Environmental effects of the Gulf War on coastal areas north of Jubail - an overview

Hans-Karl Barth & Axel Niestle

Abstract: The environmental effects of the 1991 Gulf War on ecosystems in the area between Abu Ali and Ras az-Zaur on the Saudi Arabian Gulf coast are described. The oil was deposited as a thick layer in a narrow, linear strip in the high tide zone. Damage to the fragile vegetation cover of the inland areas was caused mainly by the passage of vehicles during military activities. This has led to a partial remobilisation of sand formerly stabilised in sand sheets and fossil dunes. This reactivating process is self-accelerating and serious effects on the ecosystem in the medium and long-term scale are to be expected.

INTRODUCTION

In general, semi-desert and desert environments are characterised by a particularly high sensitivity to human activities. The 1991 Gulf War caused an ecological disaster in terrestrial, coastal and marine ecosystems resulting in extensive degradation and a destabilisation of the environmental equilibrium. In the Arabian Peninsula coastal areas were most seriously affected. The stretch of shoreline between Ras az-Zaur and Abu Ali was surveyed by the authors in November/December 1991 and March/April 1993 in order to identify and analyse the environmental impact within this area. Some of the results of these surveys are presented here.

PHYSIOGRAPHY OF THE STUDY AREA

The area under consideration is part of the central coastal lowlands of the Eastern Province of Saudi Arabia (Fig. 1). From its western boundary, marked by the eastern escarpment of the Summan Plateau, the region descends gently to the coastal plains (Al-Sayari & Zotl 1978, Barth 1980). The coastline is characterised by a wide intertidal zone. Most of the inland area is covered by quaternary sand and gravel deposits with the sandy fraction accumulated in stabilised dunes or sand sheets. These sediments, which are sometimes consolidated as calcrites, occur as beach rock formations or underlie the sand sheets and dunes.
Prominent features in the topography of the area are widely rolling dune systems which are stabilised by a cover of vegetation. Longitudinal sand ridges, representing fossil dunes, stretch in a generally north-south direction. Dune crests rise 20 m above broad interdunal corridors, forming the typical undulations of a transversal dune system. On the periphery of the dunes are sand sheets. The sand in these plains may be up to 10 m thick, covered and stabilised by up to 30% vegetation cover.

Sabkhas occur in coastal and inland areas. They may cover several hundred square kilometres as is the case for Sabkhat Murair and Sabkhat al-Fasl northwest of Jubail. Salt-marshes have developed in the low-lying, periodically flooded parts of the coastal sabkhas though, in general, the sabkhas are devoid of vegetation. A zone of halophytes may, however, be found along the edge of a sabkha and these give rise to micro-hummocks due to the accumulation of wind-blown sands (Plate I). Since the prevailing wind direction is north, these "Kuthban" are oriented north to south.

The Eastern Province of Saudi Arabia including the coastal areas of the Arabian Gulf belongs to the arid part of the subtropical belt, which has a Mediterranean type of climate regime (BARTH 1976). Rainfall is very irregular and confined to the winter and early spring. The mean annual rainfall in the study area is 80 to 100 mm. Temperatures rise to more than 40 °C during the months of April through September, whereas values below 10 °C may occur during December through February. Evaporation rates of up to 3000 mm/yr combined with low precipitation are responsible for the high degree of aridity and desert climate of the area. The aridity limits both the vegetation growth and the diversity of plant communities. In general, the diffuse perennial vegetation cover is less than 15%. The intershrub spaces are bare for much of the year but are occupied for a few weeks by a ground layer of rainy season ephemerals. The total number of species contributing to desert vascular plant biomass is relatively small. The vegetation in the area is described in BOER & WARNKEN (1992).

