**Preparatory Actions for European Marine Observation and Data Network**

# EXECUTIVE SUMMARY

**Version 1.0**

**Service Contract No. "MARE/2008/03 - Lot 1 Hydrography – SI2.531515"**

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## 1. BACKGROUND

In December 2007 the European Parliament and Council adopted a common text for the **Marine Strategy Framework Directive** which aims to achieve environmentally healthy marine waters by 2020. This Directive includes an initiative for an overarching **European Marine Observation and Data Network (EMODNet).**

The **EMODNet Hydrography lot** has a focus on bathymetric data and an overall objective to develop a thematic portal that will provide a digital bathymetry on a grid of at least a quarter a minute of longitude and latitude for selected European maritime basins based upon data sets gathered from public and private organisations.

The **EMODNet Hydrography lot** started 29th May 2009 under Service Contract No MARE/2008/03 between the European Commission and Mariene Informatie Service (MARIS) as coordinator of the EMODNet Hydrography consortium.

This executive summary describes the development of the project and its results after 3 years.

## 2. OBJECTIVES

The specific objectives of the Hydrography Lot are to:

- collate existing data from public and private organisations relating to the state of maritime basins; process them into interoperable formats which includes agreed standards, common baselines or reference conditions;

- assess their accuracy and precision and assemble them into common datasets;

- develop, test, operate and maintain a **portal** allowing public access and viewing of these data and a link to WISE-marine

- monitor and report on the effectiveness of the system in meeting the needs of users in terms of ease of use, quality of information and fitness for purpose of the products delivered;

- analyse what further steps need to be taken to improve the accuracy, precision, coverage and ease of use of the data, including a scheme for sustainable quality assurance and control of the data delivered to the system, both in this preparatory action and in the future larger system.

- analyse the necessary requirements to maintain the components built up in each lot as a sustainable infrastructure

- keep the portal operational afterwards and be prepared to transfer to the Commission.

The following geographical information system layers had to be produced and made available in the hydrographic lot:

1. water depth in gridded form over whole of maritime basin on a grid of at least quarter a minute of longitude and latitude.

2. water depth in vector form with isobaths at a scale of at least one to one million.

3. depth profiles along tracklines

4. multibeam surveys along tracklines

5. coastlines

6. underwater features – wrecks, seabed obstructions etc

The hydrographic project deals with the following geographical regions:

- the Greater North Sea, including the Kattegat and stretches of water such as Fair Isle, Cromarty, Forth, Forties,Dover, Wight, and Portland.

- the English Channel and Celtic Seas.

- Western Mediterranean, the Ionian Sea and the Central Mediterranean Sea.

Remark: In a consecutive call in June 2009 a second batch of preparatory actions were issued, including the **Seabed Mapping Lot**. This new lot was awarded in June 2010 to the same consortium that has been extended with extra partners. This way the digital bathymetry of the Seabed Mapping Lot is produced with the same methodology as applied for the Hydrography Lot. And the new data products can be integrated seamlessly in the Hydrography portal giving users a unique and harmonised access. The Seabed Mapping Lot is producing bathymetric data products for the Iberian coast and the Bay of Biscay, the Adriatic Sea and the Aegean-Levantine Sea.

## 3. CONSORTIUM AND ASSOCIATE PARTNERS

The EMODNet Hydrography Lot has been undertaken by a consortium of 7 partners consisting of:

- Mariene Informatie Service 'MARIS' BV (MARIS) – The Netherlands (coordinator)
- Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER) – France
- ATLIS – The Netherlands, replaced in July 2012 by GGSGC - The Netherlands
- NERC - National Oceanography Centre, Southampton (NERC-NOCS) – United Kingdom
- Institute of Oceanography (IEO) – Spain
- Geological Survey of Ireland (GSI) – Ireland
- Service Hydrographique et Océanographique de la Marine (SHOM) – France

The partners combine expertises and experiences of collecting, processing, and managing of bathymetric data together with expertises in distributed data infrastructure development and operation and providing OGC services for viewing and distribution.

In addition a number of associate partners have contributed to the project with data and in some cases with activities for producing the EMODNet digital bathymetry:

- UNEP/Grid-Arendal - Norway
- CNR-ISMAR - Italy
- NIOZ Royal Netherlands Institute for Sea Research - The Netherlands
- Federal Maritime and Hydrographic Agency - Germany
- Flemish Ministry of Mobility and Public Works; Agency for Maritime and Coastal Services; Coastal Division  - Belgium
- Norwegian Hydrographic Service - Norway
- OGS (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale), Department for the Development of Marine Technology and Research - Italy
- Royal Danish Administration of Navigation & Hydrography, Hydrographic Department - Denmark
- Royal Netherlands Navy Command, Hydrographic Office - The Netherlands
- Hydrographic Institute of the Navy - Spain
- Directorate General of Fisheries Management - General Secretariate of the Sea - Spain

## 4. OVERALL APPROACH AND WORKPLAN

The Hydrography portal has been developed by adopting SeaDataNet standards and services. SeaDataNet (http://www.seadatanet.org) is the leading infrastructure in Europe for marine & ocean data management. It operates and further develops a Pan-European infrastructure for managing, indexing and providing access to ocean and marine data sets and data products, acquired via research cruises and other observational activities, in situ and remote sensing. It is also developing and governing common standards for metadata and data formats, common vocabularies and quality flags as well as standard software tools.

For the Hydrographic portal the following approach has been applied:

- Involve research institutes, monitoring authorities, and HO's, in providing hydrographic data sets from which **Digital Terrain Models (DTM)** are produced with resolution of 0,25 * 0,25 minutes for each geographical region and that are loaded and integrated afterwards into a spatial database at the Portal

- Outfit the spatial database as a powerful **Hydrographic data products viewing and downloading service** that is complemented with WMS services (OGC) to serve users and to provide map layers for e.g. the other EMODNet portals, the prototype European Atlas of the Seas, and the broad-scale European Marine Habitats map;

- Include in the portal a metadata discovery and access service by adopting the **SeaDataNet Common Data Index (CDI) data discovery and access service** that gives clear information about the hydrographic survey data used for the DTM, their access restrictions and distributors; this also ensures the connection of the Hydrographic portal with the SeaDataNet portal, which includes a shopping mechanism for requesting access to basic measurements data.

The work plan was divided over 5 Work Packages:

- WP1 - Project Management
- WP2 - Data collection and metadata compilation
- WP3 - QC/QA and producing Digital Terrain Models
- WP4 - Technical development and operation of portal
- WP5 - Analysis and evaluation

## 5. PROJECT RESULTS

## 5.1 PORTAL

The portal was developed in Work Package 4 with the following objectives:

- To develop and launch the EMODNet portal services

- To keep the website and portal services operational, including monitoring

The EMODNet Hydrography website has been launched early in the project at:

http://www.emodnet-hydrography.eu.

The website is kept up-to-date following the activities and progress in the project. It describes the backgrounds of EMODNet, the project and the approach, activities and partners. Moreover it gives access to the services that have been developed during the project for giving overview and access to the data products and data services.

