Project No. 249024

NETMAR

Open service network for marine environmental data

Instrument: *Please tick*	CA	✓ **STREP**	IP	NOE

ICT - Information and Communication Technologies Theme

D7.6 Impact assessment study

Reference: D7.6_Impact_Assessment_Study_r1_20130226

Due date of deliverable (as in Annex 1): M0 + 36
Actual submission date: 26 February 2013

Start date of project: 1 February 2010 Duration: 3 years

Nansen Environmental and Remote Sensing Center

Revision 1

Project co-funded by the European Commission within the Seventh Framework Programme (2007-2013)		
Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

European Commission
Information Society and Media

	**NETMAR** Open service network for marine environmental data Project Reference: 249024 Contract Type: Collaborative Project Start/End Date: 01/03/2010 - 31/01/2013 Duration: 36 months
	Coordinator: Prof. Stein Sandven Nansen Environmental and Remote Sensing Center Thormøhlensgate 47, Bergen, Norway Tel.: +47 55 20 58 00 Fax. +47 55 20 58 01 E-mail: stein.sandven@nersc.no

Acknowledgements

The work described in this report has been partially funded by the European Commission under the Seventh Framework Programme, Theme ICT 2009.6.4 ICT for environmental services and climate change adaptation.

Consortium

The NETMAR Consortium is comprised of:

- Nansen Environmental and Remote Sensing Center (NERSC), Norway (coordinator).
  Project Coordinator: Prof. Stein Sandven (stein.sandven@nersc.no)
  Deputy Coordinator: Dr. Torill Hamre (torill.hamre@nersc.no)
  Quality Control Manager: Mr. Lasse H. Pettersson (lasse.pettersson@nersc.no)
- British Oceanographic Data Centre (BODC), National Environment Research Council, United Kingdom
  Contact: Dr. Roy Lowry (rkl@bodc.ac.uk)
- Centre de documentation de recherche et d'expérimentations sur les pollutions accidentelles des eaux (Cedre), France.
  Contact: Mr. François Parthiot (Francois.Parthiot@cedre.fr)
- Coastal and Marine Resources Centre (CMRC), University College Cork, National University of Ireland, Cork, Ireland.
  Contact: Mr. Declan Dunne (d.dunne@ucc.ie)
- Plymouth Marine Laboratory (PML), United Kingdom.
  Contact: Mr. Steve Groom (sbg@pml.ac.uk)
- Institut français de recherche pour l'exploitation de la mer (Ifremer), France.
  Contact: Mr. Mickael Treguer (mickael.treguer@ifremer.fr)
- Norwegian Meteorological Institute (METNO), Norway.
  Contact: Mr. Øystein Torget (oysteint@met.no)

Author(s)

- Torill Hamre (torill.hamre@nersc.no)
- Lasse H. Pettersson (lasse.pettersson@nersc.no)
- Øystein Torget (oystein.torget@met.no)
- Declan Dunne (d.dunne@ucc.ie)
- Vincent Gouriou (vincent.gouriou@cedre.fr)
- Peter Walker (petwa@pml.ac.uk)
- Christian van den Bosch (C.vandenBosch@ucc.ie)

Document approval

- Document status: Revision 1
- WP leader approval: 2013-02-26
- Quality Manager approval: 2013-02-26
- Coordinator approval: 2013-02-26

Revision History

Issue	Date	Change records	Author(s)
Draft	2013-01-15	Topic layout of the report.	T. Hamre
Draft	2013-01-31	First outline of impact for the different user categories and evaluation questionnaires.	T. Hamre, Ø. Torget, D. Dunne, V. Gouriou, P. Walker,
Draft	2013-02-08	Completed description of assessment for the different user categories.	T. Hamre, L.H. Pettersson
Draft	2013-02-14	Completed description of assessment for each major result.	T. Hamre, L.H. Pettersson
Draft	2013-02-15	Completed conclusion and executive summary.	T.Hamre, L.H. Pettersson
Draft	2013-02-22	Incorporated comments from internal quality control.	T. Hamre, Ø. Torget, P. Walker, C. van den Bosch
Draft	2013-03-26	Incorporated comments from internal quality control.	T. Hamre
1	2013-02-26	First version of the report approved by the coordinator.	T. Hamre

Executive Summary

NETMAR has developed a pilot European Marine Information System (EUMIS) for searching, downloading and integrating satellite, in situ and model data from ocean and coastal areas. To facilitate semantic search, EUMIS uses a semantic framework coupled with ontologies for identifying and accessing distributed data, such as near-real time, forecast and historical data. To allow users to compose new products, EUMIS offers a service chaining editor where data delivery and processing services can be combined to generate new parameters dynamically. Both pre-made and on-the-fly generated parameters can easily be co-visualised on the same map in the EUMIS GIS Viewer. The EUMIS portal (http://eumis.nersc.no/) consists of 4 pilots, each demonstrating different capabilities in different marine application domains:

- Pilot 1: Arctic Sea Ice and Met-Ocean Observing System
- Pilot 2: Oil spill drift forecast and Shoreline Cleanup assessment services in France
- Pilot 3: Ocean Colour – Marine Ecosystem, Research and Monitoring.
- Pilot 4: The International Coastal Atlas Network (ICAN)

The impact of the developed system (EUMIS pilot) and services has been assessed by selected users from the four targeted user communities. The partners interviewed their users on their view of the impact of developed tools, components and data delivery/processing services, and captured the findings in a consistent manner using a questionnaire. Since relatively few users, only ten in total, were involved in the assessment, the analysis focussed on extracting qualitative information and describing the anticipated use of results.

