MAR2: "Crisis Management System for Marine Pollution caused by Oil Spills"

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Abstract

MAR2 project designs, develops, sets up and starts up the Integral Management System for Responding to Crises (SIGE) for marine pollution events caused by accidental and non-accidental oil spill.

The system will be able to run high resolution simulations of spills through the acquisition of real-time ocean-meteorological data, centralize and store all crisis-related information, manage the operational response and provide support to the Crisis Manager Team facilitating the access and interaction with the relevant Marine Pollution Contingency Plans.

The implementation of MAR2 will be useful for end users related to Public Administrations with responsibilities on the first responders on marine pollution accidents, industries, and in general all those entities which handle hydrocarbons in their facilities during their business activity within the maritime and port environment.

The paper presents the MAR2 system architecture and their potential benefits.

Keywords: *Oil Spill, Decision Support System, Crisis Management, Marine Pollution, Contingency Plan.*

I. INTRODUCTION

Unfortunately, several accidents related to oil spills have produced catastrophes with a high impact in the marine environment as, for instance, the well-known Prestige vessel accident in the west northern of Spain in 2001, Erika vessel southern of Wales in 1996… but not all these kind of incidents are related to vessels, the most recent ones are linked to oil platforms as the PetroBras in Sao Paulo (Brasil) last April 2013, or Deep Water oil platform rented to British Petroleum in the Mexico gulf last 2012.

Although these accidents do not happen very often, their consequences in the ecosystems (fauna and flora), in the deep-sea floor, atmosphere and water pollution and their impact in the regional economies are quite important that, the Spanish Government, aware of Spain has almost 8.000 kilometres of coast, decided to promote and support different mechanisms to manage and control this kind of crisis.

MAR2 is made up of different subsystems: SIGE - Integral Management System for Responding to Crises, SIZ – Real-time Data Capture System, SIM – High-Resolution Simulation System of oil spills, SRM - Mobile Remote System. Integration of all these different systems provides a versatile and global solution useful for end users and institutions: ports, safe and rescue agencies, environmental agencies, oil refineries, etc..

The overall MAR2 system will include both, a desktop version with full functionalities to be used in the Emergency Operations Centre, and mobile-device version optimized for facilitating the work of field operators in the spill. During the project lifecycle will be executed two trials: in the Port of Vigo and in the Port of Las Palmas (both in Spain) in order to perform training exercises that will allow the validation and calibration of MAR2.

II. DESCRIPTION OF THE SYSTEM

The system is broken down in different components or subsystems: the Integral Management System for Responding to Crises (SIGE), the System for the Management and Operation of Marine Pollution Contingency Plans, the High-Resolution Simulation System of oil spills (SIM), the Real-time Data Capture System (SIZ) and the Mobile Remote System (SRM).

The SIGE is responsible for displaying the whole information integrated in the system (real time data, results of forecast models, simulations of oil spills, etc) and assessing the level of emergency guiding the user in the decision-making process. This subsystem is complemented with other components that will facilitate collaboration and coordination of the personnel involved in the management team of the crisis: logbook, reports, agenda, digitized contingency plans for online access, etc.

The SIGE has been developed on PLATEA4D (Operational Platform and Geotemporal Data Analysis). It is an ongoing R & D project performed by a member of the working group that is designed to facilitate the rapid development of monitoring and analysis systems. It has been used in various systems such as vessel traffic monitoring, evaluation/simulation scenarios for oil spill risk, emergency management of vessel traffic with polluting goods and prediction of its possible evolution, the scope of its consequences and generation of protocols.

User-friendly interface highlights from the components of the platform, with configurable user profiles and information organization. The application allows viewing orthophotos and high-resolution vector maps for geo-positioning elements. It also has tools for editing, interactive navigation, query, geographical search, upload and download data and explicit management of temporal component. A temporal navigation bar allows the system to define the observation time and temporal ranges.

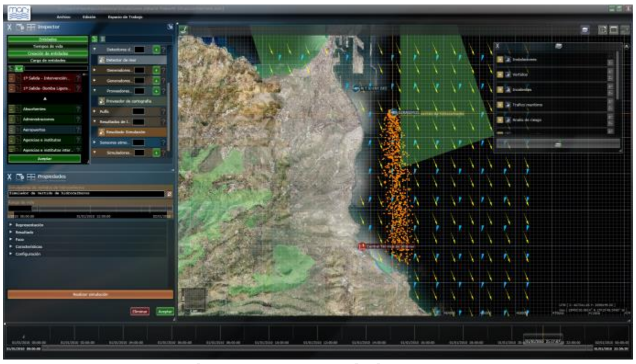

Fig. 1 The MAR2 system: desktop version.

The "System for the Management and Operation of Marine Pollution Contingency Plans" is a dynamic and easily manageable system that provides full access to all the information included in Contingency Plans. The contained information has been specifically organised for providing each user with direct and structured access to the most relevant sections of the plan basing on the role they play on the response: information about oil handling facilities, responsibilities and procedures, coordination with other plans, etc. Authorized users can access the information using both desktop (SIGE) and mobile (SRM) clients.

