EMODnet Thematic Lot n°1 – Bathymetry

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Start date of the project: 20/12/2020 (48 months)

Centralisation Phase

Interim Progress Report (2)

Reporting Period: 20/12/2022 – 19/12/2023

The European Marine Observation and Data Network (EMODnet) is financed by the European Union under Regulation (EU) 2021/1139 of the European Parliament and of the Council of 7 July 2021 establishing the European Maritime, Fisheries and Aquaculture Fund and its predecessor, Regulation (EU) No. 508/2014 of the European Parliament and of the Council of 15 May 2014 on the European Maritime and Fisheries Fund.

Contents

1.Introduction

This report gives the progress in the 3rd year of the **EMODnet Bathymetry contract (HRSM3)** which earlier ran for 2 years from 20th December 2020 and has been seamlessly extended for another 2 years till 19 December 2024. It is a follow-up of the earlier developments in EMODnet Hydrography, Seabed Mapping, Bathymetry and High-Resolution Seabed Mapping projects which took place since June 2009 and that resulted in the EMODnet Bathymetry portal with several services and products.

During the previous two-year period a lot of effort has been spent on establishing the migration of all thematic portals into one central EMODnet portal. This migration was achieved and went live 23rd January 2023. Furthermore, the EMODnet Bathymetry consortium generated the new 2022 version of the EMODnet Digital Terrain Model (DTM), the core product, together with a number of supporting data products. However, in order not to synchronize with the launch of the EMODnet Central Portal and due to adoption of new ways for publishing, it was decided to postpone the official release of the new **2022 DTM version,** which was finally released at 13th April 2023. Therefore, part of the activities during the 3rd year have been spent on arranging the publishing of the 2022 data products.

Also, activities have been undertaken aimed at a continuation of services, at an expansion of the collection gathered of bathymetry survey data sets, composite DTMs and high resolution DTMs, and at a refinement of the quality and precision of the overall EMODnet DTM of 1/16 minute * 1/16 minute, inter alia by optimizing the production methodology and associated tools next to filling gaps and replacing less accurate data with new data, where possible.

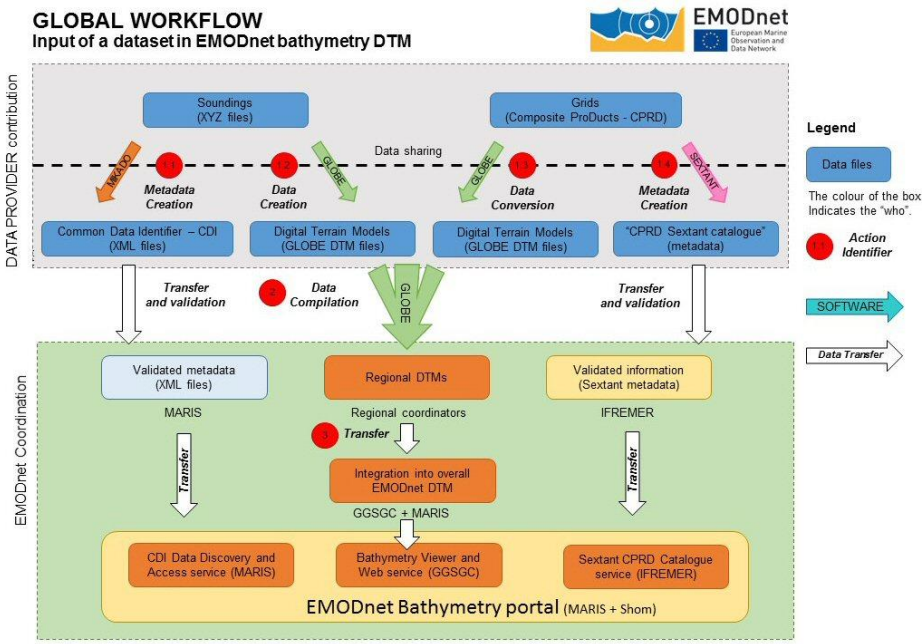


Image: Workflow for EMODnet HRSM3

The overall methodology (see image above) is a continuation from the earlier approach, although refinements have been made, for instance in the GLOBE tool, and interpolation techniques. Moreover, it is planned that as part of the process for producing regional DTMs, use will be made by Regional Coordinators of the online Collaborative Virtual Environment (CVE) for which IFREMER has upgraded the earlier developed and tested

prototype. The CVE includes an online and improved version of the GLOBE software and it runs on a High-Performance computer network, managed at IFREMER.

The first year of the extension focused again on gathering new survey and composite DTM data sets, populating these in the dedicated directory services, and preparing the data sets for use by the Regional Coordinators.

As illustrated in the flow chart above, the generation of Regional DTMs is again divided over regional sea basin subgroups, each with a Regional Coordinator and a number of contributing data providers. Since the 2022 release, the coverage of the Regional DTMs now also includes (part of) the Caribbean Sea region. Each Regional Coordinator will be responsible for a quality assessment and selection of the data contributions and the compilation of the Regional DTM using the GLOBE software. This process will start February – March 2024 when all data providers have finalized their data gathering and population activities for the CDI and CPRD catalogues and will have undertaken pre-processing and gridding of their data sets for delivery as DTMs to the regional coordinators.

The planned new 2024 EMODnet DTM will continue to have a common resolution of 1/16 minute * 1/16 minute overall. This will be published by OGC services and as a number of OGC layers, while users will be able to download DTM tiles in a range of formats. In addition, additional higher resolution DTMs will be produced as hotspots and for the near coastal areas and coastal zones, where possible. These HR-DTMs with different resolutions will be published as another OGC layer and users will be able to download each individual HR-DTM file at its highest resolution.

Furthermore, the existing inventory of national coastlines and legal baselines is being updated, trying to get also entries from currently missing countries around the European seas. New versions of the best-estimate digital European coastlines and a new set for selected islands in the Caribbean Sea region will be produced at three vertical reference levels (LAT, MSL, and MHW).

The extension of the EMODnet Bathymetry contract is undertaken by the same consortium as the previous contract and this consists of altogether 43 legal entities from 20 countries (18 EU member states) along European seas, comprising major marine research institutes (20), national hydrographic services (15), and companies (8), with major expertise and experience in the field of bathymetry, such as surveys, generating bathymetric data products, Satellite Derived Bathymetry, tidal modelling, developing services, data management, system architecture analysis, standards such as INSPIRE, ISO, and OGC, product visualisation, and project management. The extended project is again coordinated by Shom, with MARIS acting as Deputy-Coordinator.

2.Update on the Tasks

Task 1 - Maintain and improve a common method of access to data held in repositories:

During the reporting period, the number of survey data sets has increased considerably from 41315 to 42369 CDI entries, while the number of Composite DTM entries has increased from 274 to 279. New CDI entries for bathymetry survey data sets were contributed by 15 data providers, in particular with a large submission of 588 survey data sets by Marine Institute (Ireland) as an associate partner. Partner Ifremer has reviewed its data policy for survey data sets gathered in EEZ of other international countries. It has decided to publish only data sets for which diplomatic approval has been received. As a result, Ifremer has de-activated 46 existing CDI data sets from the current catalogue, while also adding 127 new data sets.

In the coming quarter more CDI and CDTM entries are expected from many regular data providers as a deadline has been set for the current contract for finalising gathering and population in the first quarter of 2024. For Satellite Derived Bathymetry, a cooperation has been established between partners EOMAP (Germany), expert in SDB, and GST (Denmark), that SDB data will be used in addition to single and multibeam surveys of GST for generating a new CDTM for the Danish waters on a 50 meters grid. This CDTM will serve GST as a national public product and also be input for EMODnet Bathymetry. Its production will start soon.

Task 2 - Construct products from one or more data sources that provide users with information about the distribution and quality of parameters in time and space:

The 2022 EMODnet DTM was made ready end 2022, but due to the launch of the EMODnet Central Portal from 23rd January 2023 and adoption of new ways for publishing, the official release of the new **2022 version of the EMODnet DTM** has been postponed to 13th April 2023. Compared to the 2020 release, a total of **21.790** unique references to CDI entries and Composite DTMs entries are used in the overall DTM versus **16.260** in the 2020 version. There is also a DTM for (part of) the Caribbean region. The 2022 DTM can again be downloaded in several formats, and includes also a version with MSL vertical reference next to LAT.

The **High Resolution DTM layer** has also been expanded and since April 2023 covers **308 HR-DTMs** which can be viewed and downloaded. Related metadata for all DTM tiles and HR-DTM files have been populated in the Sextant Products Catalogue CSW and has been harvested into the Central Portal Products Catalogue. The resolution of HR-DTMs varies between 1/32 and 1/512 arc minutes, depending on local data policy of data providers.

Next to this structured downloading of DTM tiles and HR-DTM files, users can select an area of interest for downloading. This is arranged through the CP ERRDAP service in which an integrated DTM 2022 file (NetCDF V4) has been loaded of more than 130 GB. The new 2022 release includes furthermore updates of the **source reference, quality index, and satellite derived coastlines** layers. These are also available for the Caribbean region DTM.

For the contract extension, Task 2 activities have started with data providers processing and pregridding new survey data sets and composite DTMs using the GLOBE software. The September 2023 Training Workshop included a dedicated session on using the latest version of Globe software, and guidance has been included in the Deliverable D2.1. In addition, another training session presented the latest status of the Collaborative Virtual Environment (CVE) at the DATARMOR HPC facility, that will be used by Regional Coordinators as part of the process for the 2024 DTM. As follow-up, IFREMER finalised the deliverable D3.1 which provides guidance information for using the latest release of the CVE. This Deliverable is provided as Annex 2. Finally, the Training Workshop also included a presentation and hands-on training by CORONIS on the latest interpolation techniques.

The data gathering activities will be completed in the coming months with more CDIs and CDTM submissions, whereby also the pre-processing of the associated data, using GLOBE and following EMODnet methodology,

to 1/32 * 1/32 gridded data sets will take place for transfer of the gridded data sets to Regional Coordinators. A workshop has been planned for regional coordinators together with core partners in April 2024 for monitoring and discussing the RDTM generation process. The workshop will be hosted by GGSgc in France.

Task 3 - Develop procedures for machine-to-machine connections to data and data products:

The migration from the thematic Bathymetry portal to the EMODnet Central Portal has been finalised and the new Central Portal was launched at 23rd January 2023, while the publishing of the EMODnet Bathymetry website was halted at the same date. Redirects were configured to make sure that users following old URLs will be redirected to the Central Portal.

EMODnet Bathymetry now continues to operate and maintain several catalogue services and web services, which are being harvested and/or directly feeding the Central Portal services. The services are following INSPIRE principles and their operations are being monitored from the Central Portal with good results.

EMODnet Bathymetry is regularly testing the functionality of the Central Portal and following up feedback from users. This is aimed at spotting possible bugs in the back- office systems of EMODnet Bathymetry or at the front-office interfaces of the Central Portal. Any identified bugs are reported to JIRA for further action. Also, shortcomings or requests for improved functionality are being gathered from internal consortium testing and following user feedback and these are submitted to the CP team through JIRA and/or at TWG meetings as wishes for future developments. Most are directed towards optimisation of functionalities, while also wishes for additional functionalities come forward.

Task 4 - Contribute data, data products and content to a central portal that allows users to find, view and download data and data products:

As indicated under Task 2 and Task 3, a lot of activities have taken place in the previous contract for arranging the migration from the thematic portal to a Central Portal. This was originally done around the 2020 EMODnet DTM version. While the publishing and release of the new 2022 DTM version has been postponed till April 2023, not to hinder the official launch of the new EMODnet Central Portal at 23rd January 2023 and the following EMODnet hackathon. Also, the publishing of a new version of the DTM for the first time in the Central Portal took quite some efforts and synchronisation between EMODnet Bathymetry and the CP team. However, it was a good learning curve and it is expected that the publishing of the next release end 2024 will go much smoother, also because it is planned that the thematic groups will get more access to the online CP Content Management System and use can be made of the machine-to-machine services that have been adapted and configured for this first release updating.

Task 5 - Contributing content to dedicated spaces in Central Portal:

Each thematic has its own dedicated space at the Central Portal where it publishes its so-called ‘narrative’. The maintenance is done by sending an updated document to JIRA which is then processed by the EMODnet Secretariate. In the near future, the thematic lots will get more direct access to the EMODnet CMS (Drupal) for performing maintenance activities. In the reporting period, a number of additional reports and guidelines were submitted for inclusion in the CP reports catalogue. This has been done by the EMODnet Secretariate. EMODnet Bathymetry team will provide new and updated content, where required and appropriate. Recently, EMODnet Bathymetry has received logon details for direct access to the EMODnet CMS (Drupal) for performing maintenance activities on the Reports section. This will be tested and in near future used for providing new reports, where required and appropriate.

Task 6 - Ensure the involvement of regional sea conventions:

Secretariats of the Regional Sea Conventions are kept up-to-date of the EMODnet Bathymetry services, inter alia through regional partners. The 2022 EMODnet bathymetry full grid release, launched in April 2023,

provides a good opportunity to reinforce the good relationships with the secretariats of the Regional Sea Conventions who are kept up-to-date of the EMODnet Bathymetry services and products, and where possible, engaged in wider promotion and contributing to mobilising more potential data providers and product users. Representatives of the Regional Sea Conventions have also been informed about the EMODnet progress and products during the successful EMODnet Open Conference which was held from 29 – 30 November 2023 in Brussels – Belgium.

Task 7: Contribute to the implementation of EU legislation and broader initiatives for open data:

On a global scale, good synergy is continued with GEBCO and the Seabed 2030 project. In this context, George Spoelstra (GGSgc) and Federica Foglini (CNR), both members of the EMODnet Bathymetry consortium, act as Chair and Vice-Chair of the GEBCO subcommittee TSCOM (Technical Subcommittee on Ocean Mapping). One of their targets is to promote adoption of the metadata – data management practices in GEBCO and Seabed 2030, following SeaDataNet CDI standards and services, as applied by EMODnet Bathymetry. In an early stage, the new 2022 EMODnet DTM has already been shared with GEBCO, for inclusion in their next release. While, EMODnet has made use of the latest 2022 GEBCO release in the EMODnet 2022 DTM. Also, the collaboration with IHO will be continued and leads to data contributions by several other national hydrographic services beyond the consortium partners. In practice, the EMODnet DTM is considered as the European contribution to Seabed 2030 and as such fully integrated into the GEBCO DTM. During the EMODnet Jamboree a meeting of the Bathymetry consortium took place, which included an online dialogue with GEBCO and SeaBed 2030 senior staff about the cooperation and synergies and also how to arrange that data from European data providers will go through EMODnet to GEBCO and SeaBed 2030. This dialogue will be followed up.

Task 8 - Monitor quality / performance and deal with user feedback:

The overall performance of the portal and its services is continuously measured and its results are reported in the separate indicators spreadsheet. It demonstrates that Bathymetry and its services and products continue to be quite popular, in the new setting on the Central Portal. In the first quarter, when the migration to the Central Portal had been established, the visitor and download statistics were lower than before at the thematic portal, but in the following quarters the users became more acquainted with the new portal services as traffic and downloading increased. In particular in the 4th quarter of 2023, the number of visits and downloads of the full DTM products has increased very considerably, which is most likely due to the EMODnet Open Conference and the promotion around this event. The user feedback is at a regular level both on the quality of the DTM product and the usability of the portal. Most questions are from regular users asking about how to do queries and downloads in the new configuration. Answers are directly provided to the users. Some earlier functions are being missed. These are put on a wish list from EMODnet Bathymetry for future developments and included in JIRA. From the response it is also clear that there is a need for a Help file and/or some tutorials about how to operate the various new CP services.

Task 9 - Maintain the existing thematic web portal for a maximum of six months from the start of the project:

The earlier EMODnet Bathymetry portal was maintained till 23rd January 2023 when the actual migration was finalised. The Central Portal is now the shop-window, while EMODnet Bathymetry is maintaining the operation and maintenance of the various Bathymetry catalogues and web services that feed into the Central Portal.

Project management:

The existing contract for EMODnet Bathymetry has been extended by EU CINEA for another 2 years without the need for a new tender. There was only an amendment necessary to include UK partners now as subcontractors and no longer as full partners due to Brexit. Therefore, Shom as coordinator has adapted the

prevailing Consortium Agreement which has been signed by all partners. Moreover, Shom has concluded subcontracts with the UK partners. The new contract phase runs from 20 December 2022 to 19 December 2024.
A plenary meeting (25th and 26th of September 2023) has been organised with dedicated workshops (see task 2), also discussing best practices in bathymetric data processing and management along with recent development for the benefit of the consortium (interpolation, data science and AI). Another Bathymetry plenary meeting took place during the EMODnet Jamboree to remind partners of the production schedule for the new product releases and for an online dialogue with GEBCO and SeaBed 2030 as mentioned under Task 7.
Shom and MARIS as coordinating team participated in EMODnet TWG and SC meetings, EMODnet – CMEMS meeting, and also interacted with the EU concerning future funding perspective for EMODnet and with EMODnet Secretariat concerning annual EMODnet reporting and synergy with OBPS.

Shom and MARIS, prepared four Quarterly progress reports which were reviewed and accepted by the EU CINEA. They also drafted and submitted the final report for the previous two-year period, including contributions and deliverables from WP and Task leaders, and including transfer protocol. All these deliverables were transferred to the EU and accepted, including the final invoice. Shom has followed up by paying all consortium members for their agreed shares. Finally, Shom and MARIS, have drafted this Interim Annual Report.

Milestone/Deliverable in numerical order	WP	Date due	Status (To do/ Delivered/ Delayed)	Date delivered	If Delayed: reason for delay and expected delivery date
D1.1: Quarterly concise progress reports	WP1	M4, M7, M10, M13, M16, M19, M24,	Delivered D1.1a,b,c,d	M4, M7, M10, M13	
D1.2: Annual Interim report	WP1	M12	In progress		
D1.3: Final report	WP1	M24			
D1.4: Plan for service continuity, incl. docs and sources	WP1	M24			
D2.1: Upgraded guidelines for data pre-processing and population of metadata	WP2	M6	Delivered	M6	See Annex 1
D2.2i: Training Workshop for data pre-processing and metadata population	WP2	M9	Delivered as part of meeting 25-26 Sept 2023 in Brest - France	M9	

D2.3: Pre-processed survey data sets and included in CDI Service	WP2	M12	Underway		This will continue in the coming Months till M15
D2.4: Pre-processed composite DTMs and included in Sextant service	WP2	M12	Underway		This will continue in the coming Months till M15
D2.5: Satellite Derived Bathymetry data sets and included in Sextant Service	WP2	M12	Underway		This will continue in the coming Months till M15
D3.1: Upgraded guideline of EMODnet methodology for DTM production, including using prototype CVE	WP3	M9	Delivered	M10	Attached as Annex to this Progress Report
D3.2i: Upgraded Globe software	WP3	M9	Delivered and presented at meeting 25-26 Sept 2023 in Brest - France	M9	Note that Globe is regularly updated upon request and made available publicly
D3.3i: Training and intercalibration Workshop	WP3	M11	Has been re-scheduled to better fit the latest planning for production of DTM		Workshop of Regional Coordinators and Integrator at M16
D3.4i: Processed and pre-gridded data sets as input for RDTMs	WP3	M14			
D3.5i: Regional DTMs with common resolution of 1/16 arc minutes grid	WP3	M17			
D3.6i: Best version HR DTMs for coastal waters and hotspots	WP3	M20			
D3.7: New EMODnet DTM incl Quality Index and loaded in EMODnet web services for viewing and downloading	WP3	M23			
D3.8: HR-DTMs loaded as separate layer in	WP3	M23			

EMODnet web services for viewing and downloading					
D3.9: Source reference layer in EMODnet web services to link to CDI and Sextant Catalogue services	WP3	M23			
D3.10: Refined best-estimate European digital coastlines in EMODnet web services for a range of vertical levels	WP3	M22			
D3.11: Updated Inventory of existing and ratified baselines and registered claims / disputes under UNCLOS, for European countries at the portal	WP3	M22			
D3.12: Methodology for assessing bathymetry between coastline and foreshore	WP3	M23			
D4.1: Standard machine- to-machine services delivered for common functionalities	WP4	M3	Delivered	Operational since M0	
D4.2: Dedicated machine- to-machine services adapted / delivered for special functionalities	WP4	M6	Delivered	Operational since M0	
D4.3i: CVE optimised for reginal coordinators	WP4	M14			
D4.4i: Globe software + GGSGC workbench upgraded with extra functionality	WP4	When required	Following requests and suggestions		
D5.1: Operational Help-desk	WP5	continuously			
D5.2: Monitoring data about visits and usage	WP5	continuously			

D5.3: Promotional material and up-to-date thematic space at central portal	WP5	continuously			
D5.4: Presentations at relevant conferences	WP5	Regularly			

3.Work Package updates

WP1 – Project management

Covering Tasks 5 + 9

The existing **EMODnet Bathymetry contract (HRSM3)** contract which ran earlier for two years from 20th December 2020 has been seamlessly extended for another 2 years till 19 December 2024. This was notified by CINEA to Shom in an official letter at 21 November 2022, confirming that CINEA implemented the automatic renewal clause that was included in Article I.3.5. of the existing contract. There was only an amendment necessary to include UK partners as subcontractors and no longer as full partners due to Brexit. Therefore, Shom as coordinator adapted the prevailing Consortium Agreement which has been signed by all partners, while Shom has concluded subcontracts with the UK partners to continue their activities. In addition, Shom and MARIS, acting as coordination team, discussed with core partners updating of the workplan for the coming two years. Overall, the workplan is quite similar as before, but a few amendments were made. These will be described in more detail in the workpackage reporting below.

Early 2023, EU DG MARE requested each of the EMODnet thematic lots to think about future opportunities and interesting perspectives for EMODnet as DG MARE timely has to give input for the next version of the EU programme 2028 - 2035, which will fund EMODnet developments. Currently, that programme is the **European Maritime, Fisheries and Aquaculture Fund (EMFAF)** which runs from 2021 to 2027 and supports the EU common fisheries policy (CFP), the EU maritime policy and the EU agenda for international ocean governance. Shom and MARIS together with contributions of the full EMODnet Bathymetry consortium, which was organised through collecting input by means of a Google spreadsheet, completed the survey as handed out by DG MARE and submitted a document. This response was later discussed with DG MARE and CINEA at an online meeting, taking place at 16th June 2023, giving more background to answers and brainstorming about the perspective for EMODnet Bathymetry as part of a new long-term funding program.

EMODnet Bathymetry participated in the EMODnet TWG meetings of 4-5 April 2023 in Brussels – Belgium and 18th October 2023, online, giving overviews of progress and discussing outstanding items and wishes for the functionality of the services at the Central Portal. EMODnet Bathymetry also participated to the EMODnet Steering Committee meetings of 23rd May 2023 in Brest – France, presenting progress and giving a future outlook on new product releases, and online at 1st December 2023, considering the outcomes and future actions to be derived from the successful EMODnet Jamboree and Open Conference.

In July 2023, there we two meetings, moderated by the EMODnet Secretariat, with the IODE - Ocean Best Practices System (OBPS) team discussing collaboration between EMODnet thematics and OBPS. This has resulted in a concrete action by EMODnet Bathymetry for including documentation about the EMODnet Bathymetry Quality Index and how to describe metadata for bathymetric survey data in the OBPS register. Both documents have been added to the OBPS registry and received DOIs for citation (no 1 and no 2).

EMODnet Bathymetry participated in the online EMODnet – CMEMS coordination meeting, 20th October 2023, where both initiatives highlighted their ongoing activities and plans. The formulation of a joint communication from EMODnet and Copernicus Marine Service on the *in situ* marine data landscape was discussed, which resulted in a statement, released 29th November 2023, explaining the complementarity between the two EU marine knowledge assets, and how the services work together. Also, CMEMS informed that they had launched a Call for a global coastal bathymetry derived from satellite observations. In the

meantime, this Call has been concluded with a winning proposal by a consortium from a few members of the EMODnet Bathymetry consortium, which should guarantee tuning and fitness-for-purpose of results of the CMEMS project for EMODnet Bathymetry. The press release was published in November 2023.

A full EMODnet Bathymetry consortium meeting was organised at Brest – France, 25th - 26th September 2023, with a plenary part about the workplan activities and their progress, followed by dedicated workshops (see WP3 and task 2). At the meeting also best practices in bathymetric data processing and management were discussed along with recent developments for the benefit of the consortium (interpolation, data science and AI). A second Bathymetry plenary meeting took place during the EMODnet Jamboree, 28th November 2023, in Brussels – Belgium, to refresh partners of the production schedule for the new product releases and a special, having an online dialogue with GEBCO and SeaBed 2030 as will be detailed below as par of WP5 and Task 7. As usual, all presentations have been included in the EMODnet Bathymetry extranet, that is continued for internal consortium use. Moreover, from the meetings specific actions were derived and circulated over the full consortium to remind all about planning and deadlines for keeping momentum and providing pointers to background information.

Each thematic has its own dedicated space at the Central Portal where it publishes its so-called 'narrative'. The maintenance is done by sending an updated document to JIRA which is then processed by the EMODnet Secretariate. In the near-future, the thematic lots will get more direct access to the EMODnet CMS (Drupal) for performing maintenance activities. In the reporting period, a number of additional reports and guidelines were submitted for inclusion in the CP reports catalogue. This has been done by the EMODnet Secretariate. EMODnet Bathymetry has maintained the operation and maintenance of the various Bathymetry catalogues and web services that feed into the Central Portal. Recently, EMODnet Bathymetry has received logon details for direct access to the EMODnet CMS (Drupal) for performing maintenance activities on the Reports section. This will be tested and in near future used for providing new reports, where required and appropriate.

Shom and MARIS prepared four Quarterly progress reports which were reviewed and accepted by the EU CINEA. They also drafted and submitted the final report for the previous two-year period, including contributions and deliverables from WP and Task leaders, and including transfer protocol. All these deliverables were transferred to the EU and accepted. Shom has followed up by paying all consortium members for their agreed shares. Finally, Shom and MARIS, have drafted this Interim Annual Report, after collecting input from core partners.

WP2 – Bathymetric data collection and metadata compilation for all maritime basins and coastal waters and arranging common access

Covering Task 1

Early in the year, all consortium members have been informed by group email about the planning of activities in the contract extension and in particular have been encouraged not to wait too long for populating new survey data sets. This message has been repeated a few times over the year and support has been given for data providers, asking about procedures and guidelines.

A review and update took place of the guidelines for giving guidance on the methodologies for populating the catalogues and pre-processing the data sources. This has resulted in Deliverable **D2.1 - Upgraded guidelines for data pre-processing and population of metadata -** which has been released in June 2023 and distributed to all consortium members. It is included in this Annual Report as Annex 1.

As part of the plenary EMODnet Bathymetry meeting, 25th - 26th September 2023, in Brest – France, a training workshop was organized which included a number of dedicated sessions. One session was dedicated to how to populate the SeaDataNet CDI Catalogue service for bathymetric survey data and the SeaDataNet Sextant Catalogue for Composite DTMs, which are operated and maintained for use in EMODnet Bathymetry. This included giving guidance and hands-on training concerning use of the preferred software tools (Mikado, Octopus, and Sextant). Another session was dedicated to the latest developments and release of the Globe software and how to make use of this Globe software by data providers for processing and gridding their new survey data sets and CDTMs into DTM files following the EMODnet Bathymetry standards and methodology. The DTM files should be provided to Regional Coordinators at a minimum resolution of 1/16 arc minutes but rather 1/32 arc minutes and having CDI references included of used survey data sets.

In addition, data providers were already asked to work on producing and contributing more High Resolution DTMs (HR-DTMs) which can be made of single survey data sets, but also as a composite of multiple survey data sets. The HR-DTMs should be populated separately into the Sextant HR-DTM Catalogue. The HR-DTMs are made for public downloading and for these again GLOBE and EMODnet Bathymetry methodology should be followed for delivering data at a resolution which is higher than the EMODnet DTM, so at least 1/32 arc minutes up to 1/512 arc minutes, as long as the resolution within the HR-DTM is consistent. The HR-DTMs should include CDI reference(s) of used survey data sets. The deadline for delivery of HR-DTMs is later in second half of 2024. The finalised and indexed composite DTM files must be sent to each concerned Regional Coordinator whereas the HR-DTMs files have to be sent to IFREMER and GGSGC for management and later inclusion in the High-Resolution Bathymetry map layer for viewing and downloading.

Presentations and trainings at the meeting in September 2023 were given by Coordinators, WP leaders, and specific experts, and all presentations have been included in the EMODnet Bathymetry extranet.

As a result in the first year, the number of survey data sets populated into the CDI service has increased considerably **from 41315 to 42369 CDI entries**, while the number of Composite DTM entries populated into the Sextant service has increased **from 274 to 279 Composite DTMs**. New CDI entries for bathymetry survey data sets were contributed by **15 data providers**, in particular with a large submission of 588 survey data sets by Marine Institute (Ireland) as an associate partner. Partner Ifremer has reviewed its data policy for survey data sets gathered in EEZ of other international countries. Ifremer has decided to publish only data sets for which diplomatic approval has been received. As a result, Ifremer has de-activated 46 existing CDI data sets from the current catalogue, while also adding 127 new data sets.

In the coming quarter more CDI and CPRD entries are expected from many regular data providers as a deadline has been set for the current contract for finalising gathering and population in the first quarter of 2024.

A gap on shallow water bathymetry data is evident in the extended shallow waters of the Danish EEZ. These zones include valuable habitats (seagrass meadows which are a blue carbon sink) and of increased interest for renewables. In 2023 an intense discussion with the Danish Geodata Agency and EOMAP took place which aimed to improve this situation by using the echo-sounder bathymetric survey data from the Danish Geodata Agency and the integration of EOMAP's Satellite-Derived Bathymetry for the shallow waters of the Danish coastal waters. It resulted in a collaboration agreement between those parties in Q4 2023 and a press release to announce this cooperation and highlight the EMODnet project (released Jan 2024). An important aspect of the work is the access to accurate survey data of the Danish Agency, these data have been in preparation in 2023 and a draft of the updated bathymetric survey data was provided to EOMAP in Dec 2023. The new Composite DTM is expected to be delivered in March 2024. In contrast to the Satellite-Derived Bathymetry

data which are already part of the EMODnet Bathymetry dataset for parts of Denmark, this release is a significant improvement. It will enable a continuous and smooth bathymetric surface for the Danish waters, cover more area and will be jointly released and accepted by Danish Geodata Agency and EOMAP.

WP3 – QA-QC, data processing and producing Digital Terrain Models for the basins, the integrated EMODnet DTM, best-estimate Coastlines, overview of legal baselines, and vertical reference levels Bathymetric data collection and metadata compilation for all maritime basins and coastal waters and arranging common access

Covering Task 2

This Work Package includes activities for a range of EMODnet Bathymetry products, such as the production of the EMODnet DTM releases, updating the inventory of national coastlines and baselines, and producing new versions of the best-estimate digital coastlines at three vertical reference levels (LAT, MSL, and MHW).

Activities for the EMODnet DTM releases:

The 2022 EMODnet DTM was made ready end 2022, but due to the launch of the EMODnet Central Portal from 23rd January 2023 and adoption of new ways for publishing, the official release of the new **2022 version of the EMODnet DTM** has been postponed to 13th April 2023. This was done after final checks and testing by the members of the consortium. Compared to the 2020 release, a total of **21.790** unique references to CDI entries and Composite DTMs entries are used in the overall DTM versus **16.260** in the 2020 version. The 2022 DTM is an integration of eleven regional DTMs which were prepared by regional basin coordinators, after selecting and merging pre-gridded and pre-processed datasets as received from data providers. Moreover, a twelfth region has been added, resulting in a DTM for the Caribbean region. The 2022 DTM can again be downloaded in several formats, and includes also a version with MSL vertical reference next to LAT.