The website also gives access to the **Extranet**, which was set up already in July 2009 and that gives partners an archive of all contract documents and project documents for both the EMODNet Hydrography and the Seabed mapping projects. Each partner has his/her personal log-in.

Image: Homepage of EMODNet Hydrography portal: http://www.emodnet-hydrography.eu

Two main services were developed and implemented:

- **CDI Data Discovery and Access Service:** this is based upon the SeaDataNet CDI metadata service and has been developed as an EMODNet Hydrography customised service. It facilitates users to oversee and discover bathymetric surveys and to submit requests for access to these associate datasets by means of the SeaDataNet shopping basket mechanism. CDI metadata entries have been included in this service for all bathymetric data sets that have been gathered during the project;

- **Hydrography data products viewing service:** this is based upon the SENS Distribution software. The resulting EMODNet DTM as produced during the project from the gathered bathymetry data sets has been integrated into an Oracle Spatial database. SENS Distribution is a scalable web-based solution for the distribution of bathymetric products (e.g. seafloor DTMs, contours and spotsoundings). This service facilitates users to view and to download the digital bathymetry DTM in tiles in a number of formats without any registration or constraints.

Bathymetric data sets have been gathered and provided by data providers for internal use in the DTM production as survey data, such as multibeam and single beam measurement data, but also in a number of cases as composite DTMs, gridded data sets that were already prepared by data providers themselves. To describe also these composite DTMs with metadata the overall set-up has been expanded with the **Sextant Products metadata catalogue** for creating and retrieving metadata for the composite DTMs.

The **CDI data discovery and access service** allows a user to query and retrieve the CDI metadata records of the background data sets used, with the option to request access to these underlying survey data sets via a shopping mechanism. All gathered and used survey datasets have been included (more than 8000 at present) and its data centres have been connected as nodes to the underlying SeaDataNet infrastructure. The use of the CDI service is without any registration and all metadata is public. Only once a user wants access to the actual survey data sets, then a user has to logon with his/her SeaDataNet user id - password. This facilitates the further processing of a shopping request for multiple datasets to multiple data providers by one user action. Each dataset has a data access restriction determined by its data provider and chosen from a common vocabulary of options varying from unrestricted to by negotiation. This determines whether the user gets immediate access to the requested dataset (within circa 10 - 15 minutes) or has to discuss terms with the data provider (within 1 - 3 days). Once granted access the user can download the agreed datasets using an online Transaction Register. The user registration is thus required for facilitating the differentiated access

policies of data providers, for enabling asynchronous processing of multiple requests to multiple data providers, and for providing data providers administrative information about their users which is used to improve services in contact with users and to justify their services to government and public.



Image: Set-up of portal with services

Image: Homepage of the EMODNet Hydrography CDI data discovery and access service
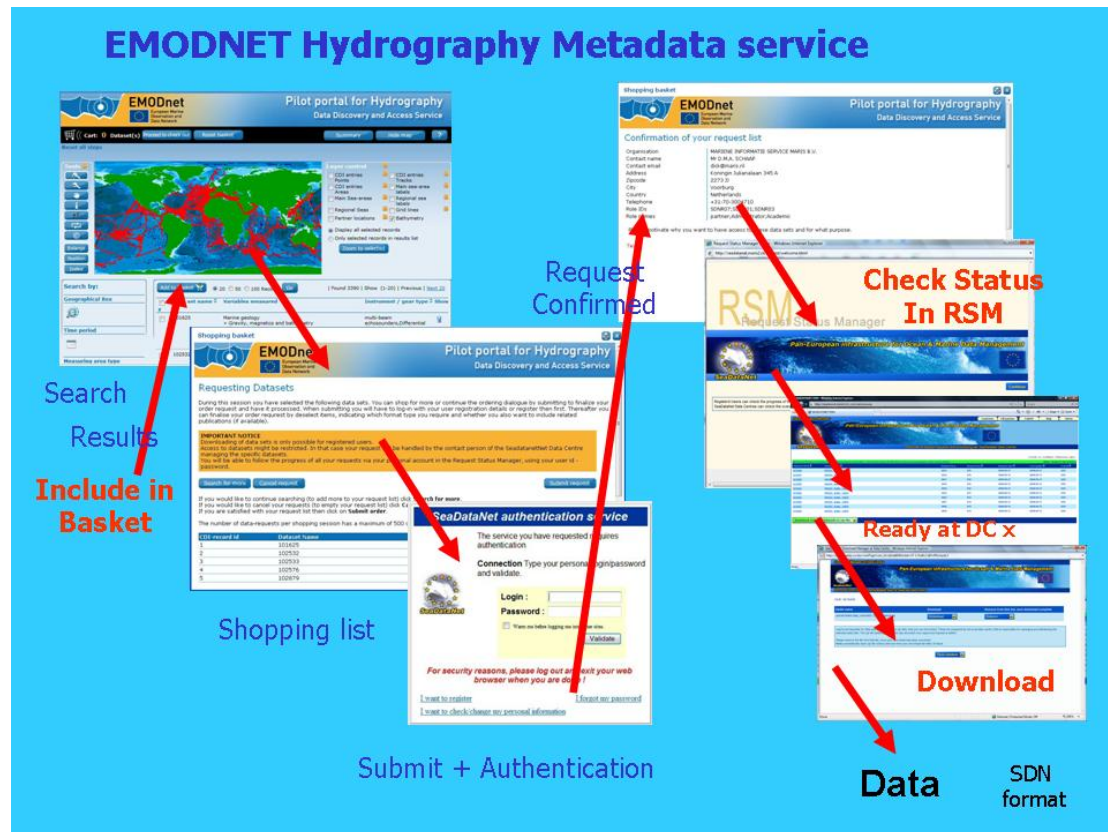


Image: EMODNet Hydrography CDI discovery and data access mechanism

The **Hydrography data products viewing service** provides users with a range of functions for browsing the EMODNet digital bathymetry (DTM) such as:

- there are multiple map layers that can be switched on / off and each interrogated for their information

- zoom in - zoom out and panning

- retrieving the DTM cell parameters such as Minimum cell depth, Maximum cell depth, Average cell depth, Standard deviation of the cell depth, Number of depths used for interpolation of cell depth, Number of subcells used for the computation of the average cell depth, Source reference by CDI reference, composite DTM reference or GEBCO in case of missing data

- retrieving depth profiles along a track

- adding external WMS map layers as an overlay such as the CDI WMS layer

- activating a source layer indicating for each cell its underlying prevailing data source

- downloading DTM tiles in different formats: ESRI ASCII, XYZ, CSV, NetCDF, GeoTiff and SD for Fledermaus 3 D viewer software

