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Design of surface drifter for the oil spill monitoring

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Abstract:
Aim of the paper is to develop and present a stategy of oil spill experiments in the coastal zone based on the use of oil spill drifters. The aim is achived by the following steps, first a review is presented organized in two sections: (i) a brief presentation of the phenomena related to the process of oil spill in the sea; (ii) a review of surface drifters.
Then the past experience and review provides the basis for the choice/design of a proper drifter for the design of the best prototype, acheived by working on the shape, the dimensions, the ballast, the equipment and material. For the project planning decisions have to be taken regarding the sampling strategy, the data acquisition and transmission, the buoy deploy position, the number of drifter in the same cluster, the duration of the experiment and the analysis. The design of the oil spill drifter is twofold, to calibrate and validate oil spill models and to propose to the scientific community a sort of protocol for the oil spill experiments, and to build proper drifters to be launched in case of accidents for the oil spill monitoring. At the end of the paper a first launch is described.

Keywords:
Coastal environment – Oil spill – Marine pollution – Drifter – Oil spill experiment strategy – Pollution monitoring

1. Introduction

The maritime transport of oil is about half of the total global exports of oil, and, according to the study done by BILIARDO and MUREDDU (2005), is about 55-60% of inter-regional exchanges, that is the trade between different geopolitical areas, involving long distances. The raw oil transported by sea is ECU 30 million barrels/day, of which the most of them, travel on large intercontinental routes, and its trend is positive, in line with expectations of growth in world energy demand, the quantity of transported oil will reach in 2030 the 50 million barrels/day. In the Mediterranean, which represents only the 0.7% of the world's water surface, around 20% of maritime traffic program is concentrated on this. In 2005 the traffic of petroleum in the Mediterranean was next to 400 million tons a year and is made possible by the handling of 8 million barrels/day, from about 3,000 shops a year. Currently, in the Mediterranean Basin about 9-10 million barrels a day, or 1,3 million tons should move per day. It is obvious the high

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risk of oil loss from tankers and the need to provide the dispersion of oil in the event of release from ships. This includes both accidental and voluntary unauthorized spills. For the prediction of oil spills several numerical codes have been developed and are in continuous improvement for the simulation of oil processing and oil spill dispersion. The calibration and validation processes require the acquisition of data and information relating to the propagation of oil coming into the sea in coastal areas. This data will be then compared with the simulation results of the dispersion in the coastal area, very vulnerable where pollutants dispersion forecast is important for a rapid plan of protection and mitigation of impact of pollution on the coasts. In our seas it's not possible and not conceivable, in current attitudes of environmental sustainability, an experiment of controlled oil spills, or of other tracers.

Instead of spilling tracers and observing their development, it is therefore chosen to launch surface buoys in certain positions in the sea and to monitor their track in the sea and in the coastal area assuming that the buoys move the same as the oil spot.

It is clear after the introduction how the planning of an oil spill simulating experiment is extremly complex, due to the complex nature of the phenomena involved, of the noumerous availability of the drifter, and to the difficulty for the appropriate choice, therefore the aim of this paper is:

- to present the problematics and questions arised during the planning of an oil spill experiment aimed to calibrate and validate coastal oil spill models;
- to present a critical review of surface drifter for the oil spill monitoring;
- to give first reccomendation on the best practices to run oil spill monitoring and experiments;
- to present the first results of oil spill drifter launch.

2. Brief description of oil spill dispersion

The particles in oil spill are transported by water in which or on which they are located. Initially, the oil spilled form a large oil cohesive. This spot is usually a layer that spreads and becomes wider, according to its physical and chemical characteristics, and is transported by winds and currents at a surface speed from studies and observations is approximately equal to a small percentage of the wind speed. Due to effect of breaking waves the oil breaks into small droplets, a phenomenon called dispersion. This phenomenon is described by empirical formulas and well represented in the model simulation of dispersion and transformation of oil spill, as in MEDSLIK (AL RABEH, 1994) and others (LEHR, 2001, PRICE *et al*., 2004). In the presence of waves and strong wind the droplets can be dragged in the lower layers of the water column, and go back to more calm conditions.