The **High Resolution DTM layer** has also been expanded and now covers **308 HR-DTMs** which can be viewed and downloaded. Related metadata for all DTM tiles and HR-DTM files have been populated in the Sextant Products Catalogue CSW and has been harvested into the Central Portal Products Catalogue. The resolution of HR-DTMs varies between 1/32 and 1/512 arc minutes, depending on local data policy of data providers. The new DTM layers are provided to the Central Portal Map Viewer by means of OGC services. For performance reasons, a WMTS service has been added, while the WMS – WFS are continued to be used for interrogating features at the maps. The HR-DTM map layer allows to zoom deeper than the common DTM layer and by clicking users will retrieve the direct download links. For retrieving the DTM tiles, an extra DTM grid map layer has been added which facilitates users to select the DTM tiles and to choose from the different data formats. Also, for each map layer there is a direct metadata link to the associated records in the CP Products Catalogue. The CP map viewer presents the 2022 versions of all DTM layers, while the Product Catalogue also lists and allows downloading of the DTM tiles of the earlier 2016, 2018, and 2020 DTM versions.

Next to this structured downloading of DTM tiles and HR-DTM files, users can select an area of interest for downloading. This is arranged through the CP ERRDAP service in which an integrated DTM 2022 file (NetCDF V4) has been loaded of more than 130 GB. The new 2022 release includes updates of the **source reference, quality index, and satellite derived coastlines** layers. These are also available for the Caribbean region DTM.

Considering the production of the new 2024 EMODnet DTM release, Task 2 activities by data providers for processing and pregridding new survey data sets and composite DTMs using the GLOBE software have started in September – October 2023. This was a follow-up to the training workshop, that was organized 25th - 26th September 2023, in Brest – France. The preparation of data input by data providers for the regional DTMs will

continue till end first quarter 2024, so that the regional coordinators can work on the compilation and generation of the 12 regional DTMs till summer 2024. While, integration and publication of the new 2024 EMODnet DTM is then planned in the period after summer 2024 till end 2024. Activities by data providers for additional HR-DTMs are planned to take place in the first half of 2024.

IFREMER has made an upgrade of the Collaborative Virtual Environment (CVE) with online GLOBE which was also presented at the September 2023 Training Workshop and it is agreed that the CVE will now be used by the Regional Coordinators as an extra instrument for reviewing the existing EMODnet DTM and for identifying and annotating artefacts and anomalies that might be corrected, replacing existing data sets with new received data sets, filling gaps with new data sets, and/or re-running interpolations with new algorithms as made available in GLOBE. Following the September 2023 Workshop an updated version of Deliverable **D3.1 - Upgraded guideline of EMODnet methodology for DTM production, including using prototype CVE** - was made and released in October 2023, which includes guidelines for use of the latest CVE. This guideline has been distributed to the consortium partners and is included in this Annual Report as Annex 2.

At the September 2023 Training Workshop also the latest developments for interpolation techniques were presented and it was demonstrated how to make use of these, looking forward to the coming generation and updating of the EMODnet Regional DTMs by the Regional Coordinators. More information about the interpolation developments will be reported under WP4. At the meeting, the overall planning for the new 2024 release of the EMODnet DTM and associated products was discussed and later circulated in a document to all consortium members. The planning is as follows:

- Till end March 2024: Data Providers:
  - gathering and populating new CDI entries for survey data and new Sextant entries for CDTM data sets, also including SDB data sets
  - completing Quality Info (QI) in existing CDI and Sextant entries, where missing, following list of Shom
  - pre-processing new CDI and Sextant data sets, using GLOBE and following EMODnet methodology, to 1/32 * 1/32 gridded data sets for transfer to Regional Coordinators
- From January to July 2024: Regional Coordinators
  - analysing known issues in their Regional DTMs, following report of Integrator
  - joining Workshop on 16-17 April 2024 for discussing the RDTM generation process
  - contact with data providers to learn about and get hold of relevant new data sets
  - setting up accounts on the Collaborative Virtual Environment (CVE) with IFREMER support for reviewing previous RDTM releases and for making annotations of issues
  - working with local GLOBE to update and improve their RDTM at 1/16 * 1/16 arc minutes with new data, better interpolations, correcting previous errors, etc
  - loading the draft new RDTMs in the CVE in June 2024 for review by all Regional Coordinators and the Integrator, identifying and discussing remaining issues
  - finalising the RDTMs for hand-over to the Integrator
- From August to December 2024: Integrator + Shom + MARIS
  - working on the overall integration of the RDTMs into a consistent EMODnet DTM
  - preparing the source reference layer, checking and correcting any missing CDI and Sextant references
  - making the new DTM ready for publishing as downloadable tiles in multiple formats, OGC services, and completing product metadata in Sextant
  - preparing the MSL version of the DTM and tiles using the LAT-MSL conversions from the GTSM

model of Deltares
- making the 3D version of the EMODnet DTM together with CORONIS
- integrating the new EMODnet DTM into the Central Portal – Products Catalogue and Map Viewer service
- preparing report of findings

The data gathering activities will be completed in the coming months with more CDIs and CDTM submissions, whereby also the pre-processing of the associated data, using GLOBE and following EMODnet methodology, to 1/32 * 1/32 gridded data sets will take place for transfer of the gridded data sets to Regional Coordinators. A workshop has been planned for regional coordinators together with core partners in April 2024 for monitoring and discussing the RDTM generation process. The workshop will be hosted by GGSgc in France.

Activities for updating and refining best-estimate European digital coastlines:

The 2022 DTM also includes the best-estimate digital coastlines for different tidal reference levels (LAT (Lowest Astronomical Tide), MSL (Mean-Sea-Level), and MHW (Mean-High-Water)) as produced by Deltares. The data set can be downloaded as vector shapefiles. It covers the entire coastline of Europe and part of the Caribbean. The production process for the 2022 version has been summarized in a report which is included in the CP reports catalogue. For the contract extension, Deltares made steps for updating and refining the best-estimate European digital coastlines for the 3 vertical levels. This concerns further optimizing of the applied methodology, the GTSM tidal model, and introducing use of new data sources.

The main goal is to build an updated version of the satellite derived coastlines at low water, mean sea level and high-water for Europe and the Caribbean. There are several changes compared to earlier versions of the dataset. Firstly, the workflow will be modified compared to earlier versions. The computations will be performed with a gridded version of the data and contouring will be performed at the last step only. This will streamline the computation and make the various datasets more consistent. The reason is that computations with polygons are slow and often somewhat ambiguous. The figure below shows the new workflow.

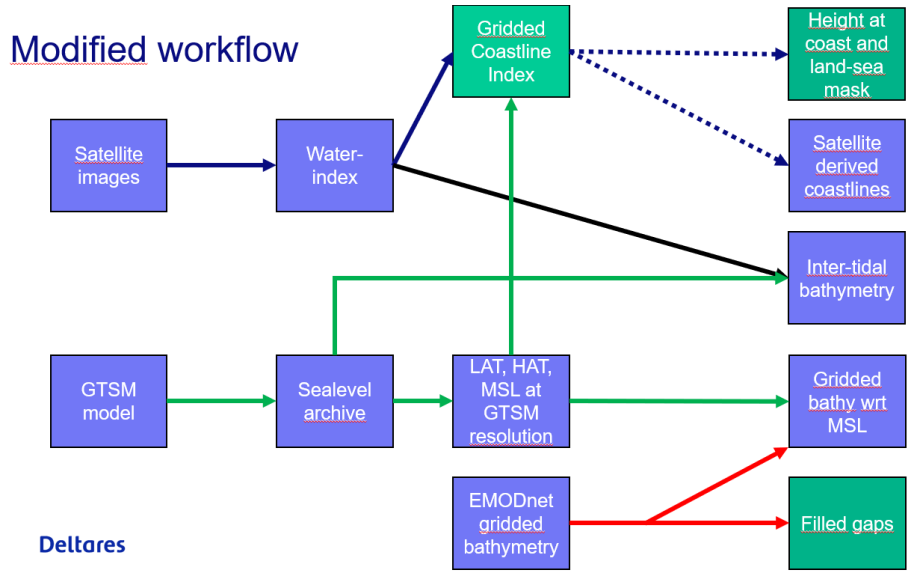


Image: Modified workflow for processing satellite derived bathymetry, coastlines and sealevel data.

With the new processing chain Deltares also aims to make the satellite-derived coastlines more consistent. This can potentially improve the EMODnet products in several ways. First, the satellite derived coastlines have a vertical level associated with them that can be used to reduce interpolation artefacts near the coast. Second,

the LAT to MSL correction must use the land-sea mask of the gridded bathymetry, and more consistency can increase the accuracy. The figure below shows an example with some of the differences between the land-sea mask from the gridded bathymetry and the satellite derived coastline.

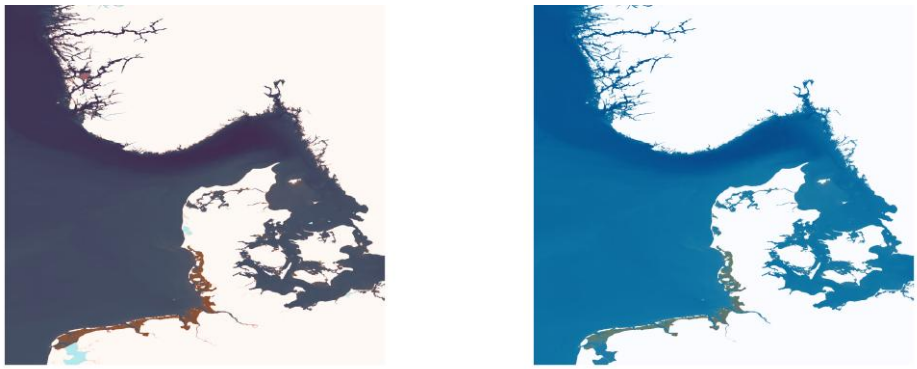


Image: Current land-sea mask (left) and satellite derived land-sea mask.

In the past year numerous preparations for the sea-level/tide datasets for the next release have been performed. The Global Tide and Surge Model (GTSM) is the core of the sea-level computations. Over the past years the quality of the model has steadily increased (see Table and Figure).

Year	version	developments	resolution	Std [cm] FES2014	Std [cm] coastalABC	Time [hr/5wk]
	gtsm1					
2015	gtsm2	Improved grid, SAL, improved IT diss	5km	9.3	25.4	5.35
2015	gtsm2_glossis		5km	11.3	25.1	5.33
2019	GTSMv3_codec	Improved grid and resolution Implementation of SLR	2.5/1.25km	7.6	18.3	23.72
2019	GTSMv3_cmip6 **(CMIP6 climate projections)**		2.5/1.25km	7.6	18.2	22.61
2020	GTSMv4.0 (EM66)	Improved bathy, calibration, Improved tidal potential	2.5/1.25km	6.3	17.4	21.08
2020	GTSMv4.0 + CA (EM64)		2.5/1.25km	4.6	15.7	20.11
2021	GTSMv4.1 (EM74)	Improved IT diss, Chezy re-tweaking, re-calibration XW	2.5/1.25km	5.8	16.8	18.58
2021	GTSMv4.1 + CA (EM75) **(GLOSSIS)**		2.5/1.25km	3.2	14.1	19.14
2022	GTSMv5.0 (GM42)	Improved grid (ortho), new bathy, improved ITfrict, cutcell **(in development)**	2km/800m	4.7	15.5	18.68
2023	GTSMv5.0 (GM42+cutcell)		2km/800m	4.2	12.8	19.23
2023	GTSMv5.0 + CA (-)		2km/800m	-	-	-
2020	FES2014 coastal stations				13.7	

Table: Development overview of GTSM over multiple years

One development in GTSM is a new numerical method for grid-cells at the coast. The coastal cells can cross the coastline and thus overlap in part with land and in part with sea. The new 'cut-cell' method removes part of the coastal cells which improves the accuracy of the representation especially in narrow channels. The figure below shows the impact of the method on the accuracy compared to satellite derived tides. A few regions show marked improvements, with smaller improvements throughout the domain. The next steps with the GTSM will be to finalize the next version of the model and commence the data generation for the other steps in the workflow described earlier.

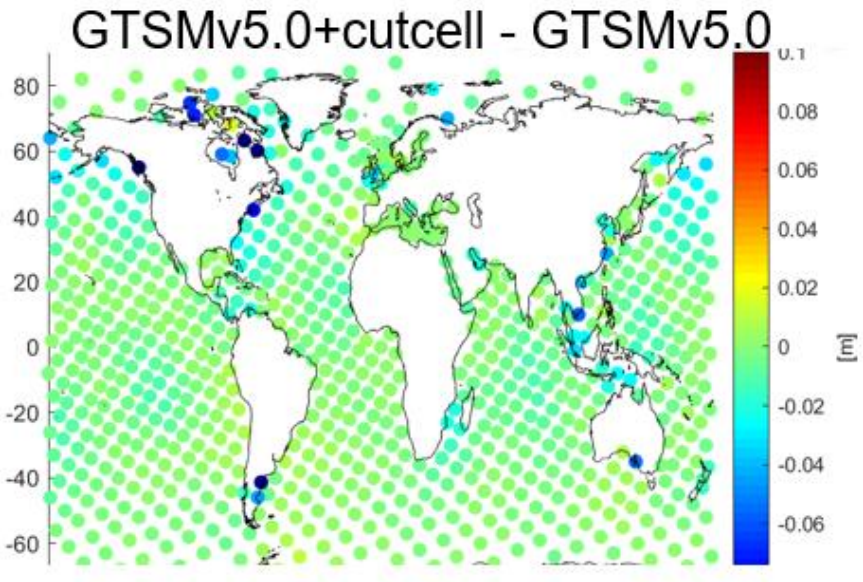


Image: Change in accuracy resulting from application of the cut-cell method. Negative values indicate improvements.

Activities for updating and further completing the overview of legal baselines:

The 2022 inventory of national legal baselines and coastlines of EU member states has also been included in the CP reports catalogue, while for the new contract, Deltares undertook activities for maintaining this inventory of national baselines and coastlines and producing in time the 2024 version.

In the past years, coastlines were collected for most European countries. This concerns existing and ratified baselines, registered claims / disputes under UNCLOS, for European countries, and official national coastlines. In the past year, existing contacts were approached and requested for updates of the coastlines and baselines for each country. Many of these contacts are a partner of the present consortium or closely linked to the relevant institutes. At the moment the data is pouring in and discussions are ongoing on many aspects of these delivered GIS datasets. More data is expected to arrive in the next weeks to months. Next, the data will be converted into a common format and compared to other datasets to scan for possible mistakes. In addition, Deltares received good input from MarineRegions and currently these differences are being studied and discussed with the data owners. Finally, Deltares is attempting to find contact points for the few remaining countries that did not contribute their coastline and/or baseline so far.

Image: Official coastlines and baselines around Europe

Activities for extrapolation of missing bathymetry with deep learning:

During the previous 2022 release, the EMODnet gridded bathymetry was extended to Venice lagoon. This included several new datasets both from bathymetric surveys and from satellite derived bathymetry. It also became clear that even though a larger and larger fraction of the coastal waters is covered with every new release of the EMODnet gridded bathymetry, there are still numerous coastal regions where no high-quality data is available and where the water is not clear enough for satellite derived bathymetry. To fill these gaps, Deltares proposed for the 2024 version to develop a generative deep learning approach to fill the gaps, at least until these can be replaced by survey data. The developments needed can be split into two topics. First, training data for the machine learning needs to be prepared, and second deep-learning methods are developed to generate probable solutions for missing parts of the data.

Training data

The training data in this work-package will be based on the EMODnet gridded bathymetry. The regions with missing or poor-quality data will be identified based on the quality parameters that are available with the product. For training, Deltares will only use those areas that have good quality indices attached to them. The best thresholds for this are still under investigation. Scripts have been developed randomly sample tiles of training data. In this way new tiles can be generated at will, which will reduce the likelihood of over-fitting to the data. The figure below shows some sample tiles with the percentage of land within the tile.

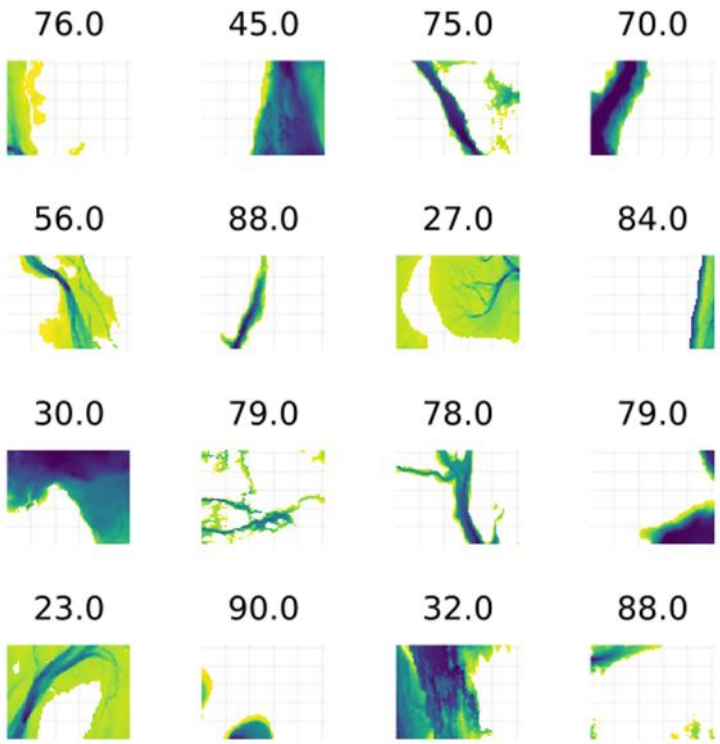


Image: Sample of generated tiles meant for training and testing of the deep-learning network

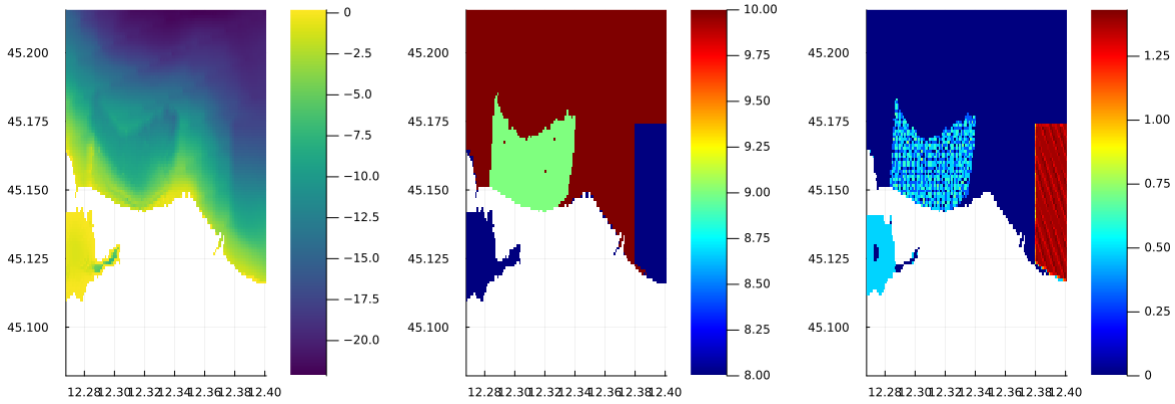


Image: Sample bathymetry tile (left), with source (middle) and quality index (right). The transitions between the different sources are clearly visible. Note, that we searched for a clear example.

Methods for inpainting

The problem of filling in missing parts of an image is often called inpainting. To illustrate one of the main challenges of inpainting, first an example is shown based on a convolutional autoencoder. The technicalities of this method are not important for this example. The figure below shows an example applied to images of handwritten digits from the MNIST dataset with a missing part of the image. The goal of the neural network in this example is to fill the gaps. As can be seen clearly the more uncertain parts of the image will become more blurred. This is a fundamental issue in trying to predict the most likely value. However, in this application, it is desirable to generate a coherent image that is a possible extension of the data into the region with missing

data. Deep learning methods of this type are often called generative AI. So, the method generates a possible solution, not necessarily the most likely solution, and can also generate multiple solutions if desired.

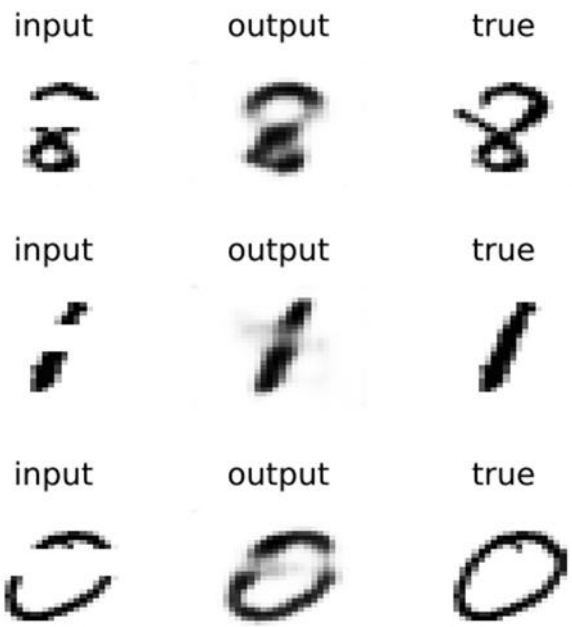


Image: Example of inpainting with a variational auto-encoder, with (on left) the input image with a missing part, (in middle) the image with generated missing part and (on right) the true original image

A well-known method for generative inpainting is called stable-diffusion. An important advantage of this class of models is that they aim to learn the underlying probability distribution of the input data. New samples (i.e. images) can be generated by sampling from the learned distribution, or gaps in images can be filled in by injecting the known parts into the sampling process. This can yield realistic looking samples as a direct result of learning the distribution, even in cases where most of the image is missing. In such extreme cases however the inpainted image is not necessarily true to the original. Rather a trained network will try to generate something that looks realistic based on the information provided during sampling. There are various schemes for generating new samples, each an iterative process with an adjustable number of steps. By choosing a particular sampling scheme and number of iterations a balance between sample quality and sampling speed can be struck. Score matching learning is flexible with respect to the choice of network architecture. For the examples here a standard UNET architecture was used. In the figure below on can see that the generated images are all realistic in the sense that they look like digits, but if too much of the input image is missing the method can generate a different digit, as seen in the second row where the 5 was turned into a 9. However, on the third row the correct digit was drawn, even though most of the image was missing. Note that this can be a coincidence and regenerating the image may give a different digit in some cases.

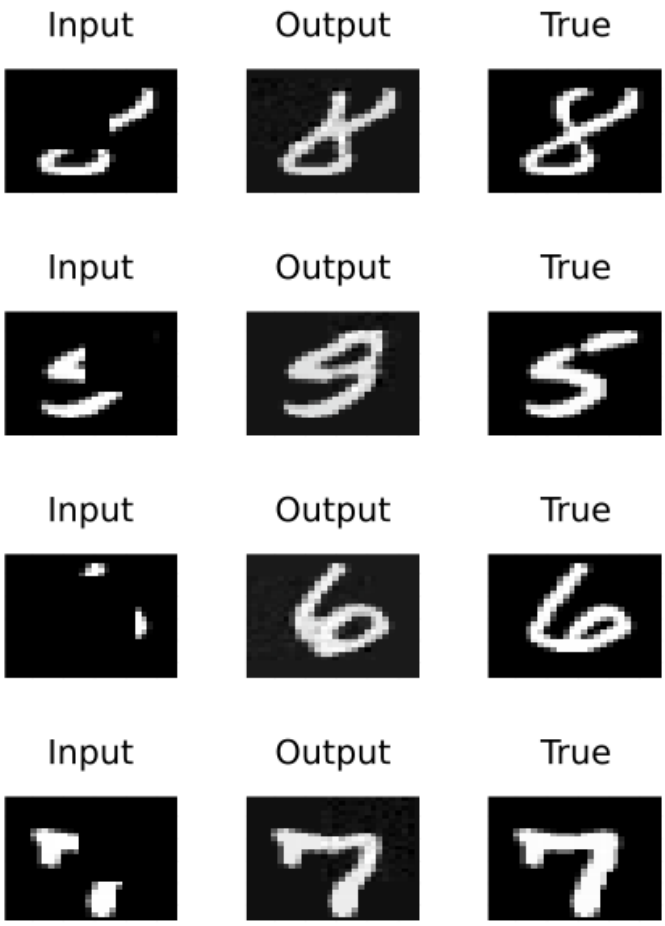


*Figure: Examples of inpainted MNIST images***.**

MNIST images with parts (input column) missing were provided to a trained network during sampling, with the results shown in the output column. The original images are shown in the true column.

Quality Index preparation for new DTM:

The new 2022 release includes an update by Shom of the Quality Index layer which provides for each location of the DTM a vertical precision indicator, a horizontal precision indicator, an indicator of the age of the local survey, indicator of the purpose for which the survey was acquired and a composite or all these indicators. The QI map layers have been integrated in the OGC web services and are available in the CP Map Viewer. The associated report has been included in the CP reports catalogue. For the new contract, Shom will prepare an updated QI once the 2024 DTM is available internally.

WP4 – Technical Development & Operation of services and tools

Covering Tasks 3 and 4

This Work Package includes technical activities for a range of EMODnet Bathymetry services, such as finalization of the migration from the existing thematic portal to the EMODnet Central Portal, the maintenance and operation of the EMODnet Bathymetry services and new site, the upgrading of the GLOBE software, the further development and optimization of interpolation techniques, and the further development and adoption of the Collaborative Virtual Environment (CVE) with online GLOBE for the regional DTM production workflow.

Activities for migration to Central Portal:

The migration from the thematic Bathymetry portal to the EMODnet Central Portal has been finalised and the new Central Portal was launched at 23rd January 2023, while the publishing of the EMODnet Bathymetry website was halted at the same date. Redirects were configured to make sure that users following old URLs will be redirected to the Central Portal.

EMODnet Bathymetry now continues to operate and maintain several catalogue services and web services, which are being harvested and/or directly feeding the Central Portal services. The services are following INSPIRE principles and their operations are being monitored from the Central Portal with good results.

The resulting situation after migration be summarised as follows:

- EMODnet Bathymetry maintains a thematic section at the Central Portal, the 'narrative'. Currently, this works by providing the EMODnet Secretariat edited texts, which they implement. Later on, each thematics will get access to an online CMS;
- EMODnet Bathymetry feeds the central Map Viewer service by means of OGC as WMS, WMTS, and WFS. This concerns all map layers that were previously included in the EMODnet Bathymetry MapViewing service. For each layer, a metadata record was generated in the Bathymetry Sextant catalogue services, which is now used to describe each DTM version, each DTM tile with their various formats, HR-DTMs, and additional bathymetry products (e.g. satellite derived coastlines), and map layers. The Sextant catalogue is managed by IFREMER based upon GeoNetWork and is now successfully harvested regularly by the Central Portal for inclusion of the bathymetry records in the CP Products Catalogue. Each entry has a UUID, which also comes back in the OGC services so that links are made between a map layer or items within a map layer and its metadata record. Furthermore, download links for bathymetry products have been included in the Sextant records. Downloading in that case takes place from the bathymetry back-office as there are hundreds of files and synchronisation between metadata and download links is easier in one space controlled by Bathymetry. The downloading of DTM tiles in multiple formats and HR-DTM files can be done from the CP Products Catalogue and from dedicated maps in the CP Viewer;
- The central Map Viewer service also includes a general Download button which is driven by ERDDAP. This allows users to make an area of interest and then download information for this area from all activated map layers in one go. For Bathymetry, one integrated file was made of the full DTM in NetCDF of circa 130 GB and loaded in ERDDAP. The function works in practice, although users should not make a too large area. However, the ERDDAP service lets users select from a long list of formats, of which most are not relevant for bathymetry and further use of output in specific bathymetry software such as ArcGIS, QGIS, and others. Therefore, there is an outstanding request to the CP team to expand the list of ERDDAP supported export formats with ESRI ASCII (known to be the most downloaded format of the EMODnet Bathymetry prior to centralisation) and GeoTIFF. Both formats are supported by the bathymetry OGC WCS service that users could use as alternative to the ERDDAP service.
- The EMODnet DTMs are composed on the basis for survey data sets and composite DTMs (including Satellite Derived Bathymetry), while gaps are completed by using GEBCO and IBCAO bathymetry products. The survey data sets are described and can be requested for downloading through the SeaDataNet CDI Data Discovery and Access service. For Bathymetry, at present more than 42.000 CDI entries are included, while metadata for the composite DTMs are included in the SeaDataNet Sextant catalogue service. The CP map viewer features a source reference map layer which allows users to interact with these two catalogue services. While users can also overview and interact with the full bathymetry CDI collection as a separate map layer. This same layer is also shared with NOAA and integrated in the IHO DCDB bathymetry viewer.
- The 3D visualisation functionality has been added to selected bathymetry map layers in the CP Map Viewer. For that purpose, an updated 3D compilation was made of the new 2022 DTM release.

- All relevant guidelines and reports from EMODnet Bathymetry are included in the CP Reports catalogue, while also CP sections describing tools and web services relevant for EMODnet Bathymetry are maintained.

Concluding, EMODnet Bathymetry is continuing its back-office system with geographical database, its OGC services, and the external CDI and Sextant catalogue services, while the Central Portal provides the user interfacing functions, interacting with and building upon the EMODnet Bathymetry infrastructure. Use is made of JIRA for communicating actions and requests between the Bathymetry team and the CP team. It is now also being used for identified bugs or requested changes, and also to receive and respond to feedback as ventilated by users.

Activities for making the CVE ready for Regional Coordinators:

Another activity under Task 3 has been the further development and uptake of a Collaborative Virtual Environment (CVE) with online GLOBe software. Ifremer has developed in 2021 a prototype for a Collaborative Virtual Environment (CVE). It then allowed analysis of the difference between the 2018 and 2020 versions of the EMODnet Bathymetry grid. The geographical area of concern were the four regions of the Mediterranean Sea and Black Sea. The objective of the CVE development is to provide a common environment for the quality control of regional DTMs and to share, between all partners, the analysis of the gaps between 2 successive releases of the regional DTMs. This analysis should contribute to identify and correct remaining issues in the DTMs. For that purpose, the CVE development project has now been extended to cover the whole EMODnet DTM for all European seas and North-West Atlantic Ocean, and undertaking further developments for optimising and expanding functionalities. The latest version of the CVE focuses on 3 main functionalities:

- Display of Regional DTMs
- Implementation of Web processing tools, which are dedicated to the quality analysis of DTMs
- Annotation tools, allowing the regional Coordinators to document and share remaining issues on regional/final DTMs.

For each Regional DTM, four map layers were made available:

- both grids of the water depth for 2020 and 2022 DTM grids
- their difference
- the 2022 source reference layer.

In order to help the Regional Coordinators delineating issues in individual depth grid, tools for the DTMs analysis have been implemented such as the calculation at grid node of the slope, the detection of erratic peaks, artificial hill shading, and iso-value (isobath) contours. Moreover, an annotation tool now allows observations to be recorded as a geographic object (point/line/polygon) associated with a textual description. This way, the Regional Coordinators will be able to oversee anomalies, look up used data sets, and make annotations for areas that have to be improved, inter alia by use of alternative or new data sets, for as far available, or changes in interpolation and/or processing.

The new functionalities were presented at the September 2023 Training Workshop in Brest – France, and also a new deliverable **D3.1 - Upgraded guideline of EMODnet methodology for DTM production, including using prototype CVE** - was made and released in October 2023, which includes guidelines for use of the latest CVE. This guideline has been distributed to the consortium partners and is included in this Annual Report as Annex 2. Regional Coordinators are given online accounts for working with the CVE as extra instrument for the workflow towards generation of updated 2024 Regional DTMs. Another workshop will be organized in April

2024, involving the Regional Coordinators, monitoring the progress of the production process and sharing together experiences and expertise.

