# REMOTE SENSING TECHNIQUES FOR OIL SLICK MONITORING IN OFFSHORE OIL AND GAS EXPLORATION AND EXPLOITATION ACTIVITIES -CASE STUDY IN BOHAI SEA, CHINA

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## Abstract

### 1. INTRODUCTION

Marine pollution resulting from discharged or spilled oil is a major environmental hazard, and early detection of oil slicks is a priority for maritime nations, including China. Different countries invest significant resources into detection of off-shore pollution, including the use of satellites. Space-borne monitoring has advantages of wide spatial coverage, multi-temporal resolution, high precision, and rapid acquisition. For these reasons, it has become one of the key techniques for marine oil slick monitoring[1, 2, 3, 4].

Bohai Sea is an inland sea surrounded by lands to the north, south, and east. There is significant economic development throughout the coastal zone. Coastal and marine areas throughout the Bohai Sea are at significant risk from oil spills because of high levels of shipping traffic, petroleum traffic, and offshore oil installations. To limit and control such pollution, oil slick detection using remote sensing has been applied in the Bohai Sea.

### 2. METHODOLOGY

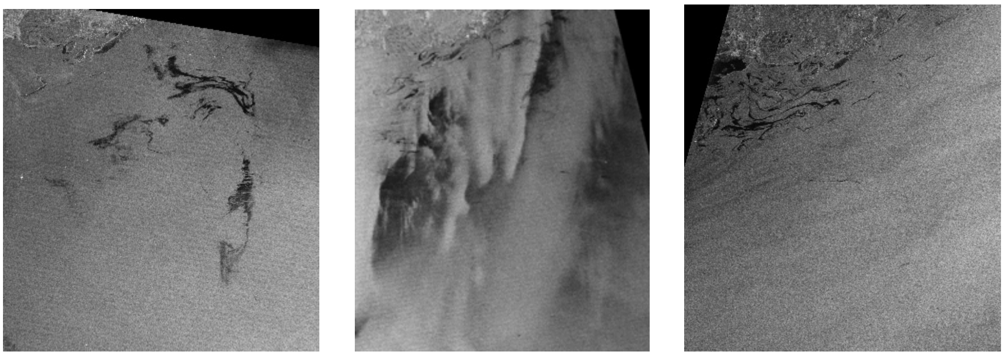
This paper uses the oil pollution accident that occurred in March 2006 in the Bohai Sea as an example. ENVISAT (ASAR) images were used to detect and monitor the movement of an oil slick for twenty days in March and April. The oil slick information obtained from satellite data and other sources were integrated to confirm the source of the pollution, evaluate the area polluted, and analyze how the slick dispersed during the observation period.

The satellite data available for this study included three ASAR scenes acquired on 23rd March, 1st April, and 11th April. All images were collected in image mode with vertical polarization. The analysis was performed in 4 steps, and the same methodology was applied to all three images.

The first step was preprocessing of the images. The selected images were converted to 8-bit data to increase the processing speed. In addition, backscatter power analysis was undertaken on the original values of the image acquired on 23rd March. The second step was to georeference the images, where images are referenced to geographical coordinates (longitude/latitude). GCP locations were obtained from a geocoded image with high precision. The third step was to filter the images. A Lee filter was applied with the aim of smoothing texture noise to improve the visual interpretation of oil slicks. The fourth step was to digitize a vector layer. Oil slicks Vector layers were created for GIS analysis.

### 3. RESULTS

On 23rd March, the oil slick was distributed over several large areas totaling more than 400 $km^2$. The slicks were well defined and had good integrity in terms of shape. Because of this integrity, the slicks persisted for a long time. The movement and evolution of oil slicks are influenced by wind and current conditions. Based on an analysis of how backscatter power changes throughout the oil spill area, oil



(a) (b) (c)

**Figure1.** Images of the ASAR on the 23rd March (a), 1st April (b), 11th April (c) showing the oil slick spreading trend.

slicks can be quantitatively divided into four phases. Based on knowledge of prevailing wind conditions when the first image was acquired (it was a north-east wind), we were able to calculate the source of the oil spill. On 1st April, ocean surface conditions deteriorated because of strong winds. Wave action resulted in the dispersal and breakup of the oil slicks, and moved them towards the northern shoreline of Bohai Bay. The total area of oil slicks decreased to 100 $km^2$. On 11th April, ocean surface conditions improved compared to 1st April. Oil slicks began to arrive immediately off-shore. Oil slick information extracted from the three images show the spreading trend clearly, as they move from north to south and east to west.

## 4. CONCLUSION

Results have clearly demonstrated that remote sensing is a useful tool for oil spill monitoring. With the rapid development of Chinese offshore oil and gas exploration and exploitation [5], it is necessary to strengthen surveillance to improve marine and environmental safety. Periodic monitoring using remote sensing techniques should be undertaken at key work areas to detect oil spills in time, evaluate the scale or severity of pollution quickly, improve field response times, and reduce field costs. At the same time, remote sensing monitoring can be used to assess responsibility for the pollution, calculate economic losses, and improve decision-making by government authorities.

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