Developing a Geoportal for Services Providing Coastal Ecosystems Mapping, Monitoring and Assessment of the North Africa Coastal Zone.

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ABSTRACT

The costal ecosystems information is diverse and large in size and always require regular updates to reflect reality and being effective in analysis. The analysis of these multi-sectorial data to meet decision makers and stakeholders' expectations, there is a need for robust mechanism of analysis and dissemination of the information across all levels. The online geoportal is a technical solution to this challenge to allow the data and information easily accessible and online analyzed to generate services for decision makers and beneficiaries. This paper presents a focus on developing an operational Geoportal for coastal zone management in all north African countries to enable for accessibility of services for Coastal Ecosystems Mapping, Monitoring and Assessment. It is an essential component of the regional project EOOS-NAfCoast" funded from the African Union Commission and European Union Commission. The proposed Geoportal is aimed at providing a unified online platform for institutions and organizations in the Northern Africa countries to work collaboratively and exchange data and information on a regional level with full data protection and security. It will enable us to provide regular services and information to different levels about marine variables such as sea surface temperature, chlorophyll-a, wind and waves. It will also be extended to the coastal ecosystems of fish farms, water quality, coastal geomorphological features as well vulnerability maps of the natural hazards on the coastal socio-economic activities. The proposed services will provide understanding about the available socio-economic opportunities that could be reflected on the economic status and

local community. The geoportal has much sophisticated technical issues that will be presented in the full paper with wide range of functions to generate maps, generate reports, publish information to different level of users.

1   INTRODUCTION

Northern African Countries have long coastal shoreline on the Mediterranean Sea, Red Sea, and Atlantic Ocean that extends for more than 6000 Km from Egypt to Morocco, in addition to about 2400 Km of the coastline on the Atlantic Ocean for Morocco and 1600Km on the Red Sea for Egypt. This coastal zone is wealthy with natural resources that attract local community and governments to development. Currently there are more than 140 cities distributed on this coastline that accommodate more than 170 million inhabitants. This is due to the availability of natural, coastal and marine resources that support such large communities and play a significant role in the economy of these countries. The coastal line of the Mediterranean Sea is rich with diverse ecosystems and flora species, which is estimated at over 25,000 species. Unfortunately, there is a growing need to maximize the value and benefit of these ecosystems for social and economic development. This could be through by accurate mapping and efficient quantification of these ecosystems as well as assessing the vulnerability status of these ecosystems.

Key challenge is to limit the pollution and discharge of human and industrial wastes into the Sea. Therefore, monitoring systems based on real-time information from earth observations and in-situ measurements interfaced in GI system would enable integrated management of the marine water and preserve the environment. this project is aiming at developing an operational tool for coastal ecosystems mapping, monitoring and assessment of the north African countries based on time series information that could be easily achieved by earth observation rather than other localized or limited coverage source.

The main objective of this Geoportal is to provide a unified online platform for institutes and organizations in the Northern African countries to work collaboratively and exchange data and information on a regional level. It will enable us to monitor issues of common interest and perform analysis for the common marine discipline. The portal will register any number of national organizations related to research in environmental and marine fields. Each Organization will be able to collaborate online with other registered organizations allowing members to work together to exchange data, generate reports, perform analysis, publish results, and query existing content. The

portal will be used for the physical and biological components of the coastal ecosystems mapping, assessment, and management. The NAfCOAST project has a clear objective: the creation of operational Earth Observation operational tools specifically designed for mapping, monitoring, and assessing coastal ecosystems in North African countries. This approach relies on time series data, readily accessible through Earth Observation, offering a comprehensive alternative to localized or limited coverage sources. The GMES and Africa initiative serves as a catalytic framework for the Northern African region, facilitating the collaborative integration required to develop these essential operational services tailored to the area's needs. This collaborative effort not only fosters cooperation but also encourages the dissemination of crucial information and the establishment of regulations that empower local communities. Furthermore, it lays the foundation for future sustainable development plans within this action implementation region, with the potential to serve as a valuable model for other regions across Africa in the years to come. The author worked in this project as a technical manager of the project, and he helped valuable business assignments. Figure (1) provides a framework of the project geoportal components and functions.
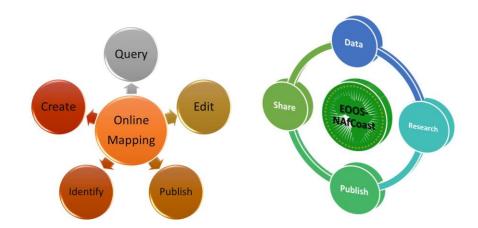

Figure 1. EOOS-NAfCoast Geoportal left) framework and right) functions.