Activities for upgrading GLOBE software:

Ifremer is continually making progresses with upgrading the GLOBE software for pre-processing and pre-gridding of input data sets and generation of the Regional DTMs. Also, in 2023 some improvements were made, following bugs or requests from data providers and Regional Coordinators. The latest status was presented at the September 2023 Training Workshop, and a hands-on training session was undertaken. A few improvements are:

- Compression of NetCDF DTM files (E*MODnet Tile : 2Go ➔ 0,3Go)*
- Computation of statistics of 1:n NetCDF DTM files
- Computation of Quality Indicators (for multibeam formatted files)

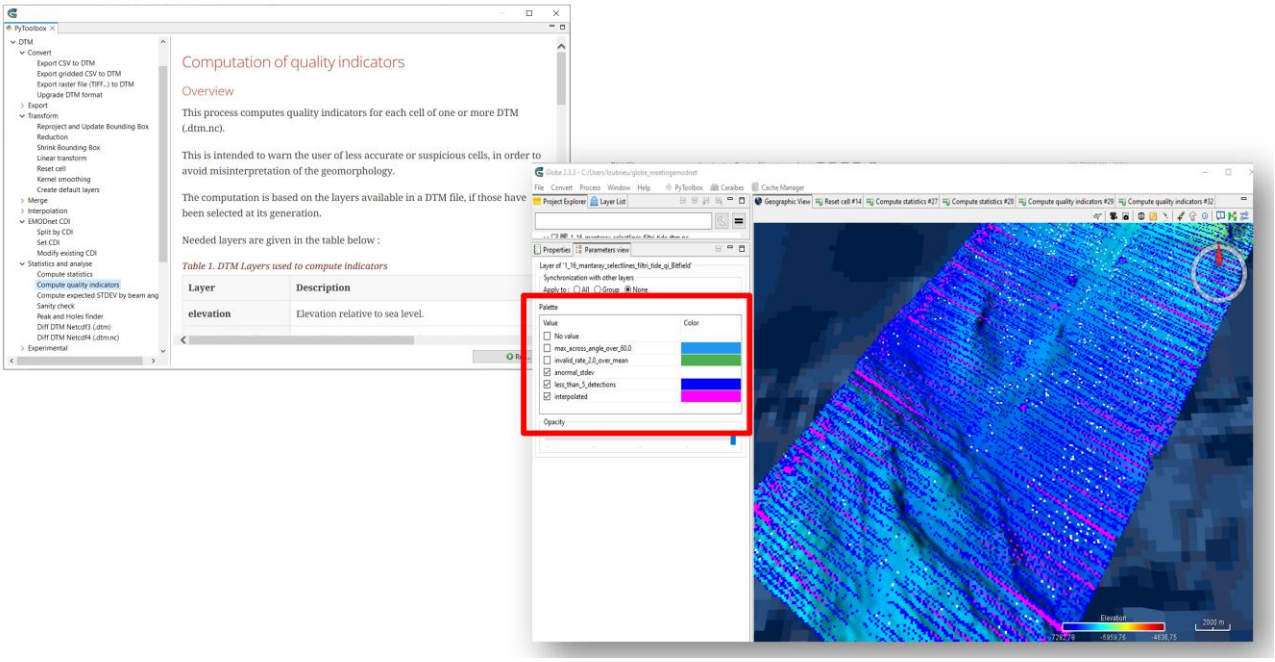


Image: example of Quality Indicators function

- NetCDF Viewer: new tool to explore NetCDF files, useful to check DTMs content, at the variable content.

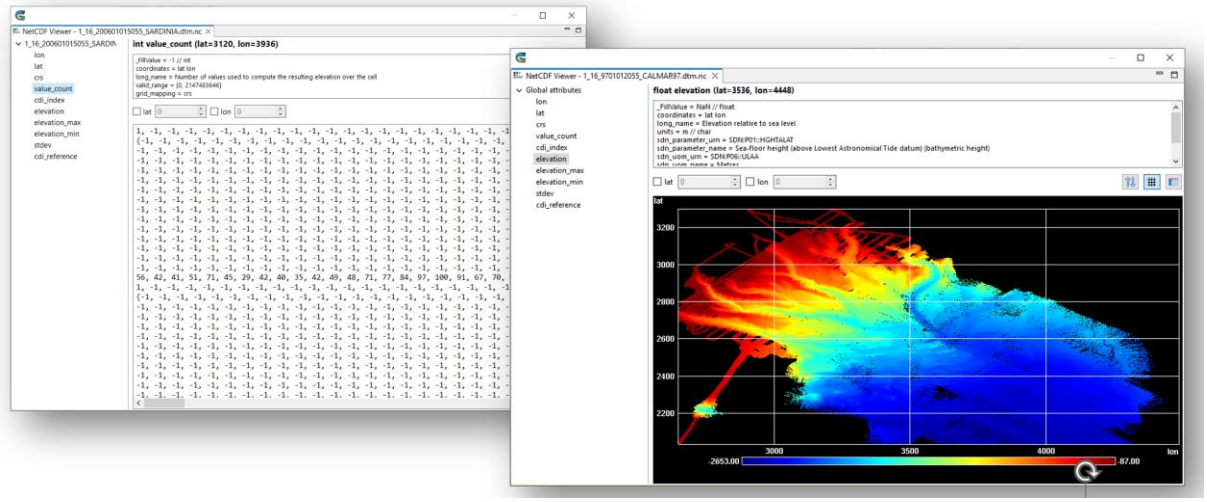


Image: example of new NetCDF Viewer in Globe software

In 2024, the workflow reproducibility will be improved with a new tool set to:

- record executed processes in a logbook
- easily summarize, edit and replay part or the entire processing chain

The aim of this is to allow users to relaunch all processes, from raw data to result DTM, when new data is available, to change only one parameter, or just to check the result in other environment.

Activities on optimization of interpolation techniques:

Earlier, CORONIS developed several interpolation methods to adapt to the processing needs of most EMODnet Bathymetry partners. However, the large resolution and amount of data normally used within this project causes some of the interpolation techniques implemented in previous phases to require large run times to execute. With the aim of alleviating this problem, CORONIS explored the possibility of adapting some of the methods to use the GPU for speeding up repetitive computations.

The use of GPUs for general computing has gained a lot of attention recently, mainly because of its heavy use on modern artificial intelligence architectures (i.e., Deep Learning). GPUs are optimal for parallelizing certain operations, convolutions being one of them. Some of the interpolation methods developed in previous phases rely on solving Partial Differential Equations (PDEs), and it turns out that the solver used by such methods uses convolutions intensively.

The heightmaps are bivariate functions of the form $u(x, y) = z$. All the PDE-based methods implemented in the EMODnet Bathymetry Heightmap Interpolation package define the properties of the desired interpolating surface $f(u)$. Such PDE is solved using a gradient-descent algorithm in a grid following update equation:

$$f(u)_{t+1} = u_t - \phi\nabla\big(f(u_t)\big),$$

where t is the iteration index and $\nabla\big(f(u_t)\big)$ is the gradient that we need to follow, computed using finite differences. Given a cell of the grid, the derivative $\nabla\big(f(u_t)\big)$ can be approximated as a "weighted average" with the value of its up/down/left/right neighbours. This operation can be casted as a convolution. Therefore, it seems natural to move all these convolutions to the GPU in order to gain speed. It was decided to re-

implement the Continuous Curvature Splines in Tension[1] method (which is the most versatile PDE-based interpolation method, but also one of the slowest) to use the GPU during convolutions. More precisely, CORONIS translated the code to a Taichi-lang[2] implementation. Taichi-lang is a domain-specific language embedded in Python that allows to write parallel programs in a way that takes advantage of the hardware on your PC. In this sense, if the PC has a GPU it will use it to run the parallel computations there. Otherwise, the program will also parallelize the execution, but on the CPU. The new implementation needs more testing to validate its improvement in performance on real datasets, but in preliminary tests it achieved up to a 7.5 speedup in moderately sized datasets when comparing the CPU and the GPU implementation. Moreover, in order to further improve the speed of the PDE-based algorithms, a new termination criterion was defined. PDE solvers iteratively update the equation presented above until "no significant change" is detected between iterations. The problem is how to define "significant" for datasets with different scales in Z. In the previous implementation, this decision was mainly left to the user, who had to define a *relative global change* threshold to decide if the difference between iterations was small enough to end the solver. The problem is that, for a dataset containing a range of elevations from -10000 to 10000, a change of 1m is not relevant. However, if the range of elevations is from 5 to 10, then 1 meter is a lot. Consequently, a relative error between iterations is difficult to set. The new approach is to define the termination condition as an *absolute value*, in the maps' units. Now two options are provided:

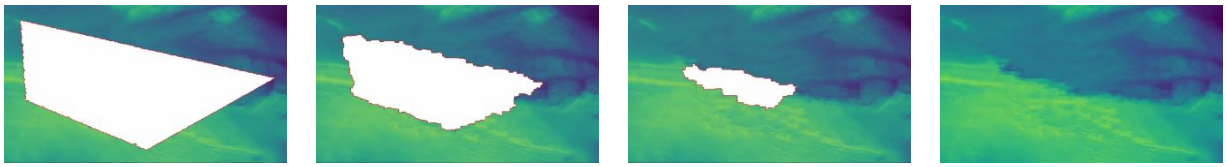
- Stop when the absolute change of one cell is below a threshold (in meters).
- Same as above, but specified as a percentage of the valid range of elevations in the map.

Finally, also related to the interpolation topic, one of the drawbacks of all the interpolation methods developed so far is that they do not take care of the gradients of the original data. In cases where the interpolation is to be used as a "hole filling" algorithm, meaning that the area to interpolate is surrounded by dense data, the structures present there (ridges, valleys, etc.) should have a continuity in the interpolated data. To this end, CORONIS has adapted and integrated the method of Criminisi et al.[3]. As a recall from previous reports, the original method was devised for image inpainting, and the adaptation made by CORONIS to use it on DTM renders an interpolation method that can preserve/continue gradients surrounding the areas of missing data (See image below). This implementation is currently internal and is being validated and tested before its inclusion in the main branch of the public Python package.

[1] Smith, W. H. F, and P. Wessel, 1990. Gridding with continuous curvature splines in tension, Geophysics, 55, 293-305.

[2] Y. Hu, T.-M. Li, L. Anderson, J. Ragan-Kelley, F. Durand. Taichi: a language for high-performance computation on spatially sparse data structures. ACM Transactions on Graphics (TOG), vol. 38, no. 6, pp. 201, 2019.

[3] A. Criminisi, P. Perez and K. Toyama, "Region filling and object removal by exemplar-based image inpainting," in IEEE Transactions on Image Processing, vol. 13, no. 9, pp. 1200-1212, Sept. 2004, doi: 10.1109/TIP.2004.833105.



(a) (b) (c) (d)

Image: (a) shows the initial DTM, with the missing area to interpolate in white and the fill front as a red polyline. (b) and (c) show two intermediate steps of the iterative filling process. Finally, the result is presented in (d).

Activities on upgrading the 3D visualization:

CORONIS also worked on updating the web 3D viewer to include recent developments in the core visualization library. A feature that is quite desirable when working with bathymetric data is the real-time exaggeration of the terrain's vertical dimensions, which allows the viewer to grasp changes in the terrain in the low or high frequencies easier and on-demand. CORONIS took advantage of the new visualization techniques available in the Cesium JS library to add this option: now the 3D viewer allows the user to adapt the Z values' scale with a slider in real time (see image below).

Image: The new terrain exaggeration tool. On the left it shows the original DTM while on the right with exaggeration values, computed in real time given the input of the user via the slider.

Currently, the updates implemented in the viewer are internal and expected to be part of the viewer in the EMODnet portal at the end of the project. This will require cooperation with the CP Team for adoption in the CP Map Viewer, replacing the current configuration.

WP5 – Uptake, cooperation, helpdesk and outreach

Covering Tasks 6, 7 and 8

This Work Package includes activities for achieving interoperability, ensuring involvement of regional sea conventions, contributing to the implementation of EU legislation and broader initiatives for open data, and to monitor quality / performance and deal with user feedback.

Ensure the involvement of regional sea conventions:

Secretariats of the Regional Sea Conventions are kept up-to-date of the EMODnet Bathymetry services through regional partners. The 2022 EMODnet bathymetry full grid release, launched in April 2023, provides a good opportunity to reinforce the good relationships with the secretariats of the Regional Sea Conventions who are kept up-to-date of the EMODnet Bathymetry services and products, and where possible, engaged in wider promotion and contributing to mobilising more potential data providers and product users. Representatives of the Regional Sea Conventions have also been informed about the EMODnet progress and products during the successful EMODnet Open Conference which was held from 29 – 30 November 2023 in Brussels – Belgium.

Contribute to the implementation of EU legislation and broader initiatives for open data:

Ever since the start of the EMODnet Bathymetry project there has been a strong relationship between various global bathymetric initiatives. For example, EMODnet Bathymetry has been using GEBCO data to fill voids in the European data coverage and there have always members of the EMODnet Bathymetry team actively contributing to the GEBCO community either as member of chair of various working groups and committees. The cooperation between EMODnet Bathymetry and these broader initiatives has been further reinforced in 2023 which is illustrated in the following sections:

GEBCO and Seabed 2030:

EMODnet Bathymetry continues to be the main data source for the GEBCO digital grid, produced yearly by the Seabed 2030 project. The EMODnet Bathymetry 2023 grid is fully incorporated in the GEBCO 2023 grid release. Due to the two-year cycle of the EMODnet grid, the GEBCO 2024 digital grid will receive no updates. The final EMODnet deliverable for the 2022-2024 will be incorporated in the GEBCO 2025 digital grid. The forthcoming EMODnet Bathymetry grid will however benefit for the GEBCO 2024 grid which is expected early summer 2024.

The EMODnet Bathymetry team as experts for EU waters continues to provide feedback to GEBCO community. George Spoelstra, from EMODnet partner GGSgc, is the current elected Chair of the GEBCO Technical Subcommittee for Ocean Mapping (TSCOM). Vice Chair is Federica Foglini from another EMODnet Bathymetry Partner, CNR-ISMAR. In addition, Dr. Thierry Schmitt from Shom, coordinator of EMODnet Bathymetry, is member of TSCOM.

The current Vice Chair for the GEBCO Guiding Committee is Marcia Rovere, also from CNR-ISMAR. Together with the Chair of TSCOM who is ex-officio member of the Guiding Committee, a strong EMODnet representation in the various GEBCO bodies is ensured. As Chair of the TSCOM Meta Data working group, Federica Foglini is undertaking various initiatives to further align the management of metadata between GEBCO and EMODnet. Chair TSCOM George Spoelstra has presented EMODnet at various Seabed 2030 and GEBCO meetings around the world. Most notably a presentation at the Seabed 2030 regional mapping committee meeting in Lima Peru was well received and various representatives of South American organizations showed great interest in the EMODnet project.

During the EMODnet Jamboree a meeting of the Bathymetry consortium took place, which included an online dialogue with GEBCO and SeaBed 2030 senior staff about the cooperation and synergies and also how to arrange that data from European data providers will go through EMODnet to GEBCO and SeaBed 2030. This dialogue will be followed up.

COPERNICUS Marine project for the Provision of global coastal bathymetry derived from Sentinel 2 observations (23134L00-COP-PROD S2 BATHY-9000):

Mercator Ocean International launched early summer 2023 a tender for the provision of global coastal bathymetry derived from Sentinel 2 observation. A consortium of EMODnet Bathymetry partners, i.e. EOMAP, Deltares and GGSgc, successfully submitted a proposal, which was awarded end of 2023. The basic idea behind this initiative is that coastal zones, at the interface of land and ocean, are of tremendous social, economic, and ecological value: About 40% of the world population is currently living within 100 km of the coast, with three quarters of all large cities being situated along coastlines. Coasts are also home to biodiverse habitats storing much more carbon than forests per equivalent area. Their high importance stands in contrast to the lack of knowledge and existing monitoring routines on a global scale. Bathymetry, the underwater topography, is a key environmental parameter for a wide range of coastal applications, such as modelling and hazard assessment, seafloor classification, and quantifying habitat loss or carbon storage capacity. For this project EOMAP acts as project leader and together with its partners Deltares and Geo Consultancy (GGSgc), will provide global coastal bathymetric data to fill this knowledge gap.

Copernicus Marine implemented by Mercator Ocean International (MOi) prioritizes the development of a coastal extension to the service. The satellite-derived bathymetry products to be developed for the Copernicus Marine Service starting with this contract will complement activities of EMODnet bathymetry. This is in line with the high-level agreement between the EU DG DEFIS and DG MARE for the coordination of activities between Copernicus Marine and EMODnet. For knowledge-based decision-making on coastal issues, reliable open data that describe, monitor and forecast the environment is key. Nearshore bathymetry datasets as delivered by this project strengthen the Copernicus Marine Service portfolio, as it will now provide better monitoring of coastal zones, maximizing the use of Copernicus Sentinel missions.

The project will combine multiple techniques to provide global shallow water bathymetry from satellite data. This will be complemented by intertidal bathymetry from Deltares, and its established modelling know-how. In view of the global scale of the project, GGSgc will add its international experience as an expert in marine cartography and bathymetry. It is the intention that the project will deliver a global dataset (where feasible) of satellite derived bathymetry at a resolution of approximately 100 meters by the end of 2025.

Through the EMODnet partners EOMAP, Deltares and GGSgc an excellent coordination between EMODnet Bathymetry and Copernicus Marine will be ensured.

GMRT:

The Global Multi-Resolution Topography (GMRT) synthesis is a multi-resolution compilation of edited multibeam sonar data collected by scientists and institutions worldwide, that is reviewed, processed and gridded by the GMRT Team (Lamont Doherty Earth Observatory) and merged into a single continuously updated compilation of global elevation data. The synthesis began in 1992 as the Ridge Multibeam Synthesis (RMBS), was expanded to include multibeam bathymetry data from the Southern Ocean, and now includes bathymetry from throughout the global and coastal oceans. GMRT is included in the ocean basemap in Google Earth (since June 2011) and the GEBCO compilation since 2014. It was used for the first time in for the EMODnet DTM of the Caribbean Sea Basin in 2022.

Just like with the GEBCO digital grid, through the use of GMRT in EMODnet products, EMODnet also provides feedback to GMRT. Because of this, EMODnet is becoming more and more a leading partner of these broader global initiatives. Not just as a data provider but also as a best practices model for the provision of gridded bathymetry.

Monitor quality / performance and deal with user feedback:

The overall performance of the portal and its services is continuously measured and its results are reported in the separate indicators spreadsheet. It demonstrates that Bathymetry and its services and products continue to be quite popular, also in the new setting on the Central Portal. In the first quarter, when the migration to the Central Portal had been established, the visitor and download statistics were lower than before at the thematic portal, but in the following quarters the users became more acquainted with the new portal services as traffic and downloading increased. Also, the publicity around the release of the 2022 EMODnet DTM and associated data products contributed to this increase. In the 4th quarter of 2023, the number of visits and downloads of the full DTM products has increased quite considerably, which is most likely due to the EMODnet Open Conference and the promotion around this event.

In comparison with the previous year 2022, the number of downloads has increased in the year 2023 from > 26.000 to > 46.000 downloads of DTM tiles and from >2.100 to >16.000 HR-DTM file downloads, and from >100 to >1.000 Satellite Derived Coastlines package downloads, while the use of OGC services has stabilized around 28 million OGC WMS service requests and 250 thousand OGC WFS service requests. This demonstrates that users after some intro period can find again and use the major products and services of EMODnet Bathymetry. Unfortunately, there are not yet statistics for the use of the ERDDAP sub-setting service for Bathymetry, but there are several feedback mails from users asking for improvements of this service, in particular with respect to the data formats that can be selected for downloads.

The user feedback is at a regular level both on the quality of the DTM product and the usability of the portal. Most questions are from regular users asking about how to do queries and downloads in the new configuration. Answers are directly provided to the users. Some earlier functions are being missed. These are put on a wish list from EMODnet Bathymetry for future developments and included in JIRA. From the response it is also clear that there is a need for a Help file and/or some tutorials about how to operate the various new CP services.

4.Identified issues: status and actions taken

A. Priority issue(s) identified and communicated by CINEA/ DG MARE/ SECRETARIAT				
Priority issue	Status (Pending/ Resolved)	Action(s) taken/ remaining actions planned	Creation date	Date resolved
EM-715 EMODnet BathymetryURL direct to new EMODnet portal	Resolved	Redirect matrix made and deployed	17/01/2023	23/01/2023
EM-82 Metadata and data URLs	Resolved	Adapted URLs in OGC web services	12/11/2020	03/2023
EM-563 Feedback on CP Main Menu (related to EM-527)	Resolved	Done	26/04/2022	05/04/2023
EM-631 Standardise the navigation menu	Resolved	Done – No changes needed	27/09/2022	20/04/2023
EM-646 Bathymetry to review layer legend	Resolved	All layers have a legend	27/09/2022	20/04/2023
EM-658 Problem with coastline around Ireland	Resolved	Solved with the new version of the EMODnet Bathy deliverables	04/10/2022	20/04/2023
EM-821 Bathymetry to send email address	Resolved	Email address provided for access of the CMS	18/07/2023	11/08/2023
EM-869 Bathymetry to provide metadata records relevant to the Ocean Hackathon 2023	Resolved	No update was provided from Bathymetry. Sorry.	17/01/2023	17/11/2023
EM-905 Geoserver 2x server side request forgery issues	Resolved (Bathymetry side)	Bathy has an updated version (2.4.1)	09/12/2023	10/12/2023

B. Issues / challenges identified by the thematic assembly group itself				
Priority issue / challenge	Status (Pending/ Resolved)	Action(s) taken / remaining actions planned	Creation date	Date resolved
EM-733 Add Bathymetry WMTS service info on CP webservices page	Resolved	Done by CP Team	08/02/2023	28/03/2023
EM-721 Rate limiting causes loading issues for tiled layer(s)	Resolved	Done by CP Team	19/01/2023	16/03/2023
EM-624 Question about deep links	Resolved	Awaiting CP team actions to provide solution	15/09/2022	27/02/2023
EM-679 2022 Bathymetry DTM publication	Resolved	Done in cooperation of EMODnet Bathymetry and CP team	08/11/2022	20/04/2023
EM-584 Supply list of rational file formats for Bathymetry downloads	Resolved	Formats for ERDDAP download provided, but CP team has to undertake action for their use. ERDDAP now gives many non-usable file types	01/06/2022	23/05/2023
EM-764 Including new technical reports to CP reports catalogue	Resolved	Done by CP Team	31/03/2023	26/042023
EM-1565 Where can we find the helpdesk form for users	Resolved	Answered by CP Team		March 2023
EM-755 Map Viewer Cache and Display issues	Resolved	Done by CP Team	15/03/2023	02/06/2023
EM-700 Update Bathymetry partner list in CP	Resolved	Done by CP Team	21/12/2022	11/05/2023
EM-861 Filter option for source reference layer shows empty list	Resolved	Filtering option to be used on the Source Reference layer was not available. CP has corrected the issue.	25/09/2023	26/09/2023
EM-806 Increase zoom level for coastline	pending	Action to be undertaken by CP to increase the zoom level. Pre-tiled level already existing	27/06/2023	
EM-766 EMODnet Baselayer is using WebMercator	Resolved	Use of the appropriate tileset is suggested from	12/04/2023	27/10/203

tileset in EPSG4326 projection		Bathy. New version developed and tested. Now active.		
EM-703 Bathymetry narrative update	pending	One series of update in the narrative done. Ticket left opened as a new series should come shortly	03/01/2023	
EM-774 GetFeatureInfo shows unnecessary RGB info for HR depth and natural colors	Resolved	Actions have been undertaken by CP team to use the appropriate field for display. Ticket is left open for REST service issue.	23/04/2023	20/10/2023
EM-805 EMODnet Bathymetry land topography cache issue	Resolved	Updates of OSM have been done. Cached dataset from previous release of OSM have been cleared out. As OSM is continuously updated, it is suggested to clear out the CP cache frequently. Investigation on the best clearing cache frequency is undergoing	27/06/2023	14/08/2023
EM-544 GeoFabrik land names layer	pending	Action to be undertaken by CP team		

5.Allocation of project resources

Information on the allocation of project resources	
Categories	Resource usage[4] (%)
Making data and metadata interoperable and available	22%
Preparing data products	14%
Preparing web-pages, viewing or search facilities	4%
Managing user feedback	1%
Project management	2.5%
Outreach and communication activities	3%
Others	2%
	48.5%

[4] Provide the workings of your calculations, *i.e*. percentage allocation of the total amount awarded.

6.User feedback

Overview of user feedback and/or requests received in this project phase							
Date	Organisation	Type of user feedback (e.g. technical, case study, etc.) and short description of the feedback received	Means of contact	Response time	Status of user query (Resolved/ Pending)	Measures taken to resolve the query	Status: if not (yet) resolved/ pending, explain reason why and expected timeline
30 Jan 2023	Scottish Oceans Institute – United Kingdom	Technical question about the satellite derived coastlines	JIRA	Same day	Resolved	Explained to te user the procedure	
17 Feb 2023	IFREMER - Centre de Méditerranée - France	User could not find previous functionality in the map viewer	JIRA	Same day	Resolved	Explained how it works in the new viewer	
22 Feb 2023	MetOcean Consult - Netherlands	User had difficulty with downloading DTM tiles in new set up	JIRA	Same day	Resolved	Explained how it works in the new viewer	
23 Feb 2023	Equinor - France	User used ERDDAP ASCII download and saw differences with previous ASCII	JIRA	Same day	Resolved	Explained how user could still download the original ASCII tile files	

27 Feb 2023	Faculté des Lettres et des Sciences Humaines de Kairouan - Tunisia	User asked about downloading bathymetry and isolines	JIRA	Same day	Resolved	Explained how to download tiles and that isolines cannot be downloaded	
27 Feb 2023	GEOxyz - Netherlands	User complained that he could not download in GeoTiff using ERDDAP service	JIRA	Same day	Resolved	Pointed user to use the OGC WCS service which gives GeoTIFF as before	
27 Feb 2023	Investigadora Informe mar Balear - Spain	User could not download Western Med Bathymetry using ERDDAP	JIRA	Same day	Resolved	Explained how the user could download the DTM tiles in multiple formats	
2 Mar 2023	Delft University of Technology - Netherlands	User tried downloading with ERDDAP but area too large	JIRA	Same day	Resolved	Explained how the user could download the DTM tiles in multiple formats	
10 Mar 2023	Ramboll - Denmark	User used ERDDAP ASCII download and was not happy with result	JIRA	Same day	Resolved	Explained how user could still download the original ASCII tile files OR use OGC-WCS	

15 Mar 2023	Instituto Geológico y Minero de España - Spain	Asked for the Bathymetry coordinator	JIRA	Same day	Resolved	Name and email given	
21 Mar 2023	BeamworX - Netherlands	User had problem with OGC WCS example URL	JIRA	Same day	Resolved	Explained that there were some issues but works again	
22 Mar 2023	LNEC - Portugal	Use asked about downloading	JIRA	Same day	Resolved	Explained the different ways for downloading	
21 Mar 2023	Madesmart - Netherlands	User experienced problem with OGC WMTS	JIRA	Same day	Resolved	Checked and informed user it should work again	
23 Mar 2023	BAE Systems Submarines – United Kingdom	User asked about using Bathy services for internal purposes	JIRA	Same day	Resolved	Informed about CC-BY-4.0 license for all products and services	
27 Mar 2023	Orsted - Denmark	User experienced double values in download files	JIRA	Few days	Resolved	Explained how to download ESRI ASCII tiles directly and was ok for user	
18 Apr 2023	??	User misses functionality in map viewer to retrieve	JIRA	Same day	Resolved	Explained that the function is no longer there , but that we are	

		instant depth at mouse location				collecting wishes for possible later deployment	
25 Apr 2023	?? Spain	User used ERDDAP ASCII download for Baleares bathymetry and did not achieve this	JIRA	Same day	Resolved	Explained how user could alternatively download the original ESRI ASCII tile files OR use OGC-WCS	
27 Apr 2023	UHMI - Ukraine	Use was looking for the depth profile function	JIRA	Same day	Resolved	Explained how it works in the new viewer	
8 May 2023	Ramboll – Denmark	User got error when using ERDDAP service	JIRA	Same day	Resolved	Explained how user could alternatively download the ESRI ASCII tile files	
24 May 2023	DLR - Germany	User downloaded NetCDF through ERDDAP but could not get in his GIS the same resolution as in viewer	JIRA	Same day	Resolved	Explained how user could alternatively download the NetCDF tile files which did the trick	
25 May 2023	GeoMod - France	User had several suggestions for improving the service	JIRA	Same day	Resolved	User and EMODnet team were at EMD 2023 in Brest – France and	

						discussed suggestions	
12 Jun 2023	CSIC - Spain	User noticed differences between two DTM releases for coast near Ria de Vigo	JIRA	Few days	Resolved	Checked and informed that new data had become available that was used in new DTM release. However, this had not improved the result. Therefore, it was put on the list of the Regional Coordinator to reconsider for next release	
19 Jun 2023	Der Spiegel - Germany	User wanted map illustrations of bathymetry North Sea and wind farm locations for an article about Renewable Energy	JIRA	Few days	Resolved	Gave user support for finding and downloading the right maps from Bathymetry and Human Activities	
19 Jun 2023	??	User asked information about the .emo format	JIRA	Same day	Resolved	Provided the link to the .emo format documentation	
30 Jun 2023	??	User had problems with OWS services	JIRA	Same day	Resolved	Gave instructions how to use	

2 Jul 2023	OceanAreo - USA	User informed if EMODnet needs autonomous vessels for surveys	JIRA	Few days	Resolved	Explained that EMODnet brings together data from multiple providers but does not do in-situ observations itself	
8 Aug 2023	NOC – United Kingdom	User noticed anomalies in the 2022 DTM release tiles E4 and D4	JIRA	Few days	Resolved	Checked and informed use that these came from GEBCO and that we informed GEBCO about this.	
23 Aug 2023	Universitat Rovira i Virgili (URV) - Spain,	User needs bathymetry for impact analysis of offshore constructions near Catalan coast	JIRA	Few days	Resolved	Explained how the user could download tiles and clip these in GIS for his purpose	
25 Aug 2023	Rijkswaterstaat - Netherlands	User wants bathymetry for the North Sea	JIRA	Same day	Resolved	Explained how the user could download DTM tiles and also could you use the CP Map Vierwer	
30 Aug 2023	DEME - Belgium	User experienced problem with ERDDAP download service	JIRA	Same day	Resolved	It appeared that user wanted a clip of a HR-DTM which	

						are not in ERDDAP. Explained how tom download the full HR-DTM files.	
30 Aug 2023	NTUA - Greece	User identified anomaly of new sea mount in Argolic gulf	JIRA	Few days	Resolved	Checked and user was right that this was an error introduced through a spike in SDB entry. Will be corrected in new 2024 Regional DTM and DTM	
2 Oct 2023	OGS - Italy	User has problem with download of part of Adriatic bathymetry and land topography	JIRA	Same day	Resolved	Explained that land topography is not included in DTM tiles; that this is included in the viewer using OSM	
21 Nov 2023	Scottish Oceans Institute – United Kingdom	User had difficulty with getting bathymetry clipped for specific area	JIRA	Few days	Resolved	Explained and helped user to download relevant tiles and given instructions for GIS clipping	

