LANGOSTEIRA FIELD EXERCISE REPORT

"Sharing information through MANIFESTS COPtool"

INTECMAR

ACKNOWLEDGEMENT

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Content

1. Introduction

Responding to maritime accidents can be especially challenging when dealing with hazardous and noxious substances (SNPPs or HNS) that behave like gases or evaporators. When there is an incident involving such substances, response operations must specifically consider their potential to form toxic or explosive clouds, which can affect the crew, responders, coastal civilians, and the environment.

The MANIFESTS project is supported by the European Directorate-General for Civil Protection and Humanitarian Aid Operations (ECHO) and aims to address such incidents and seek to improve response capabilities by creating innovative and innovative decision support tools and operational guidelines. Specifically, Work Package 3 seeks to enhance training and exercise capacities by focusing on those incidents that occur near the coast or a port area and that pose an added difficulty in coordinating the land and sea response.

2. MANIFESTS COPtool

In the event of a maritime or port accident involving HNS, authorities in charge of the contingency must take numerous decisions to organize the best response strategy, i.e., those related to human health protection (including incident response teams, crew members and coastal communities), marine and coastal socio-economic activities and environment protection, response operations and so on. While many key decisions and considerations are prescribed in national or regional contingency plans, operational response activities will generally need ongoing adjustment or review to reflect the most recent information available as the contamination event evolves. In such a rapidly changing situation, an efficient exchange of information between competent decision-making authorities and response teams on the ground can greatly facilitate both decision-making processes and organizational processes.

In the framework of MANIFESTS project (WP5) a MANIFESTS Decision Support System has been developed with the aim of developing an efficient information system that helps (1) decision makers understand the situation at stake and its likely evolution in the coming hours and days; (2) identify the population, ecosystems and socio-economic assets at risk and (3) share useful information with response teams deployed at sea, in the air or on the coast.

Building on the experience gained and development carried out during the previous HNS-MS and MARINER projects, the MANIFESTS decision support system (DSS) will integrate several services, including the DSS Common Operational Picture (COPtool).

This COPtool refers to a system designed so that during a contingency, the exchange of information that occurs between the maritime authorities and the different response teams (sea, coast, air) is carried out in the most efficient way possible, ensuring that all actors involved in the crisis committee and response teams can access the same data. These can be standard reports (such as the Standard Pollution Observation Report of the Bonn Agreement), images, videos and any other georeferenced data collected by response teams, as well as satellite observations, model simulation results, exclusion areas, location of response media or requests for new response actions shared by the crisis.

3. Toxic cloud during crude oil handling

Hydrogen sulfide (also known as H_2S, hydrogen sulfide, sewer gas, swamp gas, stinky humidity, and sour moisture) is a colorless gas known for its pungent "rotten egg" smell in low concentrations. It is extremely flammable and highly toxic. H_2S occurs naturally in crude oil (known as "sour crudes") and can be generated from refining processes, including hydropyrolysis, hydrolysis and elemental sulfur production. Because it is heavier than air, H_2S can accumulate in low, enclosed spaces, such as sewers, underground ducts, etc. Their presence makes working in confined spaces potentially very dangerous.

Control of H_2S is a challenge at every stage of production, refinement, and transportation of hydrocarbons. Hydrogen sulfide impairs product value, jeopardizes environmental compliance and safety, damages the integrity of infrastructure due to its corrosive attack, and produces unpleasant odors. The discharge of hydrocarbons with a high H_2S content can pose a risk to the operators in charge of it. The daily nature of this type of operations makes that one of the possible scenarios in the ports is an incident with the presence of H_2S. This is why within the framework of the MANIFESTS project it was chosen this kind of scenario to carry out the exercise.

The new port facilities of Punta Langosteira (NW Spain), which came into operation in September 2012, are at the service of international maritime traffic and offer large land areas, available to develop operations in excellent operating conditions. The Outer Port has the ideal facilities to become a hub port for hydrocarbons and other energy products linked to oil (Figure 1).

Figure 1. Outer Port of Punta Langosteira (Source: www.puertocoruna.com)

The company REPSOL has an unloading pier in this port where large oil tankers dock for the unloading of crude oil destined for the refinery (Figure 2). Sometimes depending on the type of crude oil may contain higher concentrations of hydrogen sulfide. In these cases, operators must take special care to the possible generation of toxic cloud by release of that substance. In this sense, both the company's staff and the port authority's staff develop periodic training exercises that allow response teams to be prepared for any contingency. On the other hand, INTECMAR is part of the Territorial Contingency Plan for accidental marine pollution of Galicia (Camgal Plan) within the framework of which it actively collaborates with REPSOL and the port authority of the port of A Coruña giving technical scientific support to the response work. Within the framework of this collaboration, this exercise was developed simulating an accident during the unloading operations of Maya crude, with a high content of H_2S and in which the tool developed in the MANIFESTS project was used for the management of information during the simulated incident.

Figure 2. REPSOL pier at Punta Langosteira (Source: REPSOL)

4. Objectives

The main objective of the exercise was to train response groups (at decision-making and operational level) to be prepared for an incident during unloading operations.