3. Surface drifter design and experiment plan

The buoys made to follow the surface currents in the coastal zone are many, they vary in shape, materials, acquisition and transmission of data systems. The CODE (Coastal Ocean Dynamics Experiment) drifters are very well known (DAVIS, 1985), but they don't seems to be appropriate to properly follow the oil spill; others are cylindrical buoys, spherical buoys or other shapes (ovals, etc). The submergence of surface buoys generally reaches 1 m or more. Recent developed surface drifters are described in JOHNSON & PATTIARATCHI (2004), MACMAHAN *et al*. (2009), and REED *et al*.. (1990).

The proposed drifter design was based on a study of ballast, rollover stability. In order to check the drifter behavior during stormy events, several tests have been carried out in a wave flume at the Hydraulic Laboratory of the Florence University (Italy). The tests allowed to select the shape of the drifter in order to garantee the maximum stability in the wave fields, comparing drifter with different ratio between heigth and diameter, and different shape (cross, cylinder, cone).

The definitive shape of the Oil Spill Drifter (OSD) is a 32cm diameter cylinder. The ballast was added up to reach the submergence of 7 cm in salty water. Figure 1 shows ballast tests at the hydraulic laboratory of the University of Bologna.

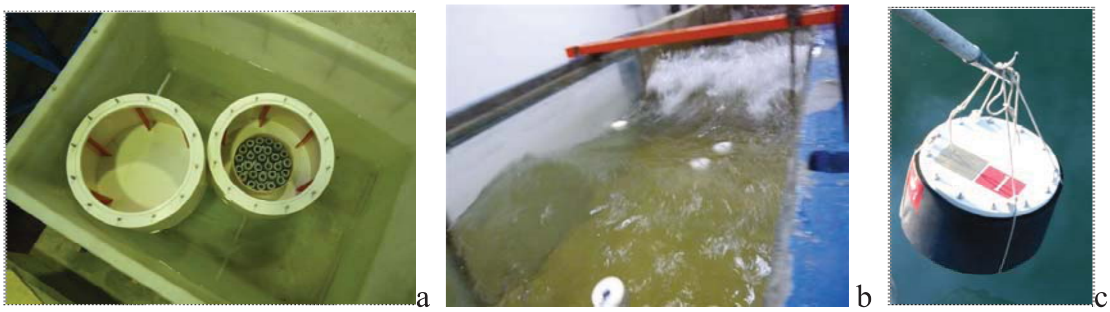

Figure 1. Test of the prototype Oil Spill Drifter (OSD).

The final prototype is covered by a rubber layer, to protect the buoy from potential crashes with boats or breakwaters. The drifters are equipped with a GPS to acquire the geographical position every 10 minuts and an IRIDIUM satellite system to send data to a server: every 2 hours, every 10 minuts (during recovery) or once a day during long deployment in order to spare battery life.

A first validation on the ability of the oil spill drifter to follow the marine pollution was carried out on September 1st 2009 in the Northern Adriatic Sea. The drifters have been launched in the water in a plume of a sewage water disposal from the channel of Cesenatico. Two drifters were deployed in the plume centre and two at the plume front The two at the plume fronthave followed the front evolution during the experiment (4 hours). Wind speed was approx. 30 m/s and significant wave heigth 0.5 m. The plume and the OSD moved in the wind direction at an average speed of 0.2 m/s.

4. Conclusions

Main advantages of the OSD, in respect to other existing drifters, are: (i) OSD has been designed properly in order to follow or simulate oil spill or surface pollution due to the extremly reduced submergence, (ii) it is posible to modify its bouyancy and as consequence the wind effects on the OSD, (iii) the satellite GPS-IRIDIUM system allows the choice between three transmission configurations, this option increases the chance to recover the drifters.

Future experiments will regard the simultaneously deploy of OSD with other difters. Future research will regard the calibration of oil spill models with OSD experiments.

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