The following images give an illustration of the Hydrography data products viewing service.
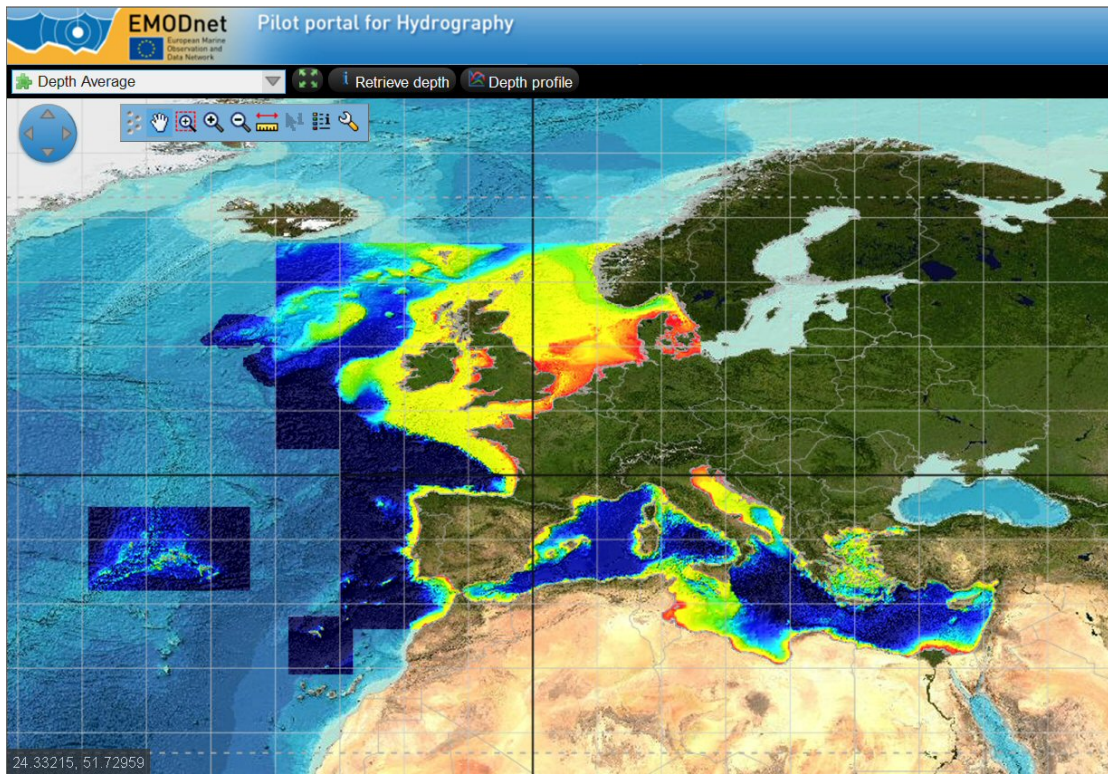
Image: opening screen of the Hydrography data products viewing service
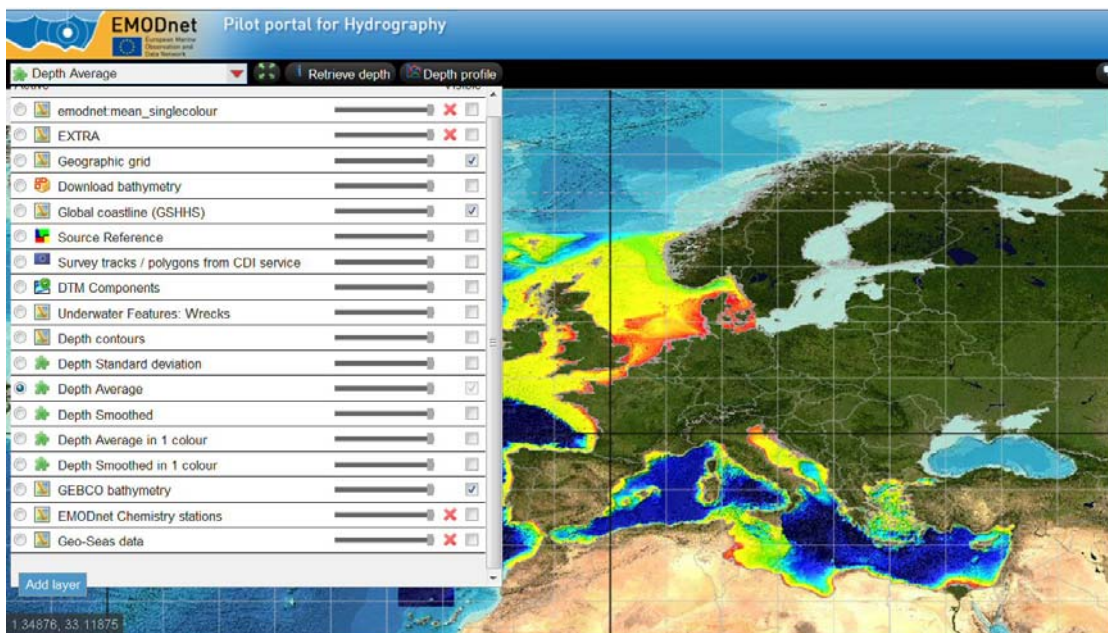


Image: Layer menu of the Hydrography data products viewing service

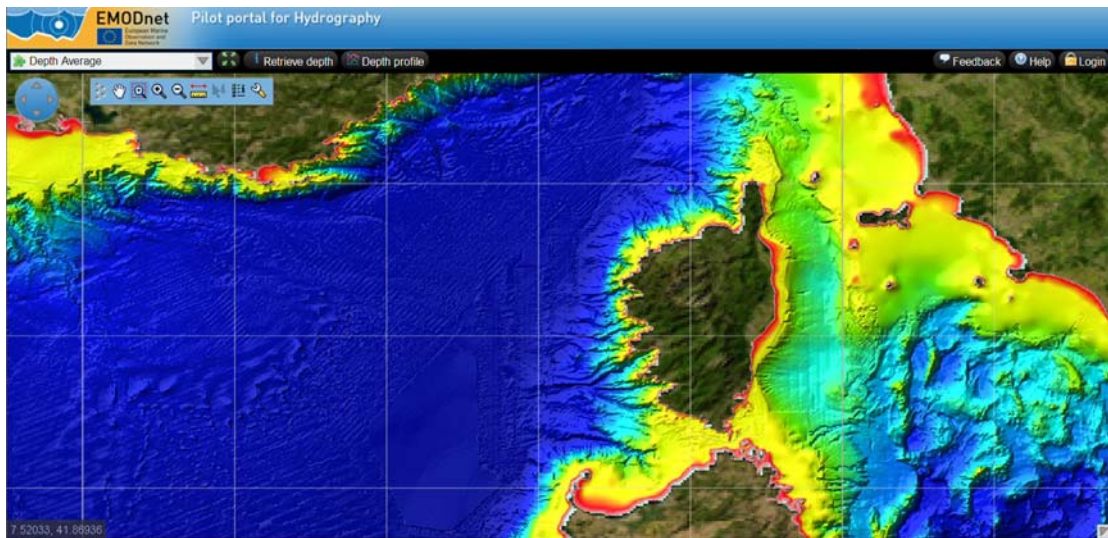Also some detailed screens are given to illustrate the use of the service:

Image: resulting DTM near Corsica with use of surveys, composite data sets and GEBCO data
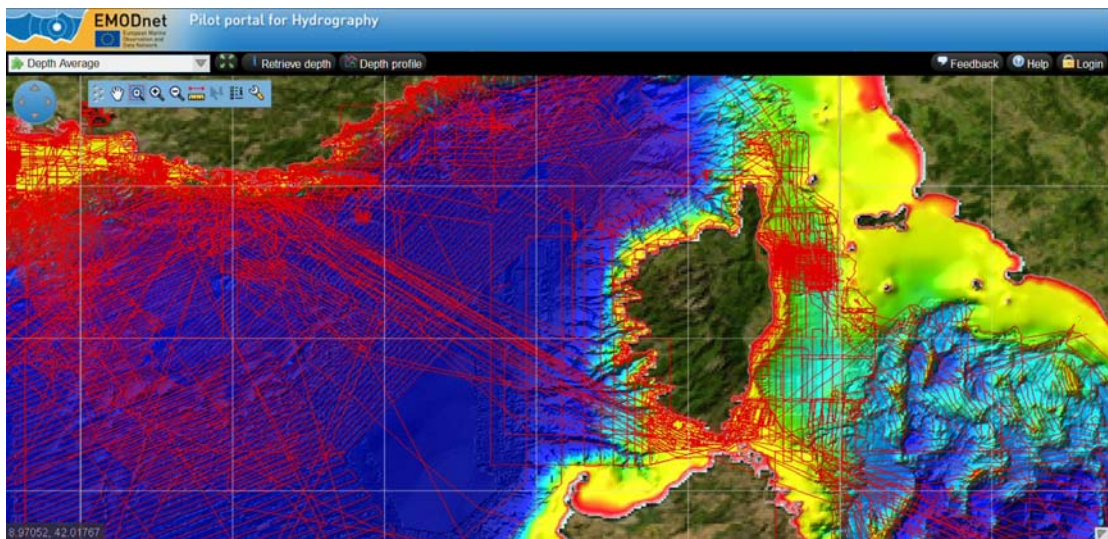


Image: resulting DTM near Corsica with tracks of the surveys as indicated by the CDI metadata records
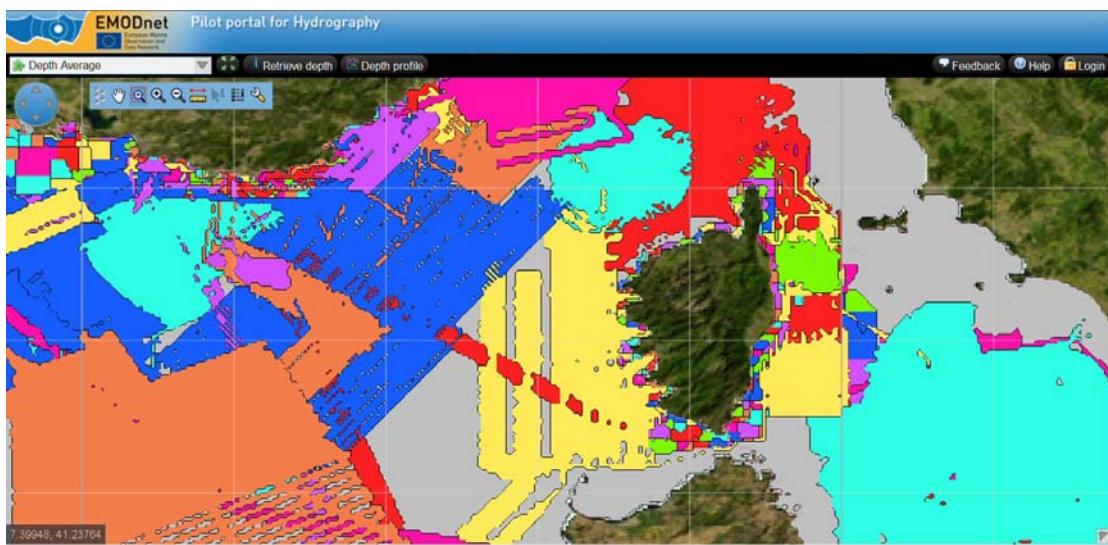
Image: resulting DTM near Corsica - sources layer indicating surveys, composite DTMs and GEBCO (= grey)
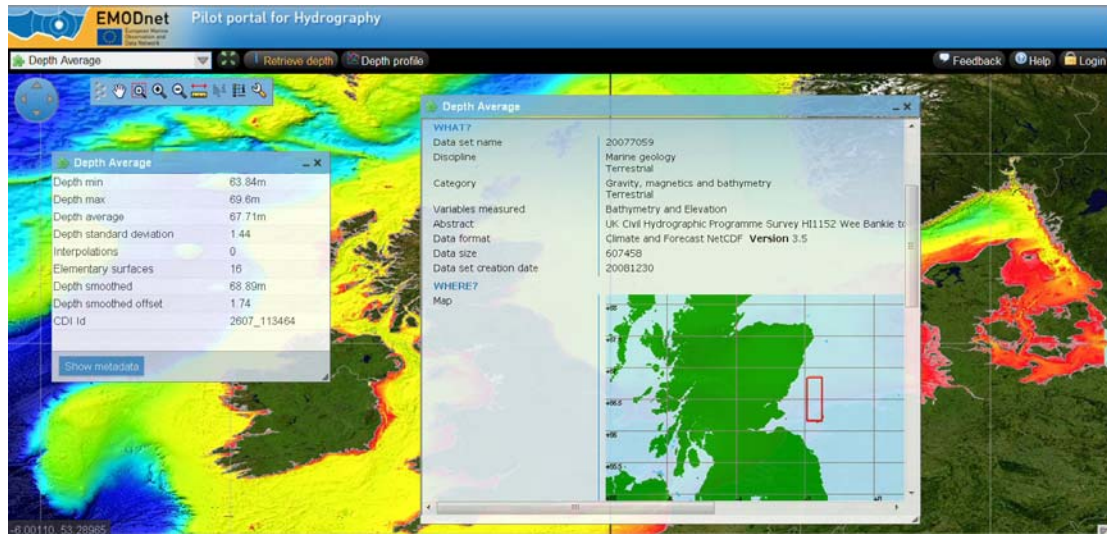


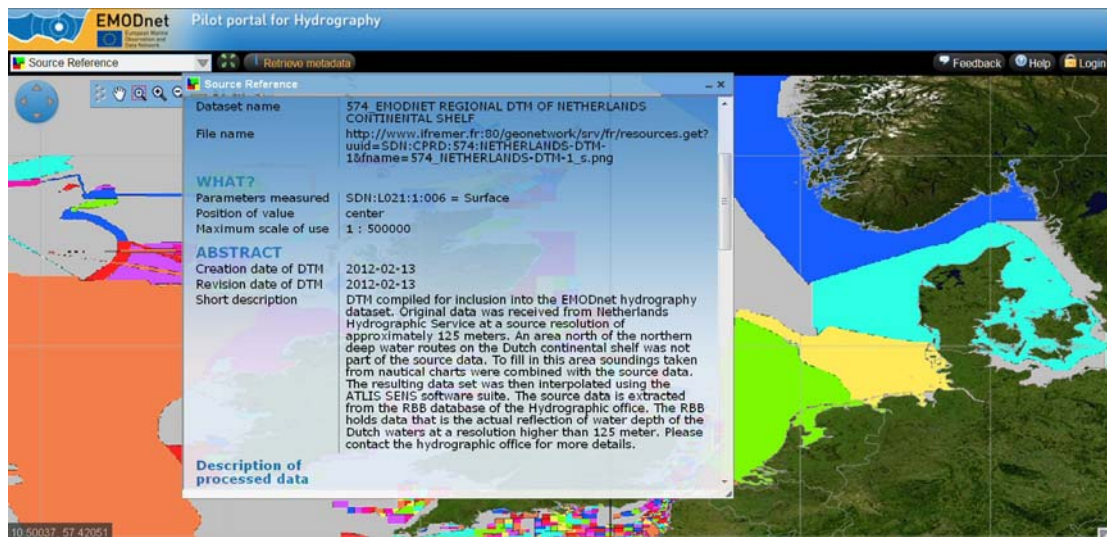Image: retrieving waterdepth parameters per cell and thereafter the CDI metadata