The specific objective in the framework of MANIFESTS project was to test the COPtool developed in the project so that crisis managers have access to information, in real time and in an agile way, on the different relevant issues needed for decision making. The responsive capability of the tool was tested by the use of the tool in different devices (PC, Laptop, Tablet & Smartphones)

5. Scenario

During the unloading of Maya crude oil in Front 1 of Repsol Petróleo S.A., a leak occurs through the discharge arm due to a sudden increase in pressure in the discharge of the ship due to human error, producing a spill into the sea of 2 m^3 of crude oil covering a surface of water sheet of 1,200 m^2, initially located between the ship and the jetty. Derived from the spill, a toxic cloud of hydrogen sulfide (H_2S) is produced, due to the high content of this gas that Mayan crude has. The cloud is initially detected with the personal detectors of the workers who observe the evolution of the stain from the commercial dock.

The duration of the exercise was set at 4.5 hours. The participants received the assumption in advance so that they could prepare their intervention thus optimizing the time of the exercise.

6. COPtool Users

In the administration of the COP of the Camgal Plan two units are involved, both belonging to the Technological Institute for the Control of the Marine Environment (INTECMAR), these units are:

Documentation and Scientific Support Unit (UDAC), it is a permanent unit responsible, among other tasks, for collecting scientific and technical information related to the fight against accidental marine pollution.

Close Observation Unit (UOP), it is activated in case of accidental marine spills and at the request of the person in charge of the Camgal Plan. Its main objectives are the cartographic description of the situation, the monitoring of the spill and the prediction of its trajectory.

During the exercise, these units were responsible for managing the different users and structuring the COP viewer to offer the relevant information for the case. Under the supervision of the emergency coordinator all the participant roles and needs of information were analysed and the COPtool users were defined.

Information of how to use the COPtool was accessible for the stakeholders (see Annex 1). And the access to the tool was enabled on the Camgal Plan website (Figure 3).

Figure 3. Camgal Plan website (www.plancamgal.gal)

The different participants in the exercise were enabled in the tool a type of user according to the tasks they develop. Likewise, each user, depending on their role in the response, had specific permissions to access the different functionalities of the tool: COP management, viewer, log, information ingestion and reports. The different users enabled during the exercise with reference to the permissions of each user, the tasks entrusted, the device through which they accessed the tool and the user's location was as follows:

Participant	COPtool permissions	Task	Device	Location
Port authority	**Viewer:** Access to the COP high level. **Log.**	Access to all information related to the contingency. Both through the viewer (geographic information) and the log that was generated throughout the contingency.	PC	Langosteira.
REPSOL	**Viewer:** High level COP access **Log.**	Access to all information related to the contingency. Both through the viewer (geographic information) and the log that was generated throughout the contingency.	PC	Langosteira.
INTECMAR (Director)	**Viewer:** High level COP access **Log**.	Access all information related to the contingency. Both through the viewer (geographic information) and the log that was generated throughout the contingency.	PC	Remote (INTECMAR)
ONG Rainbow Environmental Association * (simulated by INTECMAR personnel)	Viewer: Access to the COP low level. Not high confidential information available. No Log access	Access to the viewer that allows you to view information classified as medium confidentiality (cartography, resources, coastal inventory, cleanup atlases, vulnerability of the area, simulation of the spot)	Smartphone	Remote (ONG office)
INTECMAR (Gabiñe Ayensa, Pedro Montero, Silvia Allen-Perkins)	**Management of COP.** **Viewer:** Access to the COP high level. **Log.** **Reports.**	Register the different descriptive viewers of the exercise. Access to all information related to the contingency. Both through the viewer (geographic information) and the log that was generated throughout the contingency. Insert information related to the contingency that will be distributed through the log.	Smartphone. Laptop. Tablet.	Langosteira.
Coast Guard Service. (Director)	**Viewer:** Access to the COP high level. **Log**.	Access to all information related to the contingency. Both through the viewer (geographic information) and the log that was generated throughout the contingency.	Smartphone.	Remote.
Coast Guard (Agent 1)	**Reports** **Viewer:** Access to the COP high level. **Log**	Insert information related to the contingency that will be distributed through the log. Access to all information related to the contingency. Both through the viewer (geographic information) and the log that was generated throughout the contingency.	Smartphone.	Langosteira.
Coast Guard. (Agent 2)	**Reports**	Insert information related to the contingency that will be distributed through the log.	Smartphone.	Langosteira.
Coast Guard (Agent 3)	**POLRPEP**	Insertion of POLREP reports into the system.	Smartphone.	Langosteira.
CETMAR	**Reports** **Viewer:** Access to the COP high level. **Log**	Insert information related to the contingency that will be distributed through the log. Access to all information related to the contingency. Both through the viewer (geographic information) and the log that was generated throughout the contingency.	PC	Remote (CETMAR).

7. Contingency plans involved

In accordance with the provisions of the Spanish National Response System, the contingency plans involved in the incident are as follows:

- Internal maritime plan of REPSOL facility.
- Internal maritime plan of the Port of A Coruña with the appropriate responsibility in the operations in its field of action.
- Camgal Plan, territorial action plan with activation of INTECMAR units as technical support.
- National Maritime Plan: with the role of OBSERVER. It would have been activated if the incident would had been of national relevance covering the main responsibility in the management of the incident in relation to decisions on the ship and all operations in the maritime subsystem.

Depending on the contingency plans involved, the participating groups are:

- General Directorate of the Merchant Marine (DGMM) through:
    - the Captaincy of Coruña.

