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To cite this version:

Manuel Ruiz-Villarreal, Julien Mader, Pablo Carracedo, Ricardo Torres, Mike Bedington, et al.. DEVELOPMENT OF COASTAL MARINE SERVICES FOR TACKLING COASTAL RISKS IN THE ATLANTIC AREA: THE VALUE OF REGIONAL COOPERATION. 9th EuroGOOS International conference, Shom; Ifremer; EuroGOOS AISBL, May 2021, Brest, France. pp.420-427. hal-03328807v2

HAL Id: hal-03328807

https://hal.science/hal-03328807v2

Submitted on 24 Sep 2021

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DEVELOPMENT OF COASTAL MARINE SERVICES FOR TACKLING COASTAL RISKS IN THE ATLANTIC AREA: THE VALUE OF REGIONAL COOPERATION

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Abstract

The MyCOAST project (http://mycoast-project.org/) is an INTERREG Atlantic Area project designed to demonstrate that marine services for tackling coastal risks can be jointly developed. The main innovation and originality of the project stems from the implementation of transferable tools able to improve the risk management systems operated in the Atlantic Area. A successful outcome was achieved by identifying mature existing tools and selecting those that could be further developed by partners during the project duration. Demonstration of the tools in pilot actions showed that they are effective in supporting end users and relocatable among different regions in the Atlantic Area.

Keywords: marine services, coastal risks, joint development, transferable tools, coastal observatories, Atlantic Area

1. The MyCOAST Project

Operational oceanography relies on a cooperative effort towards ocean observing systems providing data and modeling products to support end users in the marine sector. In recent years, the IBIROOS community[1] has demonstrated the value of marine services in different topics (HABs, oil spill, chemical pollution, search and rescue, support to MFSD implementation, marine spatial planning…) through regional cooperation with support of different EU and Interreg projects. Europe has funded large scale initiatives to protect, secure and sustain marine and coastal environments. At the same time several regional coastal ocean observatories have been implemented along the North Atlantic Coast with the aim of complementing existing networks and to cover near-shore areas with higher spatial resolution observations and forecasts, e.g. RAIA, LOREA, the Western Channel Observatory, SCObs, SmartBay, HOSEA or OCASO. MyCoast is an Atlantic Area Interreg project that aims to fill the gap between large scale products and end-users whilst addressing a transnational cooperation of coastal observatories. During the time of the project, effective member cooperation in the support of the observing system and the dissemination of data has resulted in the joint development and demonstration of improved and novel marine services.

2. MyCOAST tools for coastal risks: joint development and demonstration

MyCOAST has focused on the development of tools to address the requirements and risks from extreme events/flooding (2.1), coastal pollution (2.2), search and rescue (2.3), oil and chemicals (2.4) and maritime safety (2.5). The task sequence in the project was designed to obtain ready to use tools that could be demonstrated in different sitesites in the Atlantic Area during the time of the project:

- Review of the state of the art: A state-of-the-art technical report reviewing the existing tools was used to select tools that were mature enough to advance their development during the time of the project;
- Tool development: Major efforts were applied in improving the software for efficient use by different partners and in upgrading it for ingestion of different model data outputs in standard interoperable Open Geospatial Consortium (OGC) services;
- Tool demonstration: A quick guide was prepared and distributed to MyCOAST partners in order to foster the application of tools in different areas forced by models developed in different coastal observatories.

[1] https://eurogoos.eu/roos/ireland-biscay-iberia-regional-operational-oceanographic-system-ibiroos/

Table I. MyCoast tools for coastal risks

COASTAL RISK	MYCOAST TOOL	MODELS USED FOR INPUT
Flood	Flood tool	ROMS (tide), SWAN (wave)
Pollution	MyCOASTLCS	FVCOM, MOHID, ROMS, NEMO
Search and rescue	ADRIFT	ROMS, FVCOM
HNS & Oil Spill Forecast	LI4MOHID	MOHID
Maritime safety tool	Weather Window tool	SWAN

2.1 Flood risk Tool: Floodtool

This flood risk tool entails plugins and Python code for the open source Geographical Information System QGIS, which processes met-ocean data to forecast whether or not historical flooding thresholds will be exceeded. The Floodtool platform is built on free software and is characterized by its flexibility and the possibility of extending the software, which is achieved by means of algorithms, models and plugins. The flood risk tool is intended to support municipalities in different regions.