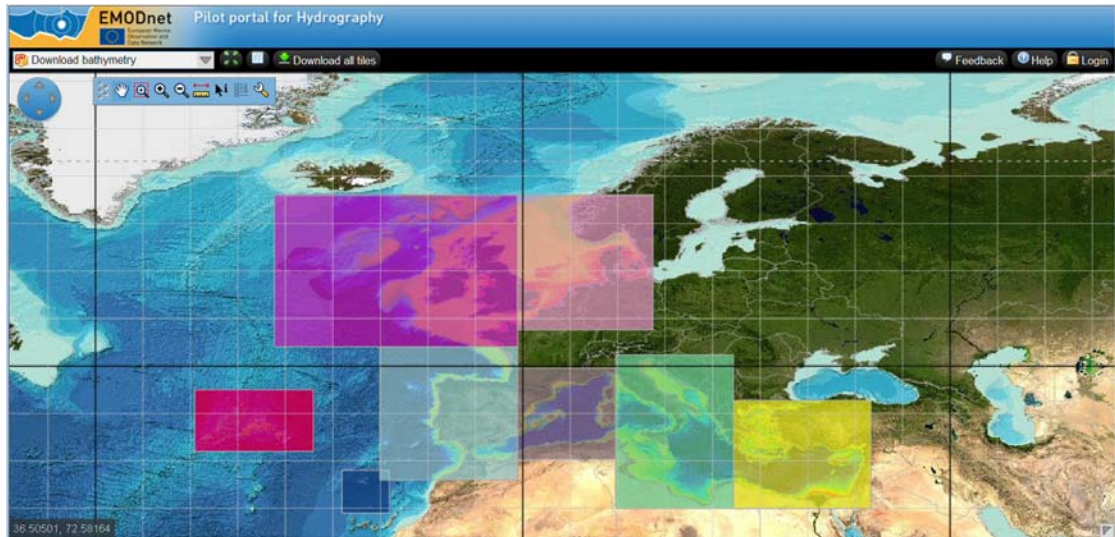Image: retrieving the composite DTM metadata from the source layer

Image: Downloadable DTM tiles

**Interoperability:**

The GIS layers in the Hydrographic viewing service can be shared as OGC WMS services with other EMODNet portals and beyond (e.g. WISE-Marine, European Atlas of the Seas, SeaDataNet). Also WMS layers from other EMODNet portals can be added to the Hydrography viewer.

The WMS for EMODNet Hydrography can be found at the following URL: http://portal.emodnet-hydrography.eu/geoserver/wms

There is also a WMS service for the Hydrography CDI metadata with the following URL: http://geoservice.maris2.nl/wms/seadatanet/cdi_v2/emodnet/hydrography

This is powering the Survey tracks / polygons from CDI service layer in the Hydrography data products viewing service.

**Compliance with INSPIRE**

The Hydrography services are fully compliant with INSPIRE as follows:

- applying Discovery – Viewing – Access services for retrieving survey data sets

- All viewers are based upon OGC WMS standards

- CDI Metadata profile is based upon ISO 19115 standards

- composite DTM Metadata profile is based upon ISO 19115 standards

Downloadable data sets and data products are available in NetCDF (CF) format


## 5.2    DATA COLLECTION AND METADATA COMPILATION

These activities were undertaken in work package 2 with the following objectives:

- To identify and gather hydrographic data sets for these regions

- To compile metadata for all hydrographic data sets in CDI format

The consortium has focused on Hydrographic Offices, Authorities and Research Institutes.

### 5.2.1    Types of bathymetric data sources

A major objective of the EMODNet Hydrography and Seabed Mapping Lots was to produce a digital bathymetry for the maritime regions as a Digital Terrain Model (DTM) with a gridsize

of .25 minute by .25 minute. This must be based upon available bathymetric data sources. In practice 3 types of bathymetric data sources have been used:

- **Bathymetric surveys**, such as single and multibeam surveys, echosoundings and even historic leadline soundings. These data sets are most preferred as data source because of their high resolution.

- **Composite data sets**, giving a gridded bathymetry. In practice it appears that a number of Hydrographic Offices (HO's) do not want or can not deliver primary surveys but composite data sets from the Digital Terrain Models that they maintain themselves for producing and maintaining their nautical charts following international IHO procedures.

- **GEBCO 30" gridded data.** GEBCO is used by the EMODNet project to complete area coverage in case there are no survey data or composite data sets available to the partners.

### 5.2.2    Metadata format for survey data sets

The SeaDataNet Common Data Index (CDI) data discovery and access service provides the basis for giving overviews and access to the high resolution survey data sets**.** All identified bathymetric survey data have been described by means of the ISO 19115 based CDI format. This way traceability has been achieved between the produced and downloadable DTM and the sources used for producing the parameters in each DTM grid cell.

### 5.2.3    Metadata format for composite data sets

Traceability of sources used for the produced DTM is an important issue. Therefore not only surveys have been described and indicated with metadata, but also composite DTMs that are delivered by a number of data providers. For this the Sextant Data Products Catalogue service has been adopted. Sextant metadata entries are based upon the ISO 19115 format and also supported by SeaDataNet Common Vocabularies.

### 5.2.4    Approach to engage data providers

To engage data providers the following access policy has been promoted:

- The metadata (CDI) in the EMODNet portal are public domain and freely available for all users.

- The resulting DTM data products (GIS layers) are freely available for all users as OGC WMS service and for downloading in several formats.

- The access to background data sets as detailed in the metadata inventory (CDI) and as used for the products respects the data copyrights of owners. The CDI metadata includes a value for data access restriction for every data set it manages, as well as a clear indication of the distributor. The SeaDataNet CDI shopping mechanism is fit for dealing with different access restrictions.

This approach in combination with naming data suppliers as associate partners at the website and in other promotional activities has encouraged potential suppliers to cooperate and contribute data sets for the EMODNet Hydrography Lot.


