A WEB-GIS OPERATIONAL SYSTEM FOR THE RISK MANAGEMENT OF MARINE AND ATMOSPHERIC POLLUTION FROM HAZARDOUS AND NOXIOUS SUBSTANCES (HNS) SPILLS IN HARBOUR AREAS

Ana J. Abascal[1], María Gonzalez[2], Germán Aragón[1], Ana María Largo[3], Begoña Lamothe[3], Luis Pedraz[1], Beatriz Pérez-Díaz[1], Ana de los Ríos[1], Andrés Martínez[1], Javier F. Bárcena[1], Javier García[1], Andrés García[1], Araceli Puente[1], Felipe Fernández[1], Raúl Medina[1]

1 IHCantabria - Instituto de Hidráulica Ambiental de la Universidad de Cantabria. Avda. Isabel Torres, 15, Parque Científico y Tecnológico de Cantabria, 39011, Santander, Spain, ***Contact e-mail:*** *abascalaj@unican.es*

2 COMPAÑÍA ESPAÑOLA DE PETRÓLEOS, S.A. (CEPSA), Paseo de la Castellana nº259 A, 28ª planta. 28046 Madrid, Spain

3 Centro de Investigación, CEPSA, Av. Punto Com, 1, 28805 Alcalá de Henares, Madrid, Spain

1. INTRODUCTION

The growth of marine transportation of chemicals by sea has led to a growing concern regarding Hazardous and Noxious Substances (HNS) pollution. Close to shore, risks are higher in sheltered bays and inlets where most harbour activities and operational HNS spills occur. High-resolution systems for spill prevention and response are fundamental given the reduced response time associated to their very local scale. Whilst operational and planning tools to oil spills are well established, there is a lack of similar tools to address HNS spills both in the water and in the air, specifically at local scales. Taking advantage of the aforementioned oil spill operational and planning tools already developed, the new challenge is to adapt them taking into account the HNS behaviour particularities, as their different behaviour in the environment, the marine and atmospheric pollution and the potential effects on human health.

In order to face these challenges, this work presents a Web-Gis operational system for the prevention and response of marine and air pollution derived from HNS spills which can occur at loading, unloading and handling operations in the maritime and port areas. The system, called SICMA, has been implemented to support the spill response at CEPSA's facilities in two refineries located at Algeciras Bay and Huelva Estuary, in Spain. The successful results of the implementation of the system shows that SICMA will enable maritime facilities and public administrations which are involved in decision-making in the fight against a pollution event, to increase the safety of operators and the population and to improve prevention and response.

2. DESCRIPTION OF THE SYSTSEM

The system consists of four different modules:

i) *Data Hub - Monitoring:* the system includes a new interface for the management of operational databases and for monitoring the spill and the environmental conditions. This module integrates: a) Sentinel-2 optical images from the European Space Agency with 10 m spatial resolution and a revisit range of 3-4 days in the study sites, as well as a Sentinel-5P satellite images for air quality monitoring; b) in-situ measurements of met-ocean variables; iii) hindcast and forecast met-ocean data obtained from numerical modelling provided by Copernicus Marine Service and national providers (Spanish Meteorological Agency- AEMET and Puertos del Estado).

ii) *Operational forecast system for the marine and the atmospheric pollution*: an operational system to forecast marine and atmospheric pollution from HNS spills in harbour areas. This module provides in real time short-term (2-3 days) spill trajectories and weathering forecasting of the HNS spill in the marine environment as well as the forecasting of the dispersion in the atmosphere of the toxic cloud. The HNS forecast module is based on an adaptation of the oil spill fate and transport model TESEO for chemical substances developed by IHCantabria (Abascal et al., 2017). TESEO is coupled to an air quality numerical model (HYSPLIT from NOAA, https://www.arl.noaa.gov/hysplit/hysplit/) to predict the HNS evolution at the whole marine environment (seawater and atmosphere). Hourly forecast currents from IBI_ANALYSIS_FORECAST_PHY_005_001 system (CMEMS-IB) and downscaled currents (~100 - 200 m) from high-resolution operational systems nested to CMEMS-IB and provided by Puertos del Estado (Spain) are used to run the model in the pilot sites. Meteorological forcing are provided by the Spanish Meteorological Agency (AEMET).

iii) SICMA – HNS risk assessment: a risk assessment system for HNS spills that estimates risk as the combination of hazard and vulnerability. Hazard is defined as the probability of the coast to be polluted by an oil spill and is calculated on the basis of a library of pre-run cases. The vulnerability assessment integrates biological and socio-economical aspects as well as the vulnerability to the population. As result, the system provides environmental, socio-economic and risk maps to population, both for marine and atmospheric pollution.

iv) *Gis Web App*: user-oriented interface to facilitate the decision-making in emergency situations. Figure 1 shows an example of the user's interface at Huelva Estuary.

