Improvements of Shorelines Defences
Against Marine Pollution

ISDAMP+
FINAL TECHNICAL REPORT

DG ECHO - Civil Protection Financial Instrument Project
Ref: 638516/2012/ECHO/A5/SUB

ISDAMP+ was co-funded by the European Union “Humanitarian Aid and Civil Protection'' DG-ECHO, developed in cooperation with MARETEC-IST-University of Lisbon, Action Modulers and Falmouth Harbour Commissioners and coordinated by EIGSI La Rochelle

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Partnership organisations, addresses and websites

The consortium was led by the engineering school EIGSI of La Rochelle, who is located on the French Atlantic coast. Partners from Lisbon and Falmouth are also on the European Atlantic Area; Lisbon University (IST), Actions Modulers (SME emerging from IST) and the Falmouth Harbour Commissioners in estuaries of the Cornwall region.

EIGSI La Rochelle Engineering School (FR)

26 rue de Vaux de Foletier
17041 La Rochelle
France http://www.eigsi.fr

The engineering school EIGSI is one of the oldest engineering schools in France. Located in La Rochelle since 1991, created in 1901 in Paris (Ecole Violet), in 2005 EIGSI opened an international campus in Casablanca (Morocco). The research activities are built upon two areas

- logistic/supply chain/decision making and planning/ LEVE energy storage experimental laboratory
- renewable energy/marine energy/LERPA laboratory/coastal protection/marine pollution.

EIGSI was leader or partner of several National, Interregional and European projects (BAR3D, ARCOPOL, ENERGYMARE…).

IST Lisbon University (PT)

Av. Rovisco Pais, 1
1049-001 Lisboa
Portugal http://tecnico.ulisboa.pt

IST is the Engineering school of the Technical University of Lisbon. It is the largest - and the oldest - Portuguese Engineering school. IST contributes to the development of society by providing high quality Education in the areas of Engineering, Science and Technology, at undergraduate and postgraduate levels as well as lifelong learning, and by carrying out Research, Development and Innovation activities in accordance with the highest international standards.
IST team involved in this project is specialized on mathematical modeling of aquatic ecosystems with special emphasis for hydrodynamics of coastal zones. The group has been involved in over twenty European Research projects (EROCIPS, ARCOPOL…). The open source model developed by this group was downloaded by more than 2000 people and is being used regularly by hundreds.

Action Modulers SME Mafra (PT)

Estr. Principal 29
2640 Mafra
Portugal http://www.actionmodulers.pt/default.aspx

Action Modulers is a private consulting company, established in 2004 and it's located in Mafra, Portugal. Action Modulers main philosophy is based on integrated asset management, where risk

assessment, value and safety planning plays a central role. Action Modulers has two main business areas: (i) safety planning and (ii) research and development.
Action Modulers research and development department has continuously worked on future development of the MOHID Water Modelling System. The graphical user interface of MOHID, MOHID Studio, is one of Action Modulers Core products. Action Modulers has also participated in projects related with integrated emergency management, environmental monitoring and safety plans.

FHC Falmouth Harbour Commissioners (Cornwall UK)

Falmouth Harbour Commissioners

44 Arwenack Street
TR11 3JQ Falmouth – Cornwall
United Kingdom http://www.falmouthport.co.uk

Falmouth Harbour, including the Carrick Roads, is reputed to be the third largest natural harbour in the world. Falmouth Port Commissioners (Cornwall, United Kingdom) is a statutory harbour authority undertaking conservancy and pilotage functions and operating small marine leisure business. It has practical experience and expertise in oil pollution response. It plans and prepares response to potential future maritime pollution incident.
Falmouth is a busy commercial port and offers a wide range of services to all sizes and types of merchant ships.
The Commissioners encourage all their stakeholders to respect Falmouth's natural environment. Through ongoing community engagement and proactive environmental management of the harbour area, the Commissioners work towards achieving port sustainability.

Abstract

Motivation

We do care about the local response to the oil-spills and the decision to take. The global scale is not enough because the local community knows better the location and their knowledge is valuable.

Problem statement

The *problem* we are trying to solve is to gather the different data and the different models in an efficiency way. The data are for example the geolocalisation, the models and the marine current, the floating barrier behaviour….

Approach

We did go about making progress on the problem by adding experimentations and training about software results. Experimentation and training permit to validate the software and the flow of data and results.

Results

Ours answer is a software and a guide of best practices. A methodological guide permits an exploitation of the results by the local community.

Conclusion

The implications of our answer are to be potentially generalizable in the field of the civil protection.

ISDAMP Final Report

This report describes the implementation of the ISDAMP+ European project in fulfilment of the requirements of the Grant Agreement No. 638516/2012/ECHO/A5/SUB.

The report is organized in two parts. The first one recalls the context of the project and its objectives and gives the best prominent realizations of the partnership activities. The second part is dedicated to the manner we will do so that the results will be effectively used by stakeholders.

1. Context, objectives, partnership

The ISDAMP+ European project supported by the Civil Protection Financial Instrument of the DG-ECHO (Humanitarian Aid and Civil Protection) was dedicated to the preparedness upon maritime pollution and particularly the usage of floating barrier as a main tool to contain the oil on the sea surface.

The following figure shows the main problematic concerning the valuable placement of a floating barrier (usually named boom). This device is a major response tool to contain a floating spill during its entertainment by the sea current flow. This technique allows that the shoreline pollution can be reduced by collecting the pollutant directly on the sea.

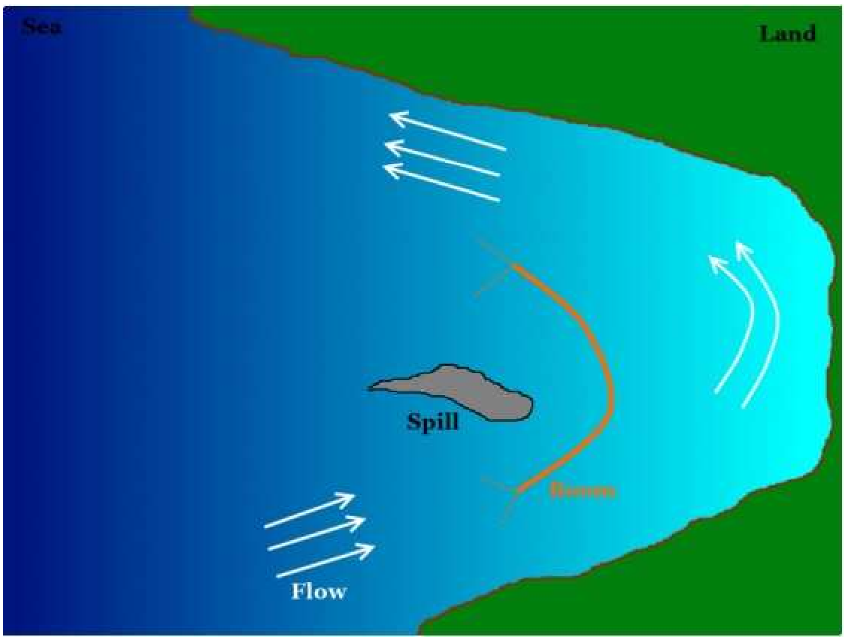

Fig. 1 Models coupling where objective informations are variable in time and in space, AM.