### 5.2.5    Results of data and metadata gathering per maritime region

#### the Greater North Sea

The Hydrographic Offices of Norway, Denmark, Germany, Netherlands and Belgium have provided composite DTMs in a number of resolutions.
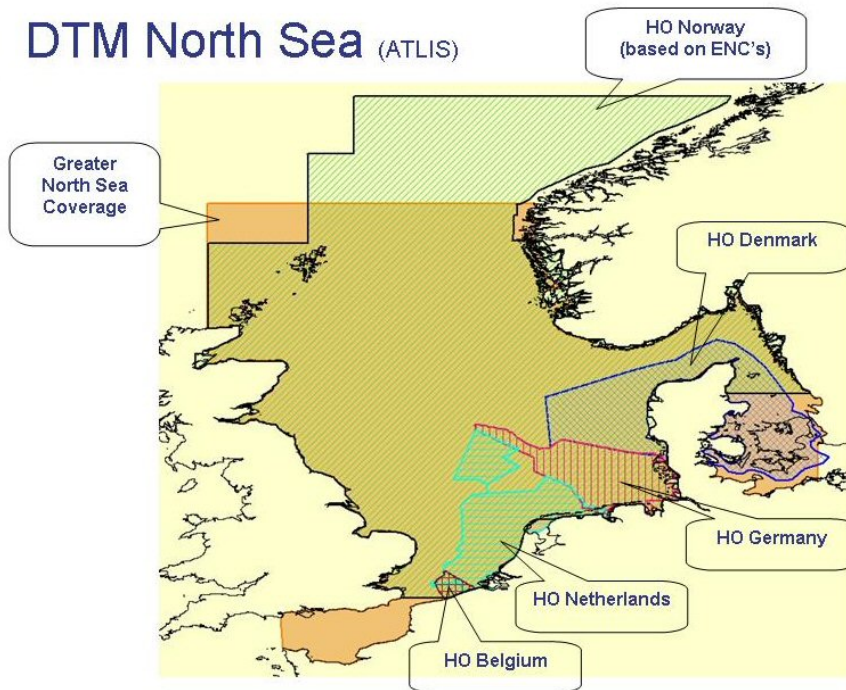
Image: geographical coverage of the composite data supplies by Hydrographic Offices.

Hydrographic surveys were provided by SHOM (the French HO and partner) and the UK Hydrographic Office via OceanWise.
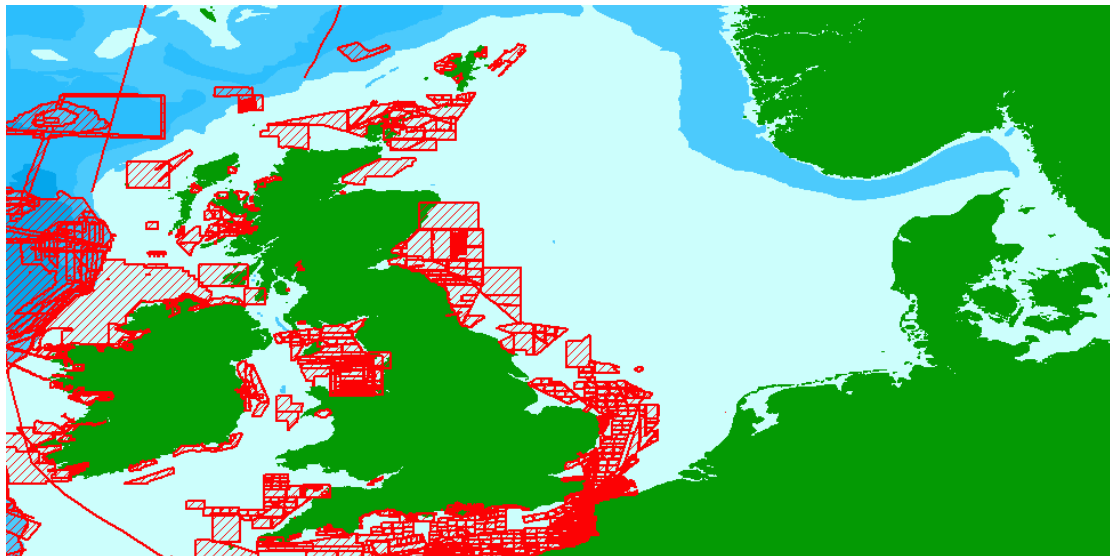


Image: CDI records of UK bathymetric surveys in UK waters as contributed and used by OceanWise

**the Channel and Celtic Sea**

Survey data sets have been gathered from NERC, SHOM, IFREMER, NIOZ, UKHO and GSI. For all these surveys CDI metadata have been produced and the data sets have been incorporated in the EMODNet DTM production.
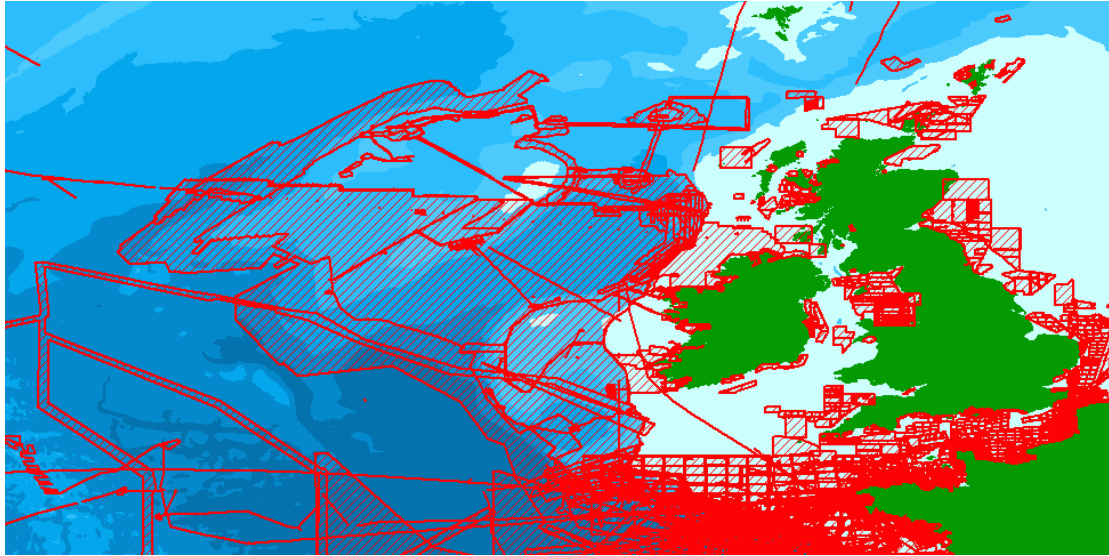
Image: CDI records of gathered data sets for the Channel and Celtic Seas

