EMODnet Thematic Lot n°0 –*Bathymetry –High Resolution Seabed Mapping (HRSM2)*

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WP4 : **EMODnet Bathymetry - Collaborative Virtual Environment (CVE) – Development of Web Processing Services (OGC-WPS) by IFREMER**

Technical report

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Introduction

The earlier development of the Collaborative Virtual Environment (CVE) was continued by Ifremer. The idea behind the CVE is the need and potential for an integrated virtual platform, to be hosted in the cloud, with strong computing power, to facilitate the data provision from data providers and the collaborative processing of regional DTMs between the regional coordinators and their interaction with the integrator.

A workplan was formulated with the following objectives:

- To specify, develop and implement the Collaborative Environment
- To upgrade the Globe tools for performing in the CVE.

A CVE prototype was developed with three components:

- A data infrastructure for storage of single data DTMs and resulting Composite DTMs
- An online version of Globe software for sharing data and joint worksessions
- Migration of processing tools into Web Processing Services (OGC WPS).

Globe online allows different users to share a same session, which is ideal for Regional coordinators who are generally skilled in using the full potential of Globe. The regional coordinators produce and finalize the Regional DTM for a specific geographic region and need to share data and information with the neighboring areas. Furthermore, Globe online allows the regional coordinators to work remotely and to benefit from computing and storage capabilities of the dedicated virtual machine.

WPSs are very useful for promoting tools and pre-defined processing workflows following EMODnet's established methodology. For regional coordinators, the WPSs can promote a standard "merging" workflow, based on single and harmonized DTMs stored on a common data infrastructure. It can also provide specific tools for validating DTMs.

This document describes the work performed by Ifremer in order to develop a prototype of WPS.

Technical approach

The main needs of users are gathered as follows:

- the user needs to be able to see contributing DTMs. The needs are: data storage read access, netCDF-aware backend, adequate mapping data transfer protocol and frontend display.
- the user needs to be able to perform selected processes on those DTMs. It requires writable workspace, process description and launch protocol implemented on a server.
- the data must be partitioned according to their regions. Needs for parametrized generation of DTM lists, user access control.

These needs led to a choice for the following technical solutions: QGIS server providing OGC Web Map Services and Web Processing Services, and a user interface built on top of the Sextant Web Viewer.

OGC services on Sextant: display with Web Map Service (WMS)

WMS defines supplying of raster images with extents and a resolution specified by the client. This OGC standard is suitable to build a map display Web UI. Our implementation is provided by QGIS Server. It is able to provide a WMS Context based on the contents of a .qgs project file referencing netCDF files and individual WMS raster service for each of the referenced netCDF DTMs. In the Sextant Web UI, we are already using the Open Layers library which is able to query WMS servers and display their data map.

So, by using QGIS server and Sextant viewer, we were able to provide users with the DTM viewing interface they need. There is one layer per DTM file with a fixed palette.

OGC services on Sextant: processing with Web Processing Service (WPS)

The user needs to be able to launch processes on the selected DTMs. There are various ways to do so, but we tried to find one which would enable us to leverage synergies with other software workflow solutions. The OGC WPS protocol specifies ways for a server to provide a list of available services, their required and optional inputs, their outputs, and the means to launch them and retrieve results. A WPS-aware library can query a WPS server to get information about available processes and their respective inputs and outputs, and given a particular process can ask the user for inputs with proper data entry fields and execute that process. WPS, like WMS, is widely supported in GIS tools (ArcGIS, QGIS...), allowing advanced users to build their own workflows using those tools if needed. We also now have provision to call WPS processes from Sextant Viewer, which made it a perfect fit for the application we were building.

On the server side, the WPS programming interface and service provider that we use are implemented by QGIS Server and a customized version of PyWPS. One can execute R or Python scripts with a few additional headers and QGIS Server/PyWPS handle the dispatch of input and output datas in WPS format. This allowed us to build a DTM merge WPS with Python, calling a command-line derivate of Globe for core data processing.

On the client side, the Sextant Web UI is able to build ad-hoc data entry fields from WPS embedded inputs/outputs description and send the appropriate WPS Execute requests. Although from a theorical point of view WMS and WPS available on a same server are completely separate, for this application, both services use the same data. Therefore, we enhanced the Sextant Web UI so it is able to use the checkboxes' state on the map layer list (coming from WMS) to build a layer list as an input for a WPS, thus giving a more streamlined experience to the user who can now directly call the merge WPS after selecting the displayed DTMs, without having to select them a second time from the drop-down lists.

Virtualisation

Both the server and client services have now been deployed in a virtual environment, under a technology named *Docker*. The virtualisation of those services gives several opportunities. First of all, it becomes easier to share the services to allow different users to build up their own server. Indeed, they only need to download an *image* which is kind of an executable, and the appropriate command line to run it. More, as the environment is easily set up, it's a step forward to put automatic tests in place for the provided processes. With automatic tests, you can detect some issues in an early stage, which will save some time to the developers when the processes needs to be modified.

Finally, it's easier to upgrade between versions. As there is only an *image* to share, and the setup is done through the command line, upgrading is only replacing a bloc by downloading a more recent one and relaunching it.

From synchronous to asynchronous for the WPS service

In the previous version of WPS, the HTTP server's response was synchronous with the WPS's one. This means that when a WPS process was running, the HTTP server was waiting for it to finish, leading to timeouts from the HTTP server, whenever the processes were a little bit too long to execute.

Since WPS 2.0 it's possible for the HTTP server and the WPS service to be asynchronous. There are no more timeouts from the HTTP server. However, there is still one from the WPS service which can be

set up, so the processes can now be as long as they need. We are no more technically limited to use big processes, but by the time a user would agree to wait for the end of his or her processing run.

Regional partition

As a regional coordinator, the user wants only to view or process the data of the region he or she works on. Therefore, we implemented a set of predefined DTM lists, one for each region. Upon an update of the set of contributed DTMs, we can launch a process that will automatically refresh qgs projects and configuration files to have an up-to-date environment for each region. We also added a simple access control using the existing Ifremer extranet connection API based on CAS (Central Authentication Service)

Prototype

The main objective is to provide tools which can be used by the regional coordinators. These tools are available as a Web application running on the DATARMOR infrastructure. Regional coordinators can thus process and merge contributed DTMs in-place, and no further download/upload of sources and merged DTMs is required.

A prototype was developed using the previously described tools which are able to access the regional data on the DATAWORK disk space for input. The WPS allows one to select DTMs stored on the "DATAWORK" space and merge them. Behind the scenes, a Python script managed by QGIS server+PyWPS calls the "EmodnetProcesses" command-line tool derived from Globe to perform the merge operation and stores the generated file in-place.

Furthermore, provision has been taken to allow the web application to query Sextant, SeaDataNet and EMODnet databases in order to display metadata and to query Quality Indicators, based on the CDI or CPRD identifier of the file.

The main functionalities developed for the prototype are:

- *Data selection tools*
    - Exploring and retrieving of available data sets from the "DATAWORK" DTMs pool,
    - 2D mapping and visualization services,
    - Interaction with the SeaDatanet CDI and Sextant services.
- *Data processing tools*
    - Spike detector
    - DTM annotation
    - Slope, hillshade

Public prototype

The working prototype is currently open for testing to selected basin coordinators, using a subset of the Central Mediterranean data sets centered on Sardinia island. One can select and merge DTMS of this area and visualize the results.

URL of the prototype (only available for selected users using an Ifremer extranet login):

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

A user manual for the prototype has been prepared and is provided at the EMODnet Bathymetry portal [14].