(Source: NAFCoast project)

The portal will be developed using an Open-Source system and will enable the partners to edit, query, analysis and share the data online with pre-setup of user access. The main functions of the portal and the methodology of the model are listed in the following sections.

2 METHODOLOGY

2.1 Study area

The project covers several regions across North Africa. In Egypt, the focus is on the northern Mediterranean coastal zone and the Red Sea coastal zone. Tunisia's project implementation area is concentrated on the Mediterranean coastal zone. Morocco's scope includes both the Mediterranean coastal zone and the Atlantic coastal zone, with a focus on El Gedida. Finally, the project in Mauritania is centered around the Atlantic coastal zone, specifically in Nouakchott.

2.2 Data sources

The project incorporates several key elements, including the utilization of Sentinel 1, Sentinel 2, and Sentinel 3-SLSTR - L2-WST satellite data. Additionally, research studies play a significant role in the project's implementation and overall objectives.

2.3 Methods and models used

Our approach began by creating a comprehensive inventory of capacities and user requirements. This inventory encompasses various aspects, such as the assessment of available space-borne capabilities, including data availability, accessibility, and interoperability. Additionally, we examined the existing in-situ networks and data access mechanisms. We also took into account the modeling and computing facilities that play a crucial role in enabling the generation of Earth Observation (EO) services. This meticulous inventory forms the foundation of our methodology.

The elaboration of the inventories is carried out by exploiting, consolidating, and extending freely available data from World Satellites such as Sentinel data and others. This is also used the historical record data from the national satellites such as Egypsat1. The main source of data in this project is:

- Sentinel data – optical and Radar satellite data
- Landsat8 data – Optical satellite data
- Archive of Egyptsat 1 – Optical satellite data from 2007 to 2010
- In-situ data and networks – from the national organizations including measuring network and devices.
- Any other earth observation data available freely from EUMETSAT or other space agency

Earth observation data from different sensors is managed to categorize and classify the coastal ecosystems using algorithms capable of separating each category with acceptable accuracy. The scientific understanding of the behaviour of each physical or biological class is studied to develop or adopt the appropriate model to map these categories from satellite data. It is anticipated that the

iterative process of using the EO data and models is enabled for creating generic models that could be used by all partners in their countries. Indeed, these models are capable of classifying the physical and biological classes.

Other statistical models is developed during the project implementation by the partners, which are based on the correlation between the irradiance of the satellite images and in-situ measurements for a specific component. For example, the project could develop a model to estimate the chlorophyll-a blooming the Mediterranean Sea based on the correlation between the satellite images and in-situ measurements in the 4 countries. Similar models are developed during the implementation for other specific physical or biological components. Furthermore, the in-situ data and networks are used to validate the outcomes from the satellite data.

2.4   Organization support

The portal will provide strong support for each organization. Each organization is viewed to be a totally independent organization, where users can make the data available for their organization or share it with other organizations as they require. Each organization will have an administrator to manage organization users and information contents. The organization will have a starting page with the organization logo and hyperlinks to all other members and organizations information. Accessibility will be controlled by a security system to reserve the and maintain the agreed policies.

2.5   Data Management

The Portal will provide many tools allowing the users to better search, store, and describe their data. The users should be able to upload data easily via the browser; once the data is uploaded the users can then assign permission to access and use the data, either to their organization or to all other Portal users. Additionally, the data can be assigned any number or keywords or grouped into categories. These cataloging options will allow for filtering and advances navigation to present and interact with the data. Data can be grouped by type, as the portal will be able to serve and manage GIS Raster and GIS vector data. In addition to the geographic information the portal will contain a document management system to manage documents and images and other content items.

