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ECOOP IP

European COastal-shelf sea OPerational Observing and forecasting system Integrated Project

EuroDeSS Northwest Shelf Seas Marine Security Applications: The V1 system and TOP Case study

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1. PUBLISHABLE EXECUTIVE SUMMARY

Executive summary: This is just what the title indicates – a summary that can be independently published. Max ½ page.

The primary goal of the services in ECOOP D9.2.1 is to provide tools that are used for marine security operations on the north-western shelf. To meet the requirements of the society and the ECOOP goals the following developments have been pursued.

- Oil drift model development to enable interface with high resolution ocean models, and development of flexible algorithms for more accurate positions of coastlines. Development of including wave drift in a more consistent way has also been targeted in this study.

- Establish a common format for initial data of the emergency (i.e., position, type of emergency, required forecast etc). This has been developed in cooperation with S9.2.3 (which carries the main responsibility of the format), S9.2.4, and S9.2.6.

- Develop a common format for output and tools to collect these data on a common service.).This has been developed in cooperation with S9.2.3 (which carries the main responsibility of the format), S9.2.4, and S9.2.6.

The oil drift model was demonstrated for a case study outside the Lofoten peninsula. The time and location of the spill were selected by end users, and the results were demonstrated and explained using a detailed analysis of the forcing data.

2. INTRODUCTION

Introduction: i) Provide an introduction to the ECOOP project (you may use the text in the appendix). ii) Give the background to your DeSS and describe the specific role of your DeSS in ECOOP (this should be specific for each DeSS). iii) Give some brief description of the organisation of the report.

2.1. General overview

The overall aim of the ECOOP project is to "consolidate, integrate and further develop existing European coastal and regional seas operational observing and forecasting systems into an integrated pan- European system targeted at detecting environmental and climate changes, predicting their evolution, producing timely and quality assured forecasts, providing marine information services (including data, information products, knowledge and scientific advices) and facilitate decision support needs." WP9 addresses the final phrase, i.e., *to facilitate decision support needs*, and aims "to develop integrated marine services in support of marine environmental management in European coastal areas (EuroDeSS, European Decision Support System), based on information products generated by the ECOOP system of systems." (All quoted passages above and in the following are excerpts from the ECOOP Annex I document.)

ECOOP WP9 will design and develop elements of a EuroDeSS for the European Shelf and Coastal Seas building upon the ECOOP observational and modelling products. The specifications of EuroDeSS will be defined in collaboration between product providers, service developers and selected users. WP9 has the following specific objectives:

- To evaluate existing elements of decision support systems (DSS) operating in European coastal seas.
- To define the specifications of EuroDeSS, in collaboration with end-users and GEOSS/ GMES stakeholders.
- To develop components of EuroDeSS in selected targeted areas where elements of such systems already exist.
- To operate and demonstrate the value of EuroDeSS for the Target Operational Period (TOP).
- To evaluate the performance of EuroDeSS and assess its impact, in consultation with end users.

WP9 is organised in three Tasks:

- T9.1: EuroDeSS specifications & standards
- T9.2: Development, management and demonstration of EuroDeSS for targeted applications/areas
- T9.3: EuroDeSS evaluation including user perspectives

The present work belongs to Task T9.2, whose specific aims are:

- Develop targeted application elements of an integrated EuroDeSS according to the specifications laid down in Task 9.1.
- Demonstrate the usefulness and applicability of EuroDeSS through user-oriented demonstrations in a representative range of European coastal areas.

The targeted application elements are: marine security (including support to marine oil spill response and search-and-rescue), ecosystem health and fisheries assessment. Eight regional demonstrations are included to represent a range of European coastal areas:

1. Marine security (oil spill and search-and-rescue support) in the northern North Sea
2. Ecosystem health in the North Sea
3. Marine security and Ecosystem health in the Aegean Sea
4. Marine security in the Iberian coast and the Western Mediterranean
5. Ecosystem health in the Bay of Bothnia
6. Oil-spills forecast in the Levantine
7. Ecosystem health in the Adriatic
8. Fisheries assessment in the North Sea

Task T9.2 builds on the existing applications that the partners bring into ECOOP. These systems will be developed towards EuroDeSS according to the methods and technology specifications emerging from T9.1 and will utilise data products from EuroMISS (European Information System of Systems). A close coordination with EuroMISS development in WP8 is necessary. Key technologies are expected to include standardised formats for data exchange and OGC-compliant web-services for data and information dissemination.