Wind and current data are required as forcing data into the oil spill model for both the forecast of the slicks trajectories and the forecast of the variation of oil the properties with time. Work and research is required previous to the operational implementation of MAR2. The best current and wind operational models existing within the implementation area need to be identified. Whenever possible, at least two of each model (wind and current) are selected. The Real-time Data Capture System (SIZ: Zonal Information System) is in responsible for the acquisition of the data provided by these models. Data from the forcing models are acquired whenever they provide a new forecast. These models are updated every 6, 12 or 24 hours, providing forecast from 48 hours to several days. Once the predictions are downloaded, the system processes and transforms data into the forcing data formats required by the oils spill model. Forcing data are stored in a Thredds Data Server MAR2 for at least a week. The process of acquisition, transformation and storage of data last only few minutes and are available to use in the case of an oil spill event within the operational area. The SIZ is also responsible for downloading and storing real-time ocean-meteorological information from sensors and buoys within the implementation area. The SIZ provides with bathymetry data and any other relevant geographic information, such as protected areas or relevant infrastructures.. The server includes different data transfer protocols, such as WMS (Web Mapping Service), WCS (Web Coverage Service) or HTTP (Hypertext Transfer Protocol).

In case of an accidental oil spill, the predictions will be used operationally as forcings into the SIM. The SIM is governed by a cutting-edge numerical model. We have developed a Langragian particle numerical model able to predict 2D advective transport. The SIM allows representing an oil spill event due to a single slick or to multiple slicks. The system allows the user to input the slick/s irregular real shape if this information is known (by geo-referenced images). If several slicks are represented, they can be of different oil types. MAR2 uses the ADIOS2 oil type library (NOAA's National Ocean Service- Office of Response and Restoration, 2011). Every slick can be represented through a set of particles, spillets. The main processes involved in the transport of an oil slick in the sea surface layer are advection and turbulent diffusion. Advection is forced by velocity and direction of wind and currents. The SIM predicts the spillet trajectory using drag coefficients. Horizontal diffusion processes occur on very different spatial and temporal scales from advection. The numerical model cannot adapt to different temporal and spatial scales, so, in order to resolve the turbulent diffusion, the Markovian models Random Walk or Random Flight (Spaulding, 2005) will be applied depending on the hydrodynamic conditions in the implementation area. A very important task during the implementation works is to validate the transport model, estimating the most appropriate drag coefficients and evaluating the application of random walk or random flight. When an oil spill event takes place, it is important for the responders to know the expected physicochemical state of the oil slick. The SIM allows for the simulation of the physicochemical weathering processes of an oil spill at sea. The most significant processes are included (spreading, evaporation, emulsification, dispersion into the water column, dissolution and interaction with the coast). These are important drivers in both the mass balance of the spill and the overall physical behavior of the surface slick. Weathering processes are dependent on each other and may take place simultaneously. The simulator will also be able to model different counter measurements for responding to the oil spill, thus helping and giving support to decision making processes during crises.

The Mobile Remote System (SRM) allows the remote access to the crisis information and management using a mobile device that will act as a collaborative tool. This objective is accomplished based on three concepts:

1. Real time information of the crisis status through logbook access, communications received and map layers corresponding to simulation results, models and resources.
2. Contribution to the crisis management through communications (via email, sms or phone calls) and shared logbook entries.
3. Analysis: During the course of a crisis, or after its termination, a user with a manager profile can delve into the received data and take actions in the fight against it. This will be achieved by looking at the logbook entries and access to the documentation repository.

The implementation of the SRM consists of the following modules:

- Maps: OGC standard protocols are used to communicate the SRM with the SIZ Thredds and other geospatial data servers to obtain multiple layers like results of simulations and forecast models corresponding to currents and winds. The user can select the desired layers to be painted on a map, or based layer, and configure their opacities and times (in layers with time dimension).
- Logbook: Users can introduce annotations or important information that can be viewed by other users in real time. Logbook entries can be filtered by time, type and crisis criteria. To minimize bandwidth usage, the logbook module contains a local data base that saves the received registers, so only new registers are retrieved after a new launch of the application. The design allows also modifications and deletions of records.
- Communications: The SRM owns an agenda that is specific for the application. The communication module is designed so as to allow a quick selection of contacts and the desired communication method (email, sms or phone call).
- Access to the service for the contingency plans: The SRM accesses the service where the contingency plans are stored through a web interface. That way an authorized user can view the right documents that are applicable to the crisis.
- Utilities: Utilities such as the integration of the compass on maps and a photo capture module will be implemented.

The communication between the desktop and mobile clients and the SIGE in the Emergency Operations Centre will use the HTTP protocol by means of web services and OGC standard protocols as interface for the map servers. Sensitive information received or transmitted by the SRM will be encrypted.

III. CONCLUSIONS

MAR2, with all its capabilities and features, proves to be a very reliable and helpful tool to those in charge of providing with a fast and efficient response in the event of an oil spill.

Further work is being carried out to include more capabilities, such as the possibility of simulate the effects of different countermeasures available within the implementation area and the possibility of simulating the oil slick trajectories backward-in-time combined with AIS data, which will help authorities to identify possible spill sources.

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