SATWEBMARE ИНТЕРАКТИВНА WEB СИСТЕМА В ПОДКРЕПА НА УСТОЙЧИВОТО УПРАВЛЕНИЕ НА БЪЛГАРСКАТА БРЕГОВА ЗОНА

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SATWEBMARE INTERACTIVE WEB-MAPPING SYSTEM IN SUPPORT OF THE SUSTAINABLE MANAGEMENT OF THE BULGARIAN COASTAL ZONE

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РЕЗЮМЕ

В статията е представен преглед на разработван прототип на интерактивна уеб картографска система SatWebMare за българската крайбрежна зона. Интерактивната система е проектирана да предоставя чрез геопортал иновативни продукти и услуги за интегрирано управление на крайбрежната зона. Уеб картографската система комбинира геоданни от различни източници като

ABSTRACT

The article aims to represent a general overview of the prototype web-mapping interactive system SatWebMare for the Bulgarian coastal zone. The interactive system is designed to provide through geo-portal innovative products and services for integrated coastal zone management. The web-mapping system combines geo-databases from different sources such as satellite imagery, maps, vector layers and other

сателитни изображения, карти, векторни слоеве и други набори от данни. Накратко е разгледано съдържанието на SatWebMare геопортала. Чрез системния уеб интерфейс ще бъде осигурен достъп до приложения и продукти с подобрена пространствена и времева разделителна способност за три области на интерес – морски вълнови климат, природни опасности и геомагнетизъм за българското крайбрежие. Уеб картографската система се разработва с използване на свободен софтуер с отворен код, OGS стандарти и в съответствие с препоръките на Европейската директива INSPIRE. След пълното разработване на прототипната система, тя ще позволи да се осигури достъп до продукти и услуги с добавена стойност, които са полезни за министерства, агенции, местни власти и други заинтересовани страни в подкрепа на вземането на решения.

Ключови думи: *проект SatWebMare, уеб картографиране, наблюдение на Земята, интегрирано управление на бреговата зона, Черно море, Българско крайбрежие*

datasets. The content of the SatWebMare Geo-Portal is briefly outlined. The web-interface system will provide access to applications and products with an improved spatial and temporal resolution for three areas of interest - sea waves, natural hazards and geomagnetism in the Area of Interest (AOI). The web-mapping system is developing based on the free and open-source software, OGS standards and following the EU INSPIRE Directive recommendations. Once the prototype system is fully developed, it will enable to provide access to value-added products and services that are useful to ministries, agencies, local authorities and other stakeholders in support of the decision making.

Keywords: *SatWebMare project, Web-mapping, Earth observation, integrated coastal zone management, the Black Sea, Bulgarian coastal zone*

INTRODUCTION

The Bulgarian Black Sea coastal zone, as a part of EU coastal regions, has an essential contribution to the European economy. This critical role is defined by several activities such as shipping, resource extraction, tourism, renewable energy, and fishing. However, all these human activities have a substantial ecological impact that leads to severe ecological degradation. This anthropogenic pressure is felt along the Bulgarian coast and has led to habitat loss, environmental pollution and accelerated coastal erosion. Climate change is likely to make coastal areas more vulnerable. On the other hand, it is happening against the backdrop of ongoing complex geophysical processes on the land-air-sea boundary. The Bulgarian coastal zone is exposed to a wide variety of natural hazards (1, 2). A timely response necessitates the implementation of sustainable coastal zone management by balancing the competing interests of human development and ensuring healthy and sustainable ecosystems.