**the Western Mediterranean, the Ionian Sea and the Central Mediterranean Sea**

Survey data and composite DTMs have been gathered from SHOM, IFREMER, IEO, CNR-ISMAR, and OGS-RIMA. The resulting coverage of data sets for the Mediterranean Sea area is shown in the following images. The first one gives CDI references for all survey data sets in the target area. The second one displays the sources, bathymetric surveys as well as composite DTMs that have been used to compile the EMODNet DTM. Grey indicates that GEBCO has been used to complete the DTM coverage for every cell.
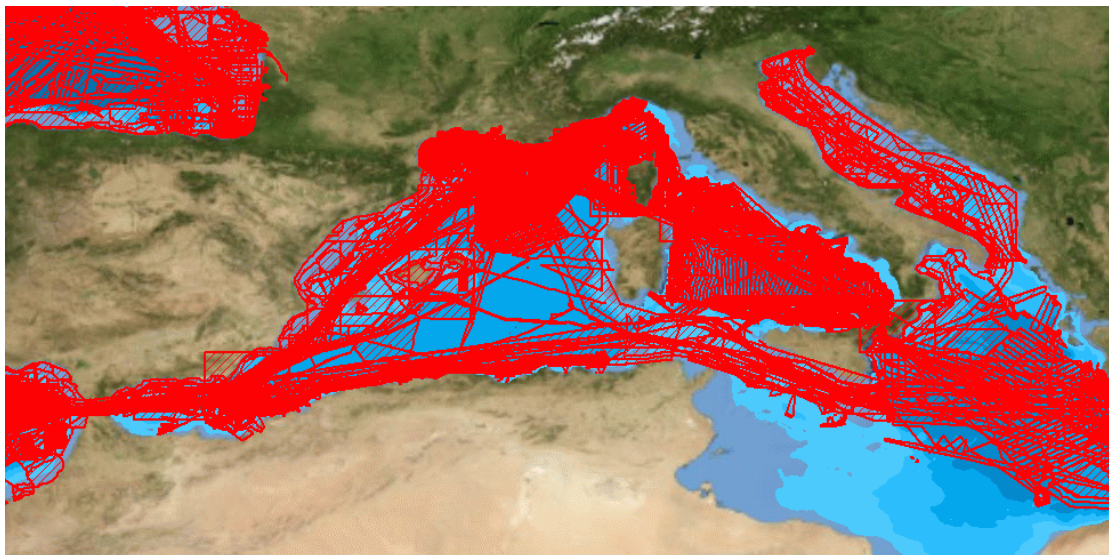


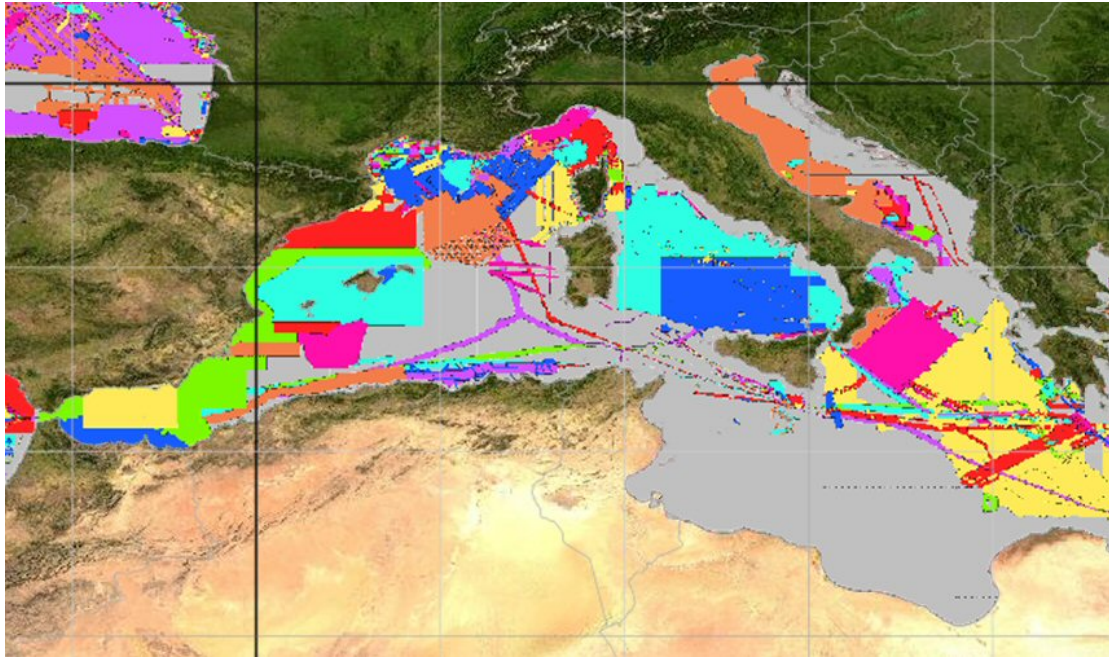Image: CDI entries of surveys in West and Central Mediterranean sea

Image: surveys and composite DTMS as used for the EMODNet DTM

## 5.3    QC/QA AND PRODUCING DIGITAL TERRAIN MODELS

These activities were undertaken in Work Package 3 with the following objectives:
- To validate and to harmonise the quality of all hydrographic data sets
- To generate a Digital Terrain Model (DTMs) per region of the waterdepth with a width per grid cell of 500 m
- To generate accuracy and reliability indicators

In the first year a guideline titled "Guidelines for metadata, data and DTM QA/QC, Version 1.4, April 2010, has been produced by IFREMER, SHOM, NOC and ATLIS for the EMODNet Hydrography and Seabed Mapping projects that is available from the public website. It describes how partners have to quality control data sets and how to produce the values for the grid cells of the DTM using available data sets, composite DTMs or GEBCO.
Moreover training workshops were organised to educate all partners in the QA/QC and DTM methodology. Moreover IFREMER gave a free licence to the Caraibes software by which partners can produce the DTM in the EMODNet way. This was followed up by several partners. These measures have been successful and have resulted in delivery of consistent DTMs by partners.