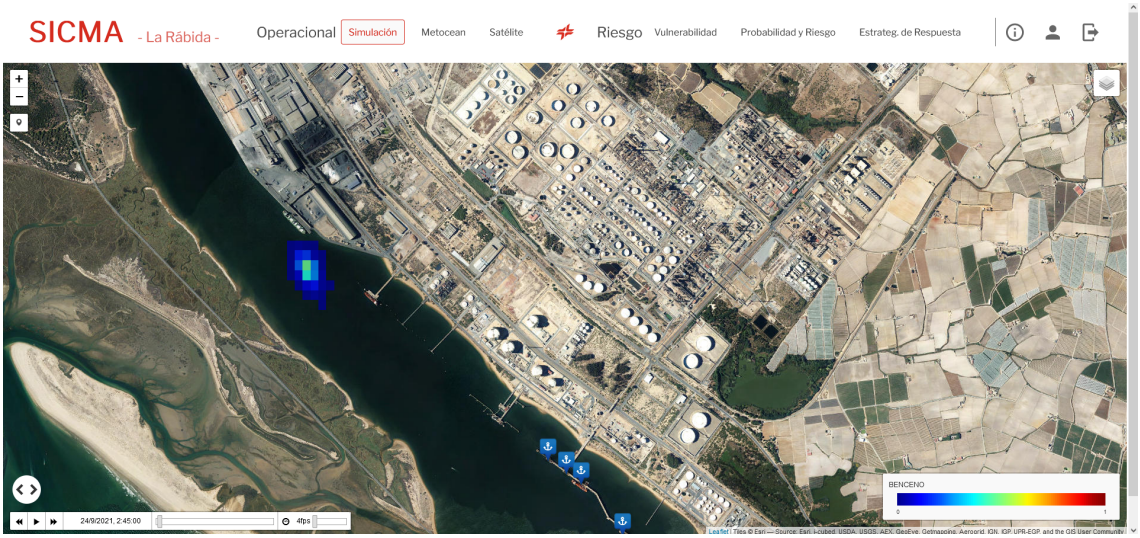

Figure 1. Hypothetical simulation of a Benzene spill at the Huelva Estuary.

3. APPLICATION AND VALIDATON

As mentioned, the system has been implemented to support the spill response of oil and gas companies in port areas, and specifically, at CEPSA's facilities in two refineries located at Algeciras Bay and Huelva Estuary, in Spain. To calibrate and validate the HNS forecast module, several laboratory experiments with chemicals substances operated within oil and gas facilities were carried out. Furthermore, to validate the operational meteo-oceanographic module as well as the transport model under different scenarios, buoy deployment exercises were carried out covering different marine conditions. Figure 2 shows an example of the validation of the system

at Huelva Estuary. The comparison between the numerical (red colour) and the actual (green) trajectory shows the accuracy of the system to simulate a floating or a floating/evaporator substance (for example, benzene).

Figure 2. Validation of the system with drifters in the Huelva Estuary. Red: model simulation, Green: drifter trajectory.

REFERENCES

Abascal, A.J., Castanedo, S., Núñez, P., Mellor, A., Clements, A., Pérez, B., Cárdenas, M., Chiri, H., Medina, R., 2017. A high-resolution operational forecast system for oil spill response in Belfast Lough, Marine Pollution Bulletin, 114, 302-314, 10.1016/j.marpolbul.2016.09.042. IF(2017): 3.241, D1 (9/106).

ACKNOWLEDGEMENTS

This work has been partly funded by the Spanish Ministry of Science and Innovation under the SICMA (RTC-2017-6642-2, 2019-2021) and the C-OIL (PID2020-117267RB-I00) National research projects.