SEA Wave: Strategic Environmental Assessment of Wave energy technologies

Deliverable Report D1.3

Data Management Plan

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Revision

Revision	Date	Description	Originated by	Reviewed by	Approved by
1.0	05/04/2019	First version of the document	José Chambel Leitão	Hélio Santos	
2.0	22/04/2019	Review of 1st draft		David Darbinyan	José Chambel Leitão
3.0	30/04/2019	Proof read		Erica Mathers	

Project Information

Project title	Strategic Environmental Assessment of Wave energy technologies
Project acronym	SEA Wave
Grant agreement number	EASME/EMFF/2017/1.2.1.1/01/SI2.787660
Project start date	01/11/2018
Project duration	36 months
Project lead	The European Marine Energy Centre (EMEC) Ltd
Project website	www.seawave-emff.eu

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1 Introduction

The present document provides a framework for Data Management within the SEA Wave project. This document follows some of the concepts of the H2020 programme, adapted to the SME initiative, which is the major funding source of SEA Wave.

Environmental monitoring campaigns around four wave energy converters (Wello Oy, CorPower Ocean, Ocean Energy and Laminaria) will be available within the project. The data collected will be analysed and used within ecological models to provide deeper insight into the response of host environments.

The present Data Management Plan is also meant to guide data organization within a Data Platform in order to ensure that it is findable, accessible, interoperable and reusable. Some standard rules by the European Marine Observation and Data Network (EMODnet) will be followed. A set of recommendations by the EU funded Columbus project are also addressed.

2 Recommendations on Data Management

The way public data-sharing initiatives engage with industry and users was addressed by the Columbus project (funded by the EU under H2020 - http://www.columbusproject.eu/) which proposed a set of recommendations designed to overcome some of the most important gaps and barriers still faced by private data users. Taken together, they represent the basic components of a strategy to open significant opportunities for the maritime industry to both benefit from and engage with public marine data initiatives. This can ensure the optimum return of public investments in the marine data sector, notably in support of meeting key EU policy goals under the Blue Growth Strategy, the Marine Strategy Framework Directive and the Maritime Spatial Planning Directive. Some barriers require further analysis and discussion, but there are already many actions that can be undertaken to improve the situation on the short and medium term (Columbus, 2017)

The main conclusion of the Columbus project was that “there is a need for a systems change in how marine observatories and associated data and information sharing initiatives engage with industry, if it is their intention to do so”.

Actions aimed at improving the situation on the short and medium term were proposed in one of the deliverables of the Columbus project[1]. The most relevant for SEA Wave are written below, along with a short description of how SEA Wave will address them.

Actions recommended by the Columbus project	How will SEA Wave address recommendations
Industry representatives should be included in the governance and take part in the entire cycle of decision making, development and operation of marine observation and datasharing initiatives.	SEA Wave includes several relevant representatives from the industry. They play a key role in the Data Platform’s development, use and maintenance.
There is a need for marine data-sharing initiatives to take a more pro-active approach and move out of the comfort zone of the traditional oceanographic marine monitoring and	Dissemination of project results will direct stakeholders to the Data Platform, as a major outcome of the project.

[1] McMeel, Oonagh; Pirlet, Hans and Calewaert, Jan-Bart (2017) Use and sharing of marine observations and data by industry, Good practice guide. Columbus project, 20 pp. [online 2017-11-01] http://www.columbusproject.eu/Columbus_engage_industry_best_practice.pdf