- Sociedad de Salvamento y Seguridad Marítima (SASEMAR) through:
    - CCS Coruña, as the competent maritime traffic coordination centre in the location of the incident.
    - Strategic base of Coruña (BEC), as manager of the means of combating marine pollution

- Port Authority of A Coruña through:
    - Sustainability Department

- XUNTA DE GALICIA through:
    - Coastguard Service as responsible for the Camgal Plan
        - Search, Maritime Rescue and Combating Pollution Service, as responsible for the coordination of operations at sea of the Camgal Plan
    - INTECMAR, responsible for the coordination of the support units for the Camgal Plan, the Close Observation Unit (UOP) and the Documentation and Scientific Support Unit (UDAC)
    - CETMAR: as a support unit for the Camgal Plan and coordinator of work package 3 of the MANIFESTS project

- Arteixo Municipality:
    - Mayor
    - Chief of Environmental issues

8. Development of the exercise

The duration of the exercise was set at 4.5 hours. The participants received the scenario description in advance so that they could prepare their intervention thus optimizing the time of the exercise. Furthermore, the process of activating and notify the contingency plans involved in the response was not contemplated and it was assumed that this process had taken place correctly.

All the agencies with competence in the response were represented in the exercise with the personnel who in a real case would oversee the response operations in each of the fields of competence of the different contingency plans involved.

During the exercise, once requested by the crisis managers the participation of the Support Units of the Camgal Plan (UDAC & UOP), the different thematic viewers of the contingency were created. Given the assumption, a viewer is created through which the following information is distributed:

8.1. Basic geographic information of interest

The layers visible in this section are the following:

8.1.1. Cartography:

- Nautical charts: Georeferenced images of nautical charts from paper charts of the Hydrographic Institute of the Navy (2009).
- Port area: Layer with the delimitation of port spaces and uses, elaborated in INTECMAR from the different legislation texts.
- Coastal municipalities: Main centers of population of Galicia and coastal municipalities (Source SITGA)
- Coastal toponymy: Names of the main landmarks on the coast of Galicia. For its elaboration by INTECMAR, own sources, field guides and data collected by the staff of the Consellería do Mar were used.

8.1.2. Marine Resources:

-Fishing resources: With information from the fishing areas. Layer prepared with information by the Technical Fishing Unit of Baixura (2010).

- Environmental resources: ESI Layer With the Environmental Sensitivity Index of the coast of Galicia, prepared by CIMA using the index published by NOAA in 2007.

8.1.3. Coastal Inventory:

Layer that shows different resources and places of special interest for the fight against pollution found on the coast, such as beaches, roads, and others. Layer developed in INTECMAR within the framework of different projects.

8.1.4. Cleaning:

Layer showing the coastline classified according to the type of cleaning to be adopted if the spill reaches the coast. The layer was created by INTECMAR through data of the Consellería do Mar.

Environmental vulnerability: Layer that classifies the coast into sections based on their different environmental vulnerability to a possible hydrocarbon spill. This layer was developed by INTECMAR within the framework of the risk analysis carried out in Chapter II of the Camgal Plan.

8.2. Information generated during the contingency

At all times the information related to the Outer Port of Punta Langosteira is kept updated in the thematic viewer, which includes the following information:

8.2.1. Ocean-meteorological forecast (Figure 4)

The following meteorological and hydrodynamic models that are executed in MeteoGalicia (Galician meteorological service) operationally stand out:

- Meteorological model: WRF model with 1 km spatial resolution for the entire port. It runs 2 times a day.
- Hydrodynamic model: MOHID model with approximate resolution of 300 m for the entire Gulf of Ártabro and two models of 50 m spatial resolution for the Ría de A Coruña and for the area of the Outer Port of Punta Langosteira.
- Wave Model: SWAN model with unstructured mesh with very precise resolutions at coastal level (> 50 m)

Figure 4. COPtool viewer: Hydrodynamic information

8.2.2. Forecast of pollutant drift

Once the support unit (UOP) is activated and after receiving the information related to the incident, the simulation of the evolution of the polluting substances is carried out. The objective of these simulations is to help the work of combating pollution and, in this case, the rapid identification of areas of exclusion of working personnel. These areas can be further refined by expert personnel.

The UOP always works with the objective of the fastest prediction and showing the worst possible case.

Forecast of the evolution of the hydrocarbon slick (Figure 5): A simulation of the MAYA hydrocarbon drift is carried out, the results of which are immediately transferred to the COP for consultation by the stakeholders involved in the contingency. The wind was checked, and it was verified that the intensity was greater than predicted by the model. With the actual data from the weather station located in the port, the trajectory of the hydrocarbon is corrected, using predicted currents, but measured wind.