All rules regarding cataloging and security should apply to any data item whether it is a geographic, tabular, documents or any other file. The portal will also provide metadata support that is compliant with OGC standards, this will ensure that all content is also available to all desktop and GIS applications. Once the data is loaded the user will be presented with tools to finalize the visualization of the data, allowing the user to create colorful and meaning presentation to their loaded data.

2.6 Online Mapping and Methods

The portal will provide a suite of tools allowing the user to create and publish maps online. Online maps are considered the starting point for analysis and advanced studies. The map content will form the base for the users to utilize these maps as the base for further additional functions like reports generation or perform geographic analysis. Due to the geographic nature of the project, it is expected that the final result of all studies will be rendered as a map, having a dynamic online mapping application that is supposed to support decision makers for better visualization and taken decisions.

2.7 Online Apps and Data Analysis

Once the data and maps are loaded and published, the users are now ready to ask interactive questions, do research and perform a lot of analysis. There are two possibilities. The first possibility is for the user to download the data from the portal and utilize advanced GIS desktop GIS applications to perform the analysis. Once the user has a result, they can upload their result back to the portal and share it with their organization or community. This solution is utilized for difficult scenarios that do not repeat often. Non-GIS users will have a number of advanced tools available online to help them with their research. A few aquatic tools (applications) can be developed for example:

- Coastal hazard observer
- Shoreline analysis
- Sea level Rise analysis
- Environmental Response (Oil Spill)
- Habitat Planner
- Tides and currents viewer

2.8 Laws and Regulations

This section of the portal will gather all the national and regional environmental and marine, legislative histories, cases, and other legal documents that are related to the protection of underwater cultural heritage and marine preservation. The application also provides additional ocean, coastal, and international laws that can be browsed by keywords or statutes. This is a very good resource to study legislation and regulation for different countries. Moreover, the initiatives of data sharing policy on national and regional level will be uploaded to open the dialogue for data dissemination and sharing. Building on previous work done by African Union Commission will be adopted to foster the data sharing and dissemination policies. The principles of the African Space Policy and African Space Strategy approved by the head of States in January 2016 clearly stated for open access data for societal benefits in Africa.

2.9 Infrastructure and Requirement

The project portal is expected to host large amount of data; satellite images, tabular information, in-situ measurements and reports that require harmonization, management and effective use. Open-source technology Geonode Geoserver and PostGIS is the core tools that develop the geoportal. These tools are an efficient environment to build and extend the portal with sustained efficiency and accessibility. Additional customization for implementing customized applications is to extend the capabilities and provide apps for the users. Such additional advanced customization is based on capacity development and training to the partners to be able to develop their own requirements. Cloud system is used to hub the portal and data to allow fast access and online analysis.

 Hardware requirements to implement the geoportal is:

- Applications Development Server: 4 core – 8 Gram – 40 GB hard drive
- GIS Mapping Server: 4 core – 16 Gram – 40 GB hard drive
- Database Server: 4 core – 32 Gram – 60000 GB hard drive

NARSS has its access to a cloud system that is capable to run the project, technical specs of the hardware:
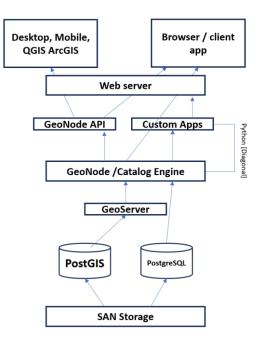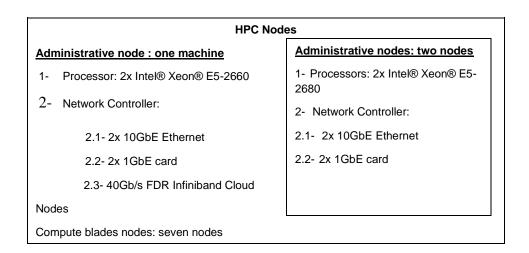

Figure (3) shows schematic diagram of the geoportal components and requirements.