observing communities. This involves, among others, developing a more **service oriented approach**, learning new communication skills and language, being present and more visible in fora that attract industry and to exploit creative technologies.	
Data, products and services offered by marine observation and data initiatives should be presented in a **user-friendly**, attractive and intuitive way which is adapted to the target users. If users from different communities or sectors are targeted, options to adjust the interface depending on the visitor should be considered.	The user experience will be taken care and tested within the project partners before going public
Clear, succinct and open communication is critical: it should be instantly clear for industry **what data, products and services are offered and what may be made available in the future**. Equally important is to provide information on what is not available, and the limitations of the resources offered.	Provision of a single access point for the wave energy industry seeking for data is a clear distinction factor from other initiatives and repositories; even if data can also be found via generic marine data portals.
More efforts should be made to build upon early achievements and successes: presenting use case examples can trigger interest where there may previously have been none.	This will be achieved by using the Data Platform design concepts of SOWFIA, a project that ended in 2012. Data from that project will also be migrated to the new Platform.
At European level there is a need for **defragmentation of the plethora of marine observation and data and information sharing initiatives** as well as online data portals. In the longer term, there is a need for a joint roadmap, agreed by the responsible coordinating and funding bodies including at the European Commission level, to set out the strategic framework.	The Data Platform will aggregate three projects: SOWFIA (ended in 2012), SEA Wave and WESE (another undergoing project).
Dedicated data-sharing policies to incentivise the private sector and address their specific needs should be developed. Ways forward could include: stating clearly the added-value or **benefits of sharing data**, moratorium on commercially sensitive data, provision of **services in return for data** which could support in-house data management, the development of a data-sharing 'green label' in recognition of corporate social responsibility. It is clear that implementation of the recommendations will require increased commitment and investment of time and resources, both from industry and from marine observation and data initiatives but should provide both with **significant returns over time**.	An extensive involvement of the private sector will be achieved in SEA Wave, from project partners to companies reached through dissemination activities. The Data Platform strategy will be oriented towards adding value to the industry.

Table 1: How SEA Wave will address actions identified within Columbus project

3 SEA Wave Data

3.1 Purpose of the data collection/generation and its relation to the objectives of the project

In SEA Wave's first 3 specific objectives, the purpose of the data collection/generation and its relation to the objectives of the project are clearly stated:

Objective 1: Undertake a comprehensive review of all existing data collected for the sector and augment this with targeted collection campaigns across four WECs which will generate over 10,000 hours of evidence on the positive and negative effects from this technology.

Objective 2: Utilise a robust statistical modelling framework that incorporates a comprehensive range of technology types and scales of deployment (e.g. number of WECs and spatial extent), to reduce uncertainty regarding the broader ecosystem responses to wave energy technology. The models will be populated with data gathered over 20,000 hours of device operational life.

Objective 3: A dedicated data dissemination strategy will be developed which will ensure that the environmental evidence base collated in the project is disseminated directly to stakeholders and also distributed through long standing EU platforms such SeaDataNet and EMODNet. Independently peer-reviewed scientific publications around the impact of wave energy technologies derived from the project will also serve as reference documents for future regulatory decisions and these will be distributed through the projects website alongside platforms such as the International Energy Associated Ocean Energy Systems' Annex IV Tethys database. A number of supplementary stakeholder engagement events will also ensure that this information is in a format useful to these organisations and utilised in future consenting decisions.

3.2 Types and formats of data

As described in EMODNet: "Marine data include a very wide range of measurements and variables derived from a broad spectrum of multidisciplinary research projects and monitoring programmes. The data are collected by different institutes, governmental organizations or private companies using heterogeneous instruments and sensors installed in various observing platform. Depending on the data type, the acquisition systems, the delivery time frame or operations of the archiving centre, there is not a unique used data model and structure and the original measurement format may not be the same with the format that the archiving centre can accept. In general, the archiving format should:

- be independent from the computer (and libraries),
- ensure that any isolated data includes enough meta-data to be processed (eg. Location and date),
- be compatible and include at least the mandatory fields (meta-data) requested for the exchange format(s),
- include additional textual or standardized "history" or "comment" fields to prevent any loss of information,

- provide similar structure and meta-data for different data type such as vertical profiles and time series."[2]

These rules will be used and adapted to specific data and archiving options taken during the project.

3.3 Existing data

Data from SOWFIA's Data Platform will be migrated along with the Platform. Metadata used in SOWFIA was already Inspire compliant and therefore, if any, only minor adjustments may be needed.