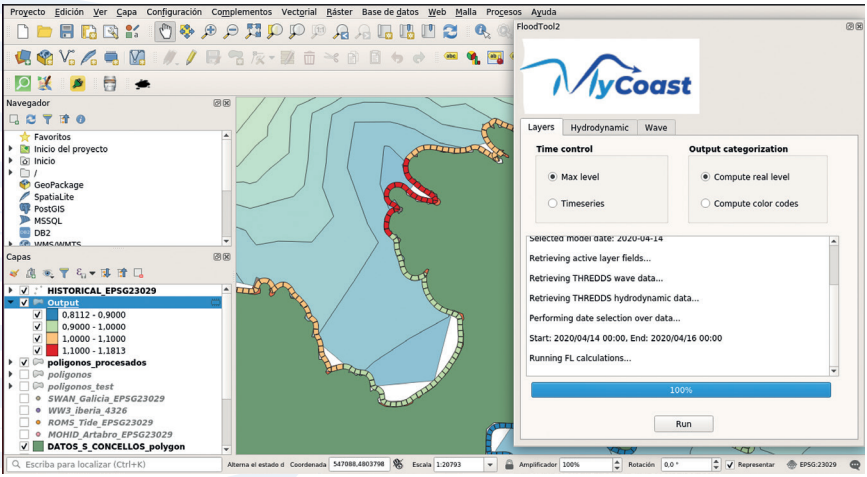

Fig. 1. FloodTool applied to the coastal town of A Coruña (Galicia, Spain)

2.2 Pollution Tool: MyCOASTLCS

MyCOASTLCS has been developed to enable the visualisation, identification and quantification of pollution hot spots of non-reactive, buoyant, slow diffusing and short-lived substances. These assumptions can approximate the behaviour of plastic debris as well as sewage waste over the time scale of a few days. The tool specifically calculates the spatial distribution and time evolution of Finite Time Lyapunov Exponent (FTLE) fields, extracts Lagrangian Coherent Structures (LCS) and estimates spatially discretised time-evolving concentrations and residence times. This coastal risk tool takes MyCOAST partners' hydrodynamic model outputs (so far FVCOM, MOHID and ROMS and any Arakawa-A grid model such as those in the CMEMS catalogue), runs point-source Lagrangian particle releases and ensembles of gridded particle releases using PyLag, and computes the Finite Time Lyapunov Exponent which indicates a Lagrangian coherent structure, in the post-processing. The tool helps to identify the source of pollutants using backward tracking, and homogeneous flow zones.

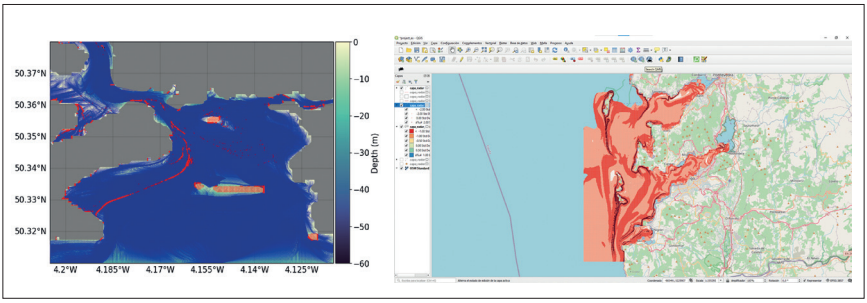

Fig. 2. MyCOASTLCS demonstrations in Plymouth Sound (UK) with FVCOM model and Galician Rias de Vigo and Pontevedra (Spain) with MOHID model.