Through the development, implementation and testing of the targeted application elements, T9.2 will lay the foundation for an assessment of the benefits of ECOOP products for coastal ocean users (cf. T9.3). In addition, it is expected that the EuroDeSS methodology developed will be ready for relocation to other areas and to other marine decision support applications.

2.2. Background to S9.2.1

Maritime transport is of fundamental importance to Europe and the rest of the world. To put this in perspective, over 90% of European Union external trade goes by sea and more than 1 billion tons of freight a year are loaded and unloaded in EU ports. This means that shipping is the most important means of transport in terms of volume, and it will continue to be so in the foreseeable future.

In this context, European citizens have the right to expect their maritime passenger and goods transport to be safe, secure and clean. So, in support of these goals, and particularly in the wake of the Erika and Prestige oil tanker accidents, the set up of the European Maritime Safety Agency (EMSA) under Regulation (EC) Nº 1406/2002 of 27 June 2002 is one of the key EU policy level initiatives aimed at improving the situation (http://www.emsa.europa.eu/Docs/other/action%20plan.pdf).

EMSA´s main objective is to provide technical and scientific assistance to the European Commission and Member States in the proper development and implementation of EU legislation on maritime safety, pollution by ships and security on board ships. To do this EMSA has the operational tasks in oil pollution preparedness, detection and response. In the case of a major oil spill disaster in European seas and adjacent waters, EMSA, through the CleanSeaNet service, is co-operating with the International Charter (Space and Major Disasters) for the rapid access to satellite imagery and information products over the areas affected by or at risk of serious pollution.

This co-operation, in recognition of EMSA's operational role and competency in the provision of satellite imagery for marine oil spill monitoring and detection in Europe, will ensure the fast and efficient delivery to EMSA of all relevant satellite images and information products made available through the framework of the Charter. In the case of a major oil spill disaster in

European seas or adjacent waters, EMSA will act as a co-ordination point, using in-house expertise and contractual arrangements with satellite operators and service providers to rapidly download information to ground stations in Europe and to further process and analyse the data. In this way the Agency can derive comprehensive results to best support affected Member States and the European Commission in the overall response chain. For more information on EMSA go to http://www.emsa.europa.eu/.

As part of its operational role within the Community Mechanism for Civil Protection, the EU Monitoring and Information Centre (MIC) acts as the unique gateway for the European Community to activate the Charter to supply data, during periods of crisis, in response to 'natural or technological disasters...providing a basis for critical information for the anticipation and management of potential crises'. The MIC (which is run by the Civil Protection Unit of DG Environment) remains the sole Authorised User for all Charter activations on behalf of the European Community, including oil spill disasters in European and non-European seas.

In particular, the European Maritime Safety Agency, through its CleanSeaNet service, was nominated International Charter "Space and Major Disasters" Project Manager for the oil spill that occurred in the Norwegian waters of the North Sea on 12 December 2007. The spill of approximately 4000 m3, occurred when the tanker Navion Britannia was loading oil from a loading buoy in the Statfjord oil field, located around 200 kilometres west-northwest of Bergen, close to the border of the UK continental shelf. On the same afternoon, the Norwegian authorities requested the European Commission (EC) Monitoring & Information Centre (MIC) of DG Environment to activate the International Charter for rapid access to satellite imagery and information products over the affected area. EMSA immediately took charge of the satellite monitoring of the interest area and Synthetic Aperture Radar (SAR) images from the European Space Agency (ESA), Canadian Space Agency (CSA), Japanese Space Agency (JAXA) satellite sensors, were planned. 10 SAR scenes was acquired, processed and delivered to the Norwegian authorities and the EC-MIC, with no oil observed on the sea surface. Kystverket, Norwegian Coastal Administration responsible for monitoring the oil spill, has confirmed that that their latest surveillance flights have observed no more oil on the sea surface, probably due to the high rate of dispersion connected with persistently strong wind and heavy seas after the accident. Satellite monitoring within the context of the International Charter continued until the 21st of December 2007. High resolution optical imagery was also planned and processed by CNES-Spot Image, USGS and CONAE, but the high density of cloud cover prevented any use of such images.

2.3. Organisation and intended readership

Following this introduction, the report starts with a description of the pre-existing DeSS applications, which are identified as the version V0 systems. From this basis, the development towards V1 and its implementation are given in Section 3. Section 4 describes the demonstrations that have been performed during the TOP.