3.4 Origin of SEA Wave's data

Data campaigns from the Universities of Exeter and Plymouth will be the main source of new data (see Table 1). WECs own monitoring devices will add to this.

Device	Date & Time	Location	Equipm-ent Type	Data description	Survey Duration / scale	Geometry
Towed camera	2019-08-11-1206	Lat/Lon	Bowtech Camera	Species abundance & diversity	20 minutes / 200 metres	Lines 2D on seabed
Baited camera	2019-08-11-1206	Lat/Lon	BRUV systems	Species abundance & diversity	30 minutes	Points 2D on seabed
Fisheries acoustics	2019-08-11-1206	Lat/Lon	Simrad EK80	NASC	Instantaneous at 30-sec interval	Points 3D
Ambient acoustics	2019-08-11-1206	Lat/Lon	Jasco AMAR-G2	Third Octave Band	1-hr interval averages	Time-series at fixed location

Table 2: Summary of data from survey campaigns by Universities of Exeter and Plymouth

4 F.A.I.R Data Management

4.1 Making data findable, including provisions for metadata

Metadata will be essential to make data generated within SEA Wave findable by stakeholders. Some standard rules on this are put forward by the European Marine Observation and Data Network (EMODnet), which will be followed.

[2] Excerpt from https://www.emodnet-ingestion.eu/guidelines

"Alongside the data, additional information (metadata) is needed not only for quality control and archiving, but also for exchanging data or integration of them into regional or global data sets. For all types of data, information is required about:

- Where the data were collected: location (preferably as latitude and longitude) and depth/height
- When the data were collected (date and time in UTC or clearly specified local time zone)
- How the data were collected (e.g. sampling methods, instrument types, analytical techniques)
- How you refer to the data (e.g. station numbers, cast numbers)
- Who collected the data, including name and institution of the data originator(s) and the principal investigator.
- What has been done to the data (e.g. details of processing and calibrations applied, algorithms used to compute derived parameters)
- Watch points for other users of the data (e.g. problems encountered and comments on data quality)"[3]

Metadata will be generated by partners who make the data available. To help on this task, a software tool will be made available by Hidromod. In this tool, metadata information will also be validated against the relevant standards. This tool will be based on GeoNetwork opensource.[4]

4.2 Making data openly accessible

Data produced in the project will be made openly available as the default. Nevertheless, access to data will be monitored via a user account. An evolution of the Data Platform made for the SOWFIA project will be set up. This previous Platform has already a number of users which will be asked to remain as users of the new Platform.

If partners have certain datasets which cannot be shared (or need to be shared under restrictions or latter within the timeframe of the project), this must be addressed in project meetings and will need to comply with the Grant Agreement.

Data will be made accessible via a dedicated web interface. The data and associated metadata will be stored, when possible, in public repositories like those accessible through EMODnet or SeaDataNet. A SEA Wave data repository will be available for data which doesn't fit anywhere else. Data in SEA Wave's repository will be freely accessible, as if it were in a public repository.

4.3 Making data interoperable

In order to allow data exchange and re-use between researchers, institutions and organisations, standards for formats and metadata will be followed as much as possible.

[3] Excerpt from https://www.emodnet-ingestion.eu/guidelines

[4] GeoNetwork is a catalog application to manage spatially referenced resources. It provides powerful metadata editing and search functions as well as an interactive web map viewer. It is currently used in numerous Spatial Data Infrastructure initiatives across the world (https://geonetwork-opensource.org/)

SEA Wave will adopt the procedures already proposed by the most relevant EU initiatives such as CMEMS, EMODNet and SeaDataNet, especially the standards in relation to vocabularies, metadata and data formats. In practice the gridded data sets addressing either dynamic data sets (similar to CMEMS) or static data sets (similar to EMODnet) will follow procedures similar to the ones adopted by these two services. Regarding the time series data, SeaDataNet procedures will represent the main guidelines and NetCDF-CF format will be the standard to be adopted.

ISO standards for metadata (ISO 19115 and ISO 19139) will be followed. The above-mentioned tool based on GeoNetwork opensource, will guarantee that metadata follows the standards.