To that end models, softwares, experimentations, workshops, and publicity activities have been deployed during the project. More precisely, two softwares (MOHID and BARRIER), four experimentations and three international workshops have been implemented.

ISDAMP was a collaborative effort from 4 main partners of three European countries, each of them with an area of expertise relevant to the project. The Charente-Maritime county council “Conseil-Général de la Charente-Maritime” was an associated partner located in La Rochelle (FR).

The ISDAMP project was planned with 5 workpackages based on the following leading:

- A Administrative, EIGSI
- B Modelling, IST
- C Software development, ACTION MODULERS (AM)
- D Full-scale experimentations, FALMOUTH HARBOUR COMMISSIONNERS (FHC)
- E Communication and publicity, EIGSI.

The workforce of ISDAMP+ represented a total number of 2 154 working days. The total budget of the action was 581 947€ and the final consolidated costs represents 545 266€. The project duration was 27 months, between the 1/1/2013 and the 31/3/2015.

The project policy in marine pollutions addressed by ISDAMP+ was the preparedness area with two themes:

- Increasing the participating states preparedness for the coastal consequences of marine pollution accidents
- Using and developing e-learning tools for spreading knowledge about civil protection and marine pollution in Participating States.

The project has been implemented in the following countries: France, Portugal, and UK.

2. The well performed realizations, description, evaluation

For each workpackage we will described the realizations of the project. We will give an evaluation of the objectives and if the objectives were achieved. The effective working of the tools and methodologies are underlined.

2.1 Modelling

The following figure shows the implementation of the MOHID hydrodynamic model at La Rochelle region, France. This hydrodynamic model has provided hydrodynamic forecasts which were used to assess the best location of oil booms in the occurrence of an oil-spill. The model results have been calibrated and validated by using public available data coming from buoy stations and cruise campaigns.

The hydrodynamic module is the core of the MOHID Water modelling system. This is a three-dimensional hydrodynamic model which solves the Navier-Stokes equations, considering the Boussinesq and hydrostatic approximations. The three dimensions of the model have given a valuable advantage comparing to the former two dimensional models developed until ten years ago.

MOHID Studio is a graphical user interface for the MOHID Water modelling system. MOHID Studio enables to edit data files, create and launch MOHID simulations and analyse model results. MOHID and MOHID Studio are commonly used on a desktop computer.

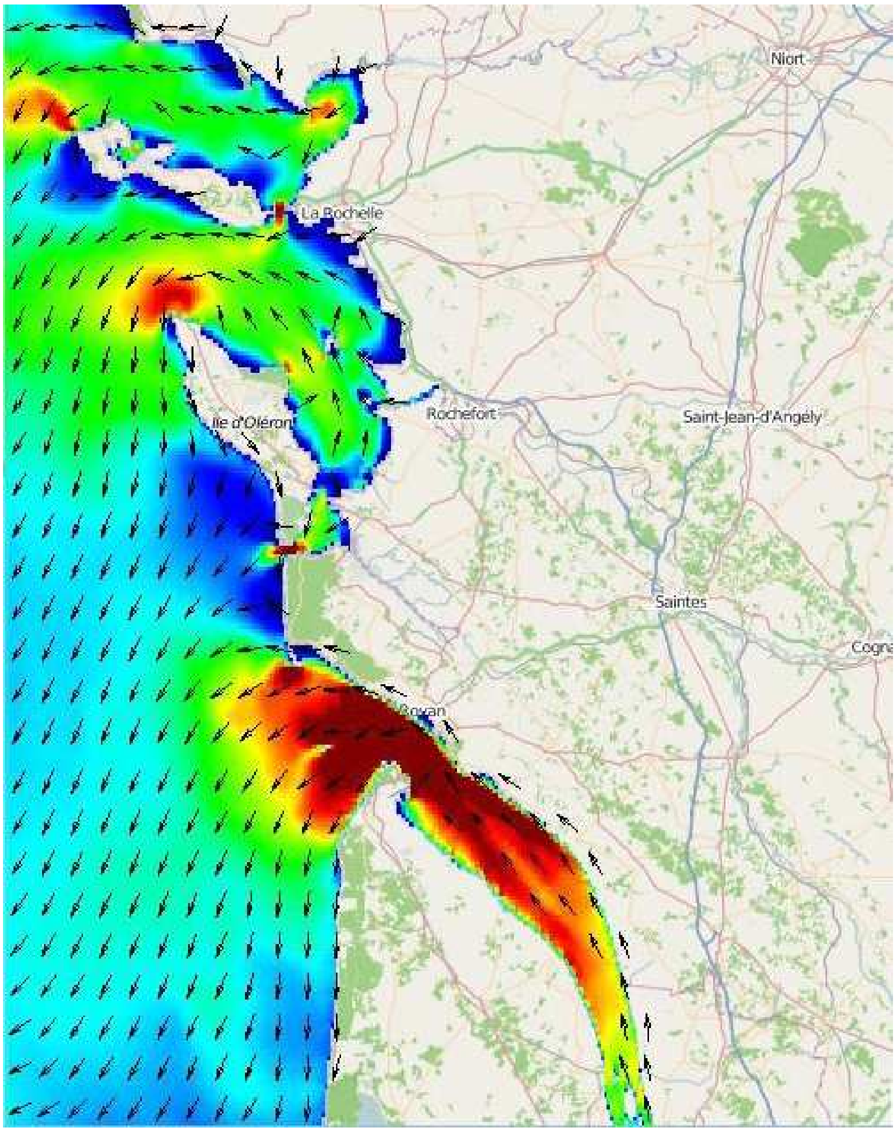

Fig. 2 Operational hydrodynamic model of La Rochelle region, the 21-10-2014, IST.

During the project, public available meteorological data with high resolutions have been used (METEO-FRANCE, METEO-GALICIA). To turn the hydrodynamic model operational, it was necessary to apply the Automatic Running Tool (ART) used at MARETEC. This software tool has been designed to enable automatic simulations of MOHID dedicated to water modelling applications. In the future, the atmospheric model Weather Research and Forecasting (WRF) could also be available to run using ART.

MARETEC research team (IST) has implemented, since 2004, an operational wave forecasting system for the North Atlantic and Portuguese Coast (http://maretec.mohid.com/ww3) based in the model WAVEWATCH III (version 2.22). The implementation of operational wave modelling forecasting systems for the Portuguese Coast (see next figure) and South West French Coast has been realized during the project. The system has provided wave forecasting data to verify the appropriate conditions and best locations to deploy floating barriers to contain oil spills in emergency situations, reducing the risk of oil leakage.

A downscaling approach (imbedded mesh grids with downscaling resolutions) was followed in the wave modelling system implementation. It allowed to properly representing the propagation of waves generated in the North Atlantic into the coast of Portugal and France, specifically in La Rochelle Bay. The grid resolution ranged from approximatively 50 km in the North Atlantic to 400-200 m in the fine local grid.