23 Nov 2023	??	User reported error when trying ERDDAP for Caribbean area	JIRA	Few days	Resolved	Explained that ERDDAP is not deployed for Caribbean. This should be done by direct downloading of DTM tiles.	
23 Nov 2023	??	User had difficult with downloading and processing with ERRDAP	JIRA	Few days	Resolved	Explained that ERDDAP was deployed for downloading while for processing use of other (GIS) software was advised	
24 Nov 2023	??	User asked how to translate colours to depths	JIRA	Same day	Resolved	Explained that there are other ways for getting the real depths and not via the colours	
6 Dec 2023	ANMB - Romania	User asked which DTM tile to download for Romanian waters	JIRA	Same day	Resolved	Explained how to find the DTM tile overview map and to use this for direct downloads	

7.Meetings/events held/attended & planned

A. Meetings/events organised and attended in the quarter					
Date	Location	Type event (internal or external meeting; training/ workshop)	Was a presentation given? (yes/no + short description)	Meeting attended (A) / organised (O)	Short description and main results (# participants, agreements made, etc.)
18/01/2023	WebConf	Kick-off meeting on updating the EMODnet portal content	No	A	Review the procedures for the transfer of the content of the thematic portal to the Central Portal
23/01/2023	WebConf	EMODnet: achievements and way forward	No	A	Collecting as a group achievements and proposition for the future
01/02/2023	WebConf	Exchange with DG-MARE on data bathymetric data gaps within the European water	Yes	O	Presenting data quality assessment, data acquisition systems and identification of areas which may need to be either initially surveyed or resurveyed
16/02/2023	Public webinar	EMODnet Centralisation: One Ocean, One EMODnet	Yes	A	Each thematic coordinator showcases the benefits of the centralised EMODnet services to a diverse audience.
28/02/2023	Public webinar	GEBCO Technical Subcommittee on Ocean Mapping : Data Discovery and Identifying gaps	Yes	A	Presenting EMODnet Bathymetry data products and associated services.
4-5/04/2023	Webconf	EMODnet 13th Technical Working Group	Yes	A	Review of technical progresses between thematic coordinators, EMODnet Secretariat and EU/DGMARE
23/05/2023	Brest - France	18th EMODnet Steering Committee Meeting	Yes	A	Review the global orientations of between thematic coordinators, EMODnet Secretariat and EU/DGMARE

24 – 25/05/2023	Brest - France	European Maritime Day	No	A	Meet with actors of the large community of users of marine information. Gather their needs. Promote EMODnet Central portal and thematic bathymetric information.
16/06/2023	WebConf	EMODnet: achievements and way forward (Bathymetry)	No	A	Presenting EMODnet bathymetry recent achievements and propositions for the future
07/2023	WebConf	Synergy EMODnet - OBPS	Yes	A	Discussing synergy with OBPS leading to uptake of Bathymetry guidelines in OBPS
13/09/2023	WebConf	EMODnet: achievements and way forward	No	A	Synthesis of previous individual meetings
25-26/09/2023	Brest - France	EMODnet Full meeting and Training Workshop	Yes	O	Full group meeting and training focusing on data preparation, fine tuning the production of the next update.
29/9/2023	WebConf	EMODnet Bathy – Pangaea collaboration meeting	Yes	O	Partners Teledyne, GGSGc, Maris and Shom discussing collaboration with Pangaea
18/10/2023	WebConf	14th TWG	Yes	A	Review of technical progresses between thematic coordinators, EMODnet Secretariat and EU/DGMARE
20/10/2023	WebConf	8th EMODnet-Copernicus Marine Service coordination	No	A	Coordinate actions between EMODnet thematics and Copernicus Marine Services to fully benefit from the complementarity satellite and in-situ observations
22/11/2023	WebConf	EMODnet Bathymetry Fugro meeting	No	O	Partners GGSGc, Maris and Shom discussing collaboration with Fugro

27/11/2023	Bruxelles - Belgium	EMODnet Jamboree -	Yes	A	Provide insights on EMODnet bathymetry services to a wide audience of users and/or experts from other thematics.
28-29/11/2023	Bruxelles - Belgium	EMODnet Open Conference -	Yes	A	Joining and presenting Bathymetry at the Open Conference
12-15/12/2023	Paramaribo, Suriname	EMODnet Bathymetry in the Caribbean	Yes	A	Presentation of the Caribbean bathymetric product to the Caribbean IHO commission
SUM				O	**Total # of meetings organised = 4**
SUM				A	**Total # of meetings attended = 14**

B. Meetings/events planned in the future				
Date	Location	Type event (meeting, training (workshop), etc.)	Meeting to be attended (A) / organised (O)	Short description and main expected outcomes
April 2024	France	Training Workshop	O	Training and tuning with Regional Coordinators aimed at optimising the Regional DTMs and following integration

8.Communication assets

A. Communication products developed				
Date	Communication material	Short description (of the material, title, …) of the asset	Main results	Name of event at which material was disseminated (if applicable)
13 April 2023	Public release of the new 2022 EMODnet DTM	https://emodnet.ec.europa.eu/en/emodnet-releases-upgraded-bathymetry-digital-terrain-model-dtm-2022	Informing our data users and potential new users of the existence of this new DTM.	
29 November 2023	Presentation by Thierry Schmitt at the EMODnet Open Conference	https://emodnetconference2023.eu/media/kqwbfbsv/6-thierry-smitt.pdf	Informing conference participants about latest on EMODnet Bathymetry and its evolution	EMODnet Open Conference

B. Planned communication products			
Date	Communication material	Short description (of the material, title, …) and/or link to the asset	Main results expected

A. (Co-)Authored peer-reviewed publications in this project phase					
Date of publication	Type of publication	Full reference	ISBN	DOI	Is it open access? Yes/No
02/2023	Paper	Le Deunf J, Schmitt T, Keramoal Y, Jarno R, Fally M. Automating the Management of 300 Years of Ocean Mapping Effort in Order to Improve the Production of Nautical Cartography and Bathymetric Products: Shom's Téthys Workflow. *Geomatics*. 2023; 3(1):239-249.		10.3390/geomatics3010013	Yes
02/2023	Paper	Maglietta, R., Saccotelli, L., Fanizza, C. et al. Environmental variables and machine learning models to predict cetacean abundance in the Central-eastern Mediterranean Sea. Sci Rep 13, 2600 (2023).		10.1038/s41598-023-29681-y	Yes
02/2023	Paper	Nenciu M, Niță V, Lazăr L, Spînu A, Vlăsceanu-Mateescu E. Fostering the Development of Western Black Sea Aquaculture: A Scientific Case Study for Finfish Cage Farming Allocated Zone		10.3390/fishes8020104	Yes

		Designation. *Fishes*. 2023; 8(2):104.			
03/2023	Paper	Parcerisas C, Roca IT, Botteldooren D, Devos P, Debusschere E. Categorizing Shallow Marine Soundscapes Using Explained Clusters. *Journal of Marine Science and Engineering*. 2023; 11(3):550.	.	10.3390 /jmse11030550	Yes
03/2023	Paper	Ángel Mateo-Ramírez, Concepción Iñiguez, Luis Miguel Fernández-Salas, Ricardo F. Sánchez-Leal, Carlos Farias, María Jesús Bellanco, Juan Gil & José L. Rueda (2023) Healthy thalli of the invasive seaweed Rugulopteryx okamurae (Phaeophyceae) being massively dragged into deep-sea bottoms by the Mediterranean Outflow Water, Phycologia, 62:2, 99-108		10.1080/00318884.2023.2177057	Yes
03/2023	Paper	Lodolo, Paolo Nannini, Luca Baradello, Zvi Ben-Avraham, Two enigmatic ridges in the Pantelleria Vecchia Bank (NW Sicilian Channel), Heliyon, Volume 9, Issue 3, 2023,		10.1016/j.heliyon.2023.e14575.	yes

04/2023	Paper	Darmanin G, Gauci A, Deidun A, Galone L, D'Amico S. Satellite-Derived Bathymetry for Selected Shallow Maltese Coastal Zones. *Applied Sciences*. 2023; 13(9):5238.		10.3390/app13095238	yes
04/2023	Paper	Agius, J & Miceli, M & Spatola, Daniele. (2023). A Geological overview of the Maltese Archipelago with reference to the Area of Sliema.		10.7423/XJENZA.2023.2.06.	Yes
05/2023	Paper	L. Ursella, S. Aronica, V. Cardin, G. Ciraolo, D. Deponte, C. Lo Re, A. Orasi & F. Capodici (2023) Calibration and validation of high frequency coastal radar waves exploiting in-situ observations and modelled data in the south-west Sicily, Journal of Operational Oceanography, DOI:		10.1080/1755876X.2023.2215111	Yes
05/2023	Paper	Rosa Mediavilla, Juan I. Santisteban, Cristina Val-Peón, Luis Galán de Frutos, Margret Mathes-Schmidt, José A. López-Sáez, Francisco J. Gracia, Klaus Reicherter,		10.1016/j.csr.2023.105028.	yes

		26,000 years of environmental evolution of an incised valley in a rocky coast (La Janda wetland, SW Iberia)., Continental Shelf Research, Volume 262, 2023			
05/2023	Paper	Muchowski, J., Jakobsson, M., Umlauf, L., Arneborg, L., Gustafsson, B., Holtermann, P., Humborg, C., and Stranne, C.: Observations of strong turbulence and mixing impacting water exchange between two basins in the Baltic Sea, Ocean Sci., 19, 1809–1825		10.5194/os-19-1809-2023, 2023.	yes
05/2023	Paper	Bajo, M., Ferrarin, C., Umgiesser, G., Bonometto, A., and Coraci, E.: Modelling the barotropic sea level in the Mediterranean Sea using data assimilation, Ocean Sci., 19, 559–579,		10.5194/os-19-559-2023, 2023.	
06/2023	Paper	Pierdomenico M, Bernhardt A, Eggenhuisen JT, Clare MA, Lo Iacono C, Casalbore D, Davies JS, Kane I, Huvenne VAI and Harris PT (2023) Transport and accumulation of litter in submarine canyons: a geoscience		10.3389/fmars.2023.1224859	

		perspective. Front. Mar. Sci. 10:1224859.			
	Paper	Brancatelli, Giuseppe & Busetti, Martina & Dal Cin, Michela & Forlin, Edy. (2023). Reprocessing the CROP95-M18 vintage multichannel seismic data acquired in the northern Adriatic Sea: the case of high penetration crustal profile recorded in shallow waters. BULLETIN OF GEOPHYSICS AND OCEANOGRAPHY, 64(3), 213-236.		10.4430/bgo00419.	
07/2023	Paper	Dove, Dayton; Lee, Jonathan R.; Kendall, Rhian S.; Gafeira, Joana; Finlayson, Andrew. 2023 Land below sea: a new generation of seabed geology mapping. *Geoscientist*, 33 (2). 16-24.			yes
07/2023	paper	Martinelli M, Zacchetti L, Belardinelli A, Domenichetti F, Scarpini P, Penna P, Medvešek D, Isajlović I, Vrgoč N. Changes in Abundance and Distribution of the Sea Pen, Funiculina quadrangularis, in the Central Adriatic Sea (Mediterranean Basin) in Response to Variations		10.3390/fishes8070347	yes

		in Trawling Intensity. *Fishes*. 2023; 8(7):347.			
072023	paper	Penna, P., Domenichetti, F., Belardinelli, A., and Martinelli, M.: Dataset of depth and temperature profiles obtained from 2012 to 2020 using commercial fishing vessels of the AdriFOOS fleet in the Adriatic Sea, Earth Syst. Sci. Data, 15, 3513–3527,		10.5194/essd-15-3513-2023, 2023.	yes
08/2023	paper	Álvaro Carrión-Torrente, Francisco José Lobo, Ángel Puga-Bernabéu, María Luján, Isabel Mendes, Till J.J. Hanebuth, Susana Lebreiro, Marga García, María Isabel Reguera, Laura Antón, David Van Rooij, Javier Cerrillo-Escoriza, Incised valleys on the Algarve inner shelf, northern Gulf of Cadiz margin: Stratigraphic architecture and controlling factors in a low fluvial supply setting, Continental Shelf Research, Volume 266, 2023,		10.1016/j.csr.2023.105095	yes

		105095, ISSN 0278-4343, .			
09/2023	Paper	María Druet, Fernando Bohoyo, Adolfo Maestro, Sandra Mink, Jesús García-Senz, Antonio Pedrera & Roberto Rodríguez Fernández (2023) Tectonics of the Iberian continental margins and abyssal plains, Journal of Maps, 19:1,		10.1080/17445647.2023.2237980	
10/2023	Paper	Civile D, Baradello L, Accaino F, Zecchin M, Lodolo E, Ferrante GM, Markezic N, Volpi V, Burca M. Fluid-Related Features in the Offshore Sector of the Sciacca Geothermal Field (SW Sicily): The Role of the Lithospheric Sciacca Fault System. *Geosciences*. 2023; 13(8):231.		10.3390/geosciences13080231	
11/2023	Paper	Gianpaolo Coro, An Open Science oriented Bayesian interpolation model for marine parameter observations, Environmental Modelling & Software, Volume 172,		10.1016/j.envsoft.2023.105901.	

11/2023		van de Vijsel, R.C., Hernández-García, E., Orfila, A. et al. Optimal wave reflection as a mechanism for seagrass self-organization. Sci Rep 13, 20278 (2023).		10.1038/s41598-023-46788-4	yes
11/2023		Stanciu I, Ioane D. Geomorphological and Neotectonic Structures Studied in the Southern Part of the Moesian Platform in Romania. *Geographies*. 2023; 3(4):743-762.		10.3390/geographies3040040	yes
11/2023		M. Gernez, J. Champagnat, E. Rivot, O. Le Pape, Potential impacts of the restoration of coastal and estuarine nurseries on the stock dynamics of fisheries species, Estuarine, Coastal and Shelf Science, Volume 295,		10.1016/j.ecss.2023.108557	yes

B. Other/non-peer reviewed types of publications (co-)authored in this project phase					
Date of publication	Type of publication	Full reference	ISBN	DOI	Is it open access? Yes/No

07/2023	Report	Schmitt, T., Loubrieu, B., Guerin, C. and Monpert, C. (2023) Use of the dataset Quality Index to expand services associated to the EMODnet DTM. Version 12-01-2023. EMODnet Bathymetry, 21pp. DOI:		https://doi.org/10.25607/OBP-1935	yes
05/2023	Report	Quimbert Erwann, Schmidt Sabine, Mercier Caroline, Vernet Marine, Dibarboure Gerald, Sudre Joel, Piolle Jean-Francois, Hoebeke Mark, Germineaud Cyril, Carval Thierry, Schmechtig Catherine, Cariou Valérie, Harscoat Valerie, Andre François, Calvat Pascal, Obaton Dominique (2023). Rapport d'activité ODATIS 2022.		https://archimer.ifremer.fr/doc/00839/95127/	yes
09/2023	Report	Vasquez Mickael (2021). Constructing EUSeaMap - User Guide. D1.14. EASME/EMFF/2018/1.3.1.8/Lot2/SI2.810241– EMODnet Thematic Lot n° 2 – Seabed Habitats.	Vasquez, M..	https://archimer.ifremer.fr/doc/00718/82999/	yes

For a comprehensive overview of publications referring to/making use of EMODnet data and/or data products, please consult Google Scholar.

9.Monitoring indicators

[Comments on the progress indicators in the indicators spreadsheet		
Progress indicator	Means of collecting figures	Comment
1. Current status and coverage of total available thematic data A) Volume and coverage of available data	CDI catalogue service	There is a considerable increase of CDIs: 1056 new entries from 15 data providers. In the next reporting period more is expected as several data providers are working on this.
What is your opinion on the data coverage within EMODnet for your thematic?	CDI catalogue service	Overall, EMODnet Bathymetry has brought together an excellent data collection (CDIs and Composite DTMs), covering all European sea regions and compiled by 65 data providers. In the coming year this will be further expanded.
B) Usage of data since the start of the project phase	CDI RSM shopping ledger service	The number of downloaded CDIs went down considerably in this first year as Central Portal
2. Current status and coverage of total number of data products A) Volume and coverage of available data products	Statistics from downloading at the Bathymetry system	The 2022 DTM has been released which comprises 58 DTM tiles in 8 different formats. This covers the European seas and now also the Caribbean region. Moreover, additional HR-DTMs have been published as well as an updated version of the Satellite Derived Coastlines for Europe and Caribbean.
B) Usage of data products since the start of the project phase	Analysing download statistics	The number of DTM tile downloads has increased considerable with ca 80%, while there is an explosive increase (660%) in downloads of HR-DTMs files. Partly this is due to the new release of the DTM which always gives a lot of traffic, but most traffic was registered in the last quarter of 2023 under influence of the promotion of the EMODnet Open Conference. The number of WMS requests is stable and also very high, while the number of WFS requests is also stable.
3. Internal and external organisations supplying/approached to supply data and data products since start of the project phase	CDI catalogue service	These are 1056 new entries as part of the new contract from 15 data providers. In the coming months we expect additional entries from other data providers.

4. Online 'Web' interfaces to access or view data	N.A.	No changes
5.1. Daily number of page views of EMODnet Thematic entry page since the start of the contract	Europa Analytics	Daily number of page views of the Bathymetry narrative ranges between circa 80 views during weekends and some peaks of >200 views per day during weeks. A decreasing tendency is observed correlated with the summer period. Most views were observed just after the migration. Overall, the peaks of daily views per week seem to stabilise to around 150 view/day. Unfortunately, we cannot see how the bathymetry map layers and products are visited, while the downloading statistics give very good stats.
5.2. Total number of visitors, page views, unique page views and percentage of returning visitors, since the start of the contract	Europa Analytics	The numbers of January 2023 and December 2023 are reasonable and comparable as the bathymety narrative is a static story. It seems that the variations/trends are not so easy to interpret between Jan/Dec 2023 as they might be related to periodic cycles.

The monitoring numbers reported as part of the progress monitoring of EMODnet performance are collected through Matomo and/or Europa Analytics, unless reported otherwise.

10. Recommendations for follow-up actions by the EU

[Give a list of recommendations and suggestions for the EU to consider and take action. Max 1 page.]

- Promote the EMODnet Bathymetry infrastructure as a repository for all european bathymetric data and more especially those financed by european funds. This could take the form of citing EMODnet Bathymetry in contractual documents (tenders or calls for proposal) which concern bathymetry data acquisition and/or management.
- Collect and analyse feedback from users to see whether users are satisfied with the functionalities of the new central EMODnet portal and whether they are missing and/or suggesting specific functions. Then analyse this feedback together with the EMODnet TWG for initiating possible adaptations and upgrades in the near future to optimise the user experience.

11. Annex: Other documentation attached

Annex 1: D2.1 - Upgraded guidelines for data pre-processing and population of metadata – Technical Report – June 2023

Annex 2: D3.1 - Upgraded guideline of EMODnet methodology for DTM production, including using prototype CVE – Technical Report – October 2023

12. List of acronyms

DTM: Digital Terrain Model

CVE: Collaborative Virtual Environment

CDI: Common Data Index

CPRD: Composite PRoDuct

OGC: Open Geospatial Consortium

HR-DTM: High Resolution Digital Terrain Model

LAT, MSL, MHW: Lowest Astronomical Tide, Mean Sea Level, Mean High Water

ISO: International Standardisation Organization

SDB: Satellite Derived Bathymetry

EEZ: Exclusive Economic Zone

ERRDAP: Environmental Research Division's Data Access Program

CP: Central Portal

DATARMOR HPC: DATARMOR High Performance Computer

RDTM: Regional Digital Terrain Model

TWG: Technical Working Group

CMS: Content Management System

GEBCO: General Bathymetric Chart of the Ocean

TSCOM: Technical Sub-Committee on Ocean Mapping

SC: Steering Committee

CMEMS: Copernicus Marine Environment Monitoring Service

OBPS: Ocean Best PracticeS

QA-QC: Quality Analysis – Quality Check

GTSM: Global Tide and Surge Model (numerical hydrodynamic model from Delatres)

WMS, WMTS, WFS, WCS: Web Map Service, Web Map Tile Services, Web Feature Services, Web Coverage Service,

UNCLOS: United Nation Convention on the Law Of the Seas

MNIST: Mixed National Institute of Standards and Technology (refers to a database of handwritten numbers, frequently used in Machine Learning algorithms)

UNET: Fully convolutional neurons network frequently used on gridded data structure (as image or DTMs)

QI: Quality Index

UUID: Universally Unique IDentifier

IHO DCDB: International Hydrographic Office Data Center for Digital Bathymetry

GPU: Graphics Processing Unit

PDE: Partial Differential Equation

GMRT: Global Multi-Resolution Topography

EMODnet Thematic Lot n°1 – Bathymetry

EASME/EMFF/2019/1.3.1.9/Lot1/SI2.836043

Start date of the project: 20/12/2022 (24 months)

Centralisation Phase

D2.1 - Upgraded guidelines for data pre-processing and population of metadata

June 2023

The European Marine Observation and Data Network (EMODnet) is financed by the European Union under Regulation (EU) 2021/1139 of the European Parliament and of the Council of 7 July 2021 establishing the European Maritime, Fisheries and Aquaculture Fund and its predecessor, Regulation (EU) No. 508/2014 of the European Parliament and of the Council of 15 May 2014 on the European Maritime and Fisheries Fund.

Disclaimer

Document info

Title (and reference)	Upgraded guidelines for data pre-processing and population of metadata (D2.1)
WP title (and reference number)	Gathering of composite DTMs and metadata in Sextant catalogue (WP2.2)
Task (and reference number)	Upgraded guidelines for data pre-processing and population of metadata (D2.1)
Authors [affiliation]	Cécile Pertuisot (Ifremer) Benoît Loubrieu (Ifremer)
Dissemination level	Public
Submission date	30 June 2023
Deliverable due date	30 June 2023

Contents

Upgraded guidelines for data pre-processing and population of metadata

1 Overall approach and explanation EMODnet Bathymetry flowchart

The generation of Regional DTMs is divided over regional sea basin subgroups, each with a Regional Coordinator and a number of contributing data providers. Each Regional Coordinator will be responsible for a quality assessment and selection of the data contributions and the compilation of the Regional DTM using the GLOBE software. This process will start at the begin of the 2nd Contract year, when all data providers have finalized their data gathering and population activities for the CDI and CPRD catalogues and will have undertaken pre-processing and gridding of their data sets for delivery as DTMs to the regional coordinators.

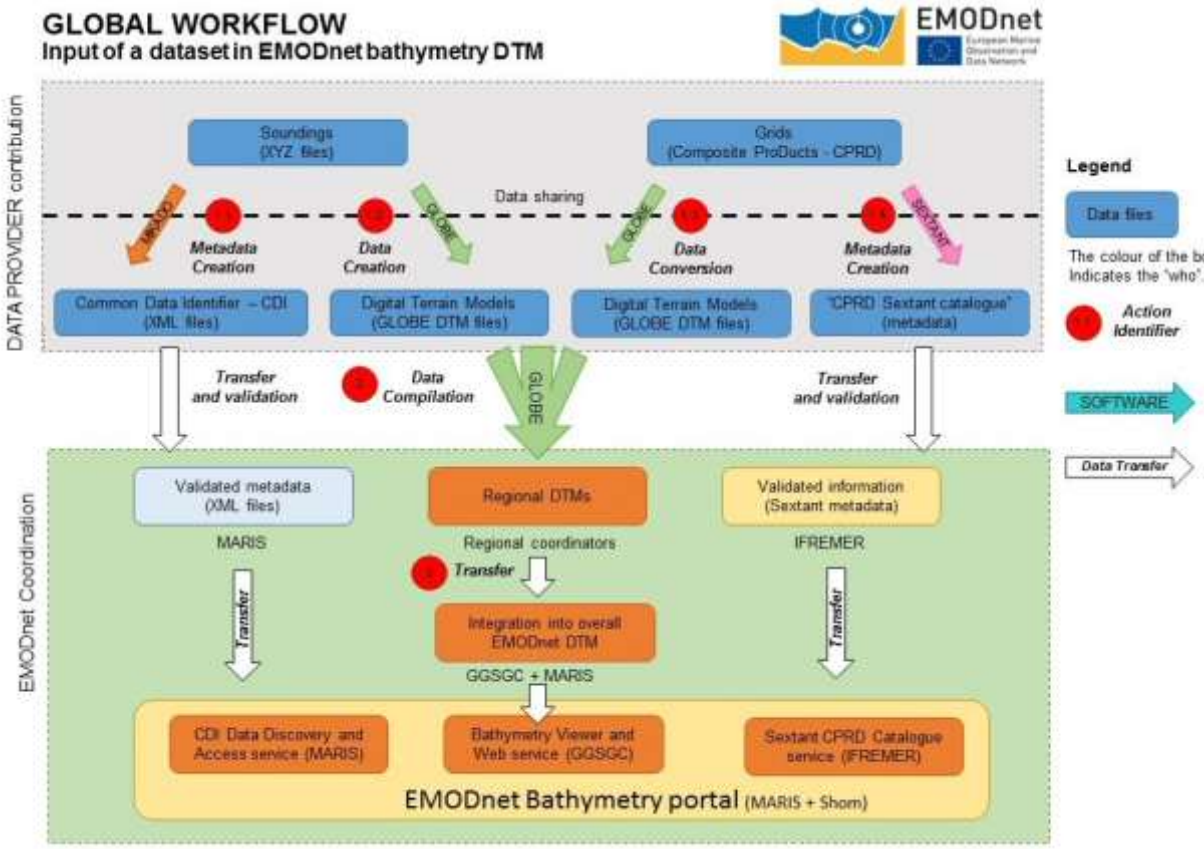


Figure 1. Example of caption which should go below the figure

2 MIKADO for population of CDI entries and related directories

MIKADO is used to generate XML descriptions, it creates XML files using SDN common vocabularies for metadata exchange of:

- CSR - Cruise Summary Reports
- EDMED - Marine Environmental Data sets
- CDI - Common Data Index
- EDMERP - Marine Environmental Research Projects
- EDIOS – Permanent Ocean-observing System

MIKADO is written in Java Language (Version >= 1.8) and is available under multiple environments: Windows, Unix – Solaris, Linux. Users can use either interactive or batch modes. The SeaDataNet common vocabularies web services are used to update lists of values but Mikado works offline once the lists are up-to-date.

2.1 Last versions

3 versions of Mikado have been released

2.1.1 Mikado 3.8 (June 2022)

- Removed
  CSR manual download from BSH, use of CSR list from BSH
- Add-ons
  CDI - EDMED reference becomes multiple
  CDI - VerticalDatum,if specified,needs min and max depth values
- Updates
  EDMED - Download from BODC restored

2.1.2 Mikado 3.8.1 (April 2023)

- Add-ons
  Automatic CDI from Nemo 2.0 export supported
- Bug fixed
  CDI AUTOMATIC - boundingbox, bad completion from point to box (.00 generated)
  PCR : xsd modified to accept https://www.seadatanet.org/urnurl/ instead http://www.seadatanet.org/urnurl/

2.1.3 Mikado 3.8.2 (May 2023)

- Bug fixed
  CDI AUTOMATIC - var11 Instruments: optional variable required (bug found in Nemo CDI summary generation)

2.2 Recommandations

Here are a few recommendations to partners to optimize the use of MIKADO:

2.2.1 Recommendation 1: Vocabularies updates

Figure 2 Vocabulary updates

Automatic check of the version of the vocabulary lists is possible when MIKADO starts:

If "On" is clicked in the Vocabulary Update Menu, then MIKADO downloads locally the latest version of each list. It is possible to enable-disable the automatic check if "Off" is selected. Manual check is also possible using the button "Update once now".

2.2.2 Recommendation 2: CSR and EDMED links in the CDIs

Each CDI can refer to a CSR Reference and an EDMED Reference:

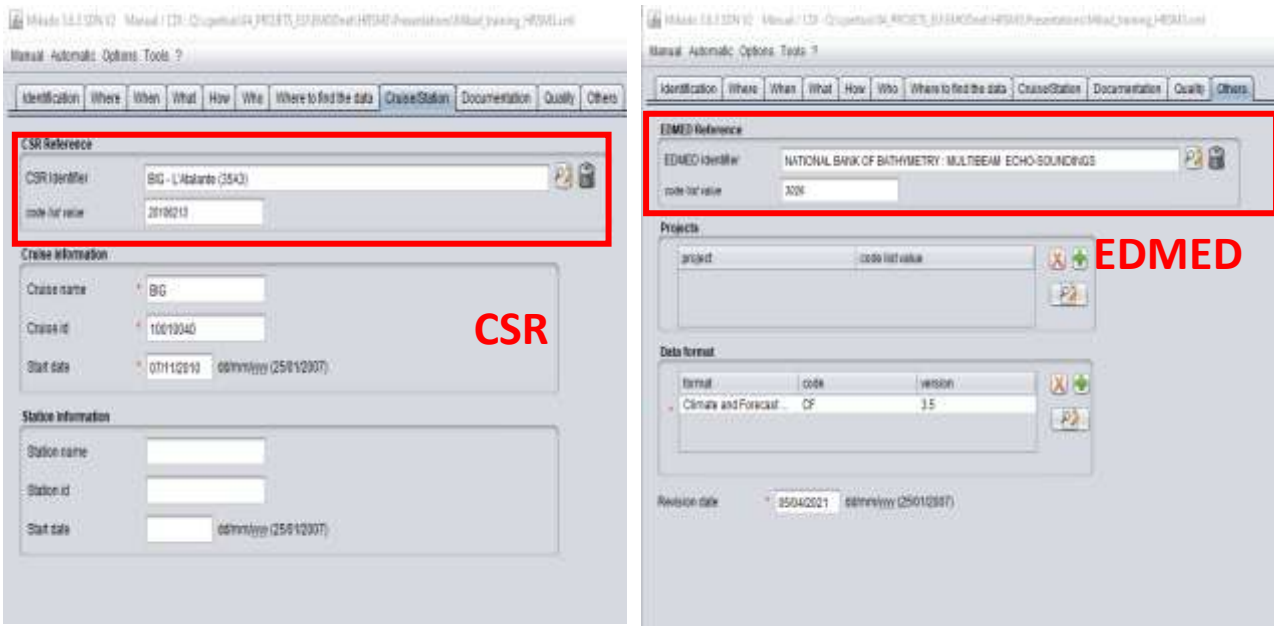


Figure 3 Implementation of the CSR and EDMED references

In Mikado manual: use of dropdown lists via webservices.

In Mikado automatic: use of var80 (EDMED), var81 (CSR).

2.2.3 Recommendation 3: EMODNet Bathymetry Quality Indicators in the CDIs

Quality Indicators (QI) have been implemented in 2017 and are used to qualify each source dataset used in the final DTM. These QI can be used for different purposes: to produce some statistics about the available data, to identify where new data or more recent data need to be acquired, etc …

The QI have been described in the document 'Completing metadata elements for the generation of the Quality Index for the EMODnet DTM.pdf'. 4 QIs have been defined to assess the quality of the datasets:

- QI_Horizontal: related to the positioning system
- QI_Vertical: related to the MBES instrument
- QI_purpose: related to the survey objective
- QI_Age: related to the survey dates

Quality indicators are not part of any SDN lists and have to be written between quote marks, using either manual or automatic modes:

- In Manual mode go to the Quality tab and add 3 distinct entries for QI_Horizontal, QI_Vertical and QI_purpose as follow:
    - Name: QI_Horizontal (free text)
    - Date: date of the QA method reference

- Comment: write down the index of the corresponding QI (free text)
- Status: true

QI_Age: fill the start and end date of the data acquisition in the When tab

- In Automatic mode: from var95 to var98 for QI_Horizontal, QI_Vertical and QI_purpose.

QI_Age: Under the single subqueries folder, define your SQL queries under var28 and var29 to describe the start and end date of your dataset.