4.4 Increase data re-use

To ensure data re-use is maximised, a dedicated SEA Wave Data Platform will be composed of: a single Web access point to relevant data (internal and through the platforms listed above); request system to access data via command lines; dedicated cloud server to store frequently used data or data that may not fit in existing portals; synchronised biological data and environmental parameters in order to feed models automatically.

The design of the SEA Wave Data Platform will also enable the generation of “secondary data” (or “Refined Data Products”) derived from measurements, serving the needs of the specific end-users without needing sophisticated skills to access and interpret primary data.

5 Data Platform

5.1 Wave energy data platforms

The Ocean Energy Systems Technology Collaboration Programme (OES)[5] has a Web GIS Database[6] which gives an overview over marine renewable energy installations and resources. This Database has generic information on ocean wave, tidal and current energy systems, and data is not available for download. Very few relevant EIA data is mentioned in this database.

OES is involved with another international effort, Tethys, which was developed in 2009 by the Pacific Northwest National Laboratory (PNNL) to support the U.S. Department of Energy (DOE) Wind Energy Technologies Office and Water Power Technologies Office. “The primary functions of Tethys are twofold: (1) To facilitate the exchange of information and data on the environmental effects of wind and marine renewable energy technologies; and (2) To serve as a commons for wind and marine renewable energy practitioners and therefore enhance the connectedness of the renewable energy community as a whole.” (https://tethys.pnnl.gov/)

Tethys includes, among other:

[5] OES is an intergovernmental collaboration between countries, which operates under framework established by the International Energy Agency in Paris (https://www.ocean-energy-systems.org/index.php)

[6] https://www.ocean-energy-systems.org/ocean-energy-in-the-world/gis-map/

- **Knowledge Base** - A table listing all content with advanced filtering and sorting capabilities for easy searching.
- **Map Viewer** - A subset of all content that can be identified with a geographic location can be viewed spatially on a map.
- **Events Calendar** - A calendar that highlights international events pertaining to wind and marine renewable energy and the environment.
- **Data Portal -** A table listing information about post-installation monitoring collected around MRE devices.
- **Management Measures Tool -** A tool generating possible management measures to safeguard marine animals and habitats, meant to aid MRE developers.
- **Annex IV Partners -** This list includes SOWFIA

5.2 Legacy platform

The SOWFIA project[7] was financed by Intelligent Energy Europe and ran from 01/10/2010 to 30/09/2013. It aimed to achieve the sharing and consolidation of pan-European experience of consenting processes and environmental and socio-economic impact assessment (IA) best practices for offshore wave energy conversion developments. Studies of wave farm demonstration projects in each of the collaborating EU nations contributed to the findings. The study sites comprised a wide range of device technologies, environmental settings and stakeholder interests.

A Data Management Platform (DMP) was developed as an interactive tool designed to present wave energy and Impact Assessment (IA) related information instantaneously in a format suitable for a non-technical audience (http://sowfia.hidromod.com/PivotMapViewer/). The DMP integrates datasets from the six different sites, providing scientifically robust data on the potential environmental effects of wave energy devices to support consenting and licensing processes. The DMP can be used to find detailed information on a particular wave energy project, test site, or to view data regarding one or multiple environmental parameters at the different collaborating test centres.

Between 2012 and 2018, 519 users were registered in the platform, from 226 institutions. 237 of those users either saw data, saw metadata (forms) or downloaded data at least once. 7279 unique requests to see data, see metadata (forms) or download data were registered.

A brief account of the most requested data from the Platform is presented in Table 2.

The evolution in time of the interactions with data items available in the Platform is shown in Figure 1. It can be seen that although the project ended in October 2013, almost half of the data requests were made after that date.