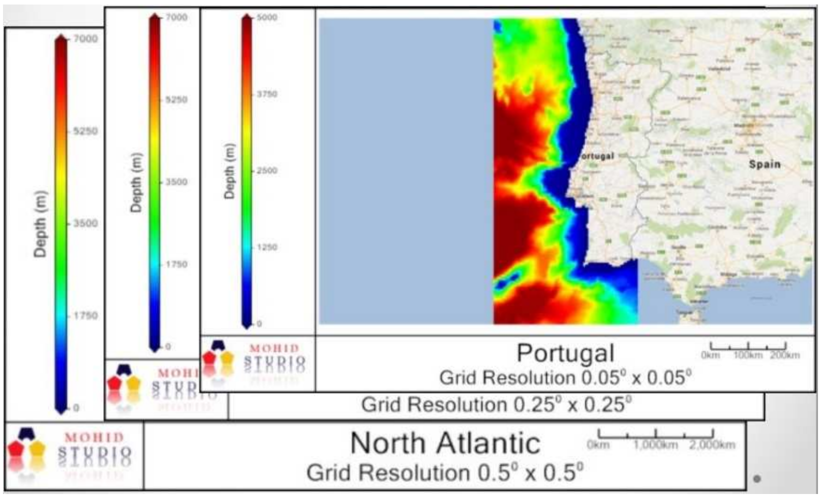

Fig. 3 Wave Watch III imbedded grid, coast of Portugal, IST.

2.2 Software development

Two softwares have been developed during the project at Lisbon (IST, AM) and La Rochelle (EIGSI). MOHID-WATER and BARRIER are the two softwares implementing the BAR3D model for booms. We underline that the BAR3D model was initialized by the BAR2D model, which started itself from BAR1D, who is issued from BAR0D.

Based on the initial proposal and the functional requirements of the system, it was proposed to develop and integrate several components of MOHID-Studio and Action-Server. The general architecture of the ISDAMP+ system, proposed in the technical and functional specifications is schematically represented in figure 4.

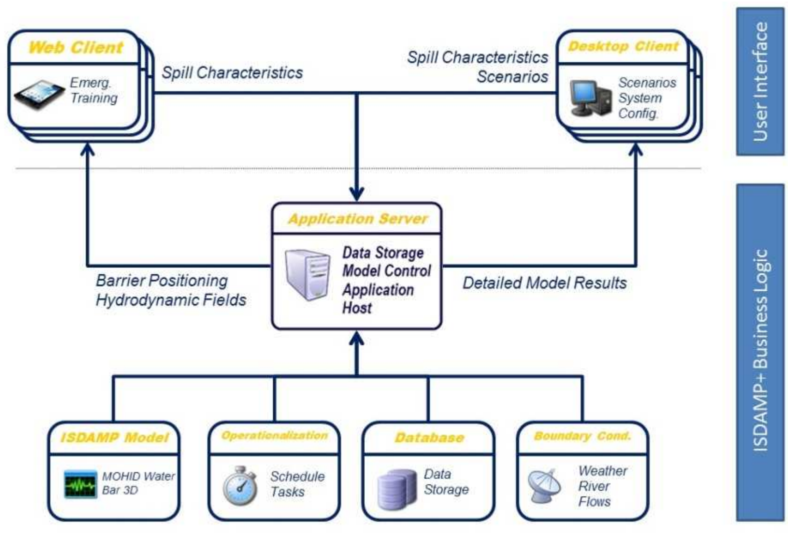

Fig. 4 Schematic representation of the ISDAMP+ architecture, AM.

A software framework is proposed to improve preparedness and response activities to marine pollution incidents. The user interfaces could be first a desktop client for process studies as modelling experts. The MOHID-Studio visualization can be made after the creation and running of a simulation tool. The following figure shows one of the Scenarios System Configuration.

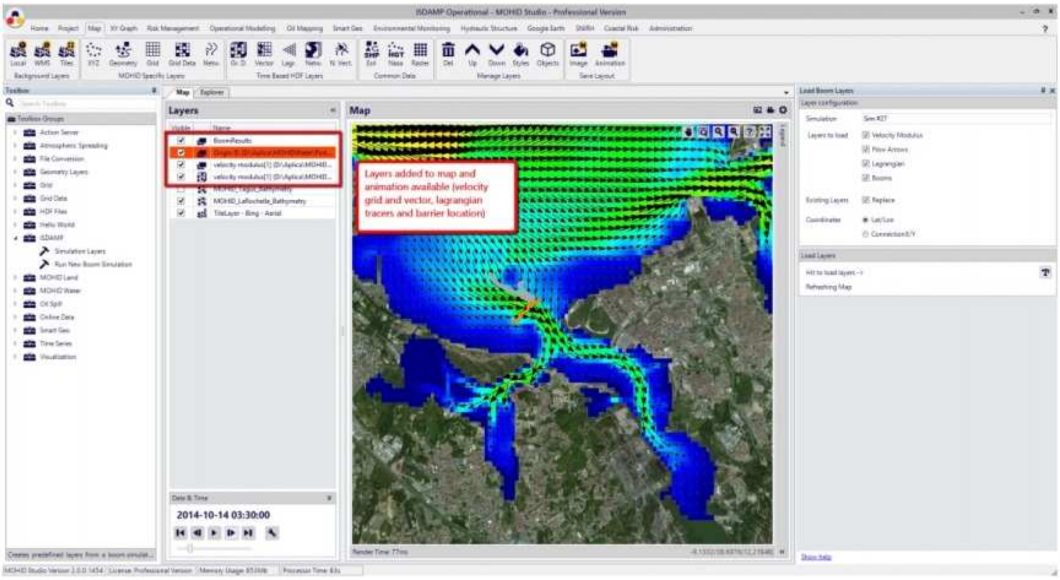

Fig. 5 User interface of the ISDAMP+ operational MOHID-Studio visualization tool and Scenarios System Configuration, AM.

The second user interface was dedicated to a web client. The following figure shows a model execution. The interface could produce chart display from RestAPI (REpresentational State Transfer-Application Programming Interfaces) or map display from a WMS Server (Web Map Service Interface Standard). WMS is a standard of the Open Geospatial Consortium (OGC). A map example could be served by Action-Server and WMS server. The web client interface could be used for emergency training.

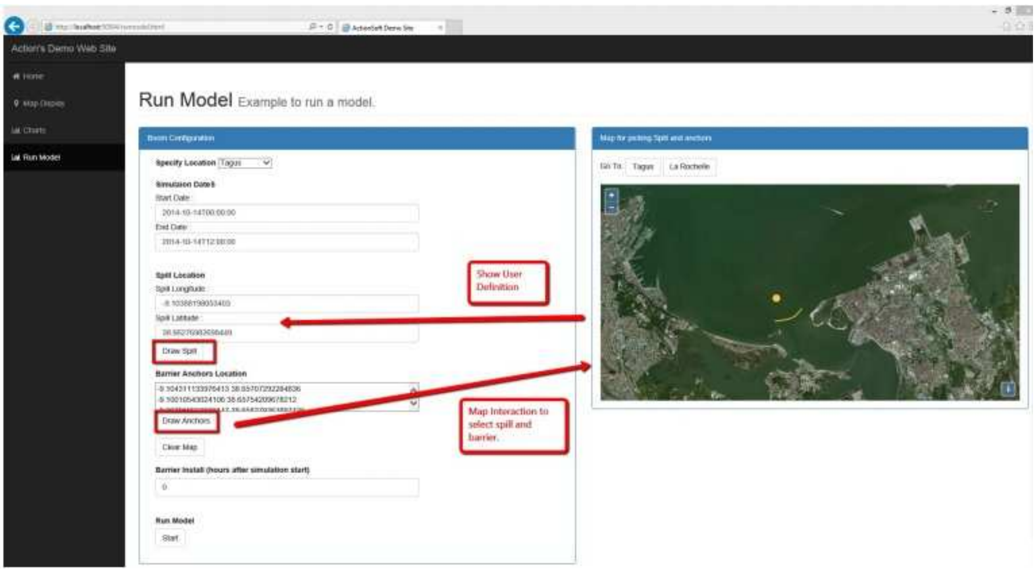

Fig. 6 User Interface from WMS Server during model execution for emergency training, AM.