The NETMAR outputs (results) are:

- EUMIS portal
- Concepts and ideas
- Publications
- Architecture
- Semantic mark-up of datasets
- Vocabularies (keyword, theme, …)
- Uncertainty representation
- Semantic discovery services
- Data and processing services (for the four pilots)
- PyWPS
- GIS Viewer
- Ontology browser and search client
- Service chaining editor w/workflow orchestration and execution
- Liferay portal framework (with built-in portlets customised for EUMIS)

The users involved in impact assessment were categorised as service providers/builders, operational service users, scientific service users and others (e.g. consultants). All service providers considered the Vocabularies as a useful result; this was closely linked to the Semantic Search services and client, which were also favourably assessed by the service providers. This group also considered the Service Chaining and Web Processing Services technologies and tools useful. The operational service user assessed the Semantic Search technology and tools positively and also found the EUMIS portal and GIS Viewer useful. The EUMIS portal and GIS Viewer also got the most positive assessments from the scientific service users. In additions, one of the scientists found the Semantic Search and Web Processing Services an exploitable result, and one scientist emphasised the Publications and especially the NETMAR Cookbooks as useful for building competence in his user community. The consultant company involved in the assessment found the EUMIS portal and GIS Viewer the most useful results from the NETMAR project.

The potential impact of each of the major results of the NETMAR project was also analysed. Eight of the interviewed users found the Vocabularies and Semantic Search services developed in the project useful, and a resource/tool that they could use to find relevant datasets, while seven of the users positively assessed of the GIS Viewer, emphasising the benefits of multi-layer co-visualisation and rich layer manipulation capabilities. Six of the users identified the EUMIS portal, the underlying Concepts and Ideas, and the Semantic Mark-up, as NETMAR outputs that they could use in the coming 3-5 year period, while five of the users considered using the Ontology Browser/Search Client after the NETMAR project ends. The other major results obtained fewer positive assessments, but can still be of use for other users. For instance, the PyWPS software is a reference implementation of the WPS specification, and is widely used by organisations developing web processing services. The public PyWPS wiki has received approximately 20000 hits since it went live in 2011, and is accessed by about 250 unique visitors per week. This indicates that PyWPS is being used by many users outside the NETMAR Consortium and Pilot User Communities.

Several results have already been exploited in external communities. The Vocabularies and Semantic Search services of the NVS, is being used by e.g. SeaDataNet-2 as well as two major U.S. programmes for oceanographic data management (BCO-DMO, R2R). The Ontology Browser/Search Client is being used in the ICAN portal, and search technologies and tools are foreseen to be re-used in the further development of the MIDA coastal web atlas.

Based on the overall positive evaluation of NETMAR outputs and the already occurring uptake in external (to the project and its user base) communities, we are confident that many components of the NETMAR system and services will have a positive impact on the development of environmental services and systems in the coming 3-5 year period. NETMAR outputs are foreseen to be used not only in the application domains targeted by the four EUMIS pilots, but also in other environmental domains as well as across domains.

Contents

1 Introduction

1.1 Background

NETMAR has developed a pilot European Marine Information System (EUMIS) for searching, downloading and integrating satellite, in situ and model data from ocean and coastal areas. To facilitate semantic search, EUMIS uses a semantic framework coupled with ontologies for identifying and accessing distributed data, such as near-real time, forecast and historical data. The semantic tools have been implemented as portal components (called portlets) and web services. The EUMIS portal also contains a Wiki, where users can find information about available products and services. To allow users to compose new products, EUMIS offers a service chaining editor where data delivery and processing services can be combined to generate new parameters dynamically. Both pre-made and on-the-fly generated parameters can easily be visualised on a map in the EUMIS GIS Viewer.

Figure 1-1 shows the underlying system-of-systems concept for EUMIS, and the implemented pilot is found at http://eumis.nersc.no/. The EUMIS portal consists of 4 pilots provided by the NETMAR service provider institutions, each demonstrating different capabilities in different marine application domains:

- Pilot 1: Arctic Sea Ice and Met-Ocean Observing System
- Pilot 2: Oil spill drift forecast and Shoreline Cleanup assessment services in France
- Pilot 3: Ocean Colour – Marine Ecosystem, Research and Monitoring.
- Pilot 4: The International Coastal Atlas Network (ICAN)

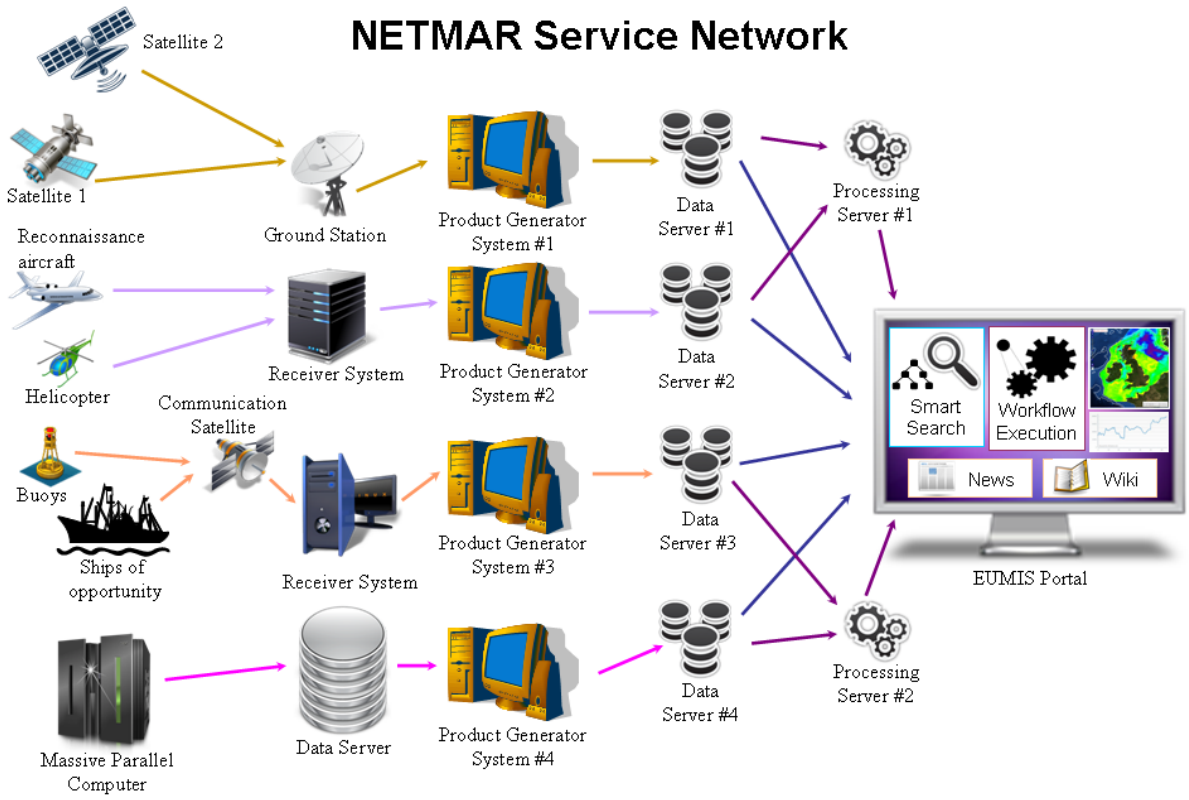

Figure 1-1 *The NETMAR Service Network*.

