OIL SPILL STATISTICS FROM SAR IMAGES IN THE NORTH EASTERN BALTIC SEA SHIP ROUTE IN 2007-2009.

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1. INTRODUCTION

The number of marine pollution arising from illegal oil dischargers from ship tank or bilge pumping is much greater than those spectacular ship accidents. Active microwave sensors deployed on satellites are an important tool in oil spill detection. Among the many different sensors synthetic aperture radar (SAR) is possibly the most suited for oil spill (OS) monitoring and identification, because of its high ground resolution and independence of weather condition [1]. Many studies have proved that radar images can provide information on possible location and extent of oil spills [2; 3; 4]. OS can be detected on SAR imagery because they have a dampening effect on the Bragg waves in the sea. When oil enters the water from a vessel or another facility, it initially spreads out and forms a continuous or cohesive patch on the water surface. OS patch of oil absorbs energy and dampens out surface waves, making the area “slick”.

Detection and identification of OS in SAR images is complex because of look-alikes, which often occur in low wind condition. The SAR features of an OS and its surroundings depend on parameters like wind speed and the amount and a type of oil. Former experience demonstrates that the best approach for operational monitoring of OS would be simultaneous employment of different remote sensing instruments (SAR, optical remote sensing, *in situ* measurement) [5].

In every country, marine surveillance agencies are responsible for oil spill combating and on identification of illegal polluters. They rely on information that has been provided on potential oil spills by responsible institution. Illegal spills are mainly detected on essential navigation routes. Therefore, the aim of current study is to perform statistical analyses of oil pollutions in the North Eastern Baltic Sea shipping route in 2007-2009.

2. METHODS

During the monitoring period we got altogether 156 SAR image reports for the North Eastern Baltic Sea from EMSA from the period April 2007 - April 2009, which gives about 4-5 images in a week. OS detection was performed on imagery that was acquired by ENVISAT/ASAR and RADARSAT-1/2 sensors. The presented algorithm has three main parts: detection of dark spots, feature extraction and dark spot classification [6]. The

figure 1 OS and look-alikes statistics on Baltic Sea ship route shared to five sectors from South 1, 2, 3, 4, 5

potential OS are marked on the images. In addition, the output consists of slick co-ordinates, area and confidence estimate. The confidence measure is computed based on the computed features and tries to resemble the rules used by operators at Kongsberg Satellite Service (KSAT). OS assigned confidence was low, medium and high level. High confidence was assigned if the wind level is moderate or high, the slick has strong contrast, surroundings were homogeneous and source can be near.

The characteristics of potential slicks (frequency, size, confidence, shape, edge, contrast) on preprocessed images for the shipping area from Liepaya (sector 1) to Vaindloo (sector 5) were analyzed (figure 1). The area was divided into 5 sub regions, as the shipping activity is different for each sub region decreasing from the Baltic Proper towards the eastern Gulf of Finland.

3. RESULTS

Potential pollution was marked on 137 images out of 156. The largest number of hits, 49, was observed in the northeastern Baltic Proper at the entrance to the Gulf of Finland, sector 3 (figure 2). The number of hits was about half of that in the western Gulf of Finland, sector 4, and in sector 1, 27 and 26 respectively. Monthly distribution of potential slicks shows well defined seasonal distribution. Illegal pollutions have the lowest frequency during January-March and have high value from April until October. During the last period July is an exception with 8 hits encountered. Also somehow exceptional is rather high number of pollutions in December.

Spatial distribution of monthly pollutions shows clear areal pattern (figure 2). In the northern Baltic Proper that is the southern area of our region, the oil slicks are observed during autumn, winter and early spring, while no