It was used the IST Tagus operational model implementation and the BAR2D model from EIGSI. These models are linked with Open-MI. As example a spill was introduced in the inner Lisbon estuary with a barrier using 5 anchors in an extension around 800m. In figure 7 is shown one instant 4h after spill the boom geometry. Here it can be underlined that the boom segments are directed towards current and that oil particles are trapped. They does not entering into the estuary branch.

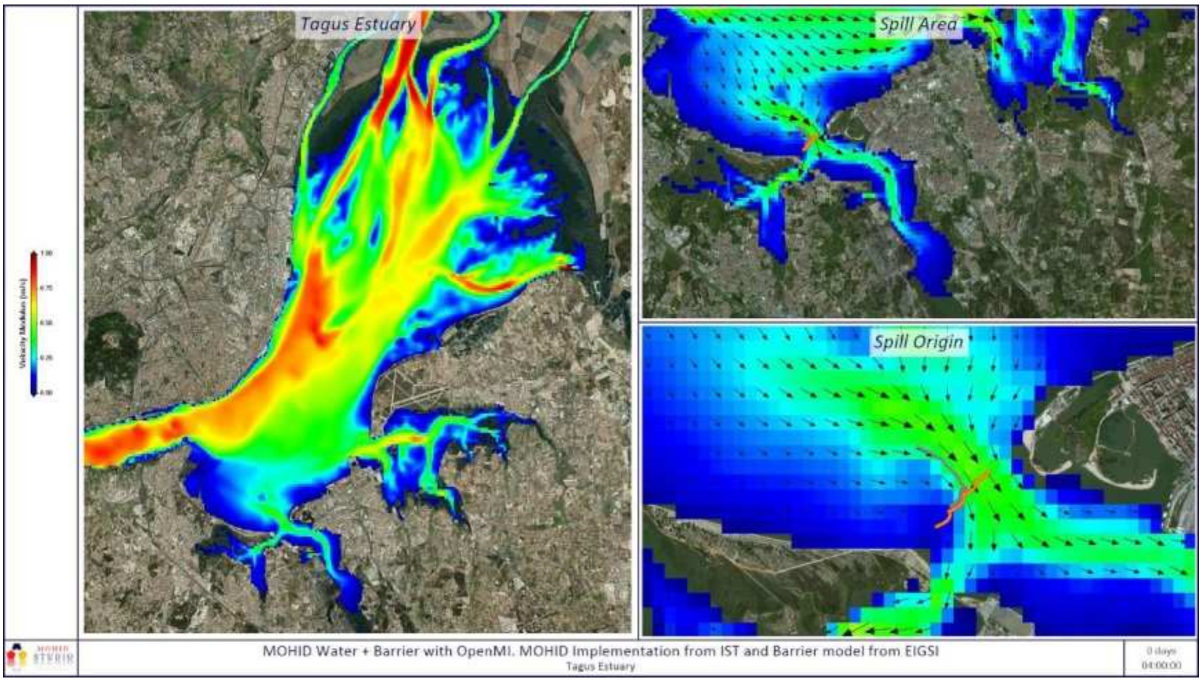

Fig. 7 MOHID - Water Tagus implementation with oil-spill and boom using Open-MI in inner estuary, AM.

Software named BARRIER was developed by EIGSI as decision support system for oil-spill booms. The software is based on imbedded numerical models for curtain and barrier booms. These models BAR0D, BAR1D, BAR2D and BAR3D permit a representation of strained boom geometry respectively as a segment, a catenary curve, a finite-element curvilinear domain and a 3D tensile membrane structure.

During an Incident in the Maurienne River (French Alps) in November 2014, we have applied BARRIER to predict the behaviour of a boom previously installed. By using the public local data of this site, the output of BARRIER could help the responders to choose a strategy. The synthetic result is displayed on the following figure.

Remark: MOHID and BARRIER have integrated the boom models into their oceanographic and atmospheric environment as well as for decision aid support. At the end of the project, and after a sequel of test cases, MOHID and BAR2D model run operationally (figure 7) within general oceanographic conditions. First operational test cases of BARRIER and BAR3D model have been delivered as decision aid tool for responders. A first example of synthetic output is given in the following figure 8. It was looked as a standard proposition for boom output computation.

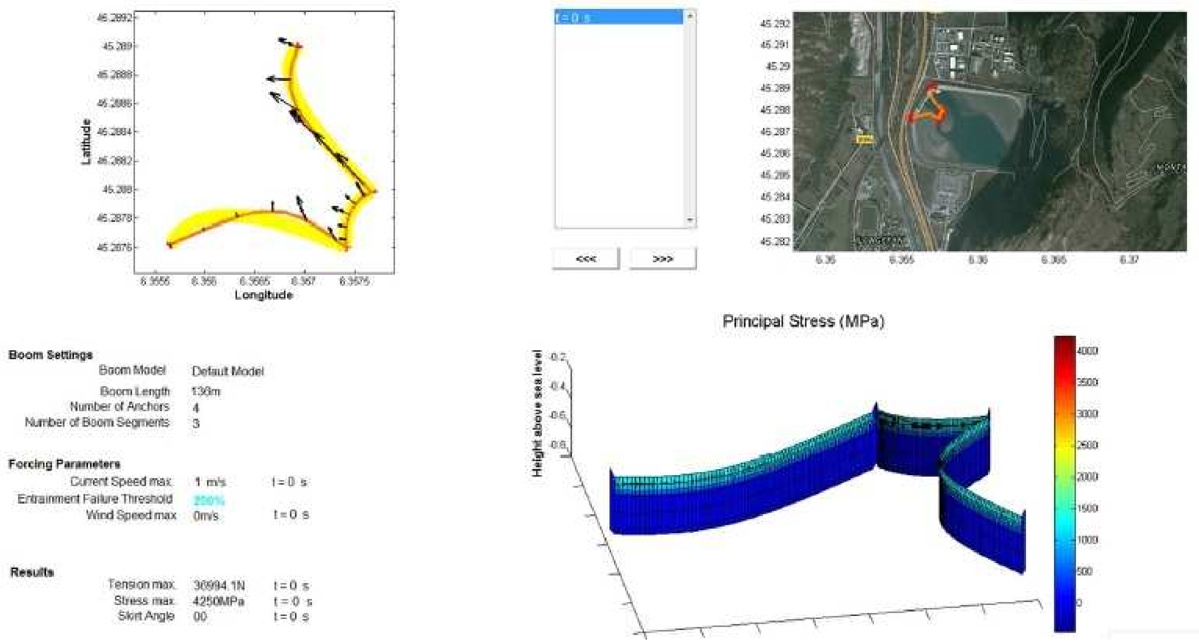

Fig. 8 Output of BARRIER using BAR2D and BAR3D models for pollution by hydrocarbon in the Maurienne River and a hydropower lake, French Alps November 2014, EIGSI.