During the implementation, we evaluate if this cloud system is sufficient for the partners, if they have high speed network, or alternatively, we purchase some hardware for the other three partners for efficient use and implementation.

HPC Nodes	

Administrative node : one machine
 	
1- Processor: 2x Intel® Xeon® E5-2660
 	
2- Network Controller:
 	
    2.1- 2x 10GbE Ethernet
 	
    2.2- 2x 1GbE card
 	
    2.3- 40Gb/s FDR Infiniband Cloud
 	
Nodes
 	
Compute blades nodes: seven nodes
	Administrative nodes: two nodes
	
	1- Processors: 2x Intel® Xeon® E5-2680
	
	2- Network Controller:
	
	2.1- 2x 10GbE Ethernet
	
	2.2- 2x 1GbE card

2.10 Economic sustainability of the Geoportal

However, the sustainability of the project is discussed later in this proposal, it is worthwhile to mention here that the geoportal can highly evolve by gaining support and visibility among participants and further inviting additional organizations, with high potential of this geoportal to be commercialize and generate revenue to sustain itself.

This could be via providing the following information with minimum annual subscription charges such as:

- Offer and provide data services in a specific topic. Aquatic and marine data is very expensive and not easy to develop by individual organization.
- Offer development of further application for handling aquatic problems. There are many more implementations needed by the government and the private sector for mapping. For example, monitoring of fishing activities across international borders or studying the effects of sea water rise towards the economies of beach cities, or the impact of oil drilling related to aquatic life.

3 RESULTS AND DISCUSSION

To increase the value-chain of the EO applications, the portal will be an enabler instrument for decision makers, planners, stakeholders and the public. Outcomes of the project information will be publicly available for individuals and small and large enterprises, real estate developers in coastal areas, NGOs, foreign instructions and all concerned society about the environment or private sector requesting more information related to their business. All these users will use the portal as a collaborated framework to exchange data and comments and ideas. Other non-registered organizations can still request to publish their data to the portal. The public can view all data available publicly and even more apply social functions to promote the data on the portal and provide rating and comments. This function will democratize the content and provide an added quality control step as everybody will be evaluating the portal data. Figure (3) shows an example of simulated screen shot of the proposed geoportal.
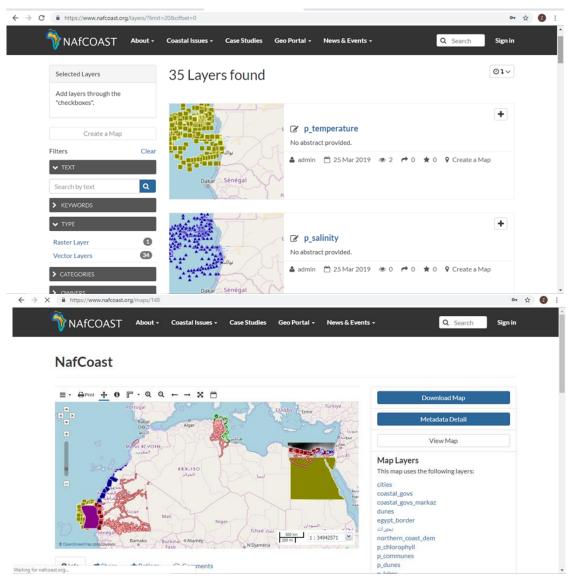

Figure 2. a snapshot of the geoportal (Source: https://nafcoast.org/)

4 CONCLUSION

The developed WebGIS portal consists of various useful GIS tools for spatial data visualization, analysis, querying and finally production of maps in the form of map prints. The use of an effective database management system allows for effective storage, management and retrieval of spatial data. The adopted approach and its implementation to develop a Web Based GIS application provides public users data sharing and mapping services. It shares the information and geospatial datasets allowing users with limited GIS knowledge to access the information customized for specific applications that will reduce operation costs management and assist people in their decision-making process. GIS and various web technologies can be efficiently combined as a mechanism to share spatial information freely, openly and easily.

5 ACKNOWLEDGMENT

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