1.2 Objective of this report

The purpose of this document is to describe how the results from the project can be utilised to develop future data products, services and systems for environmental monitoring and forecasting, with a web portal offering access to all data and services through semantic search, co-visualisation and on-the-fly processing of data in user defined workflows. Potential users and their interest for specific system components and services will also be identified.

1.3 Terminology

A **portal** is a web site that collects input from a number of sources, and presents it in a uniform manner to the user. The portal content is perceived to come from the same source – the portal – while it typically is a combination of content from several sources, or an extract of selected content from a single external source (such as a news feed).

A **portlet** is portal component that can be deployed in a portal. A portlet can provide many types of functionality, among others, retrieve data from external sources, process and analyse data, present retrieved data on a geographic map. A portlet can also communicate with other portlets running in the same portal.

A **vocabulary** can be either a list of terms or a list of terms and some text providing a definition of the term. A vocabulary ensures that terms are used, and spelt, consistently. A vocabulary can be extended in its power by providing definitions of concepts.

1.4 Organisation of this report

Section 2 describes the methodology used for assessing the impact of NETMAR results within the targeted user communities. Section 3 describes the potential impact of the developed system components and services for each of the major category of users, including, service providers, operational service users, scientific service users and others (such as commercial companies). Section 4 presents the proposed exploitation of the NETMAR results across user categories, outlining how specific results may be used to develop new or enhance existing products and services. Section 5 summarises the main conclusions of the impact assessment study and how NETMAR results can be used post-project. Appendix A contains the impact assessment questionnaire used to collect information about the impact of NETMAR results, and Appendix B the completed questionnaires.

2 Methodology

The desired functionality of the EUMIS pilot and associated data delivery, processing and semantic search services, was defined in cooperation with users in the four targeted user communities [TOR+13a]. EUMIS was tested by users in two phases during 2011 and 2012-2013, and in conjunction with the last test phase [TOR+13b], the impact of the developed system (EUMIS pilot) and services has been assessed by selected users from the four targeted user communities. The partners have interviewed their users on their view of the impact of developed tools, components and data delivery/processing services, and captured the findings in a consistent manner across domains using a questionnaire designed for this purpose.

The impact assessment questionnaire collected information about:

- What category of users performed the assessment (service provider/builder, operational service user, scientific service user, and other)
- Which of the NETMAR outputs (results) were assessed
- What is the user's need for data management, delivery and visualisation in the next 3-5 year period
- Which of the NETMAR outputs were considered useful (and might contribute to the user's future needs)
- What improvements could be made to make the NETMAR outputs more usable

The impact assessment questionnaire is included in Appendix A. The analysis of the responses is found in Section 3 (for each user category) and Section 4 (for each major result). Since relatively few users, only ten in total, were involved in the assessment study, the analysis focussed on extracting qualitative information and describing the anticipated use of results in the coming 3-5 year period.

3 Impact assessment for different user categories

This section presents the users' assessment of the impact of results from the NETMAR project. The presentation is organised based on the category of users, i.e. service providers, operational service users, scientific service users and 'other' (e.g. consultant companies). It will identify which of the NETMAR results, such as tools, portal components, and data or processing services, which will be further used by external parties.

Table 3-1 User categories and organisations involved in the assessment study.

User category	User organisation
Service providers	Norwegian Ice Service, operated by the Norwegian Meteorological Institute (METNO)
	METNO IT Department
	Western Channel Observatory (WCO)
	Mohn-Sverdrup Center for Global Ocean Studies and Operational Oceanography (MSC), NERSC
	StormGeo AS
	Coastal and Marine Resources Centre (CMRC)
Operational service users	Centre de documentation de recherche et d'expérimentations sur les pollutions accidentelles des eaux (CEDRE)
Scientific service users	Plymouth Marine Laboratory (PML)
	Mohn-Sverdrup Center for Global Ocean Studies and Operational Oceanography (MSC), NERSC
	International Coastal Atlas Network (ICAN)
Other	LE FLOCH DEPOLLUTION / OTRA

3.1 Service providers

The service providers involved in the EUMIS impact assessment are comprised of public/governmental organisations (Norwegian Ice Service and IT department at METNO, Western Channel Observatory at PML), scientific providers (NERSC), commercial companies (StormGeo AS) and user community volunteer organisations (represented by CMRC).

METNO is responsible for all meteorological observations in Norwegian territories and is also providing operational weather and ice forecasting services for Norwegian waters, the European Arctic and other ocean areas in Europe. In NETMAR, their prime interest has been in evaluating and assessing NETMAR outputs for the national ice service in Norwegian waters.

The Western Channel Observatory (WCO) provides oceanographic time-series and marine biodiversity data for the Western English Channel through a web portal. At the time of writing, the WCO portal gives access to different types of in situ and satellite data, but work is ongoing to extend the portal to support also model forecasts as well as integrate new sources of observation data. NETMAR results have been assessed as potential technologies and open source tools that can be used in the process of further developing the WCO portal.

NERSC is an independent research institute, which conducts basic and applied environmental and climate research. A major activity of the centre is within operational oceanography and data assimilation in ocean and sea ice models, where one of the services being developed is sea ice model forecasts for the Arctic Ocean as a Marine Core Service in MyOcean. In this project NERSC has assessed the NETMAR tools and services with respect to the activities of the operational oceanography research department of the centre.