From the upper left to the bottom right of figure 8 we can observe the BAR1D and BAR2D results, the temporal window, the geographic projection of the 3 boom sections moored in a hydropower lake, the numeric threshold upon the boom efficiency (oil containment and structural integrity), and the stress map in the fabric material of the 3 boom sections issued from BAR3D.

2.3 Full-scale experimentations

Four real-life experimentations have been realized during the project. The experimentations were carried out to validate the models and for training activity. Falmouth, Lisbon, Rochefort and La Rochelle are the four Atlantic harbours were the in-situ experimentations of different floating barriers have been made.

2.3.1 Falmouth

The Falmouth exercise has been called ‘Exercise Maia’ because it was spring in Falmouth in May. The instrumentations used GPS trackers and load shackles, buoy data and PICSES simulations.

FHC used six GPS trackers, regularly spaced along a ‘V’ shaped boom. These were battery operated. The autonomous satellite based trackers were located on the ends of the two arms of the boom and in the centre of both with six trackers in all. These would report the boom position every 30 minutes and would allow a “real time” web based visualisation of its movement. Existing data buoy measured meteorological and tidal information. It was positioned in the centre of the mouth of the boom, and be able to demonstrate a direct correlation between boom movement, wind speed and direction and tidal flow.

Two load shackles has been also used. These load cells were fitted in the horizontal chain sections on the two main mooring clumps for the boom. The load cells were closed to the sea bed and the signal from them were brought to the surface, processed and transmitted ashore. The data were displayed on the same screen as the boom position (using the trackers), giving a complete dynamic picture of position, wind, tide and the chain loads.

Also was available a visualisation from FHC oil simulation model (PISCES) which shown the V boom location in the harbour. The simulation was an oil spill starting at 05:30 AM on 2014 May 12th. The pollutant amount was approximately 4 tonnes of bunker fuel oil. It was used real tidal predicated data for this day, but FHC has made up the wind information.

The following figure shows the position of the exercise in the estuary front of the Falmouth docks.

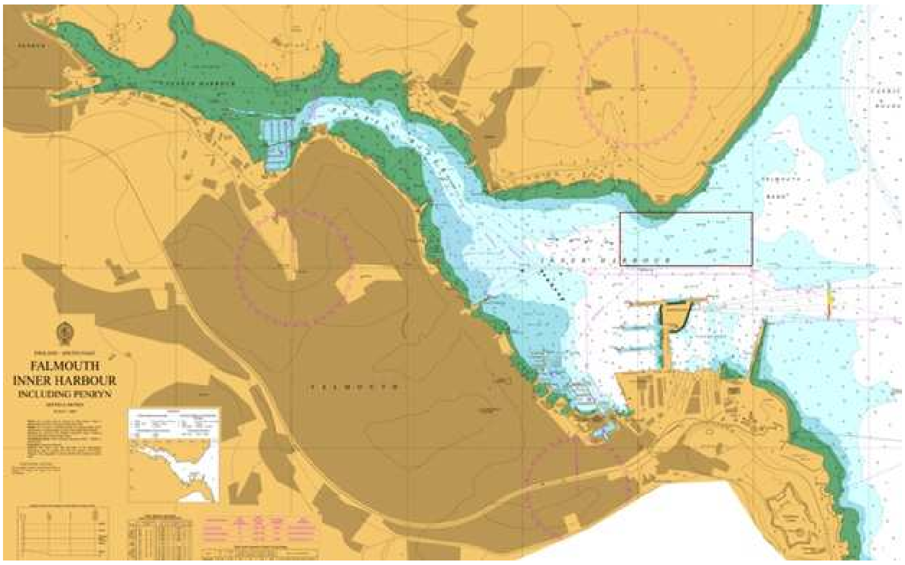

Fig. 9 Red box indicating the pollution exercise area in front of Falmouth docks, FHC.

The exercise was not a real time exercise because the various stages of the response were staggered over a period of a few days. Seventeen lengths of (75cm inflated depth) by (20m length) PU alloy inflatable boom were deployed (Sea Sentinel Boom).

Fig. 10 Exercise Maia in Falmouth estuary May 2014, FHC.

The moorings (see figure 11) were deployed the week before and up to Monday 12th May 2014 by FHC's 'Pendennis' boat.

Fig. 11 Granite 3 tonne blocks chain and pick up buoys formed the oil boom's mooring, FHC.

The GPS positioning software on the boat ensured the moorings were deployed in the exact position intended with 30 cm accuracy (see figure 12).

Fig. 12 Moorings deployed via 'Pendennis' boat and by using GPS software, FHC.

FHC realized a risk and vulnerability assessments and a modelling. The boom was left in situ for nine days. The exercise MAIA was ambitious with a strong training issue. Reports and comparison of our exercise and that of other partners were made. A training film on the exercise and another training film for higher level have been realized.

2.3.2 Lisbon

The Lisbon ISDAMP+ exercise occurred in October 2014 in a specific area of the Tagus estuary. The exercise was coordinated by IST and the Lisbon Port Administration (APL), and has also included the REPSOL Company. The exercise location was decided in coordination with APL, considering the location of liquid bulk terminals, their strategic position, model accuracy, harbour traffic, and experience in previous exercises. This test case used booms as physical barriers with a closing loop around a wreck (a fixed point barrier). It permitted to study the behaviour of those barriers during an accident, and to test and validate the ISDAMP+ decision tool with the coupling of the Message Passing Interface (MPI) together MOHID.

The boom was fixed in two points at the Banática Liquid Terminal. Those planned point positions are represented in figure 13. This operation was operated by APL team (3 persons), and using the APL ship.

Fig. 13 Possible positions of the boom around the Banática liquid terminal at REPSOL terminal, Lisbon harbour experimentation, IST.

During the exercise the boom deformation was registered by photo images (see figure 14). An APL semi-rigid boat has been used for photography. The boom used is a NOFI 350 EP with 150 meter.