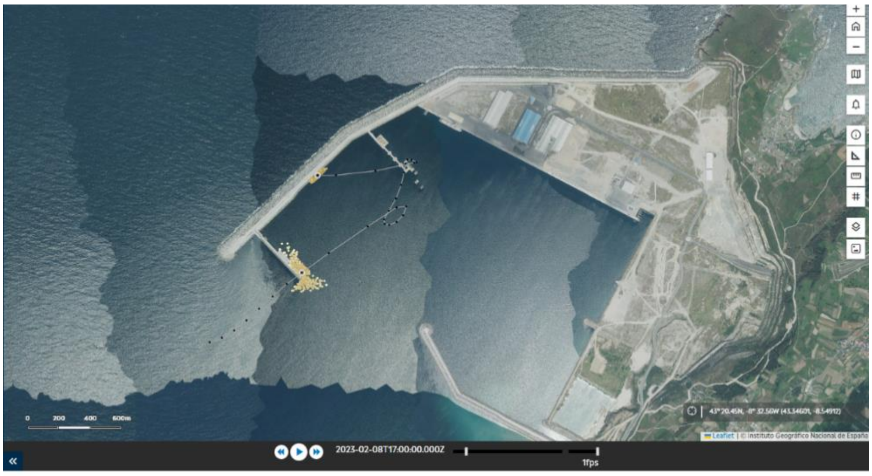


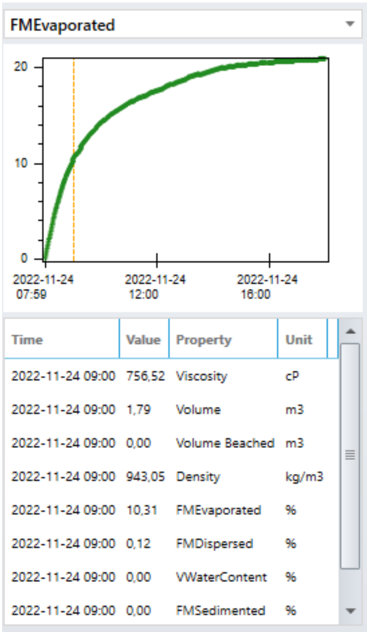
Figure 5. COPtool viewer: Pollutant drifting forecast information

8.2.3. Modelling of the toxic cloud

The UOP proceed to the simulation of the exclusion areas determined by a possible toxic cloud using the ALOHA model (Figure 6). The following data were used for them: Place of issue: 43.3510º, -8.5185º; Substance: 2 m3 MAYA crude oil, containing 3.669 S of its weight; Density = 0.9238kg/m3; Mass spilled: 2 * 0.9238x103= 1847.6 kg; Quantity of S: 1847.6 * 3.669/100 = 67.79 kg of S; H2S content: (67.79 *34/32 =72.025 kg.

Figure 6. COPtool viewer: ALOHA model output information

It was assumed that all H2S is released into the atmosphere, which is quite unlikely considering the dissolubility of this substance. Actually, a small part should be released, but it was assumed the worst case. For the calculation of the release flow, the evaporation curve of a MAYA crude oil has been graphed and the following approximate assumption of weathering has been made (Figure 7).



Time	Value	Property	Unit
2022-11-24 09:00	756,52	Viscosity	cP
2022-11-24 09:00	1,79	Volume	m3
2022-11-24 09:00	0,00	Volume Beached	m3
2022-11-24 09:00	943,05	Density	kg/m3
2022-11-24 09:00	10,31	FMEvaporated	%
2022-11-24 09:00	0,12	FMDispersed	%
2022-11-24 09:00	0,00	VWaterContent	%
2022-11-24 09:00	0,00	FMSedimented	%

Figure 7. Maya crude oil weathering information

It can be assumed that half of the evaporated part does so in an hour (10% compared to 20% of the total evaporated at the end of the day). We assume that the content of this volume collects the entire H_2S content of the 2 m^3 of hydrocarbon. Therefore, we can assume a linear dispersion in that first hour of the middle of the H2S: 72,025 kg / 2 ~ 36 kg during the first hour. This is the amount that is introduced into the ALOHA, an exhaust of 36 kg of H_2S for one hour. With these calculations, the ALOHA model describes 3 exclusion areas considering the AEGL level (Acute Exporsurer Guideline Levels). The AEGL level estimates the concentration at which most people, including particularly sensitive people such as the elderly or children, will begin to experience health effects due to exposure to a toxic substance for a while. ALOHA model does not incorporate dynamics into its equations and therefore the restricted zones are static and do not vary with wind. In general, they tend to overestimate the area, but it is useful for reference.

The 3 levels of AEGL correspond to: AEGL-3 is the airborne concentration, expressed as parts per million (ppm) or milligrams per cubic meter (mg/m^3), of a substance above which the general population, including susceptible individuals, is predicted to experience life-threatening health effects or death. AEGL-2 is the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible adverse health effects or other serious and lasting adverse effects or an impaired ability to escape. AEGL-1 is the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience noticeable discomfort, irritation, or certain asymptomatic non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

The three levels (AEGL-1, AEGL-2 and AEGL-3) are developed for five exposure periods: 10 minutes, 30 minutes, 60 minutes, 4 hours and 8 hours. In our case we have taken into account the exposure period of 60 minutes and the results for H2S are: AEGL-1 (60 min) 0.51 ppm; AEGL-2 (60 min) 27 ppm and AEGL-3 (60 min) 50 ppm.

Other model used in the exercise was the CALPUFF model executed by MeteoGalicia for the occasion (Figure 8). Although the CALPUFF model can reproduce chemical processes, the model was executed as a passive tracer that at each instant reproduced a field with the relative concentration of a substance. Combining this result with those of ALOHA model can be used to give an indication of the true extent and direction of the spot and its evolution over time.