3 Sextant for DTM population

Since the EMODnet Bathymetry webportal has been transferred to the EMODnet central portal, Sextant is used as the metadata editor tool and is harvested by the central portal to feed its product catalogue. Each sextant metadata record has also a Landing Page that can be reached from the Map Viewer.

The Sextant Catalogue, portal, and data infrastructure have been developed by Ifremer for the management and the distribution of spatial data, and have been adopted for EMODnet Bathymetry for describing composite DTMs and HR-DTMs from the EMODnet Bathymetry data providers. Moreover, the resulting EMODnet DTM products are included in Sextant together with DOIs.

Sextant is implemented using

- Geonetwork to set-up the Catalogue Service for the Web and the Open Geospatial Consortium (OGC) and ISO TC211 standards.

- the Seadatanet Marine Profile for ISO19139 together with the European Directory of Marine Organisations (EDMO), the European Directory of Marine Environmental Research Projects (EDMERP) and the SeaDataNet Common Vocabularies NVS2.0 (**https://www.seadatanet.org/**) for consistent descriptions of products (DTMs) with the EU SeaDataNet Common Data Index for survey data.

3.1 Sextant API for CPRD, PRODUCT and Tiles metadata population

A Sextant API (Application Programming Interface) has been deployed to respond to the harvesting need of the EMODnet central portal and gathers the 3 catalogues dedicated to EMODnet Bathymetry projects. (https://sextant.ifremer.fr/documentation/emodnet_bathymetry/api/catalogue.html#/search?from=1&to=30).

Sextant is used to provide a Common Index (Catalogue) and descriptions of the composite products (CPRD catalogue) and the high resolution products (PRODUCT catalogue) delivered by partners and associated providers of EMODnet bathymetry projects who have opted to deliver bathymetric data as products of their own for the construction of the EMODnet final DTM. They are not an observed data files, but a derived product. So they cannot be described in the SeaDataNet catalog.

This table allows to distinguish the differences between these 2 types of DTMs:

Table 1. Distinction between Composite PRoDuct and High Resolution DTMs

	CPRD **(contribution to the regional DTMs)**	**PRODUCT (HR-DTMs)** **(contribution to the HR layer)**
Content	- Historical Composite DTMs in your institution	- Higher resolution DTMs (1/32,1/64 …)

	New composite DTMs at a resoltuion of 1/16 arc minute	- Initially on smaller area or specific area of interest for showcases
Methodology	- Compilation using Globe software - EMODnet Bathymetry methodology - Historical DTMs might differ	- Compilation using Globe software - EMODnet Bathymetry methodology
Use	- Integration in the regional DTM - To be sent to your regional co-ordinator	- Integration in the HR layer of the Map Viewer - To be sent to Benoit Loubrieu (Ifremer), Cécile Pertuisot (Ifremer), George Spoelstra (GGSGC)
Visibility	- Connected to Sextant API - Visible from EMODnet website	- Connected to Sextant API Visible from EMODnet website
Access	- No direct access to the DTMs for the end users - DTMs are stored at each partners	- Public downloading through the EMODnet Map Viewer - DTMs are stored on a centralised cloud

The sextant API also gathers the descriptions of each tile of the EMODnet final DTM in the Tiles catalogue.

Each metadata described in any of these 3 catalogues is given a Landing Page (LP) having the following typology: https://sextant.ifremer.fr/record/UUID (where UUID is the metadata unique identifier constructed for the project needs (see chapter 4.2)).

3.2 Managing spatial data using Sextant

Before creating new metadata, read the EMODnet HRSM specifications documents which contain instructions for filling some of the metadata : "Methodology and guidelines for processing original input data into DTMs" and "Completing metadata elements for the generation of the Quality Index for the EMODnet DTM".

3.2.1 Vocabulary

- Common vocabulary lists and organization identification
  Lists implemented in the EMODnet template use the SeaDataNet Common Vocabularies (https://www.seadatanet.org/).
  Organizations are identified using the European Directory of Marine Organizations (EDMO) maintained by Seadatanet. Organization name and identifier can be querried on the SDN portal at: https://www.seadatanet.org/Metadata/EDMO

- File identifier

  The unique file identifier (UUID) at the top of the metadata information of the form is generated automatically using a combination of metadata edited by the partner. The unicity of the entry is guaranteed by an automatic combination with the EDMO id. The syntax (derived from SeaDataNet practices) is:

SDN_CPRD_**EDMO-Id**_**short-name-of-dataset**

EMOD Id of the holding data center — must be unique

It is requested to rename the DTM file corresponding to your metadata entry as EDMO-Id_ short-name-of-dataset.dtm.

The EDMO_Id of the holding data center and the short name of dataset of the product are also recorded in the "Identifier" layer of the EMODnet DTM (see EMODnet hydrography specifications). This allows viewing services of the EMODnet portal and the 3D viewer of the Ifremer Globe software to generate the URL to access the metadata set of the sextant catalogue.

3.2.2 Log in instructions

Each partner needs an external account. If you don't have any, please contact the Sextant team: sextant@ifremer.fr.

Log in function is available through Sextant API on EMODnet website: https://sextant.ifremer.fr/documentation/emodnet_bathymetry/api/catalogue.html#/search?from=1&to=30. Sign in with your sextant credentials on the top right hand corner, The "Administration" functionality appears.

3.2.3 Metadata check-list

Here is a "check-list" that the partners can follow in the suggested order to have a quick overwiew of the main steps to describe their products and to see their metadata validated (this is not a exhaustive list of the required metadata but guides you in the process) :

- ✓ **Log in (§4.2)**
- ✓ **Chose the appropriate template (§4.4)**
- ✓ **Start with the Short name of dataset (What) + EDMO-Id o the data holding center (Who) and Save (§4.4.1)**
- ✓ **Continue with all the other fields and with specific attention to:**
  - **Dataset name (different form the short name of dataset) (§4.4.1)**
  - **Project name**
  - **Parameter Discovery/Measure devices/Positioning devices**
  - **Geometry**
  - **Abstract**
  - **QI (§4.4.3)**
  - **Temporal extent (§4.4.5)**
  - **EDMO-Ids**
  - **Licence**
  - **Associated ressources: thumbnail + EMODnet links (§4.4.2)**
- ✓ **Save and close**
- ✓ **Submit for review**
- ✓ ***For HR-DTMs only* : send your HR data files (named as EDMO-Id_ short-name-of-dataset.dtm) to george@ggsgc.eu + cecile.pertuisot@ifremer.fr + benoit.loubrieu@ifremer.fr**
- ✓ ***For CPRDs only*: send the files to the Regional coordinator**

3.2.4 Detailed instruction

To create a new metadata description, a dedicated metadata template has been designed for the purpose of EMODnet projects.

Select "New metadata" in the menu “Administration” (see 4.2.):

- Create a Dataset;
- As Template, select "Template for EMODnet Bathymetry metadata";
- "In": select the appropriate catalogue: "EMODnet hydrography - CPRD" for cDTMs OR "EMODnet hydrography - PRODUCT" for HR-DTMs according to the description in Chapter 3.1;
- And then "Create".

SEXTANT disconnects you automatically if you are inactive. Save regularly what you have edited (every15 mns).

Mandatory fields have been defined not only in function of the ISO and Inspire standards and Directive but also in function of the requirement of the projects. Most of the fields are pre-filled or user friendly and don’t need specific explanation. Attention will be paid to specific or text fields - **more details with corresponding screenshots are given in the dedicated Sextant use manual as an annex of D2.1**. Explanations are given by thematic tabs.

- **What tab**

It is **strongly recommended** to start filling the “Dataset name” and “Short name of dataset” to avoid Sextant to save your entry under a default name. Use the “Save metadata” button and continue.

File identifier: is generated automatically using a combination of metadata edited by the partner. The syntax is: “SDN_CPRD_EDMO-Id_local-product-Id”

Project name: Choose EMODnet HRSM4. This field corresponds to the EDMERP SDN list.

Dataset name: title of the data set that will appear in the catalog.

Short name of dataset (SDN Local Product-ID): Local identifier of the bathymetric grid (according to local rules of Data Center). This is a component of the file identifier. The local identifier must not be longer than 75 characters (this constraint comes from the length of the string used to keep track of the source of data in the DTM NetCDF format.

Parameter Discovery/Measure devices/Positioning devices: metadata are given by default but you can also delete them and/or add others by clicking on “Search” (auto completion search). Use of L05 and P02 lists.

Geometry: fill in the information, and use lists or “Recommended” values when proposed

Pixel size: Select “Arc minute” entry in the Recommended values or write “Arc minute” in the text field close to the value field. To fill the value, please refer to decimal value in the following table:

Table 2. Correspondence table between the pixel size and its decimal value

Grid size	Arc minute
1/512	0,00195313
1/256	0,00390625
1/128	0,0078125
1/64	0,015625
1/32	0,03125
1/16	0,0625

Dataset description abstract: write down a summary about the dataset (cruise/purpose/context description, specific characteristics, valuable details…).

Description of processed data sources: indicate the data sources and ***write down the corresponding CDIs when they exist and/or DOI if needed.***

Description of data processing: any valuable detail about the processing software or processing methodology.

- **Associated ressources** (tab "What" upper right corner) – thumbnail and online resources

It is recommended to attach a thumbnail to illustrate your DTM in the catalogue. Click on the add button of the "**Associated resources**" field and seclect "**Add document**".

Click on "Add a thumbnail" (1), select the thumbnail with the "Choose or drop resource here" tool

(2) and click on your thumbnail in the "metadata file store" to update the URL(3). Click at the very bottom of the page to "add online resource" (4).

For HR-DTMs only: references to the EMODnet viewer and to the WMTS webservice have to be done using the online resources as follow :

Click on the add button of the "**Associated resources**" field and select "**Link an online document**" and enter the followings:

Protocol: Web link (URL)

URL: https://emodnet.ec.europa.eu/geoviewer/

Resource name: EMDOnet viewer

And click on "Add online resource"

Click a second time on the add button of the "**Associated resources**" field and select "**Link an online document**" and enter the followings:

Protocol: Web link (URL)

URL: https://tiles.emodnet-bathymetry.eu/

Resource name: EMODnet Bathymetry WMTS service

And click on "Add online resource"

These links will be attached to your metadata description in the catalogue.

- **Quality tab**

Horizontal accuracy:

Measure description: give any information about the horizontal accuracy of the acquisition system, the positioning system as well as the sounding method.

Value: In case you wish to give a digital estimator of the horizontal accuracy.

Evaluation method description: Reference to standard which have been used to qualify the horizontal accuracy (hydrographic standards, industrial specification…)

Vertical accuracy:

Meaure description: any information about the vertical accuracy of the depth in the file

Evaluation method description: Reference to standard which have been used to qualify the horizontal accuracy (hydrographic standards, industrial specification…)

Shoal bias: tick this field only in case of existing bias and precise details in text field below.

Suitability: precise the type of use that can be made of the datasets (example: not suitable for navigation)

Quality Indicators have been implemented in the EMODnet HRSM project to use further qualitative information (in DTMs and CDIs) related to the data source such as type of sensor. For the DTMs, the data producer has to consider giving each of the quality indicator based on the contribution with the lowest quality. Click on “search” to make appear the appropriate list.

The following document describes the Quality Index proposed in the framework of the HRSM project : "Completing metadata elements for the generation of the Quality Index for the EMODnet DTM". It will help you to verify your entries.

- **Where tab**

The **Geographic Bounding Box** can be created in 3 different ways:

By drawing your own area: click on “Draw region”, select the area and the coordinates will automatically be updated,

By entering the coordinates (decimal degrees) manually in the appropriate fields,

By selecting an area in the international SeaVox list.

Projection: fill in the geodetic system and the projection of the catalogued product. Some of them are listed in the "Add coordinate system" list. You can input additional details in the "Version or custom projection details. As examples, for a latitude/longitude file: Write "WGS84" in the "Projection" field and for a UTM Zone 33 file: Write "WGS84 / UTM" in the "Projection" field then write "Zone 33" in the "Custom projection details.

Vertical Datum uses L11 SDN list.

- **When tab**

Creation date is the date of production of the DTM.

Temporal extent covers the period of datasets used in the DTM.

Measurement frequency can be used in case od periodic acquisition of datasets.

- **Who tab**

The **Originator**, **Data Holding Center** and **Collating Center** contacts are filtered on the EDMO_id list. **The data holding center contact is a component of the file identifier.**

Enter the name of your institute or department and corresponding entries will appear (then click on the corresponding “+” button). If not, click on the binocular, and write in “search for a contact” field or use the proposed filters on the left of the screen (check number of pages). Once you have found the correct entry, click on the “+” button at the bottom left corner. Once you selected the correct contact, Organisation name, Email and EDMO id are automatically filled in.

- **Access tab**

Click on “Add distributor” to enter the **Distributor** contact details (also filtered on EDMO id). And fill in the other information using “Recommended values” when possible.

Version and **Transfer size** are optional.

Intellectual property for CPRD:

Use limitation: free text field that can be used to detail intellectual property like “NOT FOR NAVIGATION”

Access constraints: uses list SDN L08. Gives information about how to get access to the DTM.

Use constraints: gives information about the condition of use of the DTM.

Other constraints: complementary information about the use of the data. This is the appropriate field to enter the DOI of your dataset when existing or the obligation of citation.

Intellectual property for HR-DTM:

Use limitation: for example "NOT FOR NAVIGATION"

Access constraints: set as "unrestricted". Uses list SDN L08. Gives information about how to get access to the DTM. To be set as "unrestricted".

Use constraints: Uses list SDN L08. Gives information about how to get access to the DTM. To be set as "Creative Commons Attribution 4.0 International".

Other constraints: write "EMODnet Bathymetry consortium (2024), EMODnet Digital High Resolution DTM"

3.2.5 Save your metadata

Your sextant template is now complete, you can "save and close" the template. You can check your new entry on the sextant API catalogue: https://sextant.ifremer.fr/documentation/emodnet_bathymetry/api/catalogue.html#/search?sortBy=relevance&from=1&to=30.

3.2.6 Submit your metadata for validation

A workflow status has been implemented to prevent any inconsistency with EMODnet rules when updating or creating a metadata. Each creation or update has to be validated by a sextant administrator.

To submit your metadata click on the Wheel tool>Submit for review. The sextant catalogue administrator will receive a notification by email and will validate and publish your sextant entry. **This submission has to be done for each new entry and each updated entry.**

3.3 Guidelines for updating an existing entry

If you need to update any of your description, select your sextant entry on the sextant API catalogue:

https://sextant.ifremer.fr/documentation/emodnet_bathymetry/api/catalogue.html#/search?sortBy=relevance&from=1&to=30 and click on the wheel tool on the upper right hand corner and select edit.

Once updated, do not forget to submit again your entry through the sextant workflow – see chapter 3.2.6.

3.4 Sextant helpdesk

If any problem when using Sextant, you can contact the Sextant team sextant@ifremer.fr. Your question will be routed toward the appropriate person.

4 Globe for pre-processing and gridding of bathymetry data sets

4.1 Introduction

GLOBE (GLobal Oceanographic Bathymetry Explorer) is an innovative application for processing and displaying oceanographic data. GLOBE offers processing and display solutions of multi-sensor data within a single 3D environment represented as a globe.

Currently, the software is mainly used for processing, analysing and displaying acoustic data, as well as moving tectonic plates.

GLOBE software is described and freely available through the Seanoe system (Sea scientific open data publication at the following link : DOI 10.17882/70460).

For the project, Ifremer provides the Globe software for the production (1) of single DTMs by data providers and (2) of merged DTMs by regional coordinators.

During the first year of the project, DTMs processing is focused on the production of single DTMs, one per each dataset, by all data providers.

For supporting this action, a training workshop will be given by Ifremer, consisting of a half day for a general presentation of the Globe software and the dedicated tools for HRSM project, and a second half day for a training based on standard datasets and focused to exchanges between data providers and Globe team. As well additional presentations will focus on extra Globe tools that could help data providers to validate and correct their datasets.

The training will focus on the following main items :

- reminding the methodology adopted by EMODnet Bathymetry for generating DTMs,
- how to process sounding datasets described in the CDI infrastructure ? what are the appropriate Globe tools for that purpose ?
- how to process composite DTMs described in the Sextant CPRD catalogue ? what are the appropriate Globe tools for that purpose ?
- general presentation of helpful Globe tools for the project.

4.2 Type of datasources

As described below for the data collection two types of datasets can occur:

- Sounding files: these are datasets of observed bathymetry data. Their metadata are described in the CDI and they have their own CDI Identifier (CDI Id)
- Composite product (CPRD): these are pre-processed gridded datasets. They are described in the CPRD catalog in Sextant.

For both types of input, data will be processed into a gridded file, regular raster datafile with common properties:

- Latitude longitude coordinates, WGS84 ellipsoïd
- Grid spacing is a divider of arc minute (1/16, 1/32, 1/64,…) and is defined according to the depth ranges and data resolution. Coordinates of the bounding box are aligned along integer minutes,
- If possible, the raster file is a multilayer file including, for each pixel, depth and additional statistical information (as standard deviation, count of valid sounding),
- Identifier layer (CDI Id or CPRD Id) is required for the raster file, in order to link gridded files with metadata of the datasources.

The processing is in accordance with the document “Methodology and Guidelines for integrating data and processing single DTM for each input dataset”.

4.3 Processing of sounding datasets

This case covers all observed data files whom format is csv or asci, 3 rows like :

Latitude / Longitude / Depth

They can be processed in Globe software by using the “Export CSV to DTM“ tool. We provide blow an overview of the Globe tool and the way to fill in the parameters.

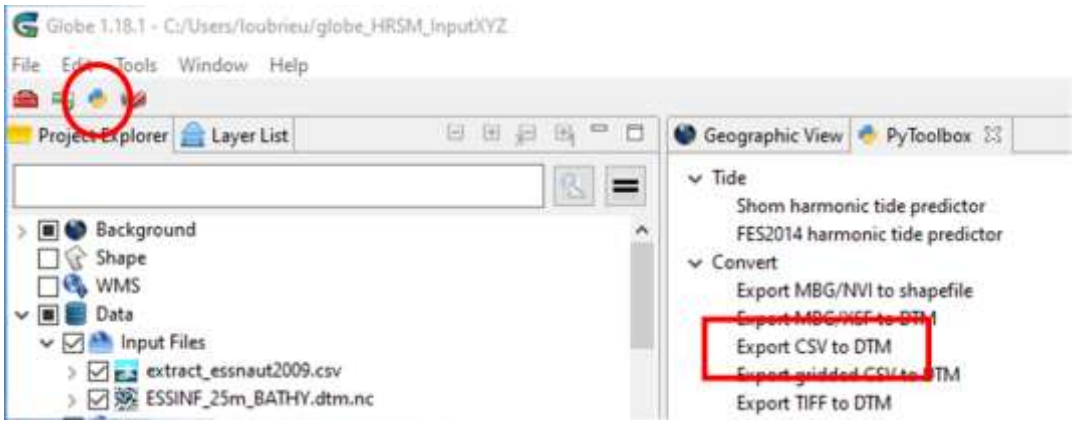


Figure 4: Location of the “Export CSV to DTM tool” in Globe software

The tool presents a set of parameters window, in order to create the grids according to the EMODnet bathymetry specification.

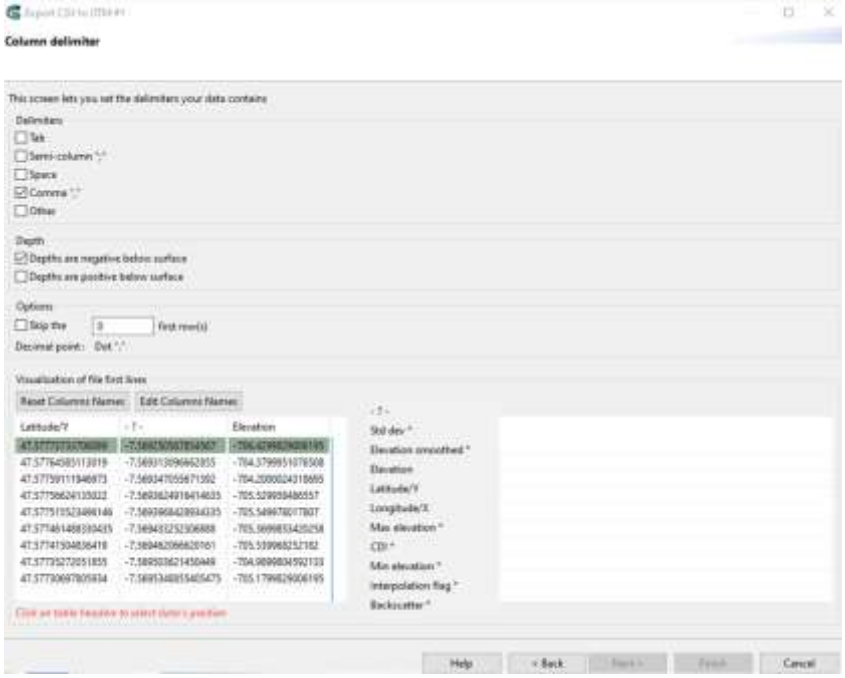


Figure 5: Import of datasets in the CSV to DTM tool

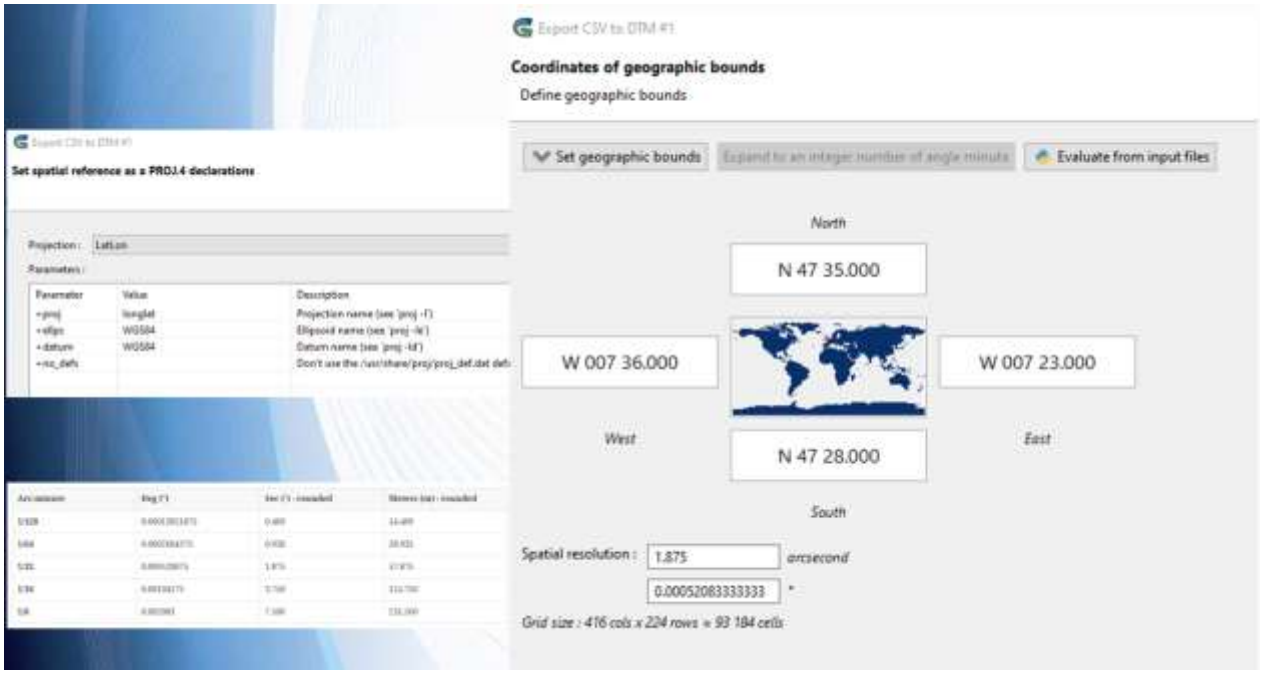


Figure 6 : Windows of the Export CSV to DTM tool for geographical parameters and cell size

Figure 7: Windows of the Export CSV to DTM tool for multilayer parameters

4.4 Processing of CPRD files

This case covers all datasources which are integrated in the EMODnet Bathymetry flow as pre-processed grids.

Their format must be a csv or asci files, XY cordinnates and depth.

They are processed in Globe in 3 steps, associated to 3 tools of Globe :

- Export gridded CSV to DTM : gridded data are imported with their original coordinates system,
- Set CDI : the Id layer is created, with reference to the CPRD Id,
- Reproject into a Lat/Lon : the grid is converted into the latitude/Longitude raster file in accordance with the EMODnet Bathymetry methodology.

Overview of the Globe tools for this case is provided below.

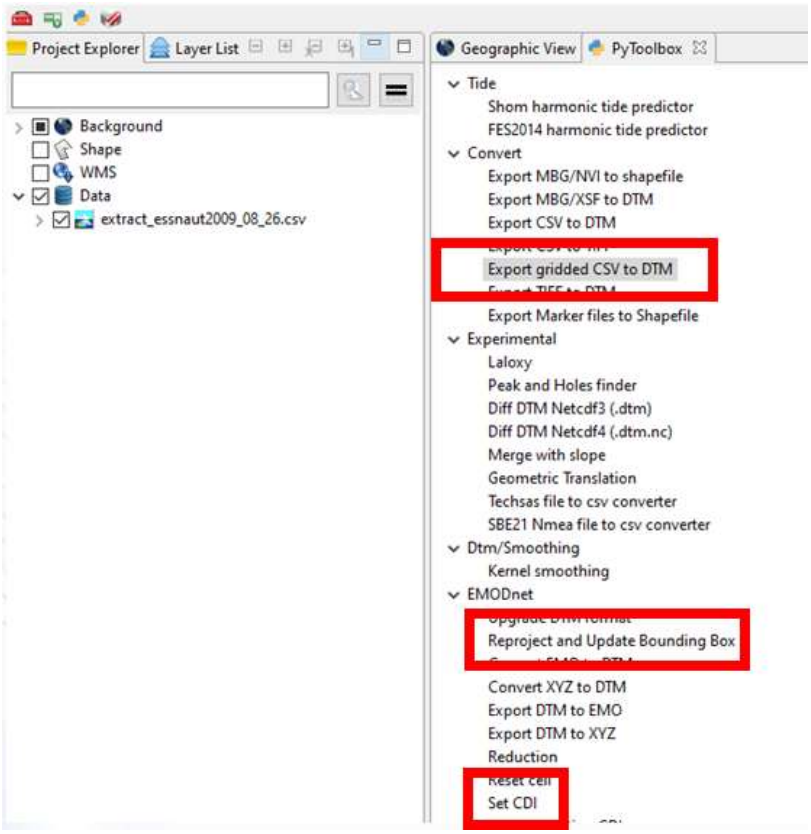


Figure 8: Globe tools for CPRD datasets

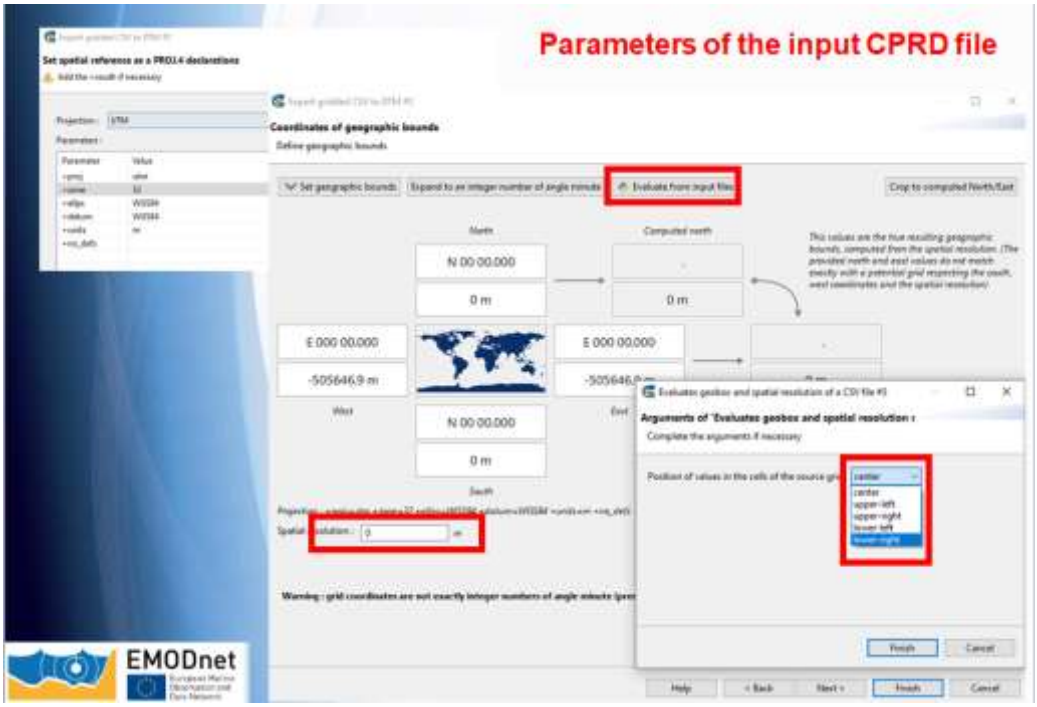


Figure 9: Windows of the Export gridded CSV to DTM tool for defining the input coordinate system

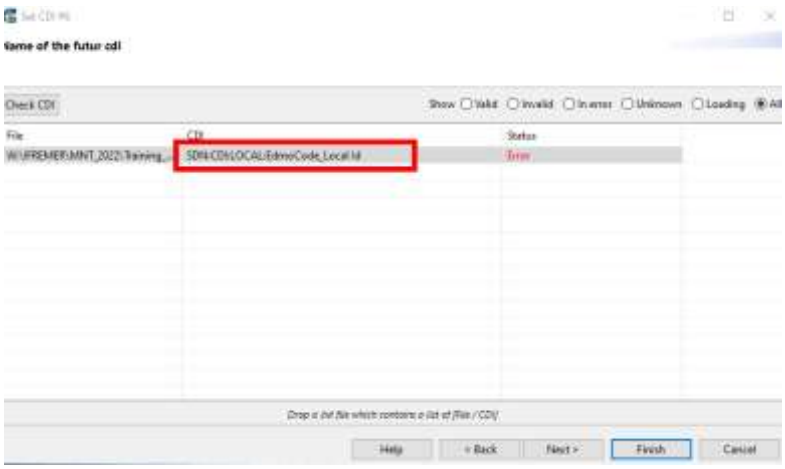


Figure 10: Window of the Set CDI tool for defining the input CPRD Identifier

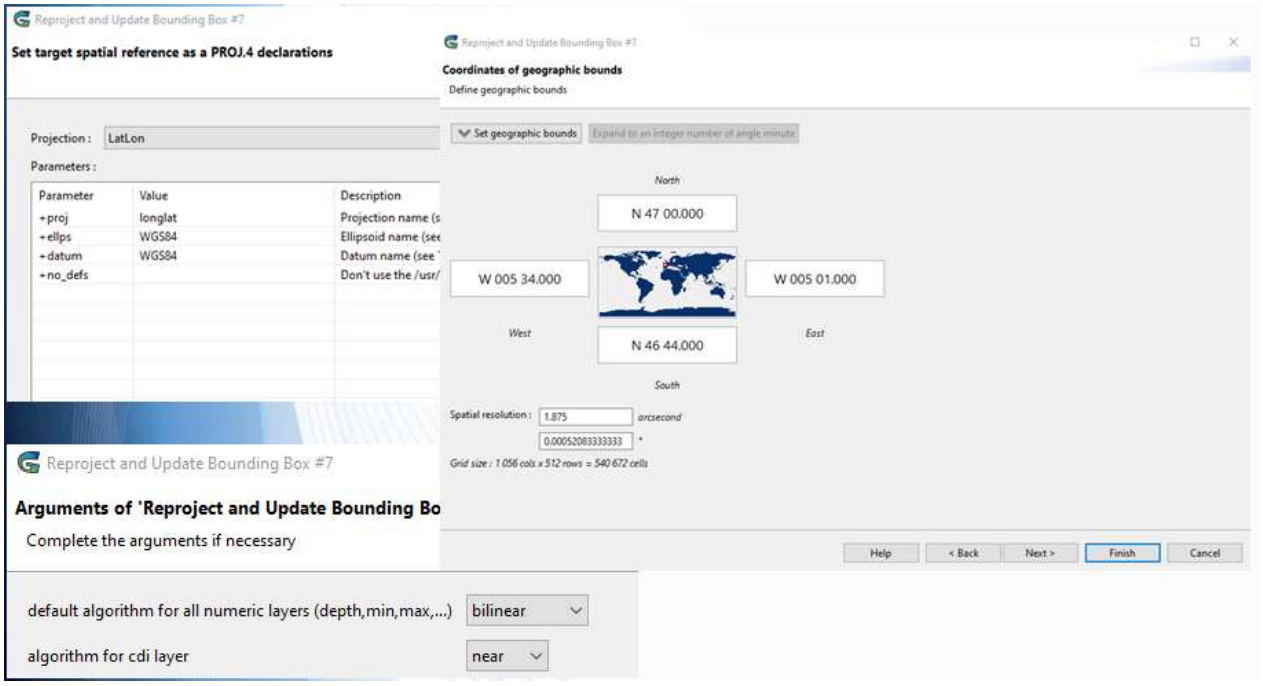


Figure 11: Windows of the Reproject tool defining the output parameters when converting the gridded dataset into a regular geographical grid