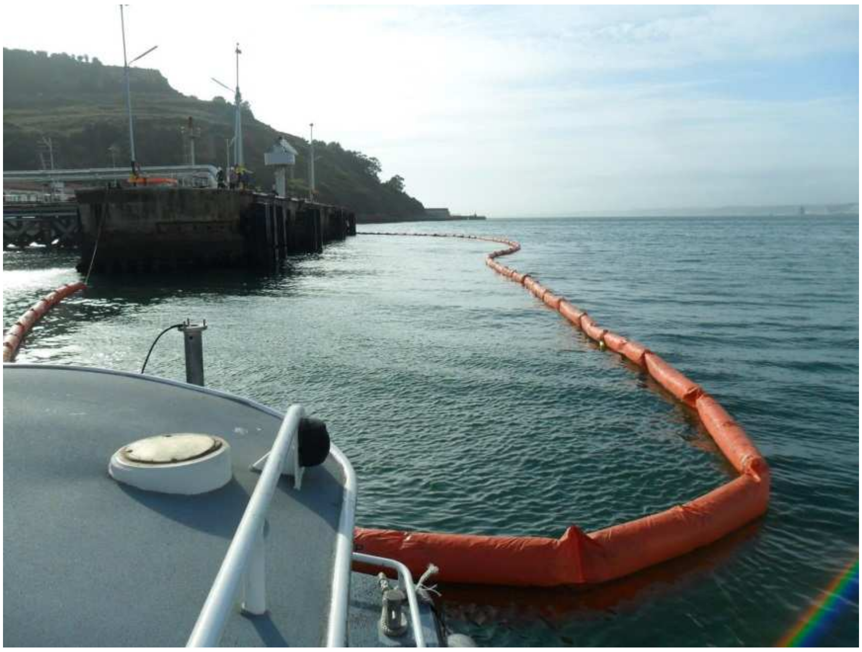

Fig. 14 Exercise in REPSOL terminal October 2014, Lisbon, IST.

A set of four drifting buoys were released to validate the 100m hydrodynamic model implemented for the study area. These buoys followed the surface hydrodynamic fields and their drift was compared with model results.

The exercise considered different objectives:

- Barriers test and study of barrier deformation
- Surface hydrodynamic measurements
- Release of surface drifting buoys in the surrounding area to validate local hydrodynamics
- Surface wind measurements with manual anemometer
- Water quality measurements (salinity, turbidity).

2.3.3 Rochefort

The ISDAMP+ boom deployment exercise took place in the basin of the commercial port of Rochefort. Rochefort is one of the most important ports in the Charente-Maritime department, located in the western part of France. Located within the marshy Charente Estuary, at 18km of the Pertuis d'Antioche (and the Gascogne Gulf) the Port of Rochefort is a medium-sized commercial and leisure port.

The port of Rochefort-Tonnay-Charente is a public port authority owned by the Charente-Maritime county and managed by the Rochefort-Saintonge chamber of commerce and industry. The port is specialized in wood, fertilizers and cereals imports. The total commercial trade amounts for nearly 1 million tonnes a year.

EIGSI engineering school has performed the boom experiment from both operational and scientific points of view. EIGSI purchased a 50 m long curtain boom to that end (boom reference is EUROSORB 1830BCR).

Different "runs" were practiced from 09:30 to 13:00 and 14:00 to 16:00, the 5th December 2014. Each run consisted in the small tug towing a boom end from the quay to the middle of the basin and back. The tug boat was fitted with a GPS tracker which provided the bearing and position of the boat during each run.

Some key numbers of the experimentation were:

- 3 sections of boom deployed during the pollution response exercise
- 2 sections of boom of 10 m in length and 1 of 30m
- Total overall length of boom deployed is 50 m
- Boom deployed in a C shape, held in place using one of a port ladder and a boat.
- Deployed in the water from a quay
- 13 people involved

Scenario focussed on providing a response solution in the case of a small portuary accidental release. For example, an incident occurred during bunkering from truck, or during the breakdown of an old ship, and a small amount of oil was released into the port waters.

Fig. 15 Sweeping boom in the commercial port of Rochefort, 5th December 2014, EIGSI.

The main goals of the experiment were to:

- Observe the boom trajectory when towed at different angles and speeds
- Measure the tension on a towed boom
- Perform a simulation reproducing accurately what was observed in real-life
- Compare simulated and observed tension values.

2.3.4 La Rochelle Chef de Baie

The Chef de Baie harbour is a fishing port located in the city of La Rochelle under the policy of the Charente-Maritime council.

A view between the floating oil pontoon (on the right) and the handling quay (on the left) is shown on the following figure. EIGSI deployed 2 sections of containment boom, 2*10 m, and 2 sections of sorbent boom 10 and 5 m, the 16th March 2015.

The experimentation duration was 6h, around full tide +-3H.

The specificity of the port infrastructures rendered difficult the antipollution operations.

Remarks:

- The forcing direction could change significantly if a squall occurs
- The forcings from the West and North were not directly taken into account
- The wave agitation in the harbour could be significant with oceanic North-West wave source
- Boom deployment was made by 2 operators
- Deployment was made without nautical mean (i.e. small ship)

Fig. 16 Experimentation at Chef de Baie fishing harbour, 2 operators and low cost, March 2015, EIGSI.

The pollution scenario is positioned at the foot of a mobile crane of 25 Tons during a fishing ship bailout (see figure 17).

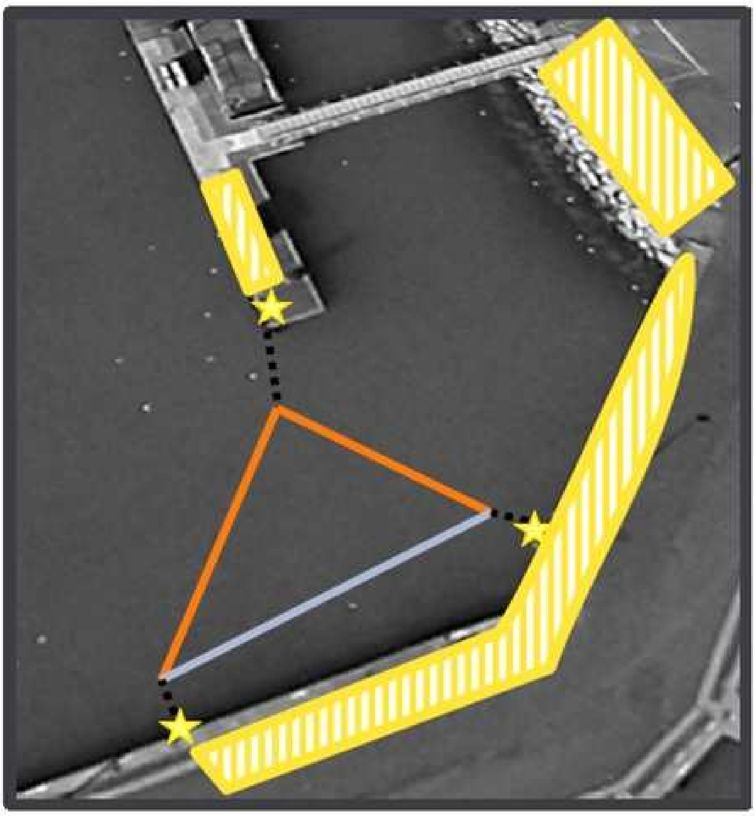

Fig. 17 Simulating containment of leaky ship in the place of refuge of La Rochelle fishing harbour, EIGSI.

The sorbent section of 15m constituted the gate for the entrance of a leaky ship (see figure 18).

Fig. 18 Triangular sorbent and containment boom La Rochelle fishing harbour March 2015, EIGSI.

2.4 Communication and publicity

Three workshops and conferences have been organised during the project. Falmouth in 2014 and La Rochelle twice in 2014 and 2015 are the three events in UK and France organized by the project.

