Remote Sensing Note

NORDA/NOAA Team Studies Oil Spills in Arabian Gulf

The efforts of a four-man federal research team, which recently studied water circulation in the Persian Gulf as part of a project to help forecast oil spill movements, were both enhanced and hindered by the fact that the area is currently enbroiled in an intense regional war.

The members of the team were Bob Pickett and Bob Arnone of the Naval Ocean Research and Development Activity (NORDA), R. M. Partridge of the National Oceanic and Atmospheric Administration (NOAA) Data Buoy Center, and J. A. Galt of NOAA's National Ocean Service.

During the summer of 1983, seven satellite-tracked drifting buoys were launched in the Gulf to record movement data. After collecting data for a month, the paths of the buoys were compared with historical data, a hydrodynamic model, and satellite imagery, revealing a generally counterclockwises mean circulation, with observed speeds of around 20 centimetres per second.

Because about half the world's oil supply is pumped and shipped through the Persian Gulf (also known as the Arabian Gulf), oil spills and leaks have long been a problem. Between 1965 and 1976, for example, Kuwait recorded more than 100 spills. Recently, the Iraq-Iran War added to the problem. In March of 1983, Iraq destroyed an Iranian oil rig in the north end of the Gulf, and a few weeks later more rigs in this area were destroyed. The initial amounts of oil entering the Gulf from these attacks were estimated at 2,000 barrels a day, but may have reached 18,000 barrels a day as damaged rigs melted down and the oil-consuming fires went out.

Most of this oil is trapped in the Gulf, which covers 240,000 km^2 and extends 800 km southeast from the Shatt al Arab River inflow to the Musandam Peninsula. At the southeast end, the Gulf ends in the Strait of Hormuz, which opens into the Gulf of Oman and then into the Arabian Sea. The width varies from 80 to 300 km. The mean depth is 40 m, and depth increases more rapidly off the mountainous northeast shore than off the flat southwest shore (Figure 1).

The oil ends up on the beaches of one of the six countries that border the Gulf. (Iran occupies the entire northeastern shore; Iraq has a 60-km frontage at the northern end; the southwest (Arabian) side is divided among Kuwait, Saudi Arabia, Qatar, and the United Arab Emirates.)

Spills present special problems to these countries surrounding the Arabian Gulf. In addition to the usual toxic effects on marine life (there are extensive shrimp and other fisheries) and shore damage, oil threatens several desalination plants and, therefore, the fresh water supply of the area.

In order to monitor oil coming into its waters, Saudi Arabia purchased a number of drifting data buoys. Seven of these air-deployable buoys (manufactured by Polar Research Laboratories of Santa Barbara, California and by Hermes Electronics, Ltd. of Canada) were launched in the Gulf in May and June of 1983. Their month-long paths were then compared to historical data and a hydrodynamic model, and the results suggest that the paths of oil spills can be predicted in the Gulf.

In the region the drifters were deployed, historical data, model results, and the drifter tracks agree: the mean current was to the south. In the northeast end of the Gulf, however, there is some disagreement. The southeastbound nearshore current forecast by the model was not observed and, hence, is not shown in the historical data. But logically, currents in that shallow region should respond to the northwest wind and move toward the southeast down the coast.

To resolve the disagreement in the northern Gulf circulation, satellite pictures from March 1983 were reviewed (Figure 2). The NOAA-7 visible and infrared bands show dark, warm streaks heading southeast from the damaged rigs. If these streaks were oil, then these pictures would confirm the model circulation. However, the burning rigs also created lots of smoke which would blow southeast with the prevailing winds. Owing to the problem of separating oil and smoke, these pictures could not definitely confirm the model circulation.

The overall tendency toward counterclockwise circulation in the Gulf, evident in both the historical and model current patterns, results partially from the interaction of the northwest wind and the asymetric bathymetry. The shallow regions on the southwestern side of the Gulf are more susceptible to these winds, and currents there tend to spin up faster and stronger than those off the opposite coast.