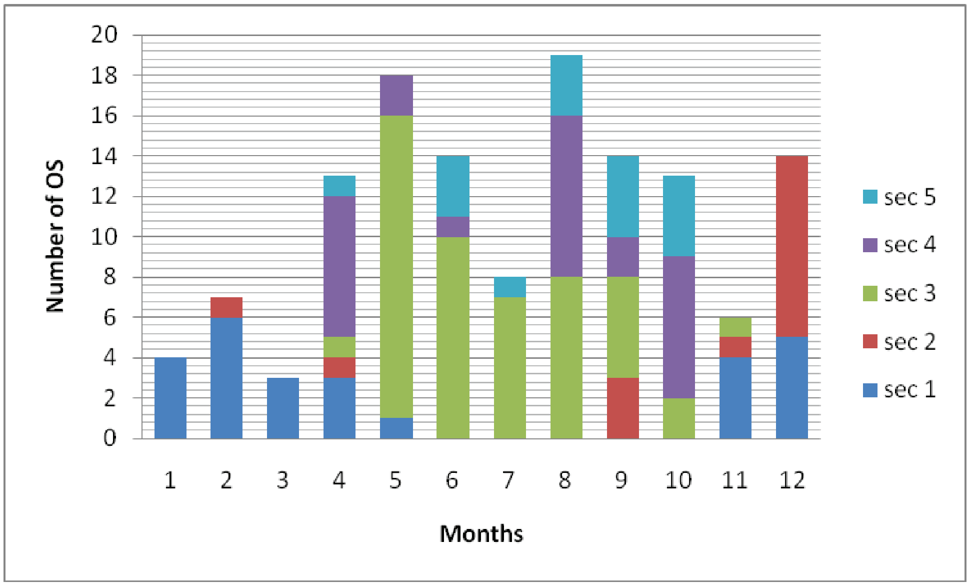

figure 2. Number of OS in different sectors from Apr 2007 to Apr 2009.

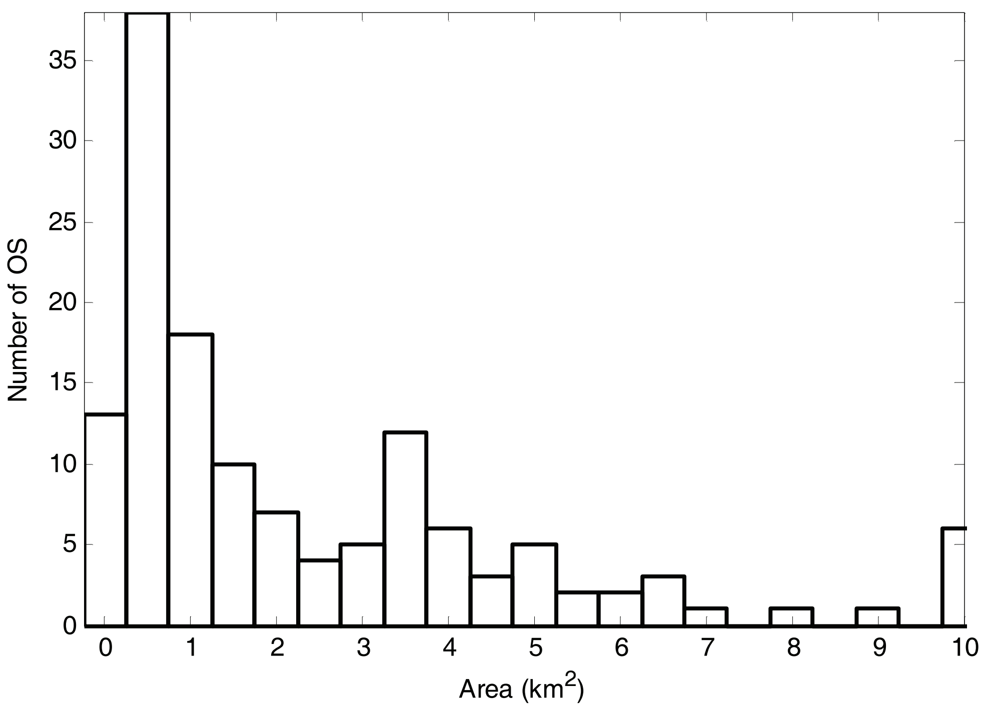

figure 3. Distribution of potential OS by area.

pollutions are detected in summer. In the Gulf of Finland the slicks are more frequent in spring, summer and early autumn, but absent during winter. This reflects intensity of the shipping, as the central and eastern part of the Gulf of Finland is covered by ice in winter.

The majority of potential oil spills had area less than 1 km^2 (figure 3). There were only 6 OS with the area that exceeded 10 km^2. Larger spills were identified at the entrance to the Gulf of Finland, in sector 3. There was also the largest number of potential oil spill. The analysis of the OS's operational mapping obtained from April 2007 to April 2009 shows that the meteorological and oceanographic conditions were favorable. The detected OS's were of low or medium confidence and contrast. The spills had mainly stripe/tail shape that did not have sharp edges and strong contrast with surrounding sea. It shows that potential spills had low concentration of oil and/or had been in water over longer period.

About 94% of detected SAR images were classified as low and medium confidence and did not get any confirmation with SLAR. Only in 15 cases the OS were confirmed by SLAR. Thus, a part of the OS detection and identification problem is to distinguish oil slicks from other natural phenomena like seaweed, foam, and other organic material. Low wind area, algae, upwelling, internal waves that appear as dark structures on the sea surface.

4. CONCLUSIONS

During the monitoring about 137 OS's of different classification and characteristics were detected in the northeastern Baltic Sea ship route. Potential spills were mainly of low confidence, had small area, low contrast with surrounding water and smeared edges. The entrance to the Gulf of Finland was classified as the area where illegal spills of oil and bilge water take place, mainly. Therefore, it is important to map and analyze the areas of more frequent illegal pollution and to increase areal surveillance there. An important part of OS's detection and identification is separation of oil slicks from look-alikes.

5. REFERENCES

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