2.3 Search and Rescue Tool: ADRIFT

ADRIFT was originally developed by the Marine Institute for the local RNLI (Royal National Lifeboat Institution) station in Galway, Ireland to aid them in marine search and rescue operations in Galway Bay. The system is based on the Ichthyop Lagrangian particle tracking software (https://www.ichthyop.org/) and a tailor-made web tool. Recently the Marine Institute has adapted ADRIFT to run with OpenDrift (Pereiro *et al.*, this conference). The existing tool can accept gridded ocean data simulated by a number of models including ROMS, NEMO and FVCOM.

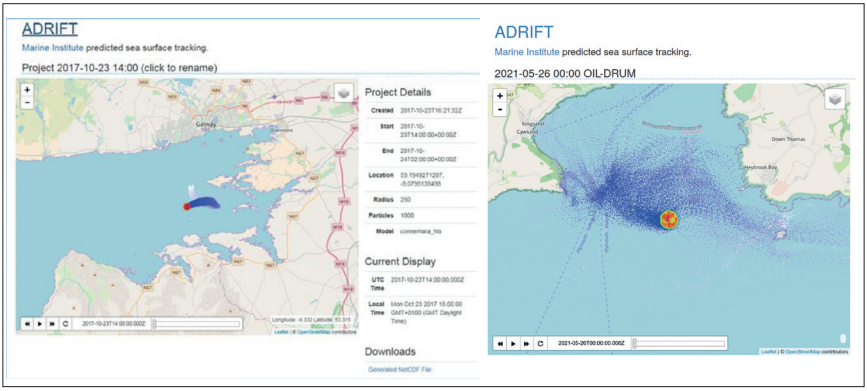

Fig. 3. ADRIFT demonstrations in Galway Bay (Ireland) with ROMS model and Devon Coast (UK) with FVCOM model.

2.4 Hazardous and Noxious Substances (HNS) & Oil Spill Forecast Tool: LI4MOHID

A plug-in called LI4MOHID was developed for QGIS in order to run and visualize the results of a marine pollutant dispersion model. The Lagrangian module of the MOHID hydrodynamic model (http://www.mohid.com/) is used in a version that optimizes the CPU time of the program. The oil and chemical spill toolkit provides pre-processing and post-processing tools to adapt partners' model data to the open-source MOHID HNS and oil spill model.

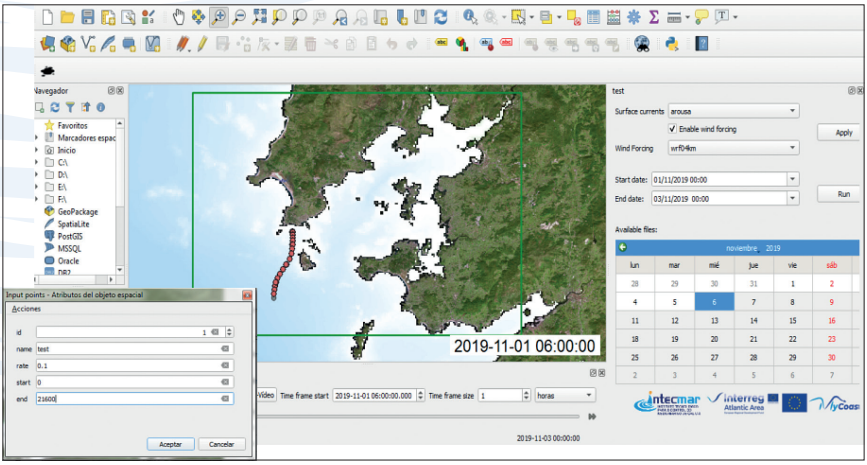

Fig. 4. LI4MOHID tool demonstrations in the Ria de Arousa (Galicia, Spain).

