited ceasefire in the blowout area. The Iranians rejected this because they did not want to be forced by Iraq to take such an action. In addition, Iran would not guarantee safe passage for the technical experts to cap the damaged and leaking wells unless Iraq guaranteed that it would not attack the Iranian oil wells in the future.

After the difficulty of reaching an agreement between Iraq and Iran ROPME established a regional policy for clean-up operations and protection of sensitive areas in the Gulf. One of their policies was to site an area in the open water north of Bahrain to be ROPME’s area. In that area oil slicks and tar balls would be collected. However, this policy has not been implemented.

On September 18, 1983, it was reported that the Iranian Offshore Oil Company (IOOC) had capped the Nowruz Well #3 under their own risk. The other two wells were still on fire. Other sources believe that there were six wells on fire during mid-1984 and that they were leaking some oil.

Starting in March, 1983, the Saudi Meterology and Environmental Protection Administration (MEPA) with coordination and cooperation from the University of Petroleum and Minerals Research Institute, ARAMCO, Arabian Oil Company (AOC), Saudi Port Authority, Royal Commission for Jubail and the Ministry of Interior have been conducting a monitoring program. Techniques and information that have been used in this program are:

1. Aerial Surveillance (over flights, sea, and ground).
2. Remote sensing and interpretation of satellite imagery.
3. Computer models to predict the trajectory of the oil slicks.
4. Data received from commercial
shipping, aircraft, and from the Gulf States.

5. Details of present conditions and forecasting meteorological and oceanographic data.

Nevertheless, it was difficult to predict the behavior of the Nowruz Oil Spill in the Gulf.

Aerial surveillance is the best way to trace the movement of the oil by starting from the source. However, it was impossible to do so because the source is located in the war zone. For that reason Saudi Arabia conducted surveillance flights in its coastal zone beginning in late March, 1983, but did not enter the Iranian area.

The Nowruz Oil is very heavy crude oil and the evaporation rate in the Gulf is very high (50% in the summer). This causes the oil to sink to the bottom or sometimes just below the water surface and makes it difficult to predict where the oil is located. Also, the associated dust storms with northwesterly winds in the summer, especially in June or July, create fallout over the water surface which makes the oil heavier and more likely to sink. This helps to explain why oil tends to appear and disappear from day to day.

There was no ground receiving station for LANDSAT imagery (80 m x 80 m resolution) in the Gulf area. The LANDSAT data give a relatively accurate picture of the oil movement and quantities. Images of the Gulf area have come from NOAA 6 and 7 satellites. Dust, clouds, smoke, sun reflections and different salinities cause interpretations of such images to be wrong most of the
time. Local observational data are important to give accurate interpretations of such images. For this reason some satellite images incorrectly show most of the Gulf covered with oil.

Between the period of March 23 and late June, Saudi coastal zones had been contaminated by oil sheens, tar balls, and heavily weathered oil slicks which affected the shoreline, islands and sea ecosystems. By the beginning of May it was estimated that at least 75,000 barrels of oil were in Saudi waters. Figures 5 to 12 show the oil sightings in Saudi coastal zones during that period. By mid-June the wind direction changed to a northwesterly pattern which pushed the oil slicks away from Saudi waters toward the Iranian side.

During the period from July 19 to early September there were no significant sightings of oil. All that had been observed were small patches of oil sheens or fresh small slicks which were believed to be from local Saudi offshore oil well operations or from tanker discharge in the area. It must be mentioned that some tankers and local industrial facilities used the Nowruz Oil Spill and deliberately discharged waste oil into the Gulf.

The Saudi plan of action required the determination of the areas of economic and environmental significance which must be well-monitored and protected. It stated that shoreline clean-up operations would not be conducted before capping the leaking wells because the continued cleaning processes would harm the shoreline. Exceptions were made for the islands' shores to maintain free access to breeding turtles and to protect birds. However, during surveill-
lance flights between mid-July and early September, oil was observed on most shorelines of the affected islands and the plan had not been implemented as intended. This was very harmful to birds, turtles, and coral reefs of the islands. Nevertheless, during the clean-up operations, about 300 tons of oil were collected from Saudi coastal zones.