One of the main challenges is to develop innovative products for the Bulgarian coastal zone with substantially improved spatial and temporal accuracy using geodata sets from different sources. Remote sensing and Earth observation data have become a substantial and powerful tool to support decision-making for planning and integrated coastal zone management. The need for more advanced data visualisation and analytics capabilities has increased in the last years with the introduction of several systems and platforms that provide environmental data (e.g. Sentinels missions from the EU Copernicus Programme). This kind of systems will provide routine monitoring of our environment at the global scale, thereby delivering an unprecedented amount of data. While the availability of the growing volume of environmental data represents a unique opportunity for science, general R&D, and applications, it also poses a significant challenge to achieve its full potential in terms of data exploitation. Firstly, because of the emergence of large volumes of data (petabytes era) raises new issues in terms of discovery, access, exploitation, and visualisation of Big Data, with profound implications on how users do "data-intensive" Earth Science. Secondly, because the inherent growing diversity and complexity of data and users, whereby different communities - having different needs, methods, languages and protocols – need to cooperate to make sense of a wealth of data of different nature (e.g. EO, in-situ, model), structure, format, and error budgets (see, e.g. 1,3).

Responding to these technological and community challenges requires the development of new ways of working, capitalising on information and communication technology (ICT) developments to facilitate the exploitation, analysis, sharing, mining and visualisation of massive EO data sets and high-level products within Europe and beyond. Evolution in information technology and the consequent shifts in user behaviour and expectations present new opportunities to provide more significant support to geospatial data exploitation. In particular, Infrastructure as a Service (IaaS) provides the infrastructure as shared platforms for scientific collaboration in large communities. It enables the sharing of data and resources at an optimised price. IaaS allows a massively scalable ICT infrastructure with different payment models for use, access to resources that users could not afford on their own. App stores and Software as a Service (SaaS) have popularised the idea of processing on the network, sourcing content (data) and applications (processors) from commercial or free interactive 'stores'. Social networking is a new level of online collaboration among communities of practice not only possible but also mainstream.

To improve the understanding of critical and destructive processes along the Bulgarian coastal zone and to support the stakeholders responsible for managing and maintaining of functional environmental status, the project SatWebMare is implemented within the framework of ESA PECS program for Bulgaria. More details about the project activities are given in an article by Kounchev et al. (1). In this article, a general overview of the prototype web-mapping interactive system SatWebMare is provided. A short description of the geo-databases from different sources and the content of the SatWebMare geoportal with a web-interface system for three areas of interest is outlined. General inferences about the usability and further development of the system are also presented.

SatWebMare Platform Architecture Design and Implementation

SatWebMare geoportal has the aim to fill this gap and to offer advanced multi-temporal statistical analysis functions and visualisation capabilities in a virtual environment, for a well-defined geographic scope: Bulgarian Back Sea coastal area. The geoportal will facilitate user access to big volumes of multi-temporal data, high computing capacity and to a set of predefined geospatial data processors (algorithm chains). Every processing cycle can be run against a temporal slice of raw data. It will produce thematic stacks (coverage cubes) of physical parameters derived directly from a single source of data or as a result of data fusion between different sources of data like model outputs, satellite data or in-situ measurements. Then, using a user-friendly web-based cartographic client, the users can visually inspect the results and apply further multi-temporal processing chains in order to do various statistical and trend analysis. The new results can be displayed as thematic maps, interactive charts or reports.

This virtual workplace will provide access to:

- relevant geospatial and non-geospatial data;
- scalable network, computing resources and hosted processing (Infrastructure as a Service - IaaS);
- a platform environment (Platform as a Service - PaaS), allowing users to integrate, test, run, and manage applications (i.e. processors) without the complexity of building and maintaining their infrastructure, and providing access to standard platform services and functions such as collaborative tools, data mining and visualisation applications, the most relevant development tools (such as Python, IDL) and documentation, accounting and reporting tools to manage resource utilisation;
- application repositories or stores (Software as a Service, SaaS) with access to relevant advanced processing applications.

This approach has the potential to generate an important impact for the communities involved in environmental management. It will enable a step change enhancement in data processing and fusion of diverse datasets, supporting improved collaboration and providing a single framework through which different data, tools, algorithms and models can be accessed.

The SatWebMare geoportal provides data discovery and access interfaces for several relevant repositories of the satellite, modelled and in-situ data like:

- Copernicus Marine Environment Monitoring Service (https://marine.copernicus.eu/)
- Copernicus Atmosphere Monitoring Service (https://atmosphere.copernicus.eu);
- Copernicus Climate Change Service (http://climate.copernicus.eu);
- Copernicus Reference Data Access - CORDA (https://corda.eea.europa.eu).