StormGeo AS is a global weather services provider within the fields of renewables, offshore, shipping and media industries. The company is providing consultancy and training, forecasts and statistics for customers in among others, offshore, industry and media. NETMAR results have been assessed as a potential source for new data products and new technologies that can be used to strengthen their existing services or contribute to development of new services for the commercial sector.

CMRC is a research institute at University College Cork, which conducts applied and basic research in marine sciences and also works on commercial contracts with government agencies and industry. CMRC is a service provider for the Marine Irish Digital Atlas (MIDA), and in that respect is interested in NETMAR technologies and tools addressing semantic search and interoperability.

Norwegian Ice Service personnel considered the NETMAR results supporting semantic search and data processing services to be the most promising outputs of the project that they want to build on when developing their operational services further. Specifically, the community approved list of keywords defined by the NVS vocabularies, the NETMAR metadata profile and its encoding of these keywords in an ISO 19139 compliant format, as well as the NVS itself, were seen as a major contribution to support discovery and use of data sets across different systems and portals. Furthermore, the PyWPS tool was seen as a major candidate for building an operational WPS server, and it was stated that *"PyWPS can be used in execution of on-demand models (oil drift/dispersion), ash dispersion)"*. METNO offers such on-demand services today for oil spills, but through general-purpose web service interfaces which are not OGC compliant. Finally, METNO considered the service chaining editor a possible candidate for building customised workflows, albeit wanted some enhancements in usability.

In the further development of the Western Channel Observatory, Dr. Tim Smyth, sees both NETMAR concepts/ideas and tools/services as capable of making valuable contributions. Especially the service chaining facilities were seen as a result that can be used to improve the WCO services, such as providing easier access to forecasts from numerical models run on highly specialised and complex computer infrastructure. As an example, Dr. Smyth points to the possibilities that service chaining opens for access to data and models from super computers: "*The concept of service chaining combined with remote execution has great potential for the modelling community in allowing them to build visualisation service chains accessing data generated by models on supercomputers such as HECTOR.*" For the scientific community it will also be beneficial to trace the history of model results, as "*it will increase traceability in papers as the workflows used in processing the data could be published along with the raw data allowing peers to reproduce the results*". The display capabilities of NETMAR were also assessed positively, and the "*flexibility given here by NETMAR to bring in datasets from other sources and co-visualise the data*" were far better than in many other web portals, which often can only serve individual data sets.

The head of the modelling and data assimilation group for operational oceanography at NERSC, Dr. Laurent Bertino, also found the results in semantic search and web processing services valuable. The ability to search for data from multiple providers and different catalogues using common terms and machine readable encoding of metadata records, such

as defined by the NVS vocabularies and the NETMAR metadata profile, will alleviate his needs to quickly find e.g. relevant forecasts from other sea ice models to compare with the TOPAZ forecasts. For WPS, he suggested a particular service that would be useful, by stating that by combining NETMAR results with other software and data *"I could select different sea ice forecast services and compute differences with the latest satellite data, in order to give the best advice about sea ice forecast in a given region"*. Such a service can be built by means of PyWPS in combination with semantic search tools to identify relevant providers of sea ice forecasts and dynamically compute the difference between them for a given date or time period. The GIS Viewer was also positively evaluated, with the ability to overlay multiple layers and support of polar stereographic projection as features not commonly found in similar (open source) tools for web GIS visualisation of environmental data, such as the current version of Thredds (version 4.2.9) which includes ncWMS and Godiva2.

As a commercial service provider, StormGeo AS has very strict requirements for a system's uptime, reliability and security. The concepts of the EUMIS portal with its semantic search, GIS viewer and service chaining facilities were all seen as potentially beneficial, but for the company to start using and build their own services based on these, an *operational* EUMIS would be required. Individual services, e.g. processing services, were also considered to be of potential value, if these could be offered by a provider that guaranteed a service meeting StormGeo's requirements for uptime, etc. If a stable and reliable service could be guaranteed StormGeo would be willing to purchase such a solution to enhance current products and/or contribute to creation of new products for the company. A paid service could either entail provision of a service from an external company or installation of open source software on StormGeo's computers.

The data manager for the Marine Irish Digital Atlas, Kathrin Kopke, CMRC, identified the benefits of the NETMAR cookbooks in capacity building and helping the build-up of coastal web atlases for new organisations joining ICAN. She further recognised that the developed technologies and knowledge in semantic search can be re-used in the existing MIDA coastal web atlas system.

3.2 Operational service users

One operational service user was involved in the EUMIS impact assessment: Centre de documentation de recherche et d'expérimentations sur les pollutions accidentelles des eaux (CEDRE). The role of CEDRE is to advise French authorities in charge of spill response in marine waters. Between spills, CEDRE assists the authorities in updating specialised contingency plans, providing information on response policies and resources, assessing techniques and equipment, preparing guides and training response teams. During spills, CEDRE assists the authorities in assessing the risks to be taken into account, organising operations, selecting response techniques to be used, and evaluating the consequences of the pollution and response. As an operational service user, CEDRE needs timely access to all relevant data for a spill or clean-up action, including not only observations but also forecasts of how an oil spill or other pollutant on the ocean surface will drift and disperse in the coming hours to a few days ahead.

Sylvie Ravailleau, engineer for the emergency response department at CEDRE, positively assessed the EUMIS portal, the semantic mark-up and search technologies and tools, and the GIS Viewer. The GIS Viewer offered co-visualisation of many different types of data needed for oil spill monitoring and forecasting, including among others "*pollution observation, oil slick drift forecast, 3D currents*". The semantic search technologies and tools could for instance be used to connect to similar international services offering oil spill

relevant data and forecasts, further increasing the amount of data available and used as basis for decision making during a crisis situation.

3.3 Scientific service users

The scientific service users involved in the EUMIS impact assessment are comprised of scientific institutions conducting basic and applied research in different marine sciences (CMRC, PML, NERSC).

CMRC is a research institute at University College Cork, which conducts applied and basic research in marine sciences and also works on commercial contracts with government agencies and industry. In the evaluation of NETMAR tools and services, CMRC represents the ICAN (International Coastal Atlas Network) community, a volunteer organisation of European, US and African organisations and companies involved in coastal zone management and research.