**ECOLOGICAL EFFECTS OF THE GULF WAR**

Carried by the prevailing currents in the northwestern part of the Arabian Gulf, the oil slicks reached the coastal water of the Project area around mid-March 1991 (Fig. 3). The islands and bays of the study area formed a natural trap for the oil which subsequently accumulated in the embayments in large quantities. Wide areas of the intertidal zone were covered by the oil. Due to the physiographic characteristics of the coast, part of the oil was carried far inland and into some of the sabkhas. The field survey along the coastline, in cooperation with other work in this Project (JONES et al. 1994), showed that the oil coverage in the immediate littoral fringe was restricted almost entirely to the high tide zone. The area of cover was determined by the physiographic zonation. In the upper intertidal zone
it was linear and often patchy, whereas the affected low level areas of the salt-marshes or sabkhas displayed a wide areal cover by the oil. Impermeable tar mats became a semi-permanent feature particularly in the littoral fringe and in the upper eulittoral. However, on rocky shores the oiled layer has started to peel off.

Observation of the spatial distribution and thickness of oil-contaminated sediments leads to the conclusion that, besides the existence of local natural and artificial oil traps, the beaches exposed to the north and the north-east suffered most in terms of the total amount of oil that came ashore. This was due to the prevailing currents and wind directions during the arrival of the oil (Fig. 3).

Measurements of the depth of the oil in impacted sediments indicated a penetration range between 2 and 50 cm. The oil content of sediment samples varied between 5% and 25% depending on the topography and texture of the sediments. Usually, a thin layer of residual oil components and algae overlay a completely oiled zone of varying thickness. A partly affected deeper zone was reached by the oil through permeable sands or via animal burrows. In the deepest zone the oil often remained liquid. In some places underlying beach rock prevented deeper penetration of the oil (HAYES et al. 1993).

Below the surface, some horizons of oil residuals were found which almost certainly dated back to earlier spills. Continuous sedimentation either by aeolian or marine processes has covered some of the recently oil-affected beach sediments. The complete spatial distribution and the thickness of these deposits can only be detected by a grid of boreholes.

Additional environmental damage was caused by the Allied Forces. During their assembly prior to the start of the ground campaign against Iraq, a large portion of the northern part of the Project area was used for training and live-fire exercises by infantry and armoured units. The debris from these live-fire exercises are still evident at numerous sites around Musallamiya Bay. The area is widely covered with tracks of vehicles including tanks, and in the stabilised dune fields and flat sand sheets the physical damage to the vegetation is locally quite serious. The continuous degradation of the vegetation and the physical disturbance of the sandy soils has resulted in a marked reactivation of the sand between autumn 1991 and spring 1993. Deflation forms were detected in many places on both the sand sheets and the dune fields. The degree of uncovering of the roots of hummock-forming plants reveals this rapid process in an area where strong winds prevail for about 700-1000 h a year. During the 'Shamal' period
between April and September wind velocities may exceed 10 m/sec. The presence of giant sand ripples, sometimes several metres long and about 30 cm high, documents the restoration of some areas as sand sources. New parabolic and/or barchane type dunes can be observed as a consequence of the accumulation of wind-transported sand.

A vegetation cover of 8-10 % is sufficient to reduce aeolian dynamics, thereby preventing large sand movements even during the windy season. Areas with a lower cover must be considered as potential deflation areas during strong winds.

The main damage caused by the oil spill occurred on beaches exposed to the north and in the intertidal salt-mashes and coastal sabkhas. The coverage of oil and residual components on rocky parts of the coast is limited to a narrow linear band in the high tide zone. Thick layers of oiled sediment occur in large areas of the intertidal zone, in salt-mashes and coastal sabkhas. These semi-terrestrial ecosystems are seriously affected not only by the surficial oil deposit but more importantly by the penetration of oil into the sediment.

Both the oil accumulation in the coastal areas and the aeolian processes in the inland areas require extensive countermeasures. The restoration of the original balanced equilibrium in the coastal and terrestrial ecosystems will be difficult.

REFERENCES


BARTh, H.-K. 1980. Geomorphologische Karte der Arabischen Halbinsel (Zentral- und Südarabien), 1:4,000,000 Tübinger Atlas des Vorderen Orients (TAVO), Tübingen, map A VIII.


Authors' addresses:
Prof. Dr. H.-K. Barth, Universität Paderborn, FB 1 - Physische Geographie/PGS, D-33095 Paderborn, Germany.
Dr. A. Niestlé, Hertzbergstr. 3, D-12055 Berlin, Germany.