[7] https://ec.europa.eu/energy/intelligent/projects/en/projects/sowfia

Data Label	N. of data requests
NOAA WaveWatch III - Hindcast reanalysis (1979-2009)	2288
NOAA WaveWatch III - Hindcast reanalysis (2005-Present)	1139
MONICAN - Ocean Buoy - Waves Position 1	269
Plymouth University Wave Buoy - Wave Hub	249
SEM-REV wave buoy data (Ménéham)	216
Wave Hub - Wave Buoy PU1	199
Shearwater Distribution Map	192
AMETS_DirectionalWaveData_WaveriderBuoy_50mContour_2011	126
WaveHub bird distribution map - August 2008	123
GalwayBay_DirectionalWaveData_WaveriderBuoy_2011	111
SEM-REV wind data	111
Locations of Dolphins Observations	107
Bimep Waves	104
OceanPlug Bathymetry data	102
Wave data Ocean Plug 2009	99
MONICAN - Ocean Buoy - Waves Position 2	92
PTN_100212	72
Wave Hub Dolphin CPOD	72
OceanPlug - Sea birds and marine mammals baseline report	71
MONICAN - Ocean Buoy - Waves Position 3	63
MONICAN - Ocean Buoy - Waves Position 5	61
WaveHub bird distribution map - February 2009	55
Manx Shearwater Distribution Map	53
WaveHub bird distribution map - September 2008	53
Geophysical Characterization	48

Table 3: Most requested data from SOWFIA's Data Platform (until Dec 7, 2018)

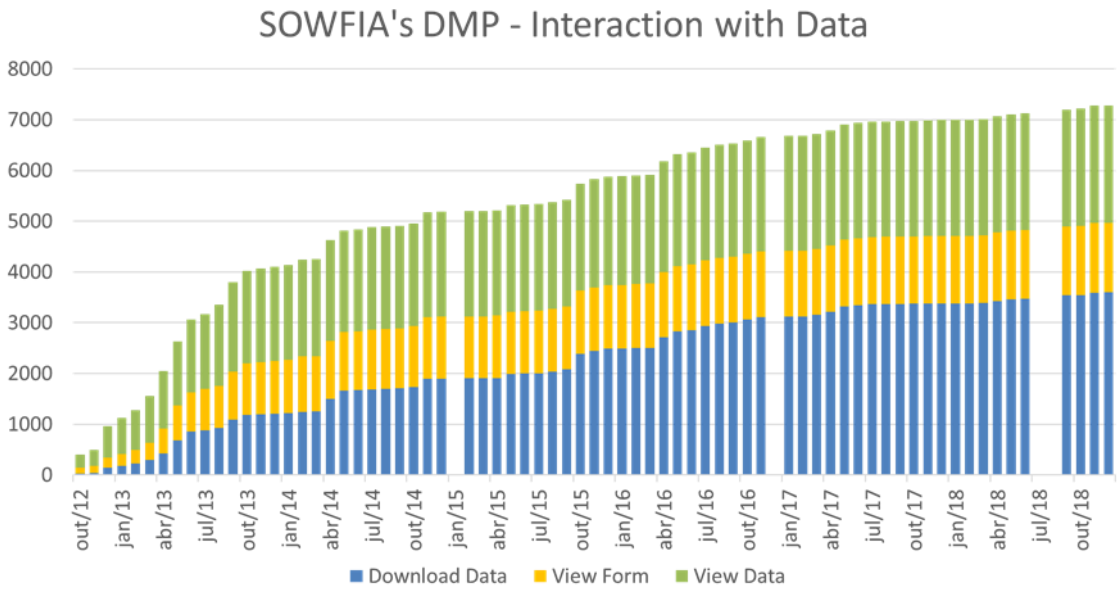

Figure 1: Cumulative number of data requests from SOWFIA's data platform

5.3 Migration to a new platform

Migration of SOWFIA's platform will use the following concepts (Figure 2):

- A new software infrastructure will be made using the main design concepts of the previous platform;
- Data gathered in SOWFIA will be migrated to the new platform;
- Registered users from the previous platform will be contacted in order to ensure personal data is kept according to GDPR[8] and migrated to the new platform.