4.5 Additional tools and Help function

Additional tools are available in Globe for processing and validating DTMs:

- Reprojection and bounding box update (manual edition, auto shrink…)
- Interpolation or fill gaps tools are available with different algorithms. Algorithms result of the work performed by the Coronis team for data interpolation
- Modification of cellsize
- Smoothing
- Conversion of tiff raster file into NetCDF file as processed in Globe
- Tools for checking and correcting Id layer (CDI or CPRD)
- Statistics for the DTM layers

They are all available in the “Python toolbox” and described in the “Help” manual of Globe software

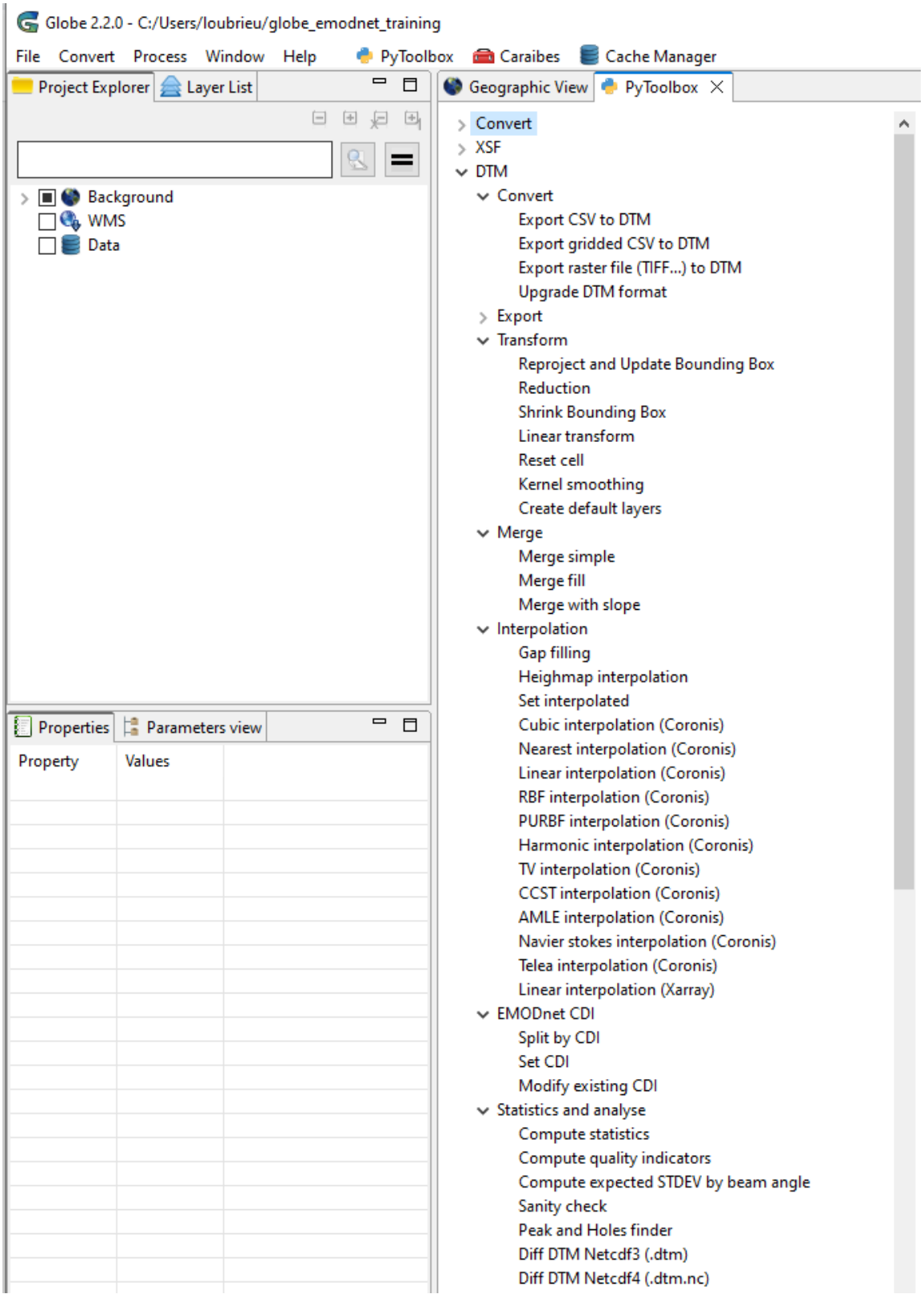


Figure 12: List of available tools in the Python toolbox

Figure 13: Dedicated chapter in the Help guide for the EMODnet tools in Globe

5 Annex: Sextant user manual

Sextant
End-User Manual for DTM management

Cécile Pertuisot (Ifremer)
Benoît Loubrieu (Ifremer)

Author	Status	Date	Comments
Cyril Goasduff	Preliminary version	06/12/2011	Edited for the Geoseas/EMODnet hydrography training
Cyril Goasduff and E.Moussat	1st release on the extranet of the projects	10/01/2012	Miscellaneous corrections
Cyril Goasduff and E.Moussat	Release for EMODnet hydrography	30/01/12	Additional metadata inserted : - type of catalogue (see liste SDN L231) - EDMERP Project identifier - Metadata identifier Miscellaneous modifications related to the address of the catalogue, the terminology and to edit metadata in order to allow a wider use of the editing form.
E.Moussat		06/05/13	Update of the document for the creation of thumbnails using the new Sextant interface
E. Moussat	Release for EMODnet bathymetry	29/01/14	Update of the overall document linked to the new interface of Sextant
C.Pertuisot B.Loubrieu	Release for EMODnet HRSM		Update to Sextant V6 Integration of Sextant API Miscellaneous corrections
C.Pertuisot B.Loubrieu	Release for EMODnet HRSM2		Log in from Sextant API API functionalities
C.Pertuisot B.Loubrieu	Update for EMODnet HRSM Phase2	19/06/2020	Implementation of sextant workflow (§4.6)
C.Pertuisot	Update for EMODnet HRSM Phase3	24/08/2020	Update of sextant workflow (§4.6)
C.Pertuisot	Update for EMODnet HRSM Phase4	10/05/2023	Update since the transfer of the thematic portal to the EMODnet central portal (§1) Agregating the HR-DTMs management (§2) Metadata Check-list (§4.3) Minor updates

Table of content

1. Sextant contribution to EMODnet

Since the EMODnet Bathymetry webportal has been transferred to the EMODnet central portal, Sextant is used as the metadata editor tool and is haversted by the central portal to feed its product catalogue. Each sextant metadata has also a Landing Page that can be reached from the Map Viewer.

The Sextant Catalogue, portal, and data infrastructure have been developed by Ifremer for the management and the distribution of spatial data, and have been adopted for EMODnet Bathymetry for describing composite DTMs and HR-DTMs from the EMODnet Bathymetry data providers. Moreover, the resulting EMODnet DTM products are included in Sextant together with DOIs.

Sextant is implemented using

- Geonetwork to set-up the Catalogue Service for the Web and the Open Geospatial Consortium (OGC) and ISO TC211 standards.
- the Seadatanet Marine Profile for ISO19139 together with the European Directory of Marine Organisations (EDMO), the European Directory of Marine Environmental Research Projects (EDMERP) and the SeaDataNet Common Vocabularies NVS2.0 (**http://www.seadatanet.org/**) for consistent descriptions of products (DTMs) with the EU SeaDataNet Common Data Index for survey data.

2. Sextant API for CPRD, PRODUCT and Tiles metadata population

A Sextant API (Application Programming Interface) has been deployed to respond to the harvesting need of the EMODnet central portal and gathers the 3 catalogues dedicated to EMODnet Bathymetry projects.
(https://sextant.ifremer.fr/documentation/emodnet_bathymetry/api/catalogue.html#/search?from=1&to=30).
Sextant is used to provide a Common Index (Catalogue) and descriptions of the composite products (CPRD catalogue) and the high resolution products (PRODUCT catalogue) delivered by partners and associated providers of EMODnet bathymetry projects who have opted to deliver bathymetric data as products of their own for the construction of the EMODnet final DTM. They are not an observed data files, but a derived product. So they cannot be described in the SeaDataNet catalog.

This table allows to distinguish the differences between these 2 types of DTMs:

	CPRD **(contribution to the regional DTMs)**	**PRODUCT (HR-DTMs)** **(contribution to the HR layer)**
Content	- Historical Composite DTMs in your institution - New composite DTMs at a resoltuion of 1/16 arc minute	- Higher resolution DTMs (1/32,1/64 …) - Initially on smaller area or specific area of interest for showcases
Methodolgy	- Compilation using Globe software - EMODnet Bathymetry methodology - Historical DTMs might differ -	- Compilation using Globe software - EMODnet Bathymetry methodology
Use	- Integration in the regional DTM - To be sent to your regional co-ordinator	- Integration in the HR layer of the Map Viewer - To be sent to Benoit Loubrieu (Ifremer), Cécile Pertuisot (Ifremer), George Spoelstra (GGSGC)
Visibilty	- Connected to Sextant API - Visible from EMODnet website	- Connected to Sextant API - Visible from EMODnet website
Access	- No direct access to the DTMs for the end users - DTMs are stored at each partners	- Public downloading through the EMODnet Map Viewer - DTMs are stored on a centralised cloud

The sextant API also gathers the descriptions of each tile of the EMODnet final DTM in the Tiles catalogue.

Each metadata described in any of these 3 catalogues is given a Landing Page (LP) having the following typology: https://sextant.ifremer.fr/record/UUID

Where UUID is the metadata unique identifier constructed for the project needs (see chapter 4.2).

3. Sextant API catalogue functionalities

3.1. Access

All the descriptions of composite and high resolution products provided by partners can be viewed using the sextant API: https://sextant.ifremer.fr/documentation/emodnet_bathymetry/api/catalogue.html#/search?from=1&to=30

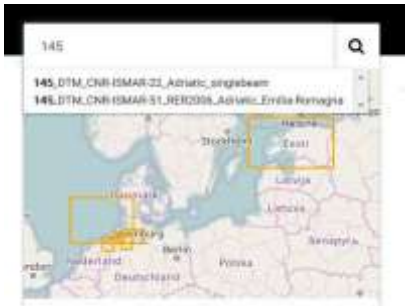
3.2.Filter criterias

3.2.1 Catalogue selection

3.2.1 Free Search

A free text search is carried out on all text fields of the metadata sets. The search tool is based on auto completion and suggests a list of words existing in the metadata sets as far as you enter 3 characters.

First, write your text and then click on the magnifying glass to display the result.



3.2.2 Geographic area

A search by geographical extent is carried out by choosing either the products strictly inside the selected area or the products intersecting with it.

First, click on the pen and draw your geographical area. Then, click on the arrow beside and select the type of spatial search "intersects with" or "within" mode.
You can switch to one or the other type of spatial area as you like.

3.2.3 Predefined content

Each selected filter automatically updates the results display and also updates the other available filters:

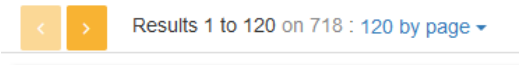
- Keywords
- Years

Note: there is a "Reset Filters" button allowing to reset all the criteria and to start a new selection

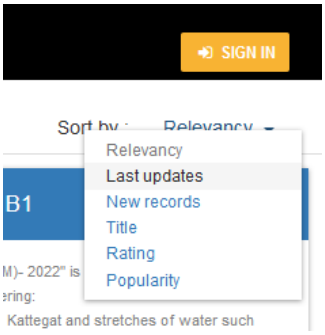
3.3. Metadata display

3.3.1 Results and sorting

The number of results after applying your filters appears on the top left of the display. By default, the first 30 results are displayed but you can choose to display 60 or 120 entries per page:



It is possible to organize the results by "Title" (alphabetic order), "Popularity" (number of consultation of the entry), "Last updates" (last updated entries appear first), "New records", "Rating":



The list of metadata sets is displayed with an optional thumbnail while their bounding boxes are displayed on the map of the left window.

To locate a data set move the mouse to the metadata set entry. The corresponding bounding box is highlighted on the map.

3.3.2 View

To display metadata, click on the title of the metadata set. Metadata are displayed according to the EMODnet Bathymetry template.

Note the file identifier at the top of the metadata information which is generated automatically from metadata edited by the partner using the following syntax : "SDN_CPRD_*EDMO-Id-of-holding-data-center*_*Short-datasetname*".

This identifier contains the EDMO_Id of the holding data center and a short dataset name of the product used as source data for the EMODnet DTM. These Ids are recorded in the CDI layer of the EMODnet DTM. This allow to generate the URL for viewing the corresponding metadataset.

4. Managing spatial data using Sextant

Before creating new metadata, read the EMODnet HRSM specifications documents which contain instructions for filling some of the metadata : "Methodology and guidelines for processing original input data into DTMs" and "Completing metadata elements for the generation of the Quality Index for the EMODnet DTM".

4.1 Vocabulary

Common vocabulary lists and organization identification

Lists implemented in the EMODnet template use the SeaDataNet Common Vocabularies (**http://www.seadatanet.org/**)

Organization are identified using the European Directory of Marine Organizations (EDMO) maintained by Seadatanet. Organization name and identifier can be querried on the SDN portal at:

http://www.seadatanet.org/Metadata/EDMO

File identifier

The unique file identifier (UUID) at the top of the metadata information of the form is generated automatically using a combination of metadata edited by the partner. The unicity of the entry is guaranteed by an automatic combination with the EDMO id. The syntax (derived from SeaDataNet practices) is:

SDN_CPRD_EDMO-Id_short-name-of-dataset

EMOD Id of the holding data center — must be unique

It is requested to rename the DTM file corresponding to your metadata entry as **EDMO-Id_ short-name-of-dataset.dtm.**

The EDMO_Id of the holding data center and the short name of dataset of the product are also recorded in the "Identifier" layer of the EMODnet DTM (see EMODnet hydrography specifications). This allows viewing services of the EMODnet portal and the 3D viewer of the Ifremer Globe software to generate the URL to access the metadata set of the sextant catalogue.

4.2 Log in instructions

Each partner needs an external account. If you don't have any, please contact the Sextant team: sextant@ifremer.fr.

Log in function is available through Sextant API on EMODnet website:
https://sextant.ifremer.fr/documentation/emodnet_bathymetry/api/catalogue.html#/search?from=1&to=30
Sign in with your sextant credentials on the top right hand corner:

The “Administration” functionality appears.

4.3 Metadata check-list

Here is a “check-list” that the partners can follow in the suggested order to have a quick overwiew of the main steps to describe their products and to see their metadata validated (this is not a exhaustive list of the required metadata but guides you in the process) :

- ✓ **Log in (§4.2)**
- ✓ **Chose the appropriate template (§4.4)**
- ✓ **Start with the Short name of dataset (What) + EDMO-Id o the data holding center (Who) and Save (§4.4.1)**
- ✓ **Continue with all the other fields and with specific attention to:**

  Dataset name (different form the short name of dataset) (§4.4.1)
  Project name
  Parameter Discovery/Measure devices/Positioning devices
  Geometry
  Abstract
  QI (§4.4.3)
  Temporal extent (§4.4.5)
  EDMO-Ids
  Licence
  Associated ressources: thumbnail + EMODnet links (§4.4.2)
- ✓ **Save and close**
- ✓ **Submit for review**
- ✓ **For HR-DTMs only : send your HR data files (named as EDMO-Id_ short-name-of-dataset.dtm) to george@ggsgc.eu + cecile.pertuisot@ifremer.fr + benoit.loubrieu@ifremer.fr**
- ✓ **For CPRDs only: send the files to the Regional coordinator**

4.4 Detailed instructions

To create a new metadata description, a dedicated metadata template has been designed for the purpose of EMODnet projects.

Select "New metadata" in the menu “Administration” (see 4.2.). A window appears:

- Create a Dataset
- As Template, select "Template for EMODnet Bathymetry metadata"
- "In": select the appropriate catalogue: "EMODnet hydrography - **CPRD**" for cDTMs OR "EMODnet hydrography - **PRODUCT**" for HR-DTMs according to the description in

Chapter 2.

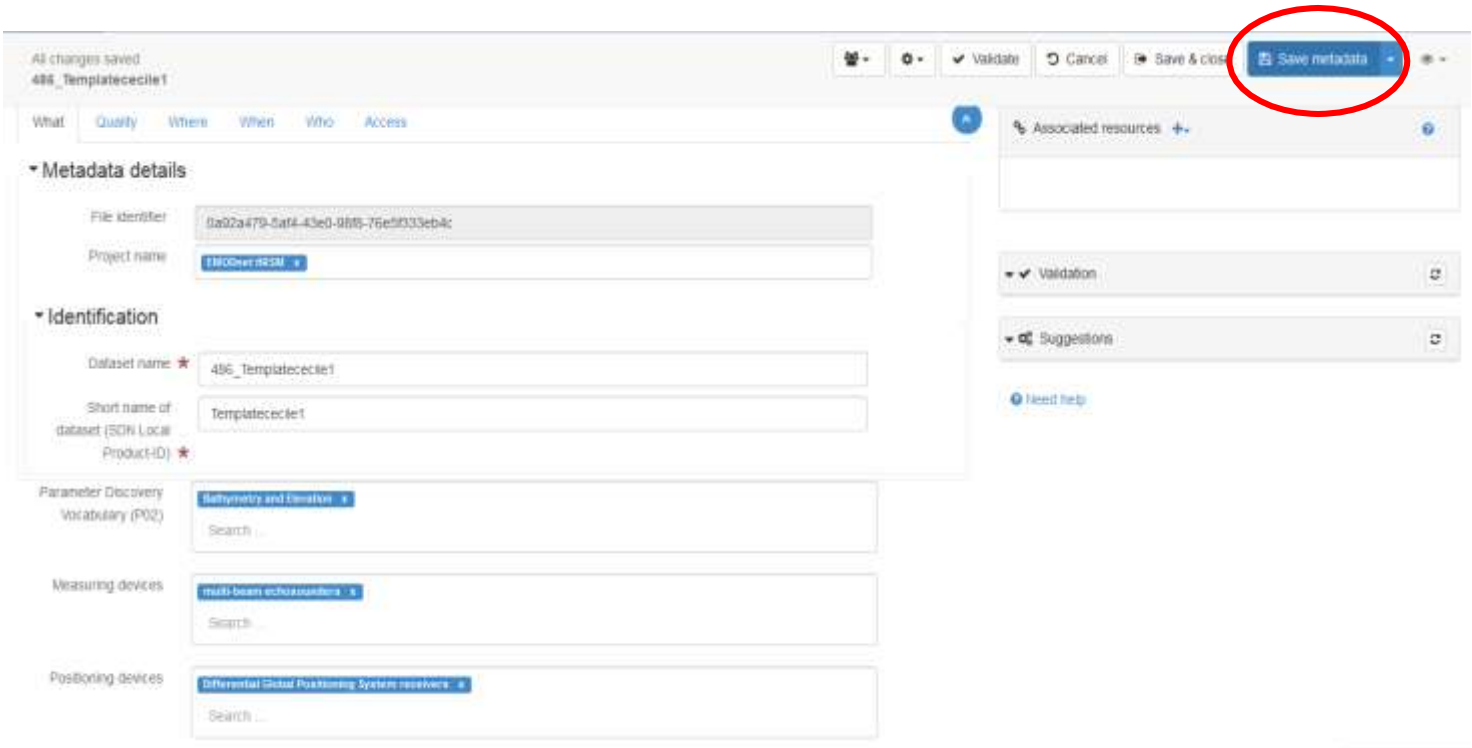
- And then "Create".

SEXTANT disconnects you automatically if you are inactive. Save regularly what you have edited (every15 mns).

Mandatory fields have been defined not only in function of the ISO and Inspire standards and Directive but also in function of the requirement of the projects.

Most of the fields are pre-filled or user friendly and don't need specific explanation. Attention will be paid to specific or text fields. Explanations are given by thematic tabs.

4.4.1. What



It is **strongly recommended** to start filling the "Dataset name" and "Short name of dataset" to avoid Sextant to save your entry under a default name. Use the "Save metadata" button and continue.

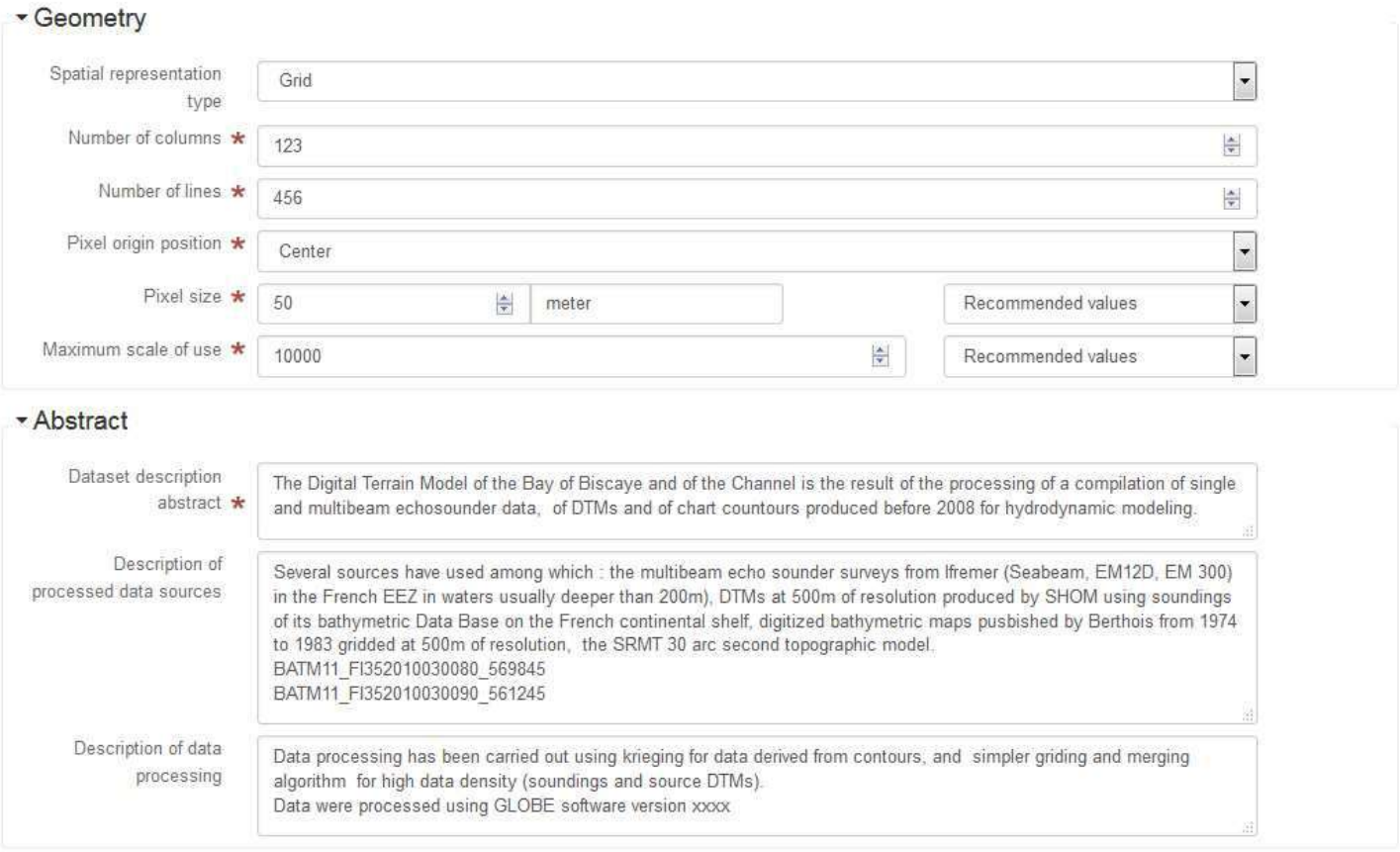
File identifier: is generated automatically using a combination of metadata edited by the partner. The syntax is: "SDN_CPRD_EDMO-Id_local-product-Id"

Project name: Choose EMODnet HRSM4. This field corresponds to the EDMERP SDN list.

Dataset name: title of the data set that will appear in the catalog.

Short name of dataset (SDN Local Product-ID): Local identifier of the bathymetric grid (according to local rules of Data Center). **This is a component of the file identifier.** The local identifier must not be longer than 75 characters (this constraint comes from the length of the string used to keep track of the source of data in the DTM NetCDF format.

Parameter Discovery/Measure devices/Positioning devices: metadata are given by default but you can also delete them and/or add others by clicking on "Search" (auto completion search). Use of L05 and P02 lists.



Geometry: fill in the information, and use lists or "Recommended" values when proposed

Pixel size: Select "Arc minute" entry in the Recommended values or write "Arc minute" in the text field close to the value field.
To fill the value, please refer to decimal value in the following table:

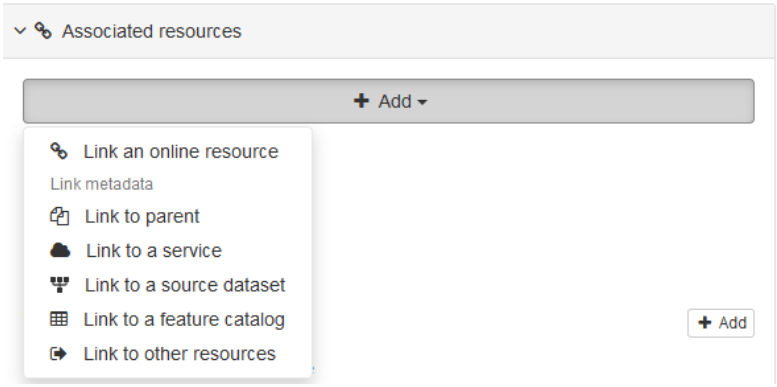
Grid size	Arc minute
1/512	0,00195313
1/256	0,00390625
1/128	0,0078125
1/64	0,015625
1/32	0,03125
1/16	0,0625

Dataset description abstract: write down a summary about the dataset (cruise/purpose/context description, specific characteristics, valuable details…)

Description of processed data sources: indicate the data sources and write down the corresponding CDIs when they exist and/or DOI if needed.

Description of data processing: any valuable detail about the processing software or processing methodology.

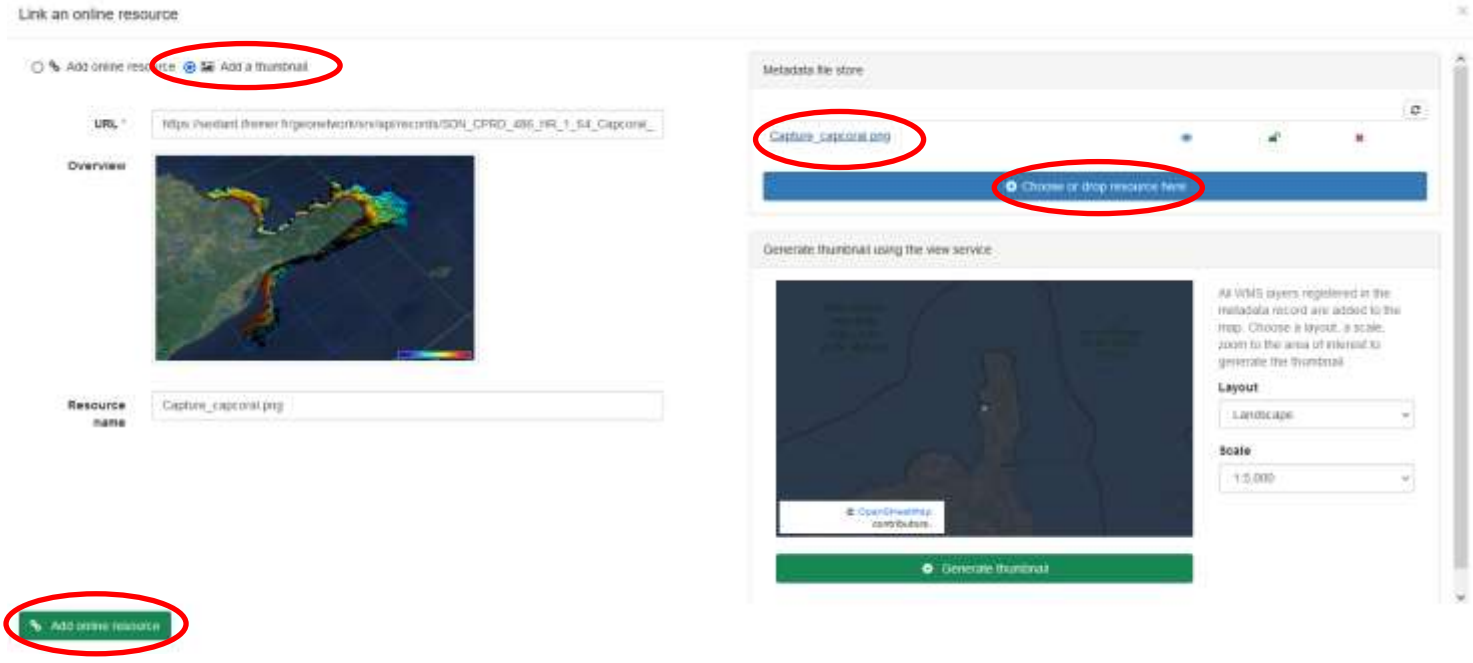
4.4.2. Associated resources (tab “What” upper right corner) – thumbnail and online resources



It is recommended to attach a thumbnail to illustrate your DTM in the catalogue. Click on the add button of the “**Associated resources**” field and seclect “**Add document**”.

Click on “Add a thumbnail” (1), select the thumbnail with the “Choose or drop resource here” tool (2) and click on your thumbnail in the “metadata file store” to update the URL(3).