To conclude, the SatwebMare platform will enable benefits like:

- rapid data access by avoiding moving large amounts of data on the network;
- full focus on exploitation as users do not spend time on ICT matters;
- synergistic use of different geospatial data sources;

- fully automated data processing framework allowing the generation of products for non-expert users.

The SatWebMare architecture is following the model proposed by the European Space Agency (ESA) in the "Exploitation Platform Open Architecture" specification document (3). As recommended in the mentioned specification, the SatwebMare architecture is split among four macrocomponents (Fig. 1). A macrocomponent is a logical collection of components that have similar or strictly related functions and implement a homogeneous set of processing services. A macrocomponent is just a logical representation used to describe the architecture easily, thus it has no direct relation to the system software implementations.

Some complementary components are dealing with coordinate transformations and search and retrieve elements using a georeferenced vocabulary of well-known place names (gazetteer service). The components were developed entirely with standard-compliant free and open-source software (Fig. 2).

A scenario to analyse and display a multitemporal dataset using SatWebmare functionalities is presented below:

- The user is using the geoportal discovery capabilities to identify a relevant dataset (e.g. 10 days synthesis of drought indices).
- The user is using the geoportal functionality to select a temporal (start date & end date

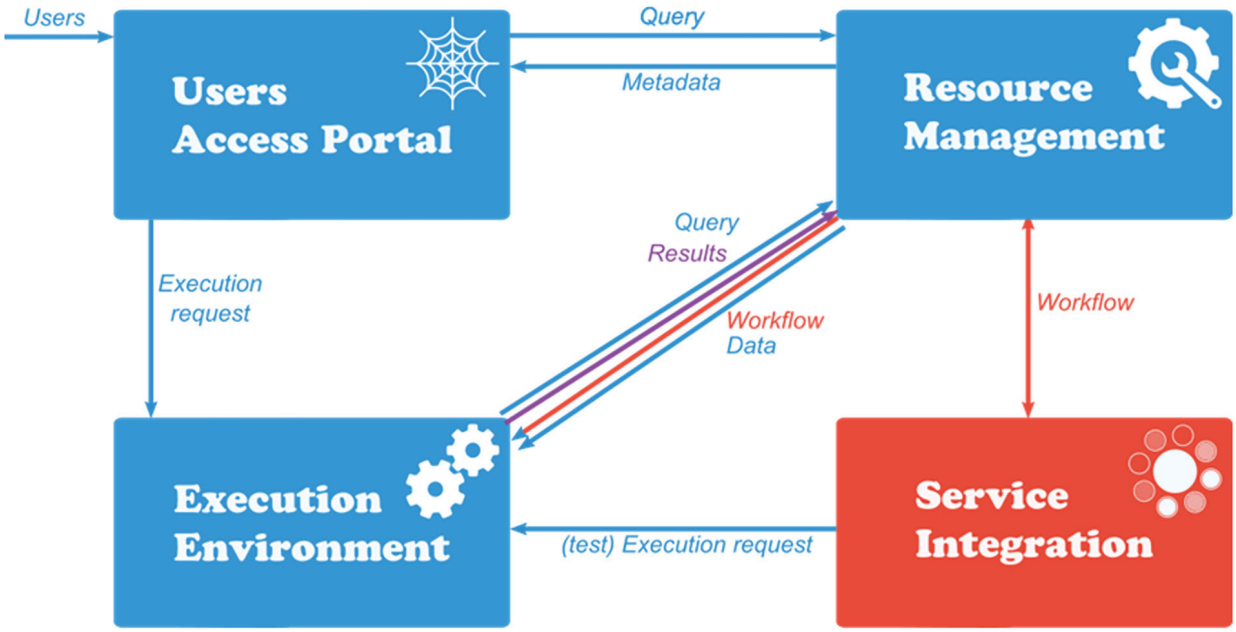

Fig. 1. SatWebMare architecture macrocomponents

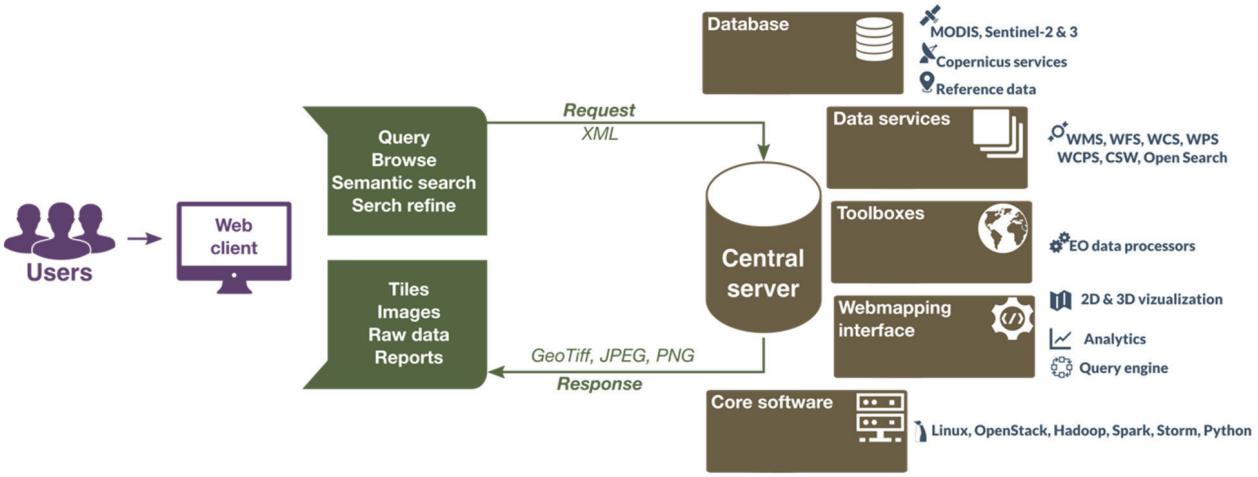

Fig. 2. SatWebMare geospatial system architecture