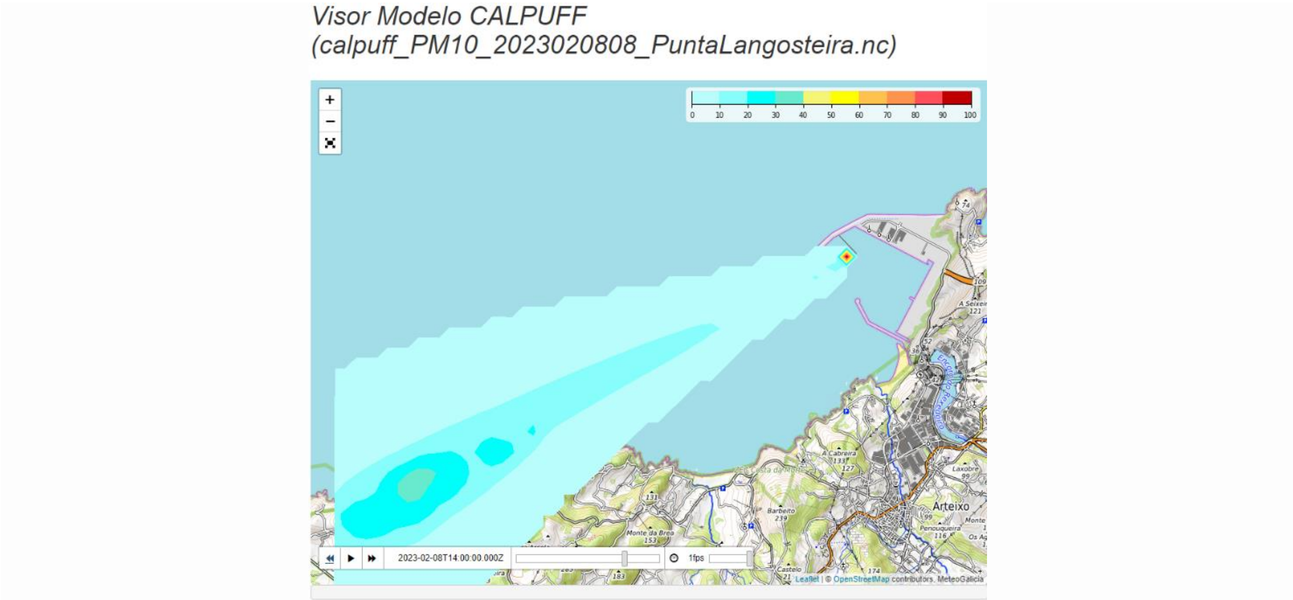


Figure 8. CALPUFF model output information

Another model that was run on an experimental basis was the MOHID Lagrangian model (Figure 9). In this case, the dynamics and chemistry of the spill are reproduced. However, its execution is not operational and a simplified case has been simulated with constant time. In any case, its results are promising. Work will be done in the future on how to transform these concentration camps into exclusion zones for personnel, as described in the ALOHA model.

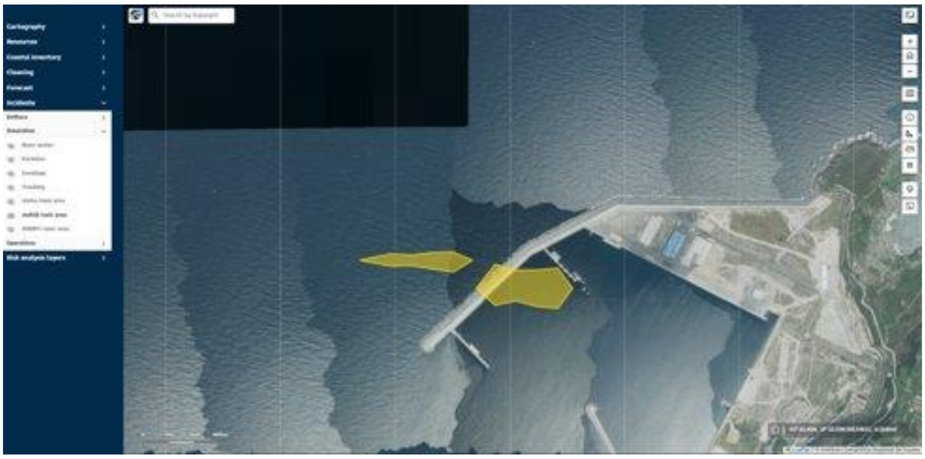


Figure 9. COPtool viewer: MOHID model output information

8.2.4. Position of drifting buoys

Once the UOP is activated, the order is given for the launch of 3 drifting buoys: 2 of them near the leeward area of the Repsol Dam to monitor the spill, and another in the centre of the port channel to verify the prevailing current. From the moment the buoys are launched to the sea, their position can be consulted through the viewfinder (Figure 10):

Figure 10. COPtool viewer: drifting buoys position information

8.2.5. Pollution response operations

The position of the teams that are carrying out the anti-pollution operations can be consulted in the viewer through the operations layer, in which the elements and barriers deployed in the contingency are graphed (Figure 11).