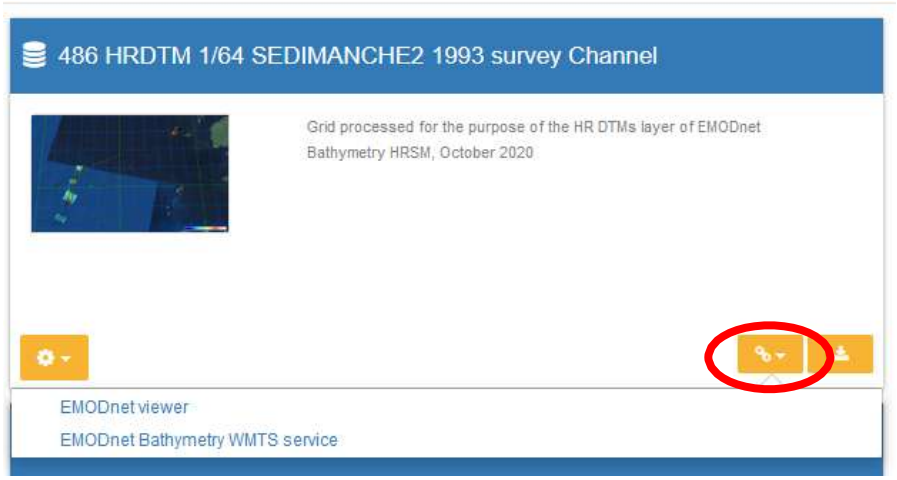
Click at the very bottom of the page to “add online resource” (4).



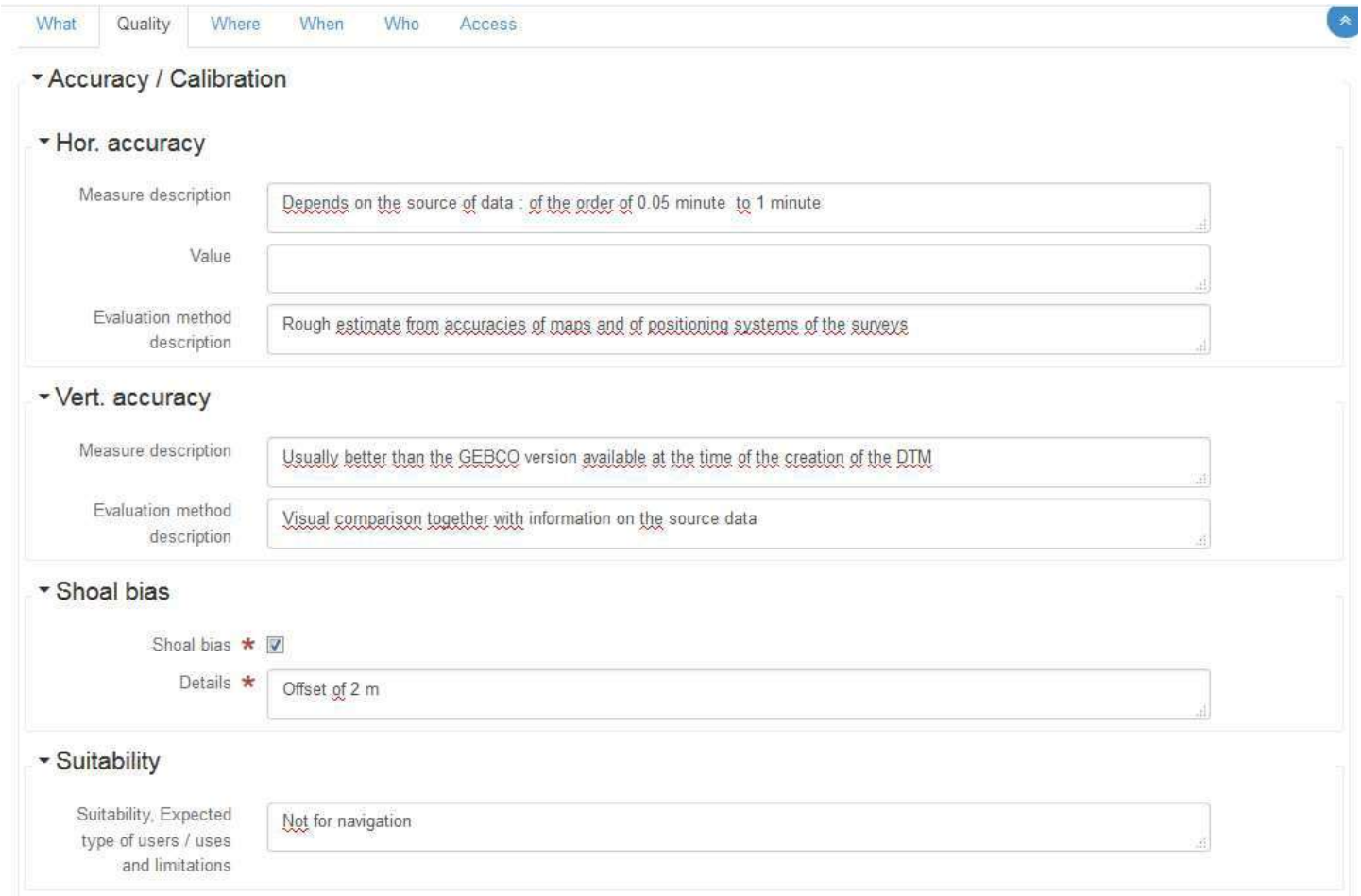
For HR-DTMs only: references to the EMODnet viewer and to the WMTS webservice have to be done using the online resources as follow :

- Click on the add button of the "**Associated resources**" field and select "**Link an online document**" and enter the followings:
  Protocol: Web link (URL)
  URL: https://emodnet.ec.europa.eu/geoviewer/
  Resource name: EMDOnet viewer
  And click on "Add online resource"
- Click on the add button of the "**Associated resources**" field and select "**Link an online document**" and enter the followings:
  Protocol: Web link (URL)
  URL: https://tiles.emodnet-bathymetry.eu/
  Resource name: EMODnet Bathymetry WMTS service
  And click on "Add online resource"

These links will be attached to your metadata description in the catalogue:



4.4.3. Quality



Horizontal accuracy:

Measure description: give any information about the horizontal accuracy of the acquisition system, the positioning system as well as the sounding method.

Value: In case you wish to give a digital estimator of the horizontal accuracy.

Evaluation method description: Reference to standard which have been used to qualify the horizontal accuracy (hydrographic standards, industrial specification…)

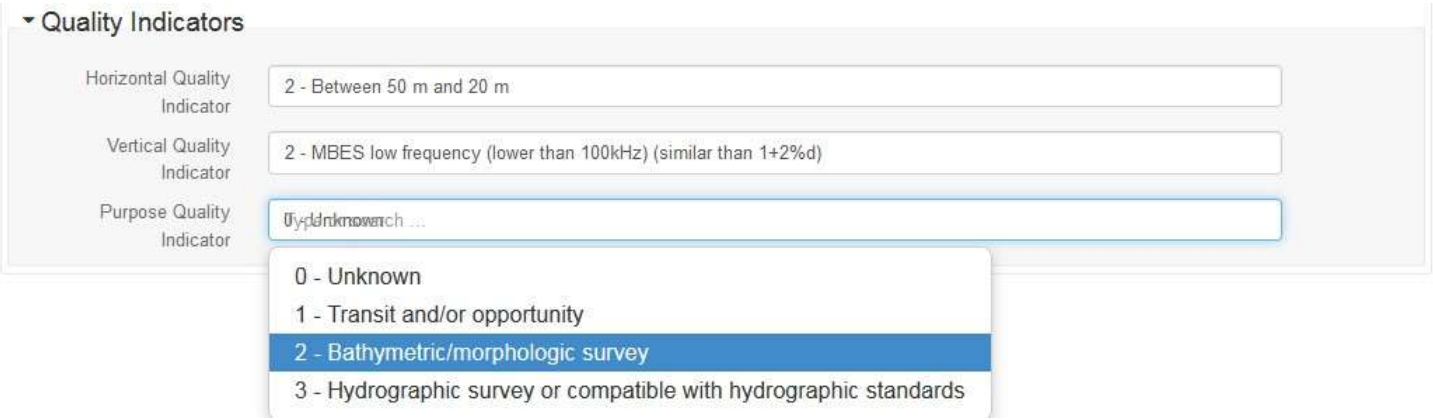
Vertical accuracy:

Meaure description: any information about the vertical accuracy of the depth in the file

Evaluation method description: Reference to standard which have been used to qualify the horizontal accuracy (hydrographic standards, industrial specification…)

Shoal bias: tick this field only in case of existing bias and precise details in text field below.

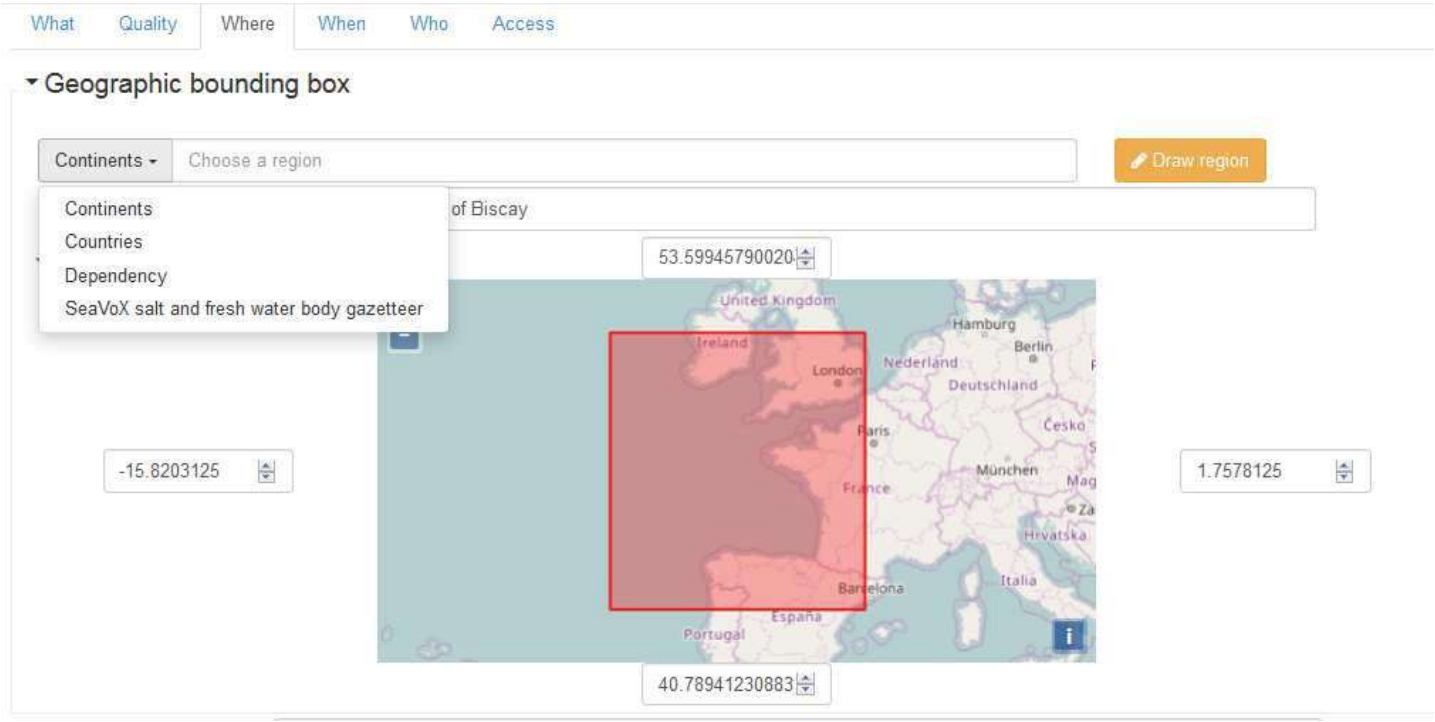
Suitability: precise the type of use that can be made of the datasets (example: not suitable for navigation)



Quality Indicators have been implemented in the EMODnet HRSM project to use further qualitative information (in DTMs and CDIs) related to the data source such as type of sensor. For the DTMs, the data producer has to consider giving each of the quality indicator based on the contribution with the lowest quality.
Click on “search” to make appear the appropriate list.

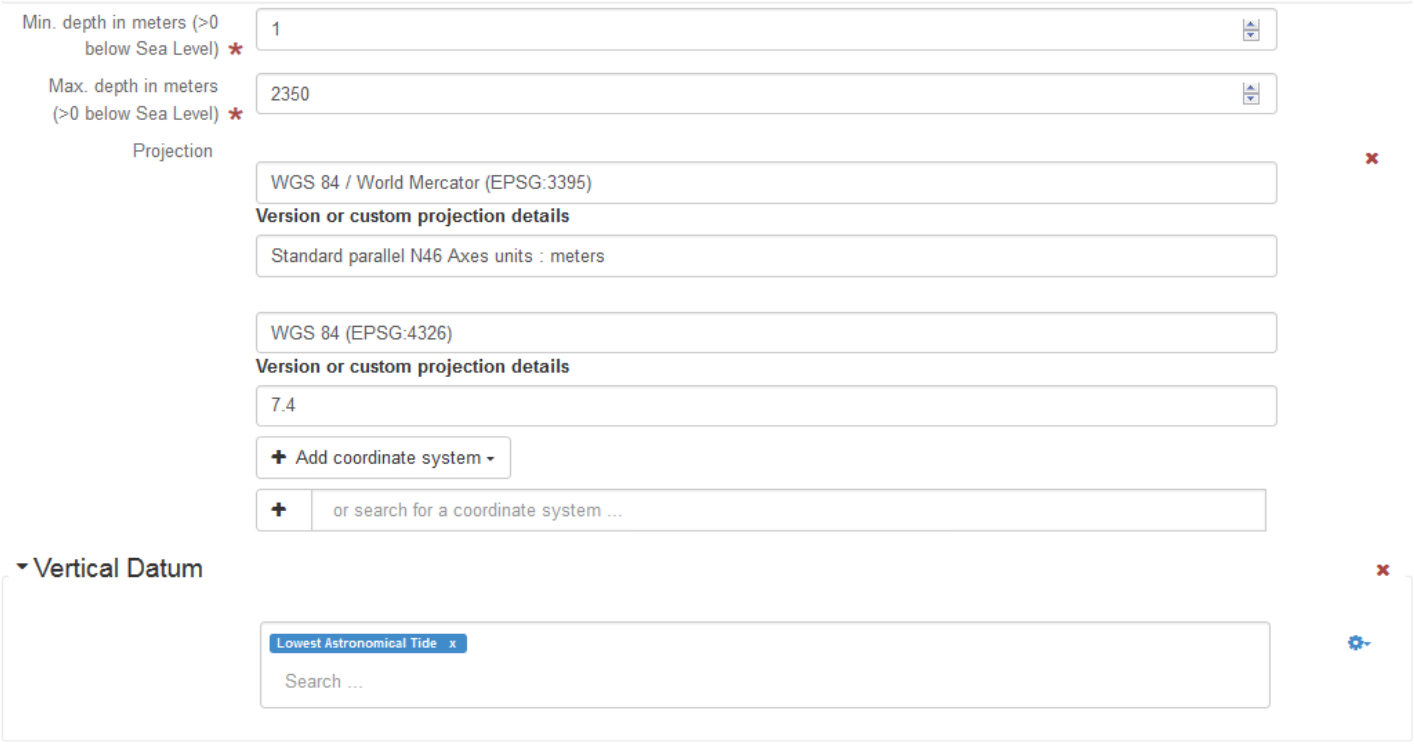
The following document describes the Quality Index proposed in the framework of the HRSM project : "Completing metadata elements for the generation of the Quality Index for the EMODnet DTM". It will help you to verify your entries.

4.4.4. Where



The **Geographic Bounding Box** can be created in 3 different ways:

- By drawing your own area: click on “Draw region”, select the area and the coordinates will automatically be updated
- By entering the coordinates (decimal degrees) manually in the appropriate fields
- By selecting an area in the international SeaVox list



Fill in the information, and use lists values when proposed.

Projection: fill in the geodetic system and the projection of the catalogued product. Some of them are listed in the "Add coordinate system" list.

You can input additional details in the "Version or custom projection details.

As example:

for a latitude/longitude file :

Write "WGS84" in the "Projection" field.

for a UTM Zone 33 file

Write "WGS84 / UTM" in the "Projection" field

Then write "Zone 33" in the "Custom projection details.

Vertical Datum uses L11 SDN list.

4.4.5. When

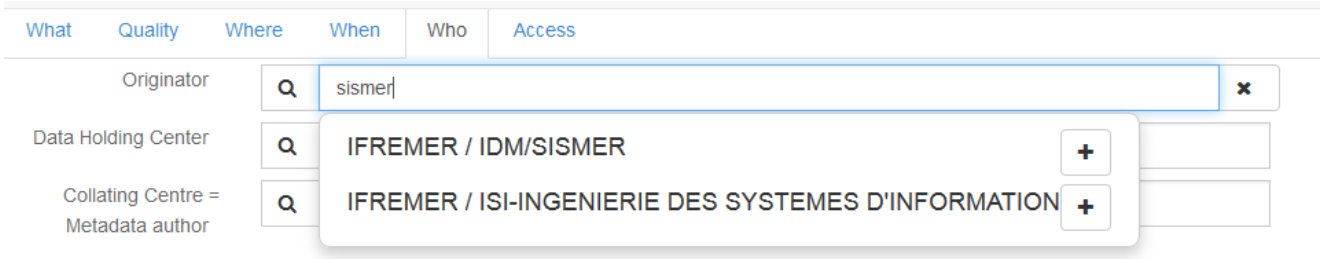
Fill in the date information using the calendar. To go throw years, click the year:

Creation date is the date of production of the DTM.

Temporal extent covers the period of datasets used in the DTM

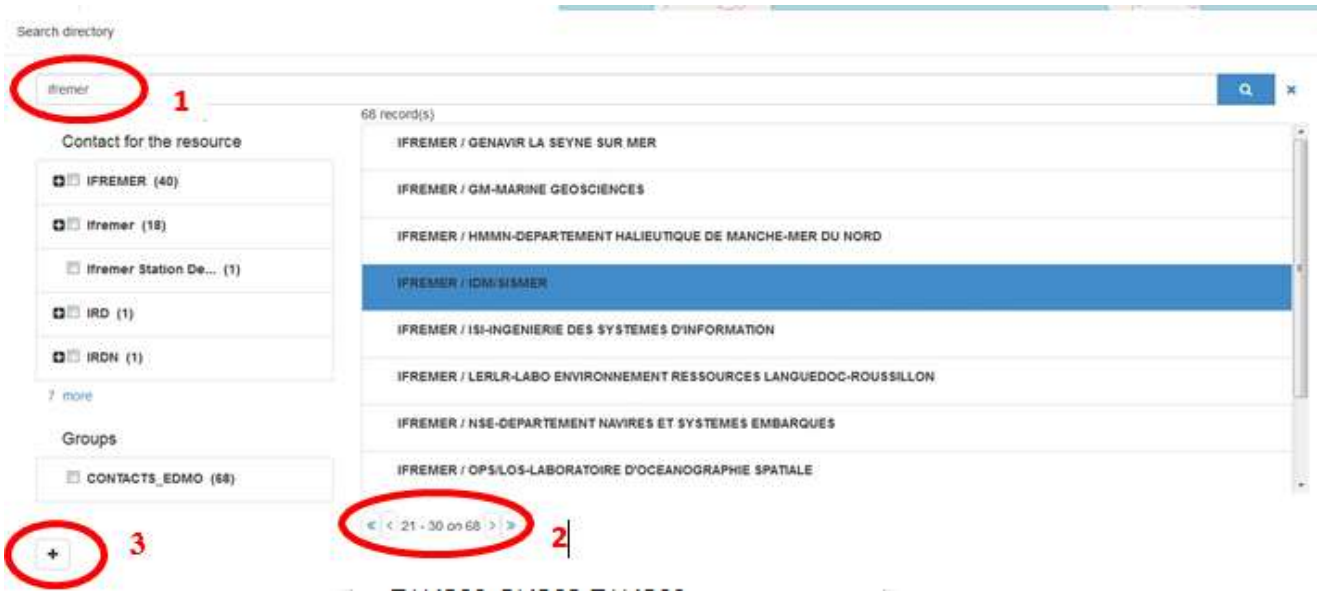
Measurement frequency can be used in case of periodic acquisition of datasets.

4.4.6. Who



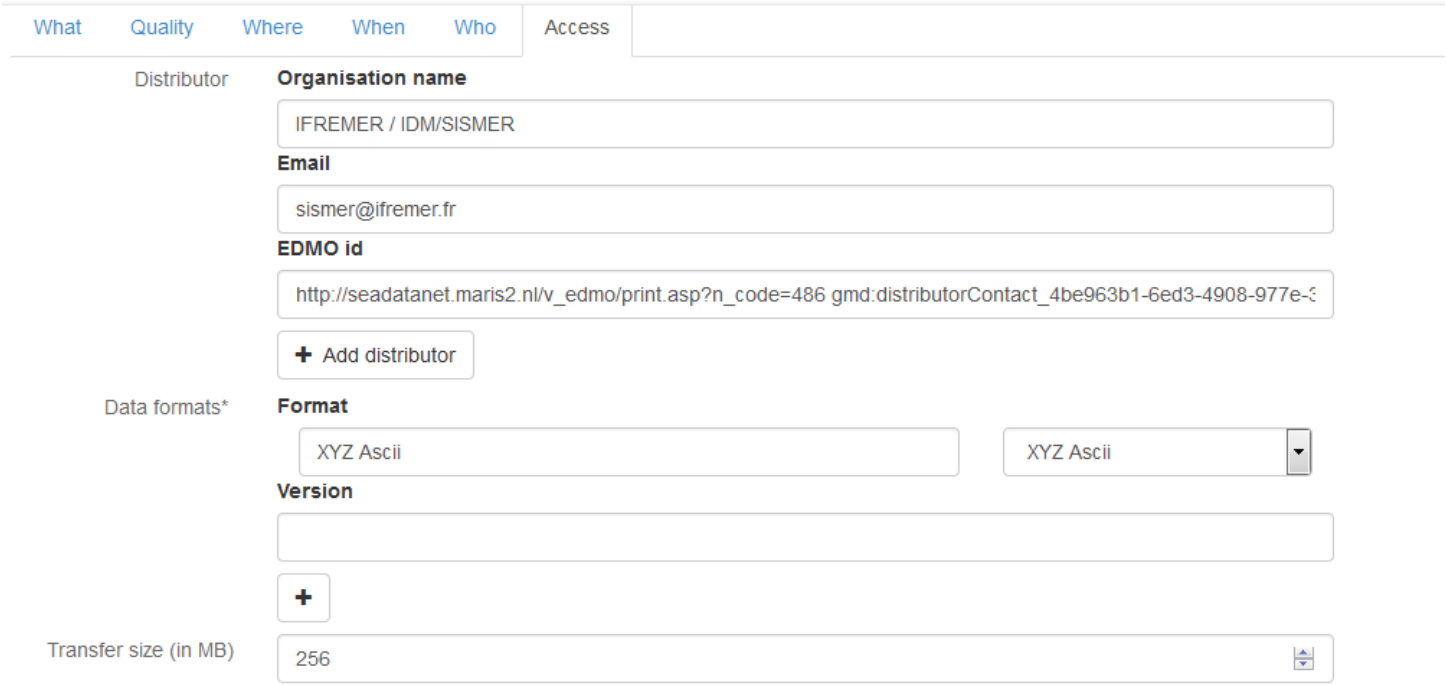
The **Originator**, **Data Holding Center** and **Collating Center** contacts are filtered on the EDMO_id list. **The data holding center contact is a component of the file identifier.**

Enter the name of your institute or department and corresponding entries will appear (then click on the corresponding "+" button). If not, click on the binocular, and write in "search for a contact" field or use the proposed filters on the left of the screen (check number of pages). Once you have found the correct entry, click on the "+" button at the bottom left corner.



Once you selected the correct contact, Organisation name, Email and EDMO id are automatically filled in.

4.4.7. Access



Click on "Add distributor" to enter the **Distributor** contact details (also filtered on EDMO id). And fill in the other information using "Recommended values" when possible.

Version and **Transfer size** are optional.

Intellectual property for CPRD:

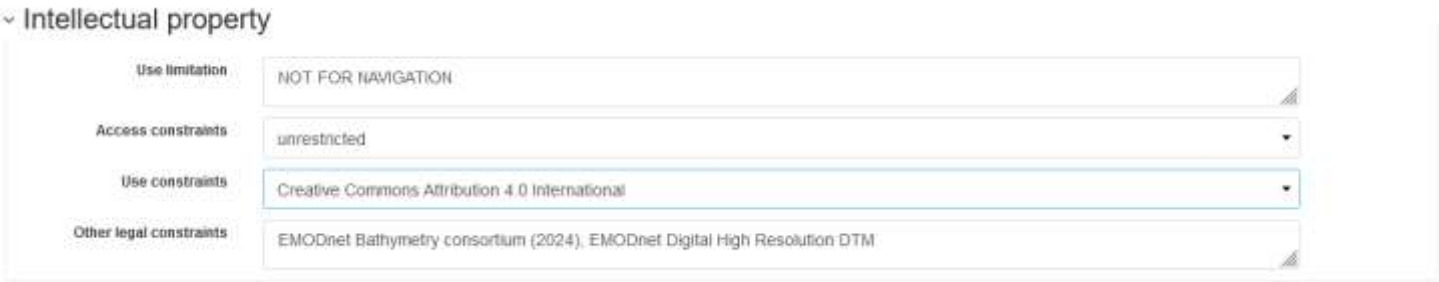
Use limitation: free text field that can be used to detail intellectual property like "NOT FOR NAVIGATION"

Access constraints: uses list SDN L08. Gives information about how to get access to the DTM.

Use constraints: gives information about the condition of use of the DTM.

Other constraints: complementary information about the use of the data. This is the appropriate field to enter the DOI of your dataset when existing or the obligation of citation

Intellectual property for HR-DTM:



Use limitation: for example “NOT FOR NAVIGATION”

Access constraints: set as **“**unrestricted”. Uses list SDN L08. Gives information about how to get access to the DTM. To be set as **“**unrestricted”.

Use constraints: Uses list SDN L08. Gives information about how to get access to the DTM. To be set as “Creative Commons Attribution 4.0 International”.

Other constraints: write “EMODnet Bathymetry consortium (2024), EMODnet Digital High Resolution DTM”

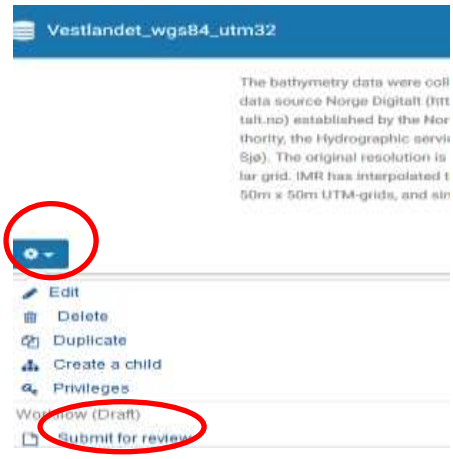
4.5. Save your metadata

Your sextant template is now complete, you can "**save and close**" the template. You can check your new entry on the sextant API catalogue: https://sextant.ifremer.fr/documentation/emodnet_bathymetry/api/catalogue.html#/search?sortBy=relevance&from=1&to=30

4.6 Submit your metadata for validation

A workflow status has been implemented to prevent any inconsistency with EMODnet rules when updating or creating a metadata. Each creation or update has to be validated by a sextant administrator.

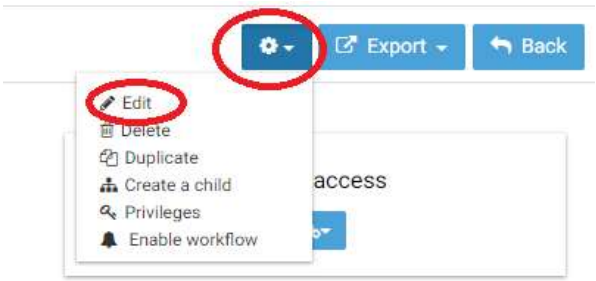
To submit your metadata click on the Wheel tool>Submit for review



The sextant catalogue administrator will receive a notification by email and will validate and publish your sextant entry. **This submission has to be done for each new entry and each updated entry.**

5. Guidelines for updating an existing entry

If you need to update any of your description, select your sextant entry on the sextant API catalogue: https://sextant.ifremer.fr/documentation/emodnet_bathymetry/api/catalogue.html#/search?sortBy=relevance&from=1&to=30 and click on the wheel tool on the upper right hand corner and select edit.



Once updated, do not forget to submit again your entry through the sextant workflow – see chapter 4.6.

6. Sextant helpdesk

If any problem when using Sextant, you can contact the Sextant team sextant@ifremer.fr .

Your question will be routed toward the appropriate person.

EMODnet Thematic Lot n°1 – Bathymetry

EASME/EMFF/2019/1.3.1.9/Lot1/SI2.836043

Start date of the project: 20/12/2022 (24 months)

Centralisation Phase

D3.1 - Upgraded guideline of EMODnet methodology for DTM production, including using prototype CVE

October 2023

The European Marine Observation and Data Network (EMODnet) is financed by the European Union under Regulation (EU) 2021/1139 of the European Parliament and of the Council of 7 July 2021 establishing the European Maritime, Fisheries and Aquaculture Fund and its predecessor, Regulation (EU) No. 508/2014 of the European Parliament and of the Council of 15 May 2014 on the European Maritime and Fisheries Fund.

Disclaimer

Document info

Title (and reference)	Upgraded guideline of EMODnet methodology for DTM production, including using prototype CVE
WP title (and reference number)	QA-QC and production of multi-resolution DTMs (WP3.2)
Task (and reference number)	Upgraded guideline of EMODnet methodology for DTM production, including using prototype CVE (D3.1)
Authors [affiliation]	Benoît Loubrieu (Ifremer) and Mickael Treguer (Ifremer)
Dissemination level	Public
Submission date	20 October 2023
Deliverable due date	20 October 2023

Contents

1 Overall approach and explanation EMODnet Bathymetry flowchart

The first year of the EMODnet Bathymetry project is mostly dedicated to data gathering and populating new bathymetric data sets in the EMODnet Bathymetry catalogue services as managed with the SeaDataNet CDI service and the Sextant CPRD service. Moreover, data providers have to pre-process and grid their new data sets using GLOBE and the EMODnet Bathymetry standards and forward these as new inputs to the Regional Coordinators.

The generation of Regional DTMs is divided over regional sea basin subgroups, each with a Regional Coordinator and a number of contributing data providers. Each Regional Coordinator will be responsible for a quality assessment and selection of the data contributions and the compilation of the Regional DTM using the GLOBE software. This process will start during the 1st quarter of the 2nd Contract year, when all data providers have finalized their data gathering and population activities for the CDI and CPRD catalogues and will have undertaken pre-processing and gridding of their data sets for delivery as DTMs to the regional coordinators.