2.4.1 Falmouth, 2014

Falmouth Harbour Commissioners organised an all-day Falmouth Oil Spill Response Conference in Falmouth Cornwall (UK) on May 21st 2014. Europeans projects SPRES (Atlantic area transnational program, ERDF) and ISDAMP+ helped to share best practices for oil-spill responders and scientific spill response tools for academics and researchers. The conference was scheduled upon two sessions:

- A morning for sharing best practices from oil-spill responders (National and European spill responses, real-life booming exercises, experiences and lessons learnt from response contractors)
- An afternoon for showcasing innovative technical and scientific spill response tools (spill fate modelling, environmental vulnerability assessments, and software tools).

2.4.2 La Rochelle, 2014

The 5th Oil Spill Studies Workshop was held at EIGSI Engineering School La Rochelle on March 6-7th, 2014. We discussed the implications of oil pollution for coastal communities, focussing on the economic aspects of oil pollution. During the two day event, three sessions of presentations and roundtable discussions were held on:

- European projects on pollution
- Software development for environmental risks and decision making
- Socio-economic and biological impacts.

2.4.3 La Rochelle, 2015

In the context of the ISDAMP+ project, the 6th Oil Spill Studies Workshop was held at EIGSI Engineering School La Rochelle, France on March 11th 2015. Three sessions were held on:

- ISDAMP+ software results based on models
- Coastal sensitivity, ecotoxicology analysis and juridical concerns
- Experiments and case studies in ports and harbours.

One book (published in 2014 by ISTE and Wiley) and participation to a collective book (published in March 2015 by Springer) were made during the project. A publication has already been made in the international journal ‘Estuarine, Coastal and Shelf Science’ (2014).

3. Futur, facilitation, contribution to the effective usage of results (tools and methodologies)

The object of this second part of the report is to give the manner we will use so that third parties will use the results of the project. Let us start by giving three examples as promising results of the ISDAMP+ project.

o Web Client

MOHID-Studio used by a web client could give responsive layout with mobile application on mobile phone, as suggested in the following figure.

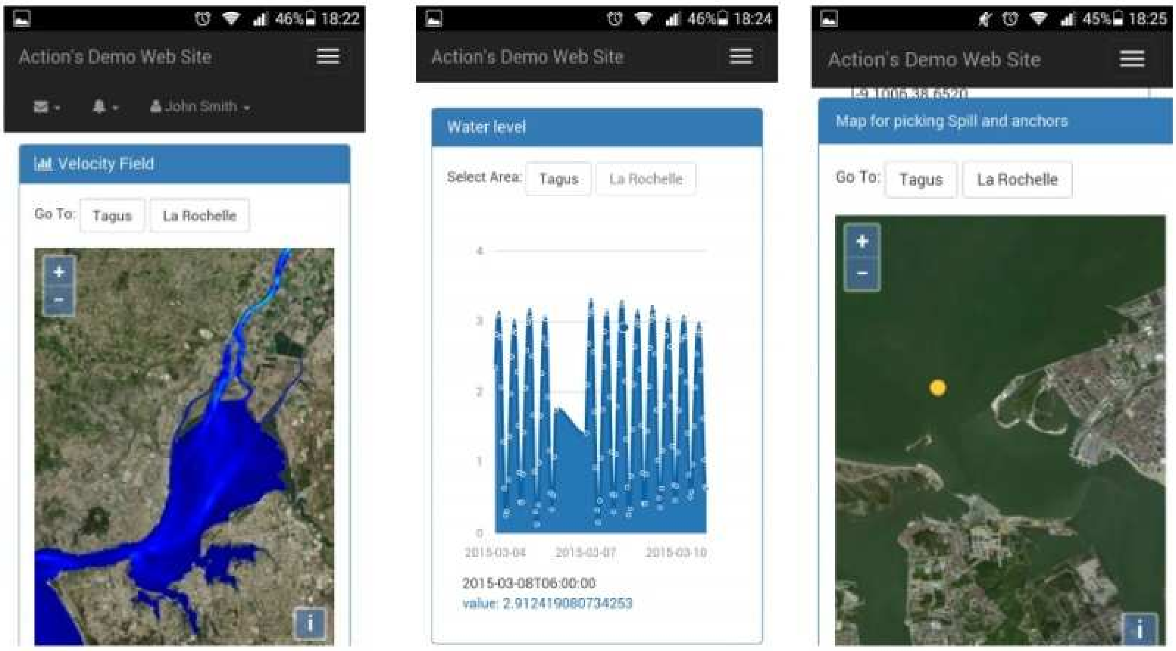

Fig. 19 User interfaces for web client, responsive layout for emergency training, AM.

The user interface, for an emergency training of a web client using the application, delivered for example the velocity field in the dedicated zone and the water level during time. It also permitted to launch the computation by giving the pollution source and anchoring points of boom devices (figure 19).

o MindUP

Representation of ISDAMP+ software as decision support system could be based on modes and capabilities. For example, modes could be linked to the end-user cases and strategies, while capabilities could define the customs zones or visualize and export maps and graph.

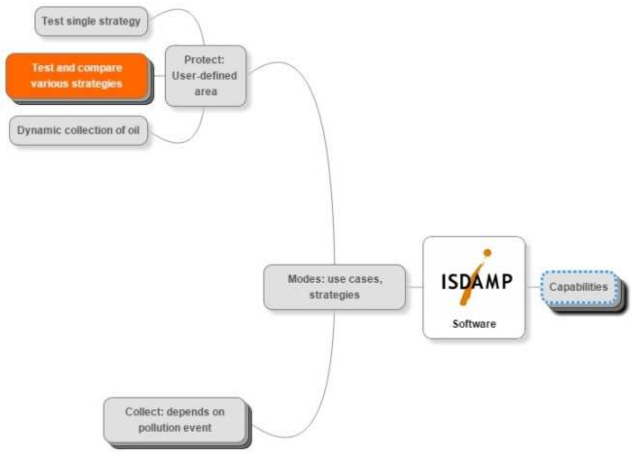

Fig. 20 ISDAMP software describing decision support system using MindUP, EIGSI.

The decision support system could use a MindUP representation as given in the previous figure.

o Operational modelling

MARETEC Operational modelling tool provided a web site dedicated to real-time modelling information system on operational oceanography. Focusing on the Lisbon and La Rochelle zones, the system could give the sea water parameters on hydrodynamics, waves or watersheds. The Atlantic zone covered is shown on the following figure.

Fig. 21 MARETEC Operational modelling on the hydrodynamics of the Atlantic coast of Europe, IST.

For the Lusitania map, the MOHID water modelling system could give on-line the salinity, temperature, and velocity of the sea surface water from 2012 to 2015. The La Rochelle and Lisbon zones of the previous figure have been tackled during the ISDAMP+ project.

The first topic of this chapter is the EU wide take-up that we deploy and the second topic is the exit strategy on what we will do after.

3.1 EU wide take-up

We address to the European National Contact Point (NCP) for maritime pollution the video showing a demonstration of MOHID integrating BAR2D software (figures 5, 6 and 7). We also address them for testing the link on the mobile application for a web client (figure 19). The NCP from Ireland, Sweden and Finland were interested by the ISDAMP+ activity.

The maritime and civil authorities of the European countries in charge of the fighting against marine pollution were informed of the coming activity with respect to the tools and methods developed.