Clean-up operations faced a major problem. The long distance traveled by the oil from the source to Saudi waters, along with the weather conditions of the area, created heavily weathered oil. Clean-up equipment was ineffective because the tar balls were too dry to be collected by skimmers. Also, it was impossible to use common dispersants on the weathered oil because these worsen the situation and make the oil more toxic.

The positive impact on the public as a result of the Nowruz Oil Spill is that it initiated an environmental awareness among the public. Young people, old people, even children were very concerned about the danger to fish in the Gulf and the water resource. Occasional exaggerated reports and news in the international and local media caused people to realize that pollution is something that affects their daily life and it now occupies a greater space in their consciousness. Public concern and knowledge about pollution and its effects will put pressure on governmental agencies to work harder, conduct studies, and combat the pollution, as well as provide a healthy environment for the people. Currently there are not many environmental specialists in the country. Therefore, this type of incident, and the resultant public awareness, might create
the urge in some people to specialize in environmental studies.

The Nowruz Oil Spill raised many questions among agencies and authorities responsible for environmental protection. They realized the national need for a data base concerning the Saudi Gulf ecosystems and oil pollution data, and they identified the necessity for remote sensing and strong monitoring program services. They discovered a shortage of oil spill combating equipment designed according to Arabian Gulf climate conditions, and the need for trained manpower for clean-up operations. This event was an experience which caused agencies in Saudi Arabia to examine their inability to deal effectively with a large oil spill accident.

In the plan of action by MEPA in response to the Nowruz Oil Spill it was stated that MEPA will prepare, coordinate, or commission the following:

   - Monitoring, studying, and assessing the impact of pollution on the Saudi Coastal Zone ecosystems including coral reefs, salt marshes, mangroves, seagrass beds, and fishery nurseries. These studies were scheduled for a period of five years.
   - Monitoring and assessing fishery food chains in relation to heavy metals and other oil-induced toxic compounds, including an evaluation of public health aspects.
   - Further developing and assessing satellite imagery and computer modeling of oil spills’ trajectories. This study was scheduled for a period of two years.
2. Studies to protect the major installations.

The Nowruz Oil Spill incident highlighted the need for greater protection of industrial facilities at all times in case of a similar catastrophe.

3. Innovative Techniques

MEPA will continue to investigate the use of micro-organisms, especially those that utilize hydrocarbons as their source of food and energy and assess their effectiveness as oil dispersants rather than use of chemical dispersants.

As a result of the Nowruz Oil Field’s spills, an oil pollution center has been established in Al Jubail Industrial Port. Also, the Arabian Oil Company at Al Kafji has developed an Environmental Division for the first time since its creation. A worldwide data search concerning oil pollution has been conducted by some agencies in Saudi Arabia to get the latest information about the impact of oil pollution and the latest techniques of combating this pollution.

After the accident several proposals and bids from many overseas companies and governmental agencies were reviewed. These contained techniques used to combat oil pollution, new equipment, etc., and would provide Arabian specialists with good knowledge and experience for future use.

NEGATIVE IMPACTS

Biological Effects

Dugongs (sea cows) occur in the Arabian Gulf in the Gulf of Salwa. Their number was estimated to be only 50 individuals; 31 were found killed on the Saudi shorelines. According to a report by World Wildlife Federation (WWF), al-
most the entire Gulf population of Dugongs was killed by oil.