- TOI) and spatial (area of interest - AOI) slice from the identified product cube (e.g. 5 years).
- The users select a primary statistic method to be applied (e.g. mean).
- The request is sent to the server-side processing applications wrapped as WPS or WCPS calls.
- The process will trim/slice the coverage cube, perform the statistic operation for the pixels within the AOI for each day in the selected time interval.
- The results are sent back encoded in a standard file format (e.g. JSON/GeoJSON).
- The geoportal displays the results in a relevant form (e.g. chart).
- More advanced statistics and visualisation are applied to the results (e.g. trend line calculation).
- The results are downloaded as graphics, reports or raw data.

SatWebMare Users Access Portal (SatWebMare Geoportal)

The SatWebMare geospatial system will have public access. Technically, the geoportal was developed using state of the art open-source web and web-mapping technologies. The users are able to access the application with a web browser (like Google Chrome or Mozilla Firefox). The system compatibility will be tested on Windows, Mac OS X and Linux (Ubuntu and Fedora) platforms.

The SatWebMare geoportal allows the users to analyse the geospatial database, the model outputs and the results of the measurement campaigns in a geospatial context. The application has a simple user interface, with several functional areas (Fig. 3):

- Map: The map is the main component of this module.
- Layer list: The layers list is used to determine the way the map is composed and displayed. A transparency slider allows changing the transparency percentage of the various layers.
- Map toolbar: This toolbar contains all the instruments needed for the map navigation (zoom, pan, etc.).
- Map menu: This menu includes links to the catalogue service, data import capabilities, map context saving and the map print module.