During the project,

- the UK authority (MCA) has participated and given a presentation at the Falmouth 2014 ISDAMP-SPRES conference
- the Portuguese authority (SCPM/ DGAM) has participated to the Lisbon harbour meeting for studying the feasibility of the exercise made in the Lisbon area
- The NCP from Ireland and Sweden were present at the workshop 2014 organized in the frame of ISDAMP+ at La Rochelle by EIGSI.

The authorities in charge of the fighting and having taken a relation with ISDAMP+ were

- the Finland's environmental administration,
- the SG-MER (FR)
- In Africa, the project results was disseminated through the African Maritime Safety and Security AMSSA https://twitter.com/AfricanMarSec
- EMSA has been interested by the Lisbon experimentation
- The Cyprus civil protection (NEREIDs DG-ECHO 2012 project).

To foster such links and a wide handling of the project results, a continuous on-line provision is made by using social media (LinkedIn, google+) and the project web-site.

The take-up of several project results in others European sites has begun with the ARCOPOL-PLATFORM project, where IST and EIGSI are partners, CETMAR at Vigo being the leader of this project. The BARRIER software has been applied for the simulation of the contingency planning using booms response into two Spanish sites:

- Atlantic Ocean, Galicia exercise at the Port of Carmaminal (Ria de Arousa, exercise the October 1st, 2014)
- Mediterranean Sea, Andalucía exercise at the Palmonés river estuary (North-west of Algeciras bay and Gibraltar canyon, exercise the February 26th, 2015).

The operational modelling of the La Rochelle area has been equally improved by IST during the ARCOPOL-PLATFORM project. Always in this project, Action Modulers has presented the illustrative video of MOHID using BAR2D at the Working Group on Oil Spill Modelling Technologies WGOS, in parallel of the INTERSPILL 2015 congress in Amsterdam, 24th March 2015. Action Modulers will continue to deliver such information through coming worldwide congress and training.

The video, photo and lessons learn as training material is continuously shared by Falmouth Harbour Commissioners with subcontractors (tier 2 exercise every 3 years), local, regional and national authorities, exercise observers, newspaper, radio and conference.

Harbour networks and donors could be interested to evaluate in a natural environment the project results and strategy. Local current map could be based on a multigrid approach allowing zoom in data grids. The cost of the meteorological data could be large; consequently, a forecast approach could use local weather station data. Between small and large docks, pollution scenario can be significantly different, small ships use gas-oil while big ships use heavy fuel oil (HFO). The validation of models results by real measurements could be made by cloud data (usage when need) and launch automatically.

3.2 Exit strategy

A survey can be addressed to the NCP of European countries, for knowing their interest in a future collaboration, helping to improve the tools and methodologies coming from the ISDAMP+ activity in software development.

Generally, the authorities in charge of the fighting aim to have more information on the numerous project results dedicated to marine pollutions. A main activity must be launch on the project results to compile the synergies and the best practices. It was addressed during the 1st session of the La Rochelle, 2014 workshop. It must be repeated in the future. The other European projects who have had a relation with ISDAMP+ were NETMAR, ARCOPOL, SPRES, POSOW and NEREIDS. Generally this links were made during the workshops and experimentations.

To that end,

- the ISDAMP+ web site will continue to be maintained during 5 years after the closure of the project (2020).
- the oil-spill studies workshop will continue to be organised annually at La Rochelle, to become a regular event followed by the oil-spill community.

After,

- the edition of a book (Marine Coastal and Water Pollutions, focus on Oceanography and Marine Biology, ISTE and Wiley) in 2014 and
- the contribution to a collective book (Mathematical Modelling and Numerical Simulation of Oil Pollution Problems, the Reacting Atmosphere, Springer) in 2015,

we continuously edit the communications made at the workshops 2014 and 2015 (La Rochelle) and the Falmouth 2014 joint conference.

These former books have permitted to diffuse to a broad audience the elaboration of the ISDAMP+ project, the models used and the experimentations carried out. The continuation of the edition process renders the activities of many projects more accessible, reducing the congestion of numerous valuable results.

Another drawback often cited for marine pollution projects, is their overlapping and more precisely the ignorance by a project of any redundancy with the others. The best strategy as part of an exit strategy is to identify if such fact concerns ISDAMP+ and to deliver in the future our feedback on that evaluation.

The valorisation and the continuation of small-scale experimentation together modelling approach allow us to confront the real situation and to provide valuable training tools. The identification of other projects practicing experimentation at small-scale (tier 1) with local authorities (harbour) will permit to foster a valuable bottom-up operational approach.

The following table presents a business model for the results of the project:

- Products: MOHID-Studio (Action Modulers)
- Research on Services: reduced stock-pile purchased during the project (EIGSI).

The web applications developed by the project:

- Action's web site with WMS (Action Modulers)
- MARETEC Operational modelling (IST),

can be seen as services for a broad audience, or as channels for data sharing. The video and photos made during the Falmouth exercise can be shared in training activities at the Falmouth harbour (FHC).

Table 1. Business model, EIGSI.

<table>
<tr><td rowspan="2">Key partners

software
research
expert
communicate</td><td>Key activities

research

software</td><td rowspan="2">Value proposition
• preparedness to pollution ocean/atmosphere interface
• products (MOHID-STUDIO; web apps)
• research on services (Stock-pile)</td><td>Customer relationships
• beneficiaries, and donors (user differs from funder)
• evaluator</td><td rowspan="2">Customer segments
• authorities in charge of the fighting
• local authorities
• donors</td></tr>
<tr><td>Key resource

skills</td><td>Channels
• bottom-up
• internet (Action's web, operational modelling)
• training (video and photos)</td></tr>
<tr><td colspan="3">Cost structure
• salaries and administration
• servers and softwares
• experimentation sensors and equipments</td><td colspan="2">Revenue streams
• research grants</td></tr>
</table>

This business model indicates as key partners:

- Software development: scientific modelling, web application,
- Research: engineering (hydraulic, civil, mechanical), oceanography (physical, modelling, coastal), informatics (decision aid tool, numeric, virtual environment)
- Expert: marine pollution, maritime
- Communication: knowledge sharing, social networks.

The following table presents a SWOT analysis of the project exit strategy. The project gathering small experimentation (field trial) and research (modelling) has the strength to confront real and virtual environments.

Table 2. SWOT analysis, EIGSI.

	Helpful	Harmful
Internal origin	Strengths • virtual and real environments (tier 1)	Weaknesses • access to oceanic and atmospheric data
External origin	Opportunities • free data sharing and standardization • open source	Threats • congestion of results • overlapping of projects

4. Conclusion

The project performances were to gather virtual operational tools with real-life operational experimentations. Both activities have theirs intrinsic difficulties and the project aimed to look at the difficulty to compare real and virtual results and strategies. Generally, the tools and results implemented by the project have a good evaluation by the partners themselves and the project results will benefit from an external evaluation.

The effective usage of the product was a close cooperation between research and software development. The eventual distinction between the end-users and the donor (funder) is an important factor for commercial activity.

The actual evolution on data sharing and interoperability in the maritime sector could be a main driver for the future. Collaboration in virtual environment appears as a main evolution of decision aid tool for preparedness in maritime pollution.

Interaction of national and local administrations favours bottom-up approach.

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http://isdamp.eu

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