Plymouth Marine Laboratory (PML) is an independent organisation providing scientific and contract services related to a wide range of marine environmental issues. Science and contract work is conducted using in situ and satellite data, as well as model forecasts, and in many projects the development and operation of processing and analysis tools, data delivery and visualisation systems is an important part. When assessing NETMAR results, PML is evaluating how the new knowledge, technology and tools can be utilised to advance their existing systems, including among others, web portals and processing services, further to contribute to their five strategic areas (Sea and Society, Sea from Space, Cycling in the Sunlit Ocean, Marine Life Support System, and Today's Models, Tomorrow's Futures).

The operational oceanography department at NERSC is both a service provider (e.g. for MyOcean Marine Core Services) and a scientific service *user* (e.g. for validation of model results against observational data). In the capacity of being a service user, NERSC is interested in new technologies and tools that can discover and extract new and relevant data sources that can be utilised in scientific studies, model development and validation, as well as tools for data for co-visualisation and interactive analysis (e.g. comparison of satellite observations and model forecasts).

The co-chair of ICAN, Dr. Ned Dwyer, CMRC, has assessed NETMAR results and found both technologies used and publications (especially the cookbooks) valuable for the ICAN community. The cookbooks for can be "*useful in outreaching and Capacity Building*" to enable technical personnel in ICAN to exploit the ontologies and semantic search tools developed in NETMAR. These cookbooks have been made available to the ICAN community during the project through the ICAN Newsletter[1] and at the EuroICAN 2012 meeting in November 2012. The semantic search technologies and tools will also be used to develop the ICAN portal and search tools further.

Dr. Weidong Xu, ocean colour scientist at PML, assessed the EUMIS portal from a scientific user point of view relating to his needs for data discovery, processing and cloud computing services in the coming years. The GIS viewer's ability to co-visualise multiple layers was found useful, as it allowed him to overlay in situ data such as sea surface temperature and chlorophyll measurements and compare these with satellite observations. The capability of re-projecting layers to different map projections was also considered a positive feature of the GIS viewer. More data such as altimeter and ocean front data would increase the usefulness of the portal, as would more quality information associated with the data sets offered through

[1] http://dusk.geo.orst.edu/ICAN_EEA/ICAN_Newsletter_September_2012.pdf

the portal and more training material. Finally, a mechanism for users to upload and process their own (local) data would a useful feature to add to the EUMIS portal.

The head of the modelling and data assimilation group for operational oceanography at NERSC, Dr. Laurent Bertino, very much appreciated the GIS viewer's capabilities of seamlessly overlaying multiple layers from different sources, its layer manipulation features (colour scale, transparency, display level) and the support of polar stereographic map projection, which is not commonly found in web-GIS viewers. The semantic search was also appealing, offering an intuitive and flexible way of discovering new data sets for use in scientific studies. The service chaining and concept of web processing services was seen as equally important for science as for service development, since it would enable scientists to e.g. compute the difference between satellite data and model forecasts or between in situ data and satellite data on the fly. Thus, the GIS viewer, search tools and WPS services of NETMAR can be utilised in future work to build web portals for discovery, co-visualisation and analysis for scientific studies.

3.4 Other categories of users

Le Floch Depollution/OTRA is a commercial oil spill consultant company with world leading competence in industrial and urban clean-up and waste management. Le Floch Depollution also providers services in integrated management of coastal areas and biotechnologies applied to the environment, and works as a consultant for petroleum industry. During all of these activities, easy and timely access to all relevant data sets for an area under monitoring is of outmost importance.

Le Floch Depollution was positive to the openness of the EUMIS portal providing access to data that were not easily obtained from other sources, and stated that "*NETMAR contributes in providing public access to some data we could not get otherwise*". At the time of evaluation, the company did not have a dedicated cartographic server or search facilities to easily find new data sources, and thus the EUMIS portal provided a valuable data source. For coming years, the addition of data quality information to more of the data sets, access to more local data (with high resolution and high accuracy), and access to data as features to enable downloading and analysis in in-house GIS were seen as most important to keep using the EUMIS portal.

4 Potential exploitation of NETMAR results

Each user involved in the assessment assessed whether they found each major result from the project of potential benefit in the coming 3-5 years. Figure 1 shows the number of positive assessments for each result. How each result is planned utilised by the users is then briefly discussed below. With a low number of users involved, ten in total, the assessment should be considered an indication of the potential exploitation of NETMAR results. Known use of NETMAR results by external projects and user communities is also described below.

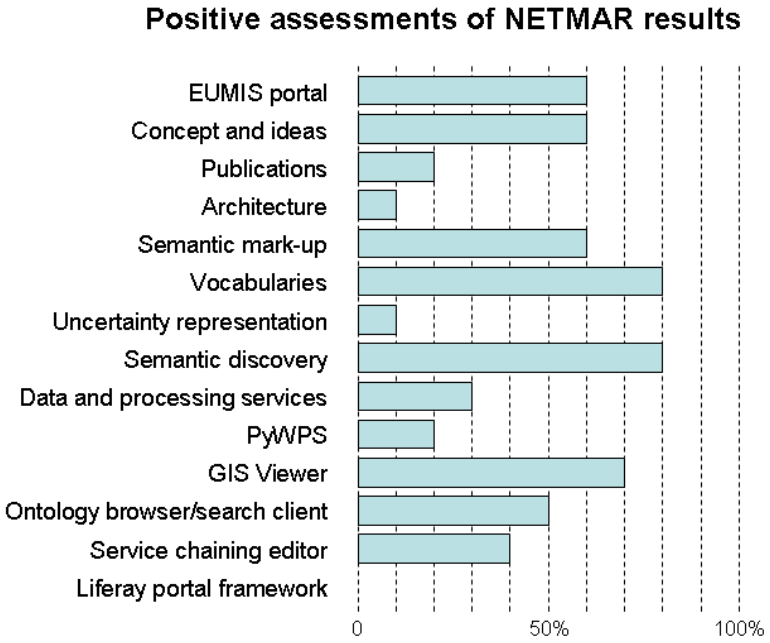

Figure 1 User positive assessments of NETMAR results.