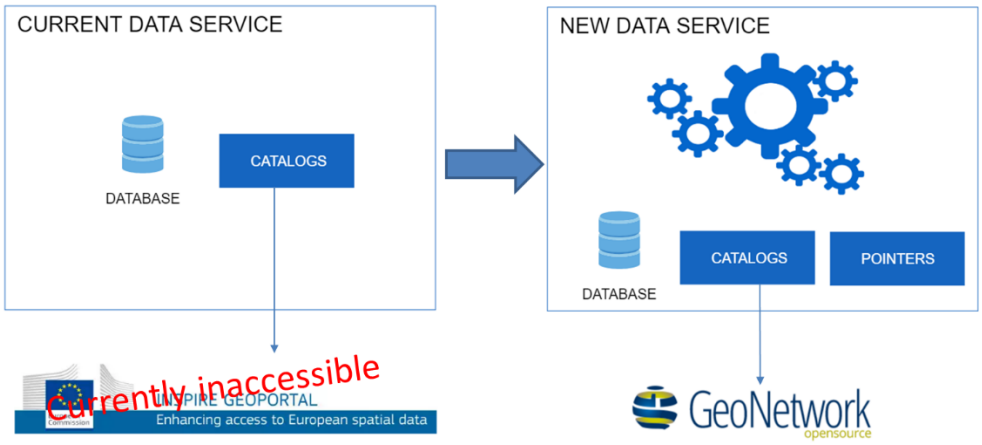

Figure 2: SOWFIA's data platform migration

[8] EU's General Data Protection Regulation

Using a common approach with SOWFIA's Data Platform will enable the project to start with a relevant number of registered users which will enhance the success probabilities of the new Data Platform. Migration of SOWFIA's data to the new Data Platform will also enable early testing of data cataloguing in order to comply with EMODnet's requirements.

5.4 New data platform

The new data platform will have a WebGis interface where the features of the previous interface will be kept. The new design will be faster and responsive to any device due to the use of Angular. New technologies like microservices or containers will be used which will make it also easier to maintain. The high-level design concepts are shown in Figure 3.

The web interface will connect to different providers over the internet (including EMODnet and others). This way the data platform will be open to a large variety of data, generated outside this project but fitting the specific objectives highlighted in section 3.1 above.

All of the above are hoped to increase the chances of the data platform surviving the project.