Sea Turtles in the Gulf area consist of two breeding species: the Hawksbill Turtle, an endangered species worldwide; and the Green Turtle, severely depleted with many of its populations nearly extinct. The breeding population in the Gulf is about 3,500 females annually with most of them using Karan Island. On the Saudi Coast more than 100 recently dead sea turtles have been found. The fact that the heat during the day melts the tar balls and causes streams of semi-liquid tar to flow across the rocks, creates barriers for the turtles and other wildlife. These tar pools are a particular hazard to the Jana Island shore life as they entrap turtles coming onto the shore and prohibit passage to the sea.

Sea Snakes in the Gulf, and there are several species, live mostly in shallow seagrass areas. It is difficult to estimate how many have died as a result of the oil spill, but many thousands have been observed dead.

Birds have also been affected by the oil on the islands' shores. Hundreds of birds were found dead, and a large number were too oily to fly. Others showed flight impairment because tar was stuck to their wingtips, feet, and other parts. Some birds suffered the loss of primary and secondary flight feathers. Field trips were conducted to the islands from early April to September and on each occasion disabled birds were found as a result of oil on the shores.

Coral Reefs on Karan Island are the most important reef system in the Gulf, and these were severely affected by the oil. The reefs were almost totally killed to at least a six meter depth, and the same was found on Jana Island. The
reefs on Jurayd Island were also affected but less severely.

**Beaches**

From the beginning of April until mid-June when the wind shifted direction to the northwest, the shorelines of the Saudi coast and islands in the Arabian Gulf were affected by oil in many areas. The most impacted sites of the coast were Azizia beach near Khobar, the area between Ras Tanurah and Jubail, and the area north of Abu Ali Island which is connected with the mainland by a causeway road. By mid-June the strong northwest wind and wave action buried the tar balls beneath the layer of sand. Between July and early September the coast appeared clear.

The islands in the Saudi coastal zone were more affected than the coast. Karan and Jana Islands were severely impacted by tar balls. Until the beginning of September most of the shoreline area on these two islands had a coating between 2 to 5 meters wide. During daytime hours, it was observed that the tar had melted and caused problems for turtles and birds all summer.

**Shipping Routes**

Since the Nowruz oil spill, tanker owners and international tanker fleets, as well as the countries of the region and other countries outside the Gulf, have been worried about the shipping routes and whether tanker traffic would be affected. As recently as early September the Nowruz Oil Spill had not presented hazards to shipping routes. However, if this problem happened it would create financial problems by increasing the insurance rates of tankers and ships, and slow tanker and ship traffic. As a result,
the Saudi economy would suffer because the country would be forced to reduce its export and import activities. Also, the international oil market would be affected because Saudi Arabia represents a large source of oil to many countries in the world, especially in the U.S. and Western Europe.

**Fishing Industry**

For about four months, from the beginning of April until early August, the government stopped commercial fishing along the Saudi Arabian Gulf coastline. The Saudi Fisheries Company was affected by the ban because the Arabian Gulf provides an important part of the total fish catch. In 1982, 3,731 tons were caught from the Arabian Gulf and 1,089 from the Red Sea. At the time of the ban the Saudi Fisheries Company was forced to concentrate their activity in the

**TABLE 3**

<table>
<thead>
<tr>
<th>Location</th>
<th>MGD</th>
<th>1000 M³/Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khobar I*</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Khobar II**</td>
<td>189.25</td>
<td></td>
</tr>
<tr>
<td>Jubail**</td>
<td>15.140</td>
<td></td>
</tr>
<tr>
<td>Jubail I*</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Jubail II*</td>
<td>210</td>
<td></td>
</tr>
<tr>
<td>Khafji**</td>
<td>0.454</td>
<td></td>
</tr>
</tbody>
</table>

Red Sea. As a result they were faced with some problems. First, the transportation expenditure from the Red Sea to the eastern province and middle region required additional marketing and consumed cost. Second, people in the eastern province and middle region prefer the Gulf fish to the Red Sea fish. Third, the psychological factor that some fish were polluted decreased the demand for all fish. These factors caused a decrease in company monthly income by 22% or more (personal communication).