4.1 Vocabularies (keyword, theme, etc.)

The controlled lists of keywords from the marine and environmental domain, and their relationships (narrower, broader, related), as provided by the NETMAR ontology resource was assessed the most positive result from the project. This ontology resource is realised by the NERC Vocabulary Server (NVS)[2], which build on numerous RTD projects conducted by BODC, including, among others, SeaDataNet-2. In NETMAR, mappings were made from the selected terms of the four pilots domains (sea ice, oil spills, ocean colour, ICAN) to the vast number of terms (on the order of hundreds of thousands terms) in the BODC ontologies.

Eight of the ten interviewed users identified the need for using standardised terms to mark-up data sets and services to allow computerised search and discover of available resources from the ever increasing network of online data sources. The NVS was seen as a key provider of standardised and governed vocabularies, and with open services that e.g. service providers like METNO and scientific service users like organisations in ICAN, can use to implement smart search. NVS is also being used by U.S. research programmes like the Biological and Chemical Oceanography Data Management Office (BCO-DMO)[3] and Rolling Desk to Repository (R2R)[4].

[2] http://www.bodc.ac.uk/products/web_services/vocab/

[3] http://bcodmo.org/

[4] http://www.rvdata.us/

4.2 Semantic discovery services

The semantic discovery services of NETMAR were built on top of the NVS vocabularies, and were comprised of the NETMAR Semantic Framework and a Semantic Web Service (SWS). The Semantic Framework and SWS in turn utilised a CSW Mediator that harvested metadata (marked up with NVS keywords) from a set of CSW metadata catalogues.

Eight users also identified the semantic discovery services as a result that could be exploited to build new smart search services. Among these were two users from the ICAN community, that plan to use these services both to develop the ICAN demonstrator[5] as well as the Marine Irish Digital Atlas (MIDA)[6] further, augmenting existing search services by re-using technologies and services developed in NETMAR.

4.3 GIS Viewer

The GIS Viewer in EUMIS supports, among others, co-visualisation of multi-source data from distributed WMS servers, manipulation of layers (colour, transparency, display level), execution of Web Processing Services, multiple map projections and storage of current map set up for later use. It is developed as a portlet (component) that runs within the Liferay portal framework, and is available from github.com[7].

Seven users identified the GIS viewer as a component that can be used to access and display data from multiple (WMS compatible) sources and/or to develop new or enhanced visualisation services. Its capabilities to co-visualise multiple datasets on the same map, to manipulate transparency or easily moving layers up/down in the display hierarchy, were assessed as superior to what is offered by most other open source web GIS viewers. Likewise, its capability to call a WPS service to compute and display a new data product on the fly was considered a feature that could be used to e.g. compare in situ observations to satellite-derived parameters or validating model forecasts against observations.

4.4 EUMIS portal

The EUMIS offers access to the ontology browsing and semantic search client (and thereby the data and processing services), the GIS viewer and the service chaining editor, as well as a wiki describing the products and services and tutorials for the different components. The EUMIS is open and available at http://eumis.nersc.no/.

Six of the users identified the EUMIS portal as a result that they would benefit from using in the coming 3-5 years. The operational user highlighted the capability to access numerous datasets and co-visualise these in the GIS viewer as a means for her to combine different types of data, such as pollution observations, oil slick drift forecasts and 3D currents, in the analysis of the current situation during an oil spill event. A service provider and scientific user pointed out that the EUMIS portal allowed him to easily compare e.g. model forecasts from different providers and to compare his own model forecasts with observations. Several of the other users with positive assessments of the EUMIS portal also at the same time emphasised the GIS viewer's capabilities to co-visualise multiple layers and to transform layers to a common map projection.

[5] http://ican.ucc.ie

[6] http://mida.ucc.ie/

[7] https://github.com/NETMAR/netmar.git

4.5 Concept and ideas

The concept and ideas behind EUMIS as a whole, e.g. in the form of cookbooks and other project reports, papers, presentations and videos, was also considered a result that could be exploited by six of the users. Several users pointed out the need for capacity building to allow (new) users to exploit the developed services and tools. For instance to learn about the concepts and/or technologies underpinning ontologies and semantic search, or to examples the new capabilities that opens up for data processing on the fly using web processing services and service chaining (workflows). Several tutorials were prepared in the project [DJW11][WGJ12][DLL12] that could be utilised to this end to introduce new technologies and tools in a community and show examples of how these could be used to obtain new products or services of benefit to the users.

4.6 Semantic mark-up of datasets

The semantic mark-up of datasets is provided through the definition of the NETMAR metadata profile [PHD+12], which in turn uses the terms from the NVS as keywords. The metadata profile is compliant with ISO 19139, and the use of NVS terms as keywords ensures that standardised names for parameters, instruments, platforms, etc. are used and that semantic search services can be built utilising the vast ontologies that the NETMAR semantic resource is mapped to.

Six of the interviewed users identified semantic mark-up as a results that they would use in the coming 3-5 year period. The Norwegian Ice Service at METNO stated that the NETMAR's metadata profile specification of encoding semantic keywords in ISO19139 will be used to create metadata that supports smart search. This mark-up combined with the standard terms and keyword lookup services offered the NVS is and will be used to create better interoperability between different metadata standards as keywords can be translated from one standard to the other. Another user, the Western Channel Observatory, pointed to the benefits of semantic mark-up to support semantic validation of input data when running a web processing service, and in extracting and visualising specific parameters from numerical models running on supercomputers which are not so easy to access without special tools and detailed knowledge of the model.

4.7 Ontology browser and search client

The ontology browser and search client is one of the three major EUMIS components, and enables the user to explore the terms and relationships in the NETMAR semantic resource (ontology) and to search for datasets and services that are marked up with these keywords. Once a data set is discovered, the user can inspect its metadata to determine whether it is applicable to his/her purpose and if so co-visualise it with other retrieved datasets in the GIS Viewer. Discovered services can be utilised e.g. in the service chaining editor, or if it is a WPS service, can be run directly from the GIS Viewer.