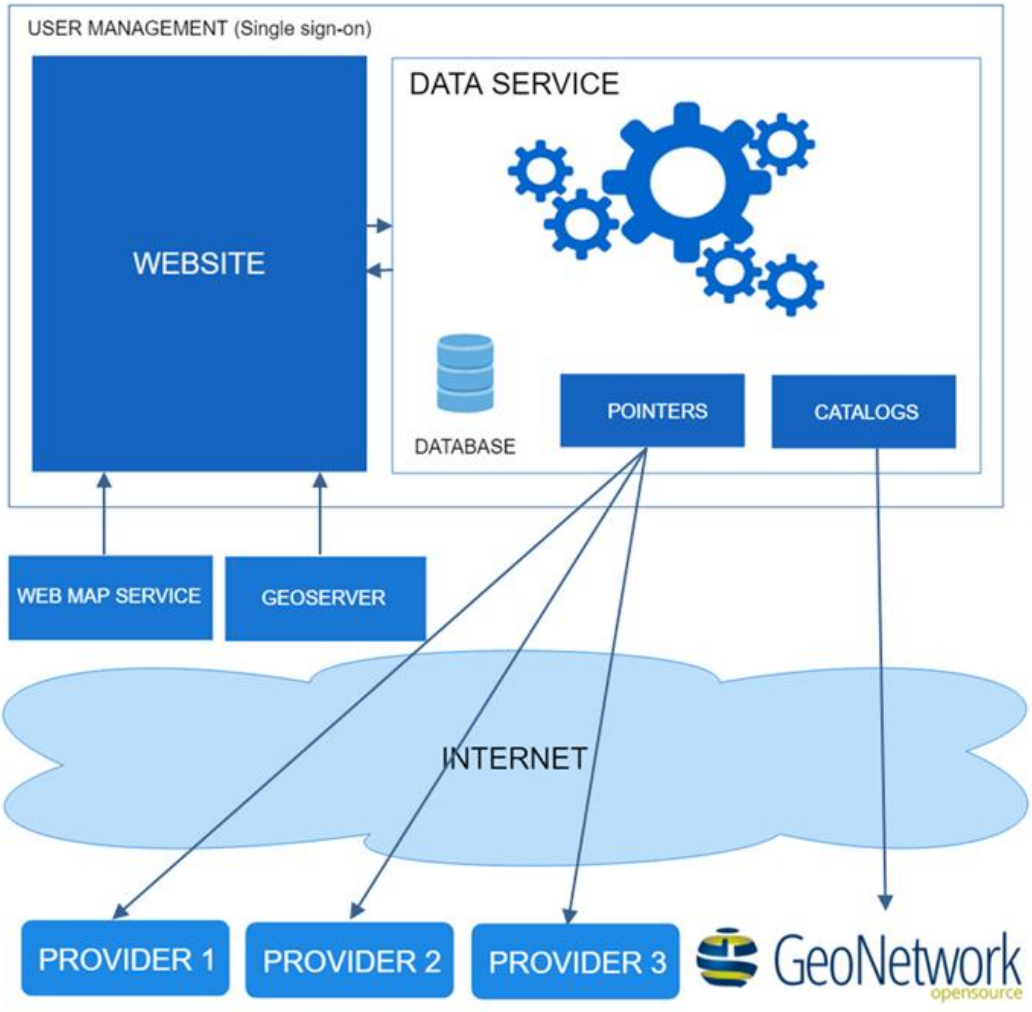

Figure 3: Design concept of the Data Platform

5.5 Hardware

A rented server will be used to deploy the software and to store data. A preliminary design of the software to deploy on the server is shown in **Error! Reference source not found.**.

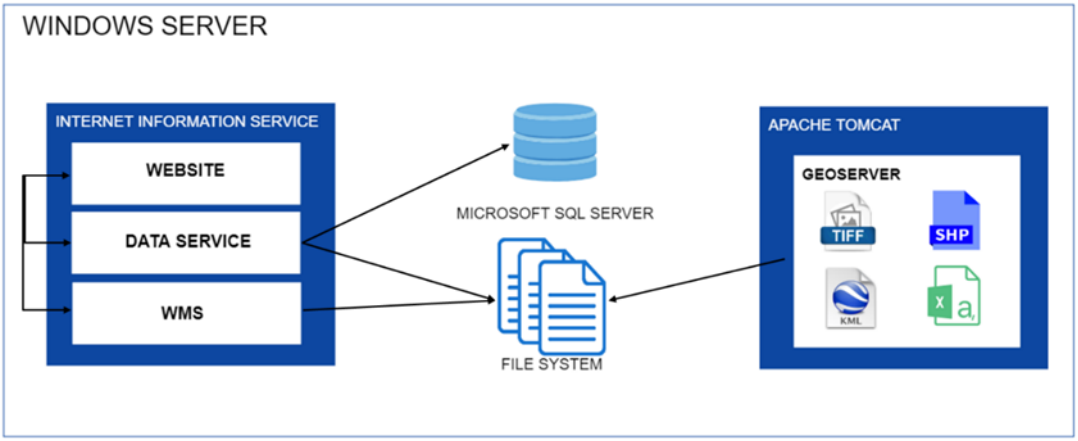

Figure 4: Server and software for the data platform

6 Other Issues

During the course of the project, other issues must be taken into account namely:

- Allocation of resources
  - Costs for making data findable, accessible, interoperable and reusable must fit within the budget of the project;
  - Strategy and associated resources for long term preservation must be discussed in the course of the project.
- Data security
  - What provisions must be in place for data security;
  - How should data be stored for long term preservation and curation.
- Are there any ethical or legal issues that can have an impact on data sharing?

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