About 1,430 individual fishermen live in approximately 20 fishing communities on the Saudi Arabian Gulf Coast. The average monthly income per person is about $2,000. For four months the estimated loss was approximately $11,440,000. In some communities on the Saudi Arabian Gulf coastline, for example Qatif, fish is very important in the daily meal. Consequently, there were some individuals who fished regardless of the ban, brought small amounts of fish from the nearby shore, and sold it at extremely high prices in retail markets.

Destination Plants

Saudi Arabia has six desalination plants in the Arabian Gulf coastline region (See Table 3). The plants not only provide a major source of water for the eastern province, but also provide water for the Riyadh area which is about 500 km. southwest of Jubail. Jubail II desalination plant, the world’s largest plant started operating in February, 1983, provides the Riyadh area with 210 MGD (its full capacity is about 264 MGD). As a result of the importance of the desalination plants, the Saline Water Conversion Corporation placed protective domes and fish mesh nets around water intakes of the desalination plants. Between the period of April 11 and late June, some of the desalination plants were closed or decreased the production of water capacity. During that period, some people tended to take advantage of the Nowruz incident by storing and selling thousands of cartons of bottled water. It has not been said that such action took place in Saudi Arabia, but similar cases were discovered in Kuwait and Qatar.

**CONCLUSION**

Oil pollution presents fundamental dangers to the world’s marine environment. The Arabian Gulf, with its unique physical features and its focus as the world’s center of oil production, is always under the threat of oil pollution. The environmental concerns were not prevalent in most of the Gulf States until the early 1980s. However, the Nowruz Oil Spill provided the example of the danger facing the Gulf ecosystem. This occurred while the Arabian Gulf States are experiencing a rapid industrialization and urbanization, consequently this will increase the amount of oil pollution and other potential hazards.

The need for stronger coordinated environmental programs among the Gulf States appears to be essential to preserve the Arabian Gulf environment. For Saudi Arabia and the rest of the Gulf States the latest incident of the Iranian Nowruz Oil Spill has been a good examination of their preparation and ability to face such an accident. It was also an opportunity for environmental issues to be presented and for plans, standards, and the environmental quality to be evaluated.

**NOTES**


2. A. Joseph’s paper in the 1983 oil spill conference indicates that on October 2, 1980 Saudi Hasbah Well 6 had a blow-out about 100 km. off the Saudi shoreline. Nineteen people were killed in that accident and the daily spillage was from 6–10,000 barrels for nine days. In the beginning ARAMCO reported it as a gas blow-out, and not until October 9 did ARAMCO reveal to the countries concerned that some dispersants might be needed. In addition, ARAMCO had not reported that the well was producing oil until October 11. Moreover, ARAMCO’s clean-up operations on October 9 consisted of spraying chemical dispersants and it was not until October 16 that they started using skimmers to collect the oil from the sea surface in the ARAMCO area.


4. R. O. Williams, ARAMCO, Meteorologic and Oceanographic Data Book for the Eastern Province Region of Saudi Arabia (Dhahran: Environmental Unit, ARAMCO, 1979), pp. 7–8.

5. ibid., p. 3.

6. ibid., pp. 99, 98.


11. Ibid.

12. Ibid.

13. Ibid.


**BIBLIOGRAPHY**


Belen, M. S. "Spreading, Dispersion, and Evaporation of Oil Slicks in the Arabian Gulf." 1981 Oil Spill Conference.


Kuwait Institute for Scientific Research, *“Nowruz Oil Slick Task Force.”* Status Reports Nos. 1–7, 1983.


Manners, Ian R. *North Sea Oil Environmental Planning: The United Kingdom Experience.* Austin, Texas: University of Texas.


Williams, R. O. *ARAMCO—Meteorologic and Oceanographic Data Book for the Eastern Province Region of Saudi Arabia.* Dhahran: Environmental Unit, ARAMCO, 1979.