Five of the interviewed users identified the ontology browser and search client as a result they would want to continue using after the NETMAR project ends. For example, a service provider from the ICAN community would re-use this component in the further development of the Marine Irish Digital Atlas (MIDA). The component is already in use by the ICAN community, and provides the semantic search facility to connect distributed Coastal Web Atlases, which are located across Europe and U.S.

4.8 Service chaining editor

The service chaining editor is the third major EUMIS component, which can be accessed through the EUMIS portal. The editor enables the user to compose and run service chains (a.k.a. workflows) using data delivery (WMS, WFS) and processing (WPS) services that are offered either by the NETMAR partners or by external parties.

Four of the interviewed users identified the service chaining editor as a result that they could benefit from using in the coming 3-5 years. For instance, the Norwegian Ice Service at METNO assessed that for the operational sea ice service "*the service chaining might be used to make it easier to share complex workflows among data scientists*". Another user, the Western Channel Observatory, foresee that the editor can be used to construct service chains that can be used to "*perform statistical comparisons between data generated by the Western Channel Observatory Autonomous Buoys and EO and model data for their location*".

4.9 Other results

The other major NETMAR results were identified as exploitable by three or less users. Given the limited number of users involved in the assessment, ten in number, this does not mean these results will not be exploited by a wider user base.

Publications, for instance, include the NETMAR cookbooks that have already been used in the ICAN community, and the WPS cookbook that have been posted publicly on the GEOSS Best Practices Wiki[8]. The cookbooks are therefore expected to be used by many new users in the coming years.

The current data and processing services may also be useful to a wider user community, and the fact that the majority of users interviewed pointed out the GIS Viewer's capability of co-visualising data from multiple providers as beneficial may be seen as an indication also of the usefulness of the underlying data services. For uncertainty representation, other users may want to use the proposed encoding of uncertainty, which is based on UncertML[9], as several of the interview users stated that more datasets should have information about their data quality.

While only two users indicated they would want to use PyWPS (with tutorials, documentation and download links at the PyWPS Wiki[10], this generic implementation of a WPS server is likely to be widely used after the project. The PyWPS wiki, maintained by PML, has received approximately 20000 hits since it went live in 2011. The website is accessed by about 250 unique visitors per week. This indicates that PyWPS is being used by many users outside the NETMAR Consortium and Pilot User Communities. More users (four of ten) also indicated that they wanted to develop service chains to make new products, and some of these may also become users of PyWPS in case they also need to set up some WPS services themselves, e.g. to perform a customised analysis for their users.

Finally, the architecture and Liferay portal framework (with built-in portlets, and wiki structure set up for the EUMIS portal) scored low on the impact assessment. The users involved that were service providers (six of the ten), were either not planning to develop a portal based solution for their users or had already chosen another web development platform. These two results could still be exploitable by other service providers that want to develop a standards

[8] http://wiki.ieee-earth.org/Documents/GEOSS_Tutorials/GEOSS_Provider_Tutorials/Web_Processing_Service_Tutorial_for_GEOSS_Providers

[9] http://www.uncertml.org/

[10] http://wiki.rsg.pml.ac.uk/pywps/Main_Page

compliant web portal for environmental data and services. The architecture is defined in a report [PHD+12], which also contains descriptions of best practices and patterns that can be used to develop new web portals. The Liferay Community Edition is an open source portal framework that is compliant with the Java Portlet Specification version 1 and 2, JSR-168 [AH03] and JSR-286 [Hepper08], and which offers several ready-made portlets such as Wiki, Forum and RSS feeds, as part of the installation bundle. This portal framework was used to develop the EUMIS portal, and is freely available to other organisations that want to develop web portals for their user community.

5 Conclusions

The EUMIS portal and services were tested and evaluated during the last quarter of 2012 and in January 2013, by users in all four targeted user communities (Arctic sea ice monitoring and forecasting, oil spill forecasting and clean up, ocean colour monitoring and research , ICAN). In conjunction with the testing and evaluation, some of the users also assessed the potential impact of the NETMAR outputs (results) and how these may be exploited by the various users in the coming 3-5 year period. The users involved in impact assessment, ten in total, provided feedback in a standardised from using a questionnaire designed for the assessment study.

The users involved in impact assessment were categorised as service providers/builders, operational service users, scientific service users and others (e.g. consultants). All service providers considered the Vocabularies as a useful result; this was closely linked to the Semantic Search services and client, which were also favourably assessed by the service providers. This group also considered the Service Chaining and Web Processing Services technologies and tools useful. The operational service user assessed the Semantic Search technology and tools positively and also found the EUMIS portal and GIS Viewer useful. The EUMIS portal and GIS Viewer also got the most positive assessments from the scientific service users. In additions, one of the scientists found the Semantic Search and Web Processing Services an exploitable result, and one scientist emphasised the Publications and especially the NETMAR Cookbooks as useful for building competence in his user community. The consultant company involved in the assessment found the EUMIS portal and GIS Viewer the most useful results from the NETMAR project.

The potential impact of each of the major results of the NETMAR project was also analysed. Eight of the interviewed users found the Vocabularies and Semantic Search services developed in the project useful, and a resource/tool that they could use to find relevant datasets, while seven of the users positively assessed of the GIS Viewer, emphasising the benefits of multi-layer co-visualisation and rich layer manipulation capabilities. Six of the users identified the EUMIS portal, the underlying Concepts and Ideas, and the Semantic Mark-up, as NETMAR outputs that they could use in the coming 3-5 year period, while five of the users considered using the Ontology Browser/Search Client after the NETMAR project ends. The other major results obtained fewer positive assessments, but can still be of use for other users. For instance, the PyWPS software is a reference implementation of the WPS specification, and is widely used by organisations developing web processing services. The public PyWPS wiki has received approximately 20000 hits since it went live in 2011, and is accessed by about 250 unique visitors per week. This indicates that PyWPS is being used by many users outside the NETMAR Consortium and Pilot User Communities.