The primary audience for this report is the Subtask 9.2.1 partners, who will use it as a documentation of the work that have been carried out. The report is also intended to support the coordination and monitoring of WP9 and its Tasks. Furthermore, it will be of interest to the ECOOP project management and to the other activities in the project. The report should be of particular interest to the developers of EuroMISS (WP8).

3. SYSTEM DESCRIPTION

Development of the system: i) provide a general overview of the DeSS, and a brief description of the V0 version of the system (the V0 was described in the earlier report). ii) Describe the development to the V1 system (as was outlined in the previous report), describe what data that are used in the DeSS, and outline how ECOOP data is used in the DeSS. iii) Describe what data that is produced by the DeSS, and who will use these data.

This section contains a description the development and implementation of the EuroDeSS elements for marine security (oil spill) in the northern North Sea, which is Subtask S9.2.1. In the original S9.2.1 Search and Rescue (SAR) was a part of this subtask; however, the subcontractor for the SAR service had problems fulfilling their duties and the SAR was therefore removed from S9.2.1. The present services in S9.2.1 are outlined in table 3-1. A more detailed description is given in the following subsections.

The pre-existing applications (version V0), and the plan for development and implementation to versions V1 (first EuroDeSS version.) was described in a first report (Hackett et al., 2008). The development to the V2 (final EuroDeSS version) will be described in this report.

DSS supported	Area	Partner	Services delivered	Users supported
Oil spill response	Northwest Shelf	MET-NO	Oil spill fate forecast	Norwegian Coastal Authority, Norwegian Clean Seas Assoc. of Offshore Operators
Oil spill response	Northwest Shelf	NERSC	Oil detection and monitoring	Norwegian Coastal Authority

Table 3-1: Summary of V0 DeSS elements for marine security applications in the Northwest Shelf region.

3.1. MET-NO oil spill fate forecast service

3.1.1. DeSS Summary and the v0 system

The met.no oil spill fate forecast service provides forecast information to support Norwegian national authorities vested with the responsibility for responding to marine oil spill incidents. The Norwegian Coastal Authority (KV) and the Norwegian Clean Seas Association of Offshore Operators represent government and the offshore industry, respectively. In case of an oil spill incident, they require numerical forecasts of oil spill movement and weathering in order to plan and carry out remedial action. In addition, they require a full suite of ocean weather information (weather, waves, currents, temperature) for planning and carrying out a number of field operations. A request for forecast information must be answered by met.no within 30 minutes. The request is normally handled by trained on duty meteorological forecaster but the users also have the possibility of accessing a web page from which the oil drift can readily be made at any time.

The core of the oil drift service is the Oil Drift 3 Dimensional (OD3D) numerical oil drift and weathering model presently used operational at the Norwegian Meteorological Institute (Martinsen et al., 1994; Wettre et al., 2001) …

3.1.2. Forcing data needed by the model

The OD3D model critically depends on forcing data from operational models for ocean temperature, ocean currents, the wave drift (Stokes drift), the significant wave height, and wind speed and direction. Some of these parameters are important for the drift calculation, while other are important for oil chemistry calculations. …

The required input parameters to the oil drift model are summarised in Table 2.

Wind speed	U_{10}, V_{10}	Fields (GRIB or netcdf)
Wave parameter (analysed)	U_{st}, V_{st}	Fields (GRIB or netcdf)
Wave parameter	H_{sig}, T_p	Fields (GRIB or netcdf)
Sea surface temperature	*SST*	Field (GRIB or netcdf)
Ocean surface current	*U, V*	Fields (GRIB or netcdf)

Table 3-2 The data required to run the OD3D met.no oil drift model.

3.1.3. Development to DeSS applications V1

Task T9.1 has produced a design document "EuroDeSS System Specifications" (project deliverable D9.1.1.1) to provide guidance for developing EuroDeSS elements. The scenario on the table now is that an ECOOP coastal “ocean weather” product suite is available that contains a range of parameters. A DeSS can make the request 'Get me OceanWeather in region (XY) over period (T)'. This can either be pushed to the DeSS or pulled by the DeSS. The delivered dataset contains both measured and modelled data in the spatial-temporal window requested. The development to V1 seeks to exploit the benefits of the ECOOP data products for the Marine security DeSS’s.

All industrial offshore activity has the risk of releasing oil into the environment. It is thus important that the society has means to detect oil spill and has a reliable model tool for predicting oil spill trajectories for at least a few days. Given the nature of these events it is clear that these tasks must be completed in near real time with a response time of order hours or better. …

The following Model developments to meet the ECOOP requirements have been pursued:

- Develop flexible interface to couple oil drift model to the model output from EuroMISS.
- Develop interface to high resolution coastal ocean models, e.g., the met.no Barents Sea and North Sea 1.5 km resolution models, and the high resolution coastal models for the area outside Bergen and for the Lofoten area.