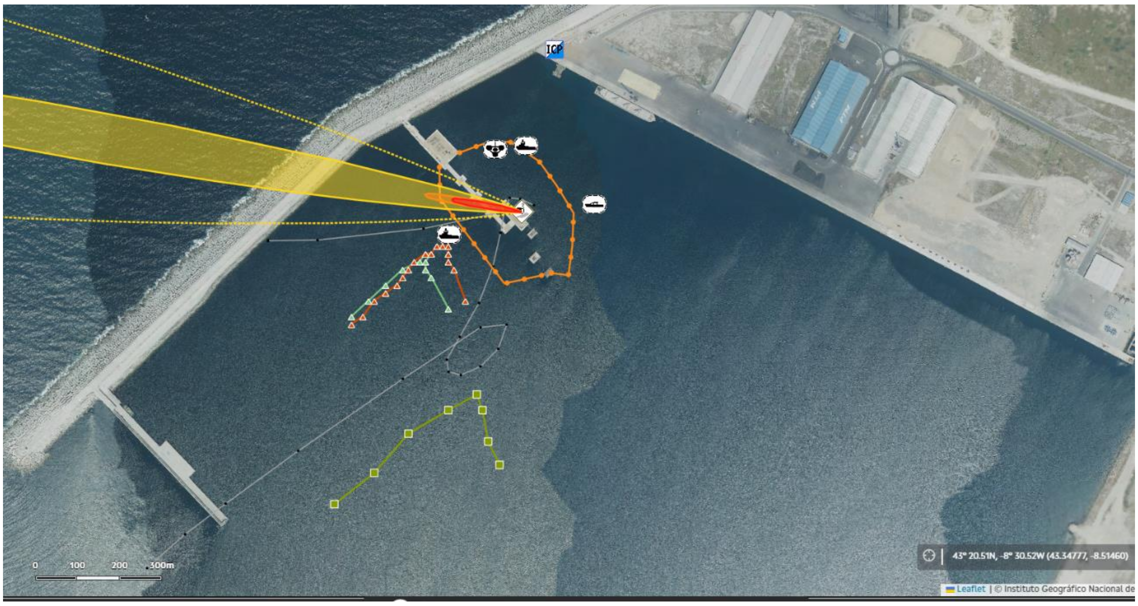


Figure 11. COPtool viewer: Response operations information

8.2.6. Information distributed through the log

During the simulated contingency, the response teams took many photos, videos and made a series of reports that decision makers should receive as soon as possible. In turn, the managers had other information to support decision-making, such as information related to the behavior of the substances involved in the incident, characteristics of the barriers, availability of experts to consult and others.

Through the specific module of the COPtool tool, all these communications could be centralized, and a common entry point was given to all the files that were generated during the crisis (photos, videos, pdf) guaranteeing that managers had them quickly and efficiently.

Through this module it was also possible to issue warnings of those events that could be of interest to the manager, such as that the drifting buoys had been launched, updated simulations by the prediction teams, the exact moment of the beginning of each operation, such as the deployment or collection of the containment barriers, availability of POLREP and other reports of a similar nature (Table & Figures 12 - 15).

Type of information	Event	Emitter
Communication	Drifting buoys in the water	Coast Guard
Communication	The deployment of the booms begins	Coast Guard
Information of interest	Valve position	Coast Guard
Information of interest	Information concerning H_2S	INTECMAR
Notice	Spill simulation available	INTECMAR
Notice	Aloha model simulation available	INTECMAR
Information of interest	Material Container Position	Coast Guard
Information of interest	Features Expandi boom	Coast Guard
Information of interest	Photo of the boom	Coast Guard
Information of interest	Information available on HNS in http://knowledgetool.mariner-project.eu/ and tools to help decision-making on discharges in https://manifests-project.eu/#wp5-decision-support-system	CETMAR
Notice	Spill forecast evolution available	INTECMAR
Notice	New spill simulation available	INTECMAR
Communication	The Sebastián de Ocampo ship moves to leave the pier free	Coast Guard
Communication	Deployment of boom in the north pier	Coast Guard
Notice	New spill simulation available	INTECMAR
Communication	Starting of boom recovery by placing the stevedore arm	Coast Guard
Communication	Change of stevedore arm position to vertical	Coast Guard
Communication	Stevedore arms placed to start recovery in the South pier	Coast Guard
Communication	Boom recovery finished	Coast Guard
Notice	POLREP Available	Coast Guard