Several results have already been exploited in external communities. The Vocabularies and Semantic Search services of the NVS, is being used by e.g. SeaDataNet-2 as well as two major U.S. programmes for oceanographic data management (BCO-DMO, R2R). The Ontology Browser/Search Client is being used in the ICAN portal, and search technologies and tools are foreseen to be re-used in the further development of the MIDA coastal web atlas.

Based on the overall positive evaluation of NETMAR outputs and the already occurring uptake in external (to the project and its user base) communities, we are confident that many components of the NETMAR system and services will have a positive impact on the development of environmental services and systems in the coming 3-5 year period. NETMAR outputs are foreseen to be used not only in the application domains targeted by the four EUMIS pilots, but also in other environmental domains as well as across domains.

6 References

[AH03] Abdelnur, A. and S. Hepper, 2003. Java Portlet™ Specification Version 1.0. Online at http://jcp.org/aboutJava/communityprocess/final/jsr168/index.html (accessed 12 April 2010).

[DJW11] de Jesus, Jorge and Peter Walker, 2011. WPS Cookbook. NETMAR (Open service network for marine environmental data) Deliverable D7.8. European Commission Information Society and Media Directorate-General Grant Agreement Number 249024.

[DLL12] Dunne, Declan, Adam Leadbetter and Yassine Lassoued, 2012. ICAN semantic interoperability pilot cookbooks. NETMAR (Open service network for marine environmental data) Deliverable D7.9.2. European Commission Information Society and Media Directorate-General Grant Agreement Number 249024.

[Hepper08] Hepper, S., 2008. JavaTM Portlet Specification Version 2.0. Online at http://jcp.org/aboutJava/communityprocess/final/jsr286/index.html (accessed 6 April 2010).

[PHD+12] Patterson, Anthony, Torill Hamre, Declan Dunne, Peter Walker, Yassine Lassoued and Jorge de Jesus, 2012. NETMAR system architecture design – Final version. NETMAR (Open service network for marine environmental data) Deliverable D2.2.2. European Commission Information Society and Media Directorate-General Grant Agreement Number 249024.

[TOR+13a] Torget, Øystein, et al., 2013. D1.1 Use case specification and schedule for testing. Third revision. NETMAR (Open service network for marine environmental data) Deliverable D1.1. European Commission Information Society and Media Directorate-General Grant Agreement Number 249024.

[TOR+13b] Torget, Øystein, et al., 2013b. D1.3.2 Evaluation of NETMAR system applied to use cases – Final version. NETMAR (Open service network for marine environmental data) Deliverable D1.3.2 European Commission Information Society and Media Directorate-General Grant Agreement Number 249024.

[WGJ12] Walker, Peter, Michael Grant and Jorge de Jesus, 2012. Semantic Data Delivery and Processing Services Cookbook. NETMAR (Open service network for marine environmental data) Deliverable D7.8. European Commission Information Society and Media Directorate-General Grant Agreement Number 249024.

Appendices

Appendix A. Impact assessment questionnaire for NETMAR

IMPACT ASSESSMENT QUESTIONNAIRE **NETMAR System & Services**

1. User information	
Organisation:	Date:
Name:	Position:
Short description of your responsibilities within the organisation:	
What type of user of the NETMAR System & Services are you? [ ] Service provider/builder [ ] Operational service user [ ] Scientific service user [ ] Other (please specify): _____	

2. NETMAR outputs assessed
2.1. Please specify which NETMAR outputs(*see list below) you have assessed:

(*) EUMIS portal, concepts and ideas, publications, architecture, semantic mark-up of datasets, vocabularies (keyword, theme, …), uncertainty representation, semantic discovery services, data and processing services (name those that are relevant to you), PyWPS, GIS viewer, ontology browser and search client, service chaining editor w/ workflow orchestration and execution, Liferay portal framework,

3. Data and information needs

3.1. What are your current and expected (in the coming 3-5 years) needs for data management, delivery and visualisation?

3.2. To what extent can other existing products and services satisfy these needs?

[ ] Fully or nearly so
[ ] To a large extent
[ ] For some parts
[ ] To a smaller extent
[ ] Only in a few cases

Please describe what other products and services you have considered:

3.3. Which of the NETMAR outputs(*) presented to you, do you consider useful?

[ ] EUMIS portal
[ ] Concepts and ideas
[ ] Publications
[ ] Architecture
[ ] Semantic mark-up of datasets
[ ] Vocabularies (keyword, theme, …)
[ ] Uncertainty representation
[ ] Semantic discovery services
[ ] Data and processing services (name those that are relevant to you)
[ ] PyWPS
[ ] GIS viewer
[ ] Ontology browser and search client
[ ] Service chaining editor w/workflow orchestration and execution
[ ] Liferay portal framework

3.4. How do you see the useful NETMAR outputs(*) contributing to meeting these needs?

3.5. How would you assess the usefulness of combining NETMAR outputs(*) with other known products/services (including your own)?

[ ] Very useful
[ ] Clearly useful in many cases
[ ] Useful in some cases
[ ] Useful in certain (specialised) cases
[ ] Of little or no use

Please give some examples of other products and services that you might use in combination with NETMAR outputs and in which way:

4. Other comments and recommendations

How can the NETMAR outputs(*) be further developed to better suit you needs?

(For instance, extending data delivery services, data quality, uncertainty representation and propagation, flexible data processing components, vocabulary servers and semantic search)

Do you have any other comments or recommendations?

Thank you for participating in the NETMAR impact assessment action!

Appendix B. Completed impact assessment questionnaire

The questionnaire has been completed by the following organizations:

- Norwegian Ice Service, operated by the Norwegian Meteorological Institute (METNO)
- METNO IT Department
- Western Channel Observatory
- Mohn-Sverdrup Center for Global Ocean Studies and Operational Oceanography (MSC), NERSC
- StormGeo AS
- Coastal and Marine Resources Centre (CMRC)
- Centre de documentation de recherche et d'expérimentations sur les pollutions accidentelles des eaux (CEDRE)
- Plymouth Marine Laboratory (PML)
- International Coastal Atlas Network (ICAN)
- LE FLOCH DEPOLLUTION / OTRANERSC: fill in the list of organisations]

The questionnaires themselves are confidential, and not included in the public version of the report.