2.2 Pollution Tool: MyCOASTLCS

The primary objective of the maritime safety tool is to identify the appropriate weather window to facilitate safe operations and maintenance, especially of offshore renewable energy and offshore aquaculture operators. End users can view the relevant met-ocean parameters provided by operational wave and circulation models run at partner coastal observatories and establish the suitability of met-ocean conditions with respect to relevant thresholds. The Weather Window Tool was initially developed by the Marine Institute under the AtlantOS project (Dale *et al.*, 2018) and provides a user-friendly interface of short-term wave forecasts; plots two time series, one of significant wave height and another of mean wave period and wave direction. The user specifies a personally preferred cut-off significant wave height; considered as the maximum accepted to ensure safe operations, and the time series of safe windows of opportunity appear highlighted in green. It is currently hosted at [http://www.digitalocean.ie/Home/WeatherWindow] and demonstrates the support for planning of operations at different sites including aquaculture sites in Ireland (7 sites), Galicia (28 mussel raft polygons) and the Basque Country (Mendexa site), ocean-meteo buoys (PML Western Channel E1 and L4, IEO AGL and Xunta de Galicia buoys) and also pilot sites for locating marine renewable energy devices.

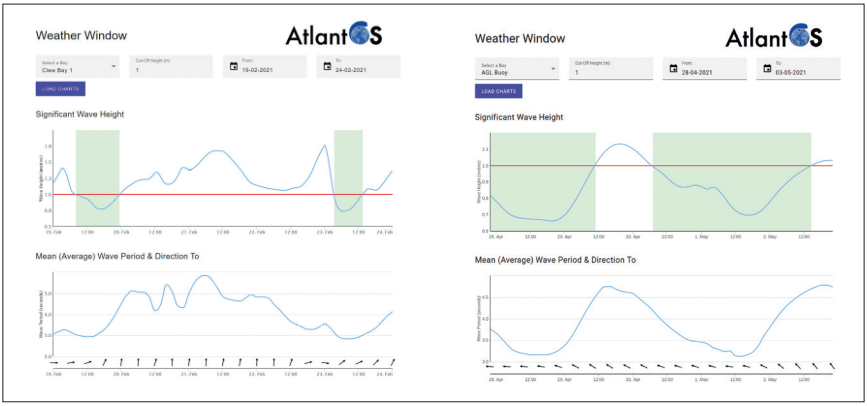

Fig. 5. Weather Window demonstrations in Clew Bay (aquaculture site in W Ireland) and IEO AGL Oceanographic Buoy off Santander (N Spain). The existing tool processes SWAN model forecast data for a five day window.

MyCOAST tools for tackling coastal risks are summarised in Table I. Tools were demonstrated in a first phase (see results in previous sections) to show the transferability and interoperability of existing tools between different coastal observatories in the Atlantic Area. These pilot demonstrations and case studies resulted in recommendations for the improvement of tools and are expected to contribute to the design of associated policies and risk management and prevention systems.

Another MyCOAST objective was to demonstrate that tools can support authorities responsible to manage actual risks. A trans-boundary pollution response exercise to test the operational products developed under MyCOAST project was performed on 21 September 2020 in the Galician-Northern Portugal boundary between the latitudes of Vigo (Spain) and Porto (Portugal). Several drifting buoys were launched in the outer shelf and near the coast. MyCOAST tools (LI4MOHID, ADRIFT) and the Galician administration tool CAMGAL were used to forecast the trajectories of the buoys. Agencies responsible for marine operations like the Harbour Master´s Offices of Caminha, Viana and Póvoa de Varzim in Portugal, the Galician Coastguard and the SASEMAR (Spanish Maritime Safety Agency) were involved in the exercise.

Fig. 6. Drifters deployed during the Caminha exercise (left). Trajectory forecasts with Mycoast oil spill tool (red), Mycoast ADRIFT tool (blue) and CAMGAL tool (gray).

Demonstration of the tools in pilot actions showed that MyCOAST tools are effective in supporting end users and transferable among different regions and coastal observatories in the Atlantic Area (Spain, Portugal, UK, Ireland). All tools are intended to be distributed in software repositories at the end of the project. The IBIROOS community will work towards finding ways to maintain and develop these tools after the end of MyCOAST.

Acknowledgements

This work has been funded by the European Union's Interreg Atlantic Area project MyCOAST (EAPA_285/2016, http://mycoast-project.org/).

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