Over the 3 project years 4 releases have been generated of the regional DTMs applying the common QC activities and DTM method and integrating any new survey and composite DTMs that became available and were considered useful. The regional DTMs have been integrated into the EMODNet DTM of which the latest version has been loaded and made public through the Hydrography portal in August 2012.
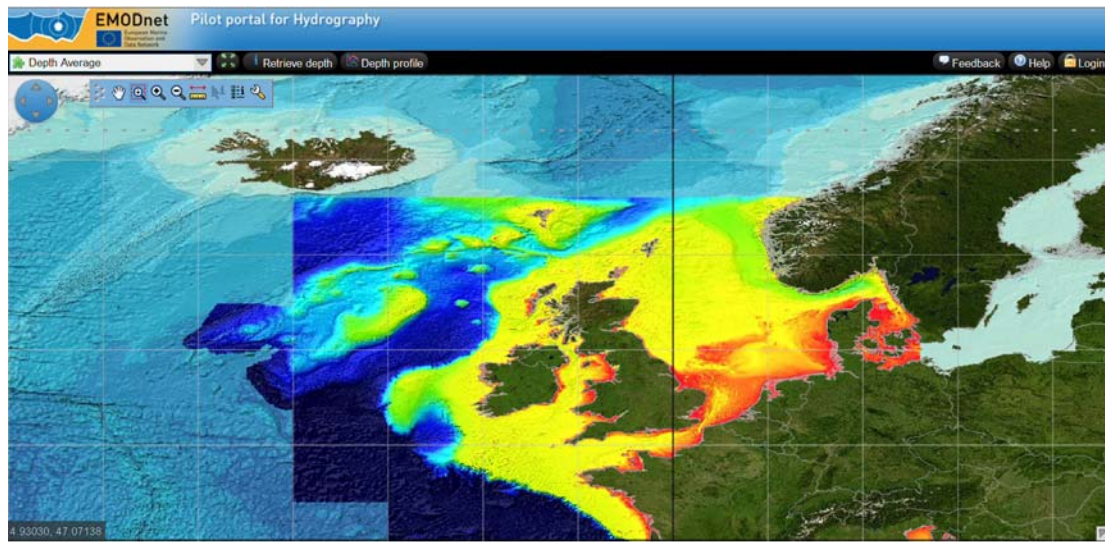
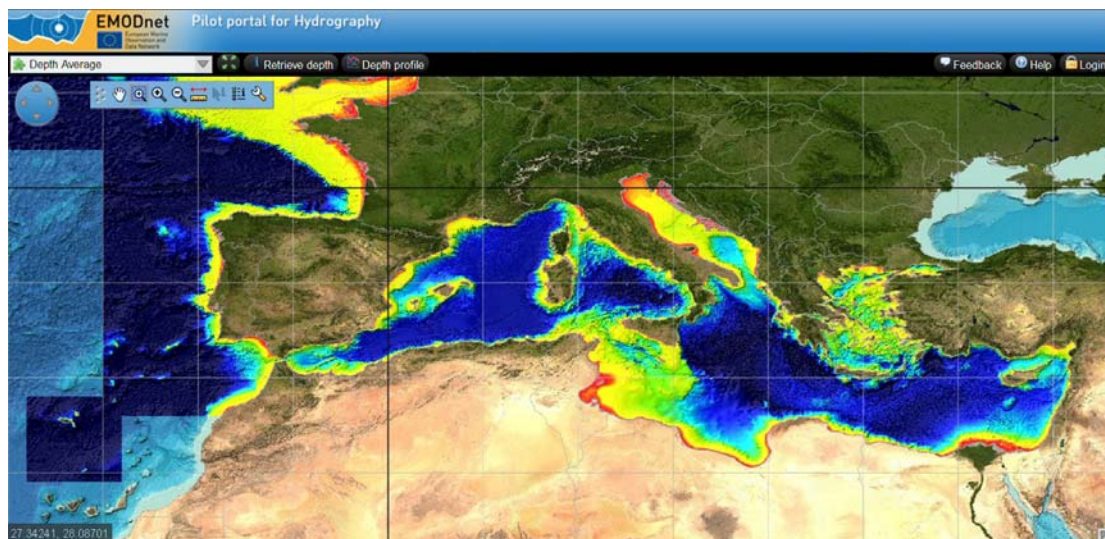Image: Present DTM for Celtic Sea, Irish Sea, Channel and Greater North Sea



Image: Present DTM for Western and Central Mediterranean Sea

## 5.4    DISSEMINATION AND PROMOTION

During the project years several activities have been undertaken to promote the project and portal to potential users and potential data providers. This included giving presentations at several conferences and meetings:

- GEBCO Bathymetric Science Day - September 2009 in Brest – France
- IMDIS conference - 29th – 31st March 2010 in Paris – France
- 2010 GEBCO Science Day - 11-18 September 2010 in Callao - Peru
- 29th North Sea Hydrographic Commission Conference - September 2010 in Brest - France
- MCA's Civil Hydrography Annual Seminar - 24th February 2011 in London - United Kingdom
- GEBCO Science Day - 4th October 2011 in La Jolla, USA
- Geo-Seas Workshop - 14 March 2012 at the Oceanology International exhibition in London - United Kingdom
- Days of Hydrographic Engineering event - June 2012 in Lisbon - Portugal

Early 2011 press releases were distributed to a long list of online and traditional publications that are frequented by potential users and data providers from government, research and private industries. The press release encourages wider use and feedback of the portal and its services by users; it also calls up managers of additional survey data sets for European maritime regions to come forward and to contribute to the project. Several websites and magazines have placed (parts of) the press release.

## 5.5 ANALYSIS AND EVALUATION CONCLUSIONS

- Overall cooperation from data providers has been satisfactory to good. Up till August 2012 more than **8400** bathymetric survey datasets, managed by **14** data centres from **9** countries and originated from **118** institutes, have been collated and used in the EMODNet Hydrography and Seabed Mapping projects for analysing and generating the EMODNet digital bathymetry.

- Data providers in bathymetry generally do not want to give open access but welcome the SeaDataNet based concept, that their datasets are advertised by public metadata and internally used for public data products while they keep control themselves over the actual data access.

- In a number of cases internal data sharing was not possible but an alternative was found by sharing composite DTMs prepared by data providers.

- The spatial and temporal coverage of gathered datasets for the European maritime regions is being analysed in deep in the EMODNet Seabed Mapping project. As a preliminary conclusion it can be said that many parts of the European waters have not been surveyed at all or at least not by modern techniques.

- SeaDataNet standards for metadata, data, data product and vocabularies have been applied with success for rendering all consistent.

- More high resolution multibeam survey datasets should become available including sufficient documentation about e.g. positioning accuracy, tidal corrections, etc for producing a really contiguous digital bathymetry with a common high quality.

- The grid resolution of the digital bathymetry at present is 0.25 minutes by 0.25 minutes. The grid resolution is considered as useful. However for further use in applications such as habitat mapping, numerical oceanographic prediction models etc it appears that a higher resolution would be preferred.

- Users bring forward that not all areas require a common high resolution grid. In shallow areas the requirements for a high resolution grid are much stronger than in deep oceans.

- The Hydrography portal and its distributed services are continuously monitored and procedures are in place to guarantee a 24 hour 7 day a week operational performance.

- The EMODNet approach with thematic portals for specific disciplines and communities and with EMODNet concertation meetings together with MODEG experts is considered as very useful and effective. This way many potential players from a given discipline or theme can be engaged for their own specialism and interest, while the interoperability and cohesion between the thematic portals is achieved by using common standards from OGC for viewing services and SeadataNet for data discovery and access services and semantic interoperability.

- The number of visitors of the EMODNet Hydrography portal is gradually increasing. It is visited nowadays by circa 500 - 600 users per month that visit on average 25 pages of the website. Also the number of downloads of the DTM tiles is gradually increasing and

numbers nowadays circa 40 per month. These statistics are still relatively low and should be increased.

- Therefore a central EMODNet promotion campaign should be undertaken. It can be considered also to establish an overall EMODNet portal that can serve as central domain in the overall promotion. However that portal should guide users to the thematic portals for specific thematic functions and details and not try to take over everything at a common top level. The shared WMS services and shared CDI and Data Products services could be common elements at the top domain, but more in depth queries should be performed by the underlying thematic portals.

- More EMODNet development projects are required to go "wider" and "deeper". This will encourage more data providers to come forward for data sharing and participating in the process of making complete overviews and homogeneous data products.

- Further RTD work will and must continue on standards and protocols that can be applied as basis for the EMODNet portals. For example SeaDataNet II is continuing for another 4 year and this looks into establishing common marine standards for using sensorML, handling biological data, developing generic viewing services, achieving full INSPIRE compliance etc. EMODNet stimulates a wider implementation and adoption of these standards by more data holding organisations.