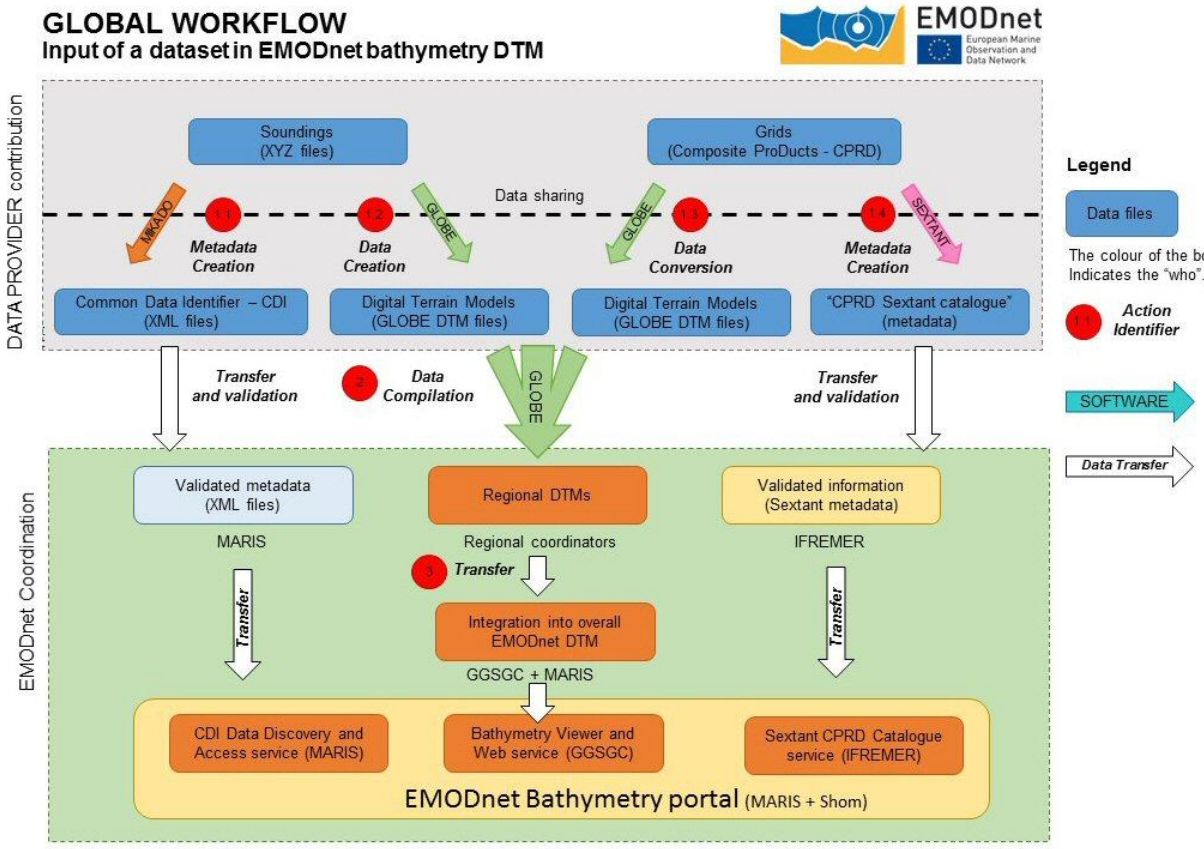


Figure 1. Example of caption which should go below the figure

The Regional Coordinators will make use and review the latest EMODnet DTM tiles, the previously used data sets, and the new data sets as received as potential input. Their task is then to update and improve their Regional section, focusing on updating parts of the DTM with new and possibly higher quality data, and on improving already known and new to be identified anomalies in the latest EMODnet DTM release.

2 Principles for set-up of CVE

As part of WP4, Ifremer has developed in 2021 a prototype for a Collaborative Virtual Environment (CVE). It then allowed analysis of the difference between the 2018 and 2020 versions of the EMODnet Bathymetry grid. The geographical area of concern were the four regions of the Mediterranean Sea and Black Sea.

The objective of the CVE development is to provide a common environment for the quality control of regional DTMs and to share, between all partners, the analysis of the gaps between 2 successive releases of the regional DTMs. This analysis should contribute to identify and correct remaining issues in the DTMs.

For that purpose, the CVE development project has been extented in 2022 to covering the whole EMODnet DTM for all European seas and North-West Atlantic Ocean, while in 2023 further developments have taken place for optimising and expanding functionalities.

The current version of the CVE focuses on 3 main functionalities:

- Display of Regional DTMs
- Implementation of Web processing tools, which are dedicated to the quality analysis of DTMs
- Annotation tools, allowing the regional Coordinators to document and share remaining issues on regional/final DTMs.

3 Current configuration

The latest vesion of the CVE has the following specifications.

3.1 Technical framework

The CVE Website is based on three components which are all based on OGC standards and which all benefit of previous technical choices made by the project (NetCDF grid format, OGC WMS services). The project setting up is based on the free open source QGIS. Display/Delivery of the grid is based on WMS/WMTS functionalities. Dedicated processing tools on the grid are based on the emerging OGC Web Processing Services (WPS) technology.

3.2 Data input

All regional DTMs are now part of the CVE project.

For each of them, four layers of information are made available:

- both grids of the water depth for 2020 and 2022 DTM grids
- their difference
- the 2022 source reference layer.

3.3 Analysis tools

In order to help the Regional Coordinators delineating issues in individual depth grid, tools for the DTMs analysis have been implemented such as the calculation at grid node of the slope, the detection of erratic peaks, artificial hill shading, and iso-value (isobath) contours.

An annotation tool allows observations to be recorded as a geographic object (point/line/polygon) associated with a textual description.

3.4 Further actions

These annotations are made available to all the partners of the project, so that all stakeholders can share a common understanding of remaining issues, which then can be directed to the relevant partner (data provider or regional coordinator, respectively) for actions such as further data processing or modification of the selection of data source used as part of the fusion process.

Developments in 2023 have been dedicated to implementing additional tools:

- Extra tools for grid analysis, such as QGis tools aspect, rugosity,…
- Export of the observations file (json format) to the Globe software, in order to combine the CVE analysis with the data processing workflow in Globe.

In 2024, a preliminary release of the regional DTMs with the new data provided by the partners, will be made available on the CVE project, for a preliminary analysis of their difference with the current version of the 2022 DTM. For this option, it is required to produce for each region a preliminary merged DTM of the new single DTMs, which are made available for the project.

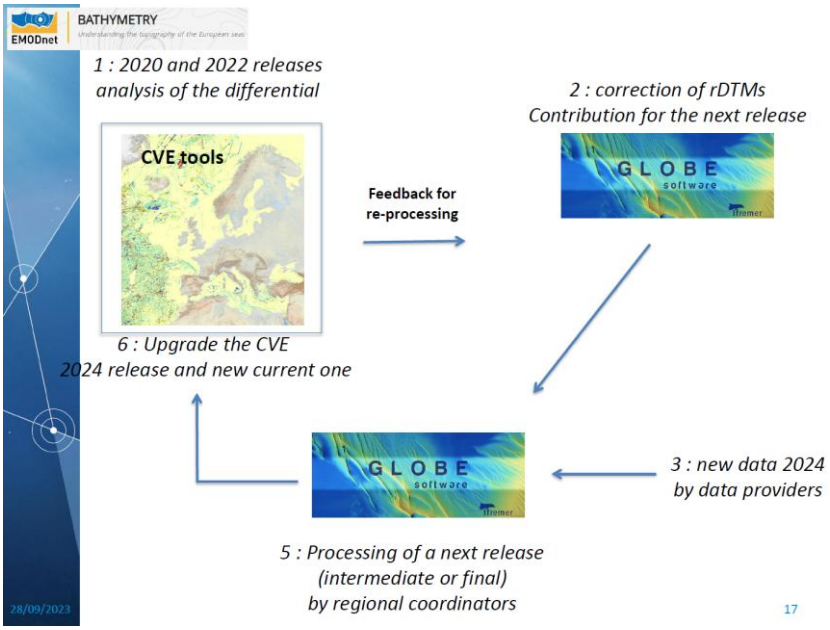


Figure 2: Scheme for a workflow integrating the CVE

There is currently a prototype available at the following website:

https://www.ifremer.fr/sextant_doc/emodnet_bathymetry/api/whole_mediterranean_wmt s.html#/map

Connection can be provided to EMODnet Bathymetry partners and it works with an IFREMER Extranet login.

In April 2024 another workshop will be organized with all regional coordinators to discuss progress with the RDTM generation process and to exchange experiences with the use of the CVE as part of that process.

4 Illustrations

The following screens, extracted from a presentation and online demonstration made during the EMODnet Bathymetry meeting in Brest in September 2023, give illustrations of the current CVE configuration.

Figure 3: Presentation screen 1

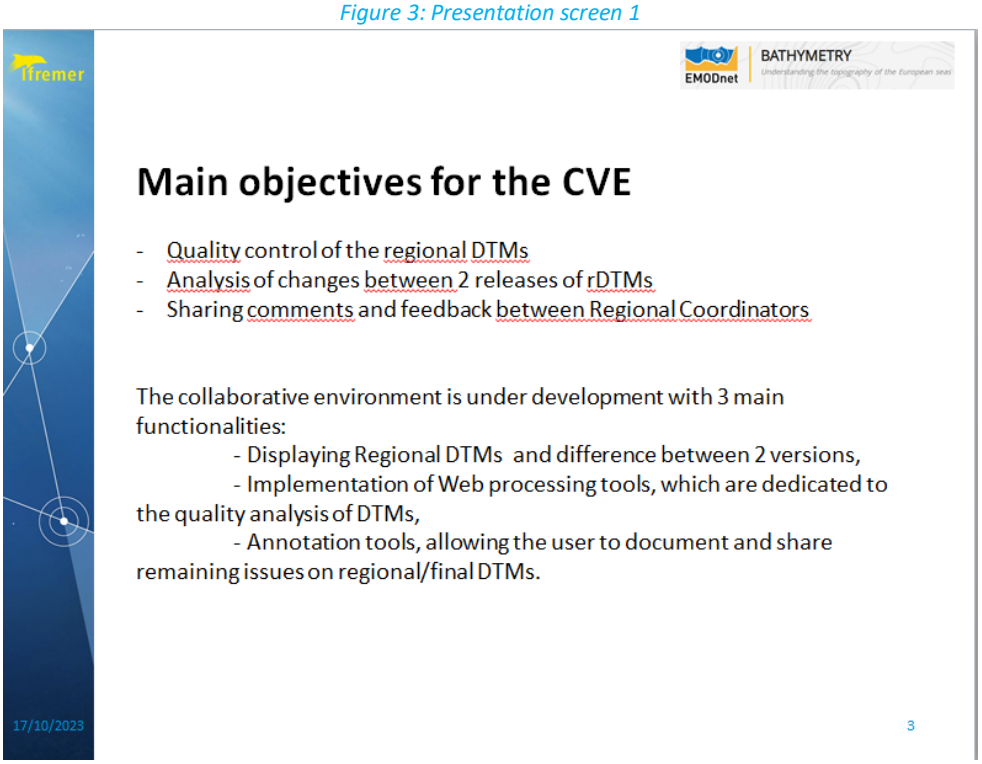


Figure 4: Presentation screen 2

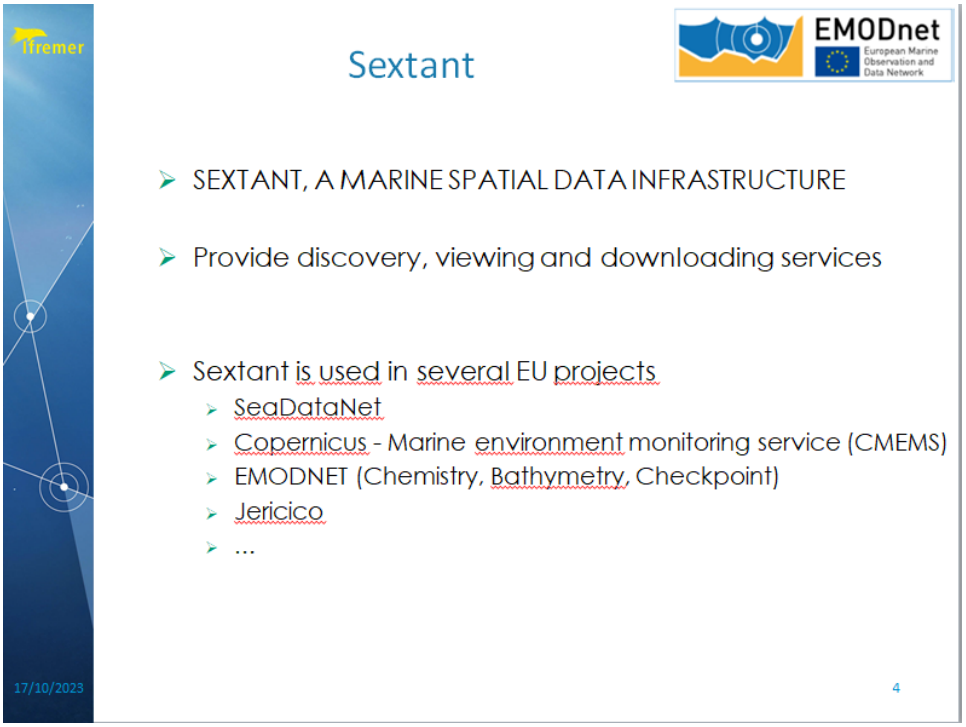


Figure 5: Presentation screen 3

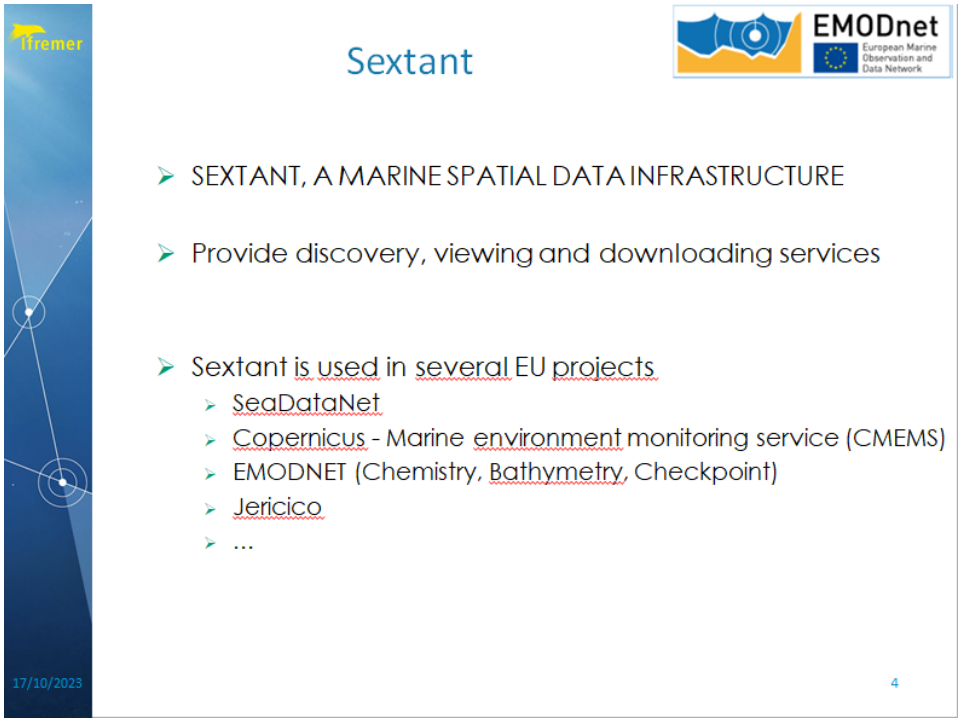


Figure 6: Presentation screen 4

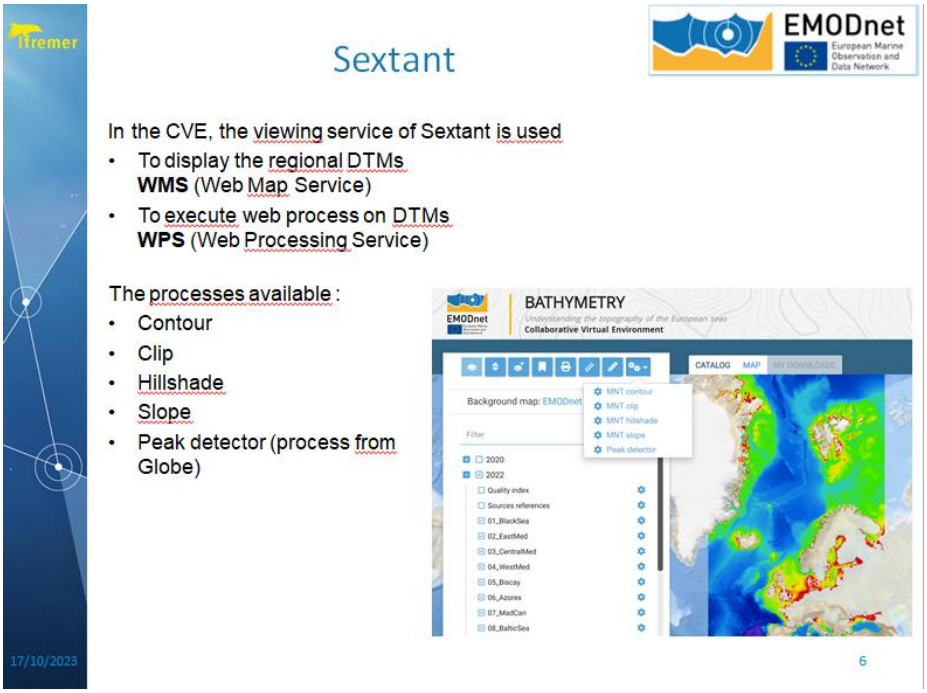


Figure7: Presentation screen 5

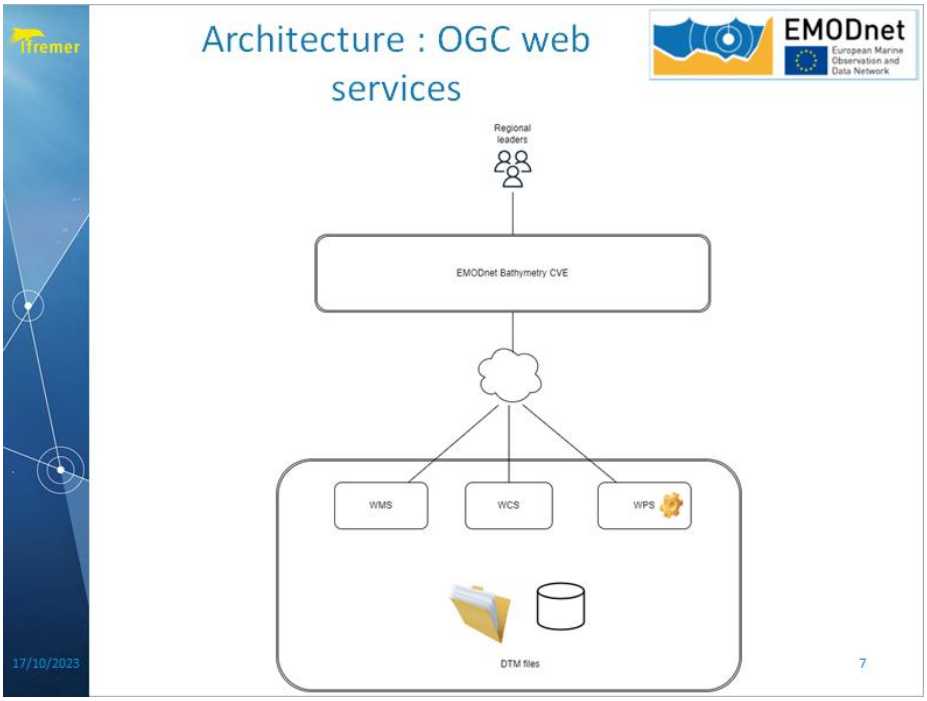


Figure 8: Presentation screen 6

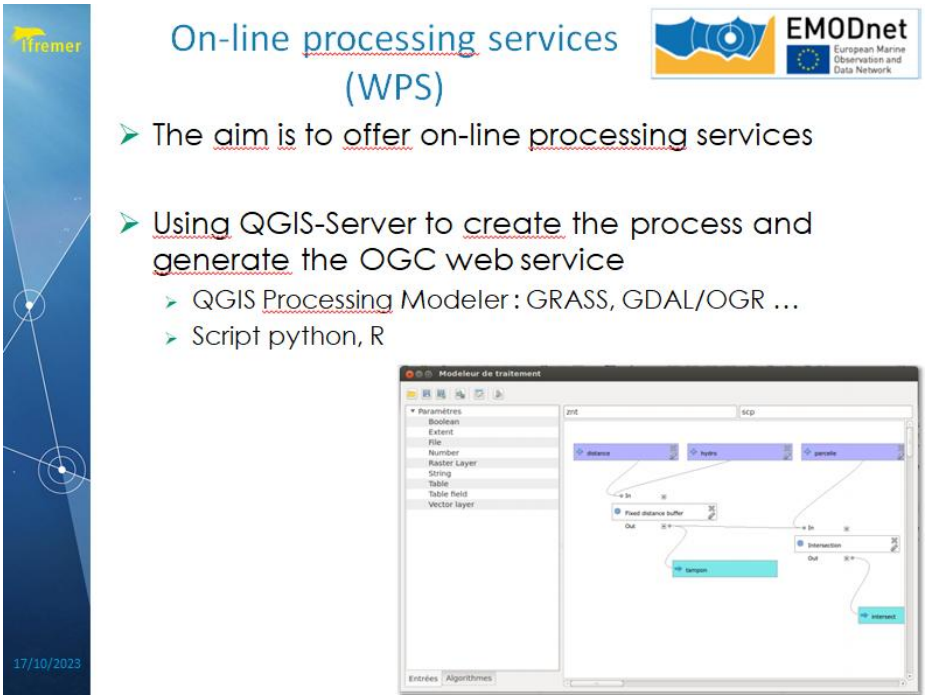


Figure 9: Presentation screen 7

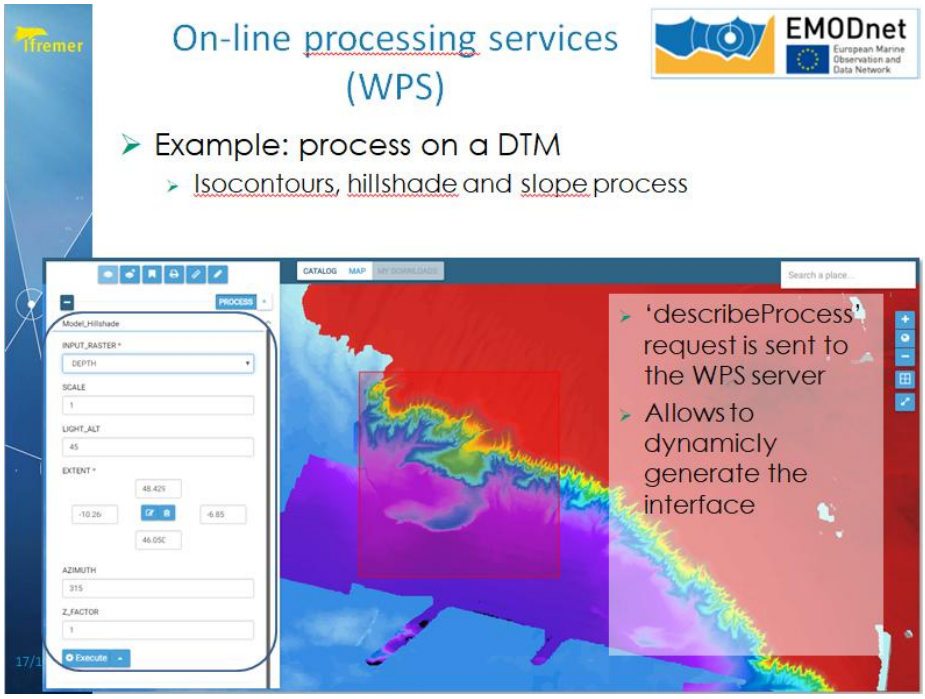


Figure 10: Presentation screen 8

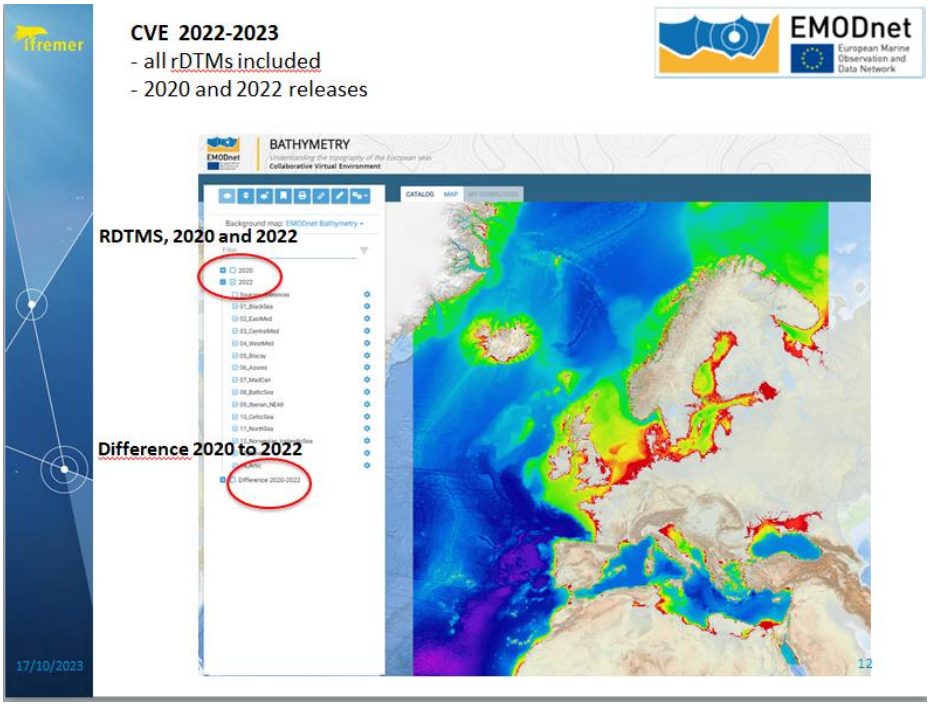


Figure 11: Presentation screen 9

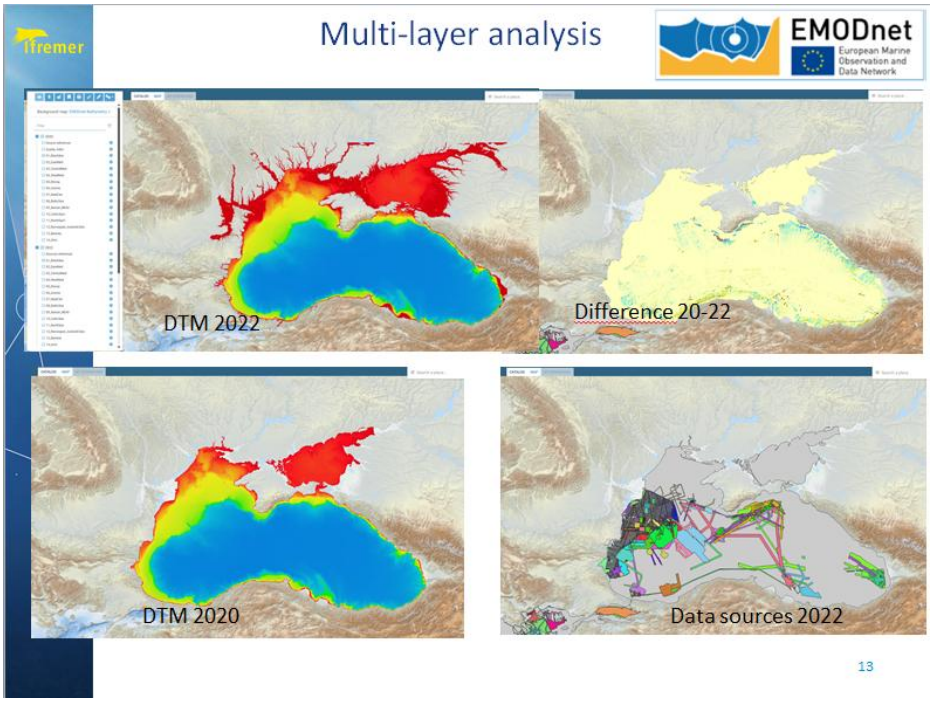


Figure 12: Presentation screen 10

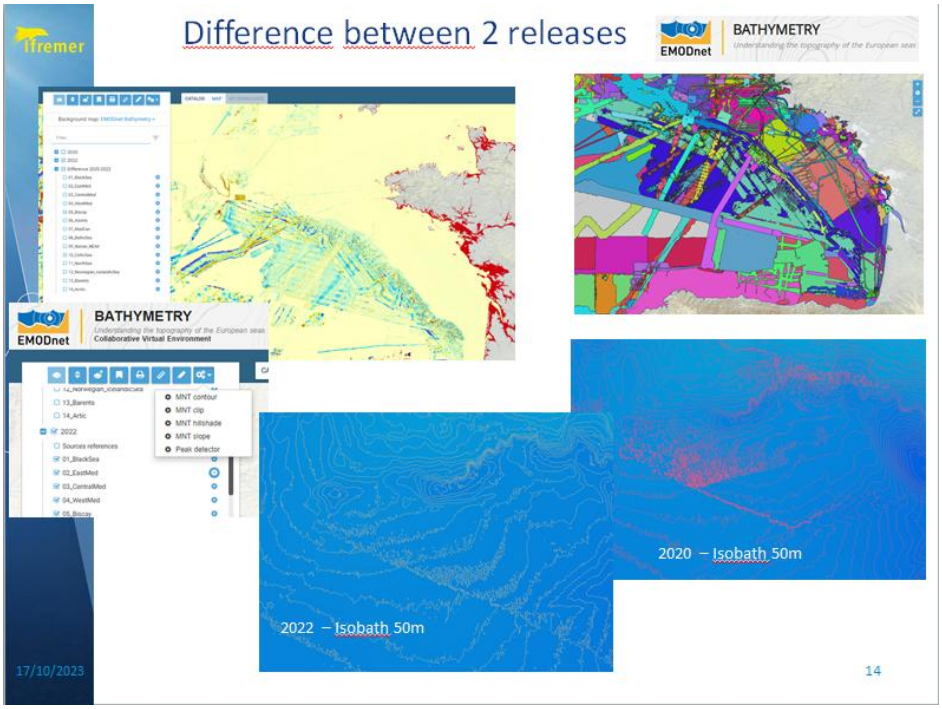


Figure 13: Presentation screen 11

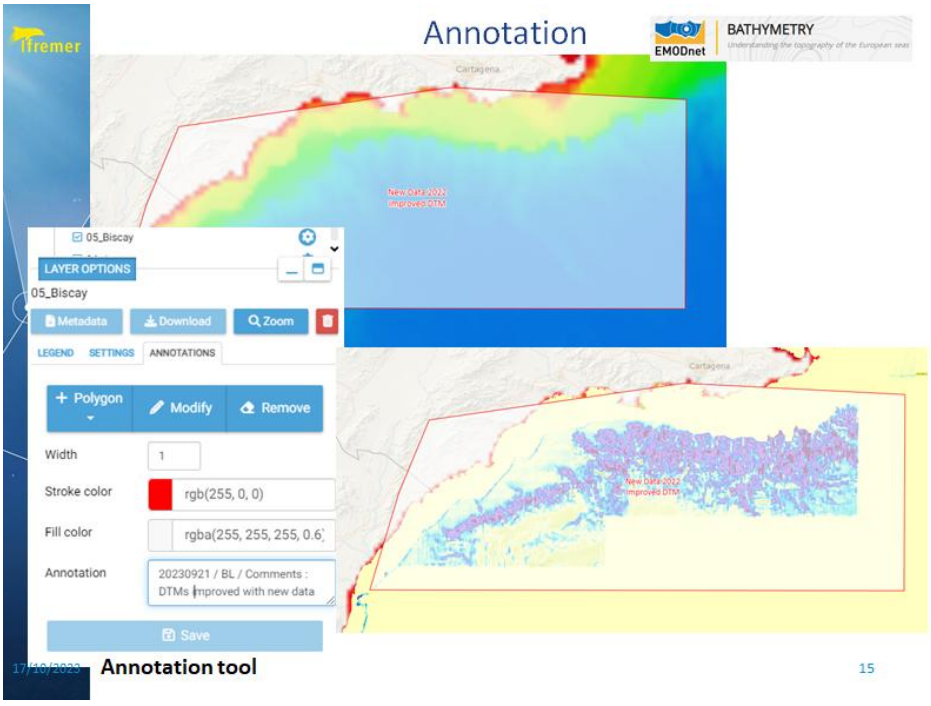


Figure 14: Presentation screen 12