DISCUSSION

The SatWebMare web-based platform will provide services based on OGC standards for data retrieval (WMS, WCS, WFS and server-side processing (WPS). The platform is developed according to the INSPIRE directive. The services were built upon open-source solutions such as GeoServer, OpenLayers, ZOO, PostgreSQL, GDAL, GRASS GIS. The prototype system can serve as the main source of near-real-time information for decision making in emergency response and risk assessment, security operations in maritime, etc. The speed of the access to the

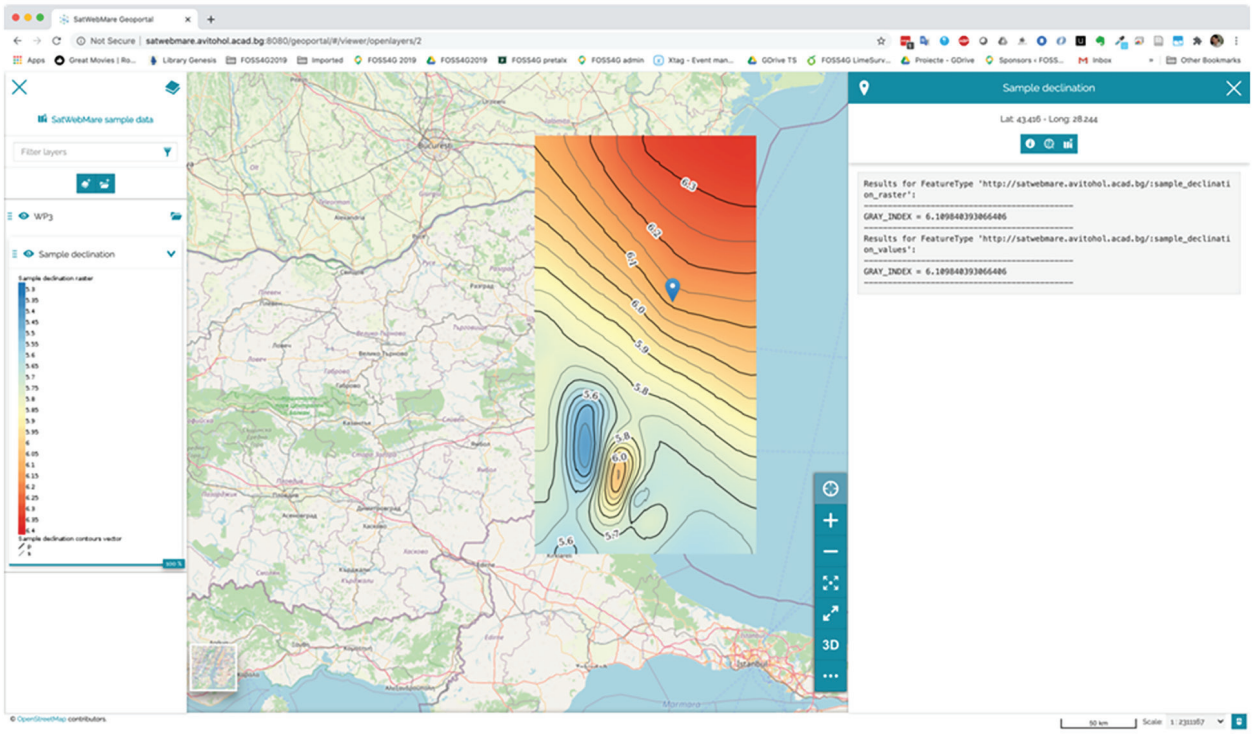

Fig. 3. SatWebMare geoportal interface

services of the SatWebMare prototype system will practically depend on and is limited by all sources of data, incl. ESA services.

CONCLUSION

The SatWebMare prototype system will supplement the already elaborated Romanian ESPOSS platform (4). This platform aims at developing into a mature solution for handling big geospatial data for the Bulgarian coastal area. It shall provide new and interesting capabilities of interpreting and connecting various types of datasets in order to extract the most valuable information to be further used. The web-based platform will integrate existing data from different sources, which will be accessible to a wide range of users and stakeholders.

Once the prototype system is fully developed, it will provide access to value-added products and services that are useful to ministries, agencies, local authorities and other stakeholders in support of the decision making. Its further integration of the SatWebMare system with the already existing technical exploitation platforms (TEPs) of ESA and Copernicus monitoring services DIAS is envisaged. The platform will provide the users with an access, among other geospatial data, to a wealth of satellite data coming from various sources and sensors of ESA, which are related to the Bulgarian coastal area.

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