A water particle following the observed current pattern at the mean speed of 20 cm s^{-1} would require several months to travel the length of the Gulf. During such a trip, tidal and inertial currents

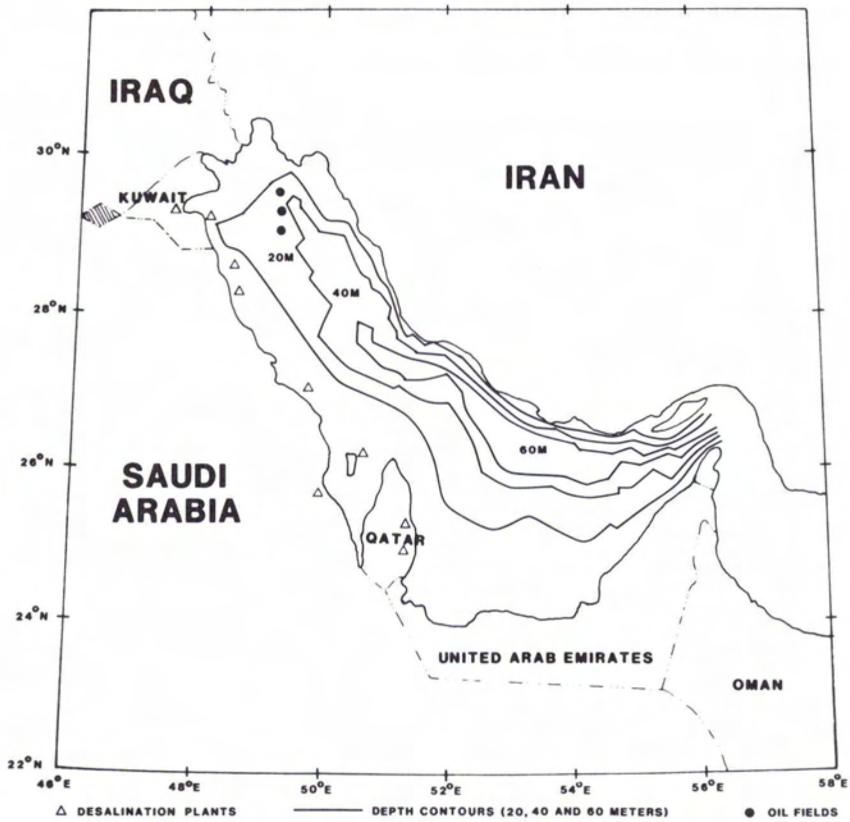

FIG. 1. Desalination plants, bathymetry, and war damaged wells, among the countries in the Persian Gulf region.

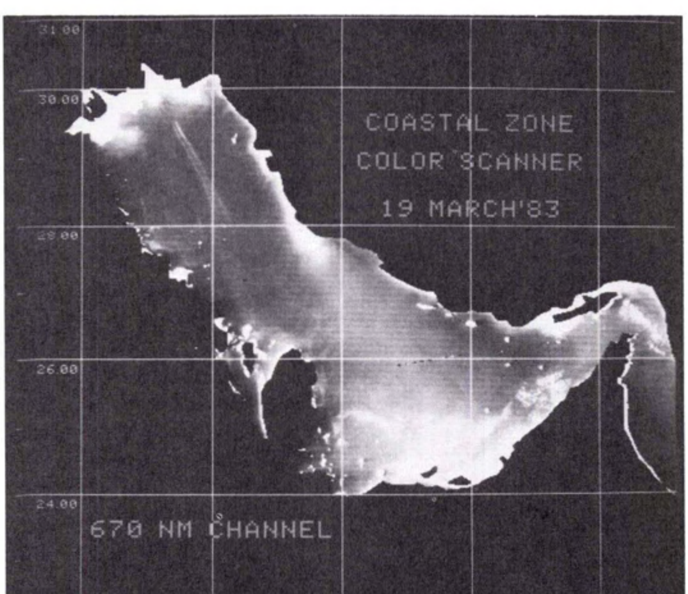

FIG. 2. NOAA-7 Coastal Zone Color Scanner image of the Persian Gulf, taken 19 March 1983.

would produce oscillations along the way (with displacements of about 10 to 20 km). For oil spills, these currents would combine with 2 to 4 percent of the wind. Hence, spills in the northern reaches of the Gulf would be carried west and then south by the currents. In addition, winds from the northwest would drive the oil straight to the southeast. This combination will result in oil from the war-damaged rigs beaching well away from the source and far down in the Arabian Gulf.

The NORDA/NOAA team members feel that the discrepancies between the historical and model circulations in the northeastern part of the Gulf need to be resolved. This is the area where most oil is being spilled, but the war rules out direct observations. It would take a highly sophisticated analysis of the satellite pictures to separate smoke from oil and, thus, resolve the discrepancies in the northern circulation of the Arabian Gulf.

New Sustaining Member

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