…

3.1.4. Interfacing the ECOOP system

The oil drift model will be interfaced with existing operational ocean models focusing on the coastal areas of north-western shelf, as available through EuroMISS. Focus will be on coastal

models with high resolution including met.no operational high resolution coastal models for the Barents Sea and the North Sea.

3.1.5. Products delivered

The primary products delivered by the met.no oil spill fate forecast service are model data and graphical renditions of the data from the OD3D forecast simulations. In addition, graphical renditions of relevant numerical weather and ocean forecasts are offered. ..

The key users for the oil spill support services will be the Norwegian national authorities working on marine safety on the north-western shelves: the Norwegian Coastal Authority (KV), the Norwegian Clean Seas Association of Offshore Operators (NOFO) and the State Pollution Control Authority (SFT). The key user for the search-and-rescue support service is the UK Maritime Coast Guard Agency.

4. DEMONSTRATIONS

Demonstration: The report should include a demonstration of the system. It is also useful to include the background for the demonstration.

An important milestone in the ECOOP project was the Target Operational Period (TOP), scheduled for project months 24-27 (Feb-May, 2009). During the TOP, the V1 systems were demonstrated operationally for selected users. Consequently, an initial plan for the TOP demonstrations is an integral part of the overall implementation plan. The primary purpose of the report is to provide a description of the outcome of the TOP demonstrations, both for describing the lessons learnt during TOP but also to provide illustrative examples of the capability of the system. Furthermore, the report will also be used by the WP9 leadership to coordinate developments with the other WP9 tasks. In addition, it will provide relevant user information for the development of Euro

4.1. MET-NO oil spill fate forecast service

4.1.1. Background to the demonstration

The Lofoten area in the northwestern Norway is very rich in natural resources such as fisheries, oil and gas resources. The area is a natural spawning area for both coastal cod and for the Barents Sea cod, which has fueled an extensive cod fishery industry for more that 1000 years. There is presently concern that oil prospecting will disturb the sensitive ecosystem calling for further studies on possible oil spill scenarios. …

The purpose of the present study is to exemplify the usage of ECOOP products for studying possible oil release scenarios in the Lofoten area. The main aim is to use the high resolution Bodø-Loppa model that is run at met.no in these oil drift examples. The forcing from the Bodø-Loppa model is presently not included in the met.no oil drift service, but has been made possible though the ECOOP project.

4.1.2. Outline of the weather and ocean forcing

4.1.2.1. Atmospheric forcing

Pressure and wind speed from 12:00 on July 5 to July 10 from the met.no HIRLAM8 model are shown in Fig 5.1, and the wind speed at a location outside the tip of Lofoten peninsula is shown in Fig. 5.2. …

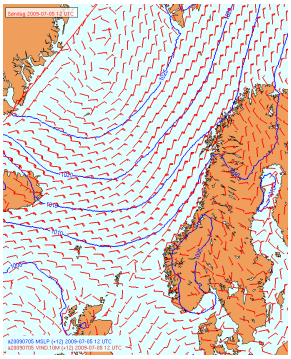

Figure 4.1: Atmospheric conditions from July 5 to 10 (maps are from 12:00 each day). The map shows the pressure at the surface (blue) and wind arrows (red).

4.1.2.2. Wave forcing

Waves are important for the oil chemistry and transport of oil by Stokes drift. Waves are strongly driven by wind, and the wave height and the direction generally follows the wind pattern. The significant wave height and Stokes drift from the met.no WAM10 model for different days are shown in Fig. 5.3.

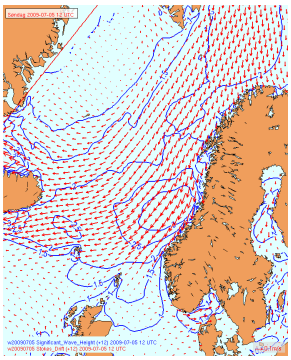

Figure 4.2: Wave fields from 5 to 10 July (maps are from 12:00 each day). The maps show the significant wave height (blue) and the Stoke drift (red).