COPtool: information shared during the exercise through the log

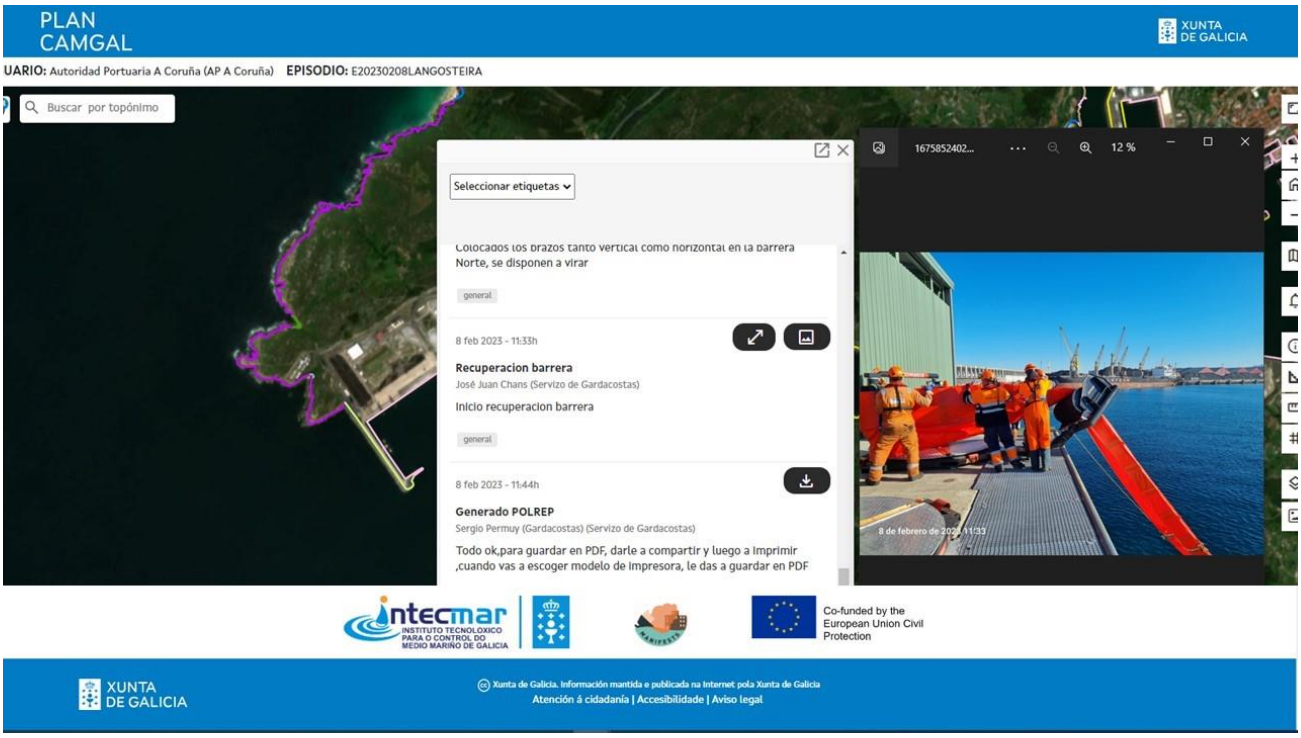


Figure 12. COPtool log: Boom deployment information

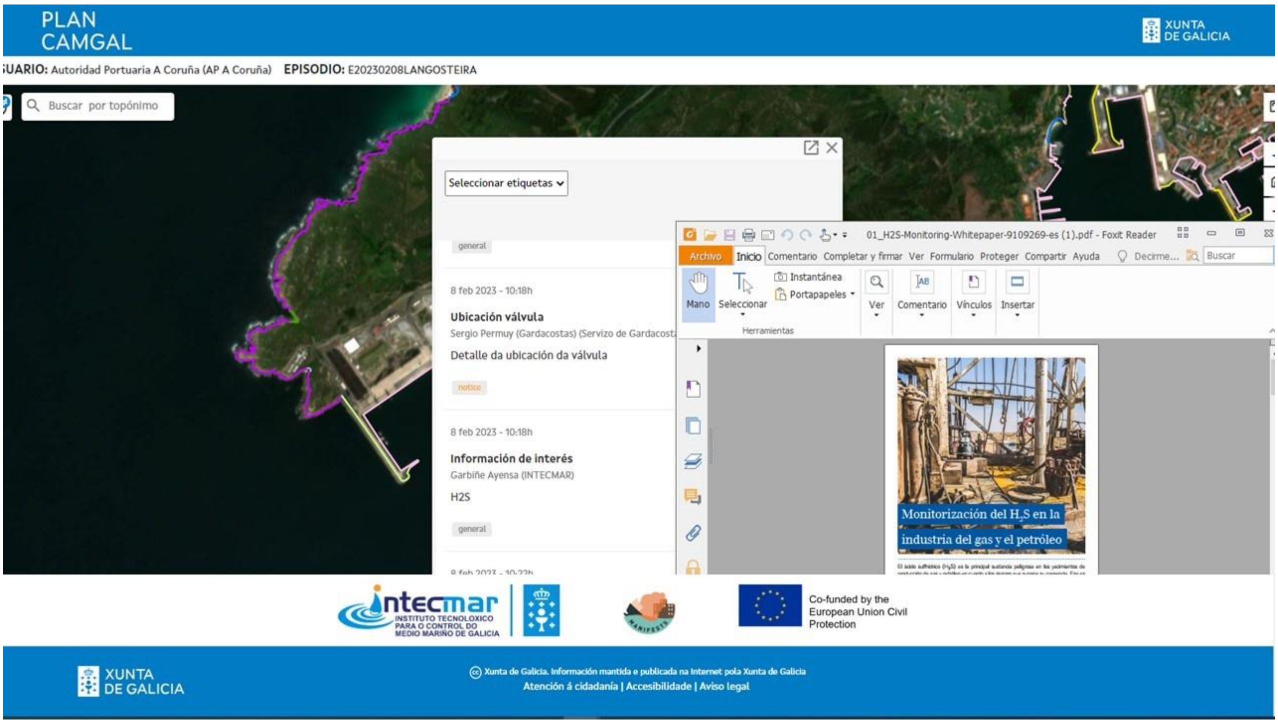


Figure 13. COPtool log: H2S monitoring information

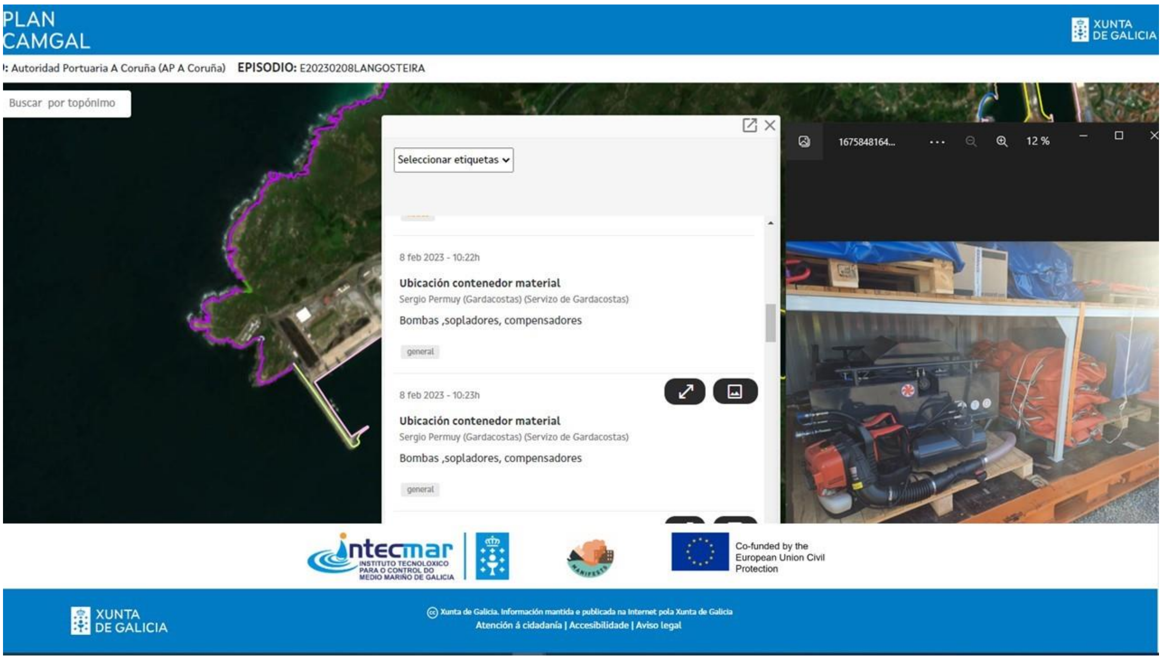


Figure 14. COPtool log: Response equipment location information

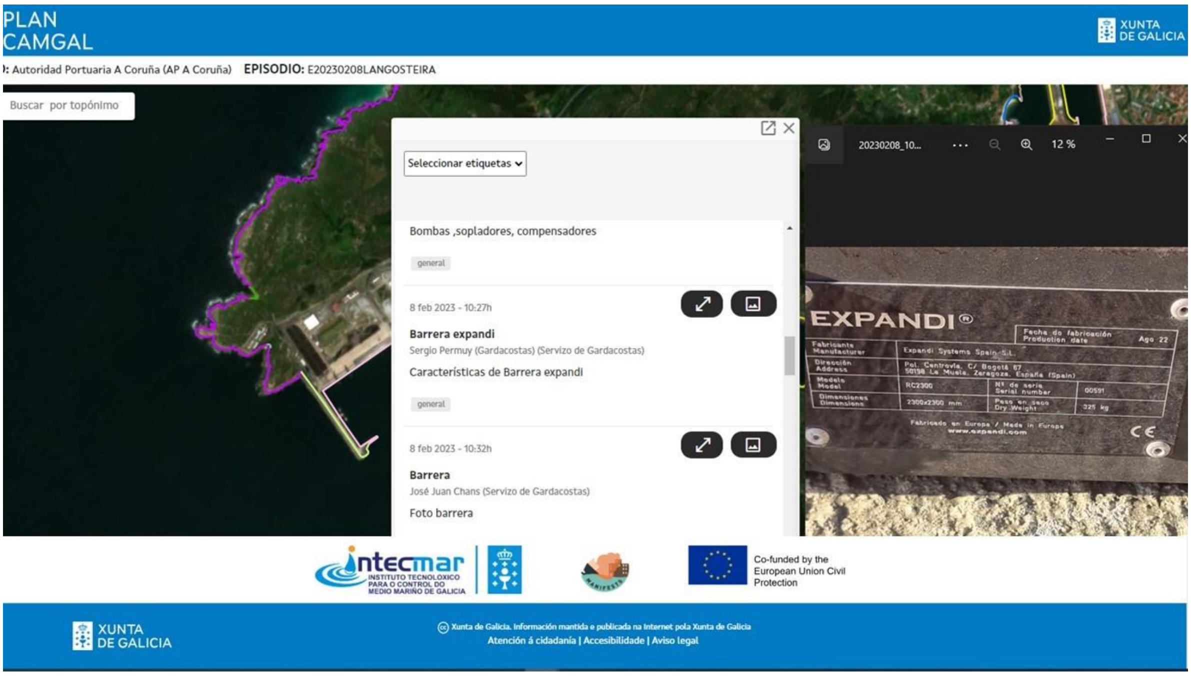


Figure 15. COPtool log: Response equipment characteristics information

Once the exercise was finished, an analysis of the information collected was carried out and the development of some improvement actions that were identified are ongoing.

9. Conclusions

The participation of all the institutions with competences in a real case like the one simulated during the exercise offered the opportunity to have a global analysis of the COPtool utility. Thus, made easier the identification of opportunities for improvement.

The duration of the exercise did not allow to evaluate in depth how the COPtool works in long time contingencies, however, it was possible to highlight the main advantages to the managers of the response in a case like this for sharing information.

The number of contingency plans involved in the exercise, the different organizations working together and the use of several devices to share information, was a good opportunity to test the utility of the COPtool for the coordination between different levels of response according to their field of competence. In this sense, the tool improved the simplification and strengthening of the exchange of information both between response groups and between levels of contingency plans (port, local, regional, and national).

The possibility of centralizing all kinds of information in the COPtool in a quick and easy way was highlighted by all participants. In addition, the possibility of customizing the access to information according to the needs and role of the user makes the tool useful for all participants in the response regardless their role. Likewise, the responsive quality of the tool facilitates access to information and its transmission from anywhere. This aspect was valued very positively especially by smartphone users.

The expressions of interest of all participants in carrying out more exercises of this type based on real cases that occurred on the European coasts, confirmed the usefulness of addressing the different aspects of the response in a calm and multilateral manner.

10. Annexes

Annex 1- COPtool User's manual