4.1.2.3. Ocean currents

Ocean currents are the main agent for moving the oil in the oil drift model (however, it should be noted that wave drift as manifested by Stokes drift may be as important in the upper ocean as ocean currents under strong wave conditions). …

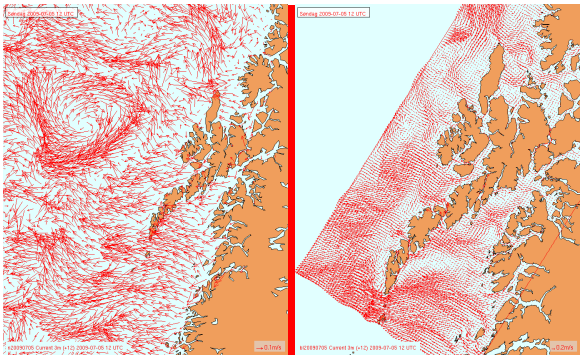

Figure 4.3 Ocean currents from the met.no Nordic4 ocean model which is the standard operational modelat met.no and from the Bodø-Loppa model, which use has been enabled by the ECOOP project.

4.1.3. Oil spill scenarios

Based on a discussion with end users we release oil at four different positions. Two of the oil spills are based on a blow-out from a well and we consider continuous release of oil over a 5 day period from two open ocean locations. The other two locations represent a ship that leaks oil close to the coast, the scenario is that the oil is released during a 6 hour period. The results from these experiments are shown in Fig. 4.4. …

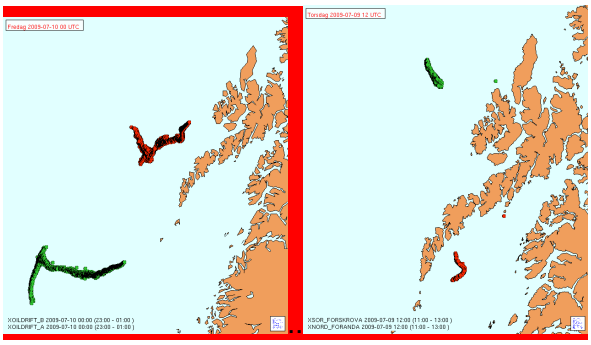

Figure 4.4: The oil spill super particles from four release scenarios; one set with continues release (left panel) and one set with a release of oil during 6 hours. The figures represent model calculations after 5 days.

4.1.4. Results from the demonstration

The results from these demonstrations have been presented to the main organisations for oil spill monitoring (coast guard), combating of oil release (NOFO), and AkvaNIVA (an organisation who contribute to increase the preparedness and oil spill risk analysis for the Lofoten area). The developments of using high resolution models that target coastal areas has been much appreciated and, according to representatives from these organisations, and the need for high resolution coastal models represent one of the most important challenges for improving oil spill modelling. The interaction of oil spill and stranding in areas with complex topography represent one of the largest unknowns in oil spill predictions for Norwegian coastal waters. …

5. DISCUSSION

Discussion: Finally the report should include a discussion where the role of ECOOP is described. The development to the V2 system may be discussed here.

In this report we have presented results from the met.no oil spill Decision Support System (DeSS), using products made possible through the ECOOP project. The demonstrations focuses on using high resolution ocean models in oil spill modelling, these model results can be used both for improved oil spill predictions in case of an emergence, or as an improved tool for risk analyses and designing the means for preparedness in case of an emergency. The model we use ….

Interaction with key users clearly shows that the usage of ECOOP products enhance the possibility to plan recovery actions, and to perform risk analysis to design oil spill preparedness. The users …

5.1. Roadmap for the V2 system

The main objective of ECOOP is no enable pan European usage of high resolution ocean models. The task of the V1 system was to use high resolution ocean models developed at met.no in the oil drift service. For the V2 system we aim at using forcing data from other ECOOP partners such as BSH to enable ensemble forecast for specific areas (where both met.no and e.g., BSH models are run) using high resolution coastal models. We will use the OpenDAP interface developed for the oil drift model …

6. REFERENCES

Hackett, B., G. Broström, K. Haines, and J.A. Johannessen 2008. EuroDeSS Northwest Shelf Seas Marine Security Applications: Development and Implementation Plan. ECOOP report D9.2.1.1.

Martinsen, E.A., A. Melsom, V. Sveen, E. Grong, M. Reistad and coauthors 1994. The operational oil drift system at DNMI, Norwegian Meteorological Institute, Oslo, Norway.

Wettre, C., Ø. Johansen, and K. Skognes 2001. Development of a 3-dimensional oil drift model at DNMI, Norwegian Meteorological Institute, Oslo, Norway.