The Global Solar and Wind Atlas: a unique Global Spatial Data Infrastructure for all renewable energy

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ABSTRACT
The Global Solar and Wind Atlas (GA) is a unique Global Spatial Data Infrastructure (GSDI) that aims to connect and bring together in a common platform the major databases and information sources around the world in the field of solar and wind energy. The initiative will be expanded to encompass all renewable energies by 2015, and will be the largest information source on renewable energy potentials ever created. It has been developed under the umbrella of the Global Atlas initiative led by IRENA in partnership with the Clean Energy Ministerial. The GSDI is based on open standards and open source and composed by fundamental datasets, a geospatial catalogue and a Web based GIS Interface. The GIS interface provides a way of interaction between users and the other components, including spatial data and tools. The GIS allows users to identify opportunity areas for renewable energy development by searching and loading data listed by the catalogue, overlaying information, and computing locally the technical potential of renewable energy. In this demonstration we aim to show the GA infrastructure and how users can interact with all the different modules with emphasis on the GIS interface.

Categories and Subject Descriptors
H.4.m [**Information Systems Applications**]: Miscellaneous.

General Terms
Management, Documentation, Design, Standardization.

Keywords
Spatial Data Infrastructure, Web GIS, Renewable Energy, Spatial Data Interaction, Open Geospatial Consortium, OGC, GEO, GEOSS.

1. INTRODUCTION
Doubling of the share of renewable energy globally and ensuring universal access to energy will require detailed planning for large investments in projects and infrastructures. The fundament of this ambitious goal is an accurate estimate of the local renewable energy potential for each resource. Renewable energy resources are often irregularly geographically distributed and therefore different renewable energy technologies are more or less suitable in different locations [1]. Based on renewable energy potential information, it is possible to identify the most suited technology opportunities for each location, identify priority development areas over a territory, plan the investments in projects and infrastructures over time, and ensure that the regulatory framework is adequate to create an attractive investment environment [2].

A large technology and knowledge gap exists between nations having access to the necessary funding, technologies, and expertise to evaluate their national potentials, and those deprived of those elements.

The Global Renewable Energy Atlas is an initiative coordinated by the International Renewable Energy Agency (IRENA)[1], which aims at federating the existing knowledge on renewable energy potentials and making it free and publicly accessible. The core of the initiative builds on a single freely accessible internet-based platform, called Global Atlas (GA), developed based on open source software and open standards.

Since 2012, the platform acts as a prospector for hotspots and a repository of the existing works at international, national and regional level. The initiative gathers datasets and methods from the most experienced institutes and private companies active in resource assessment. The platform was designed from the recommendations of the end-users, and was developed through a large international partnership. Thirty-nine countries declared their interest in the initiative, making it the largest program on renewable energy potentials. This level of international collaboration could only be achieved by using a decentralized data infrastructure, based on open standards.

The interaction between users and data is a key concern on the development of the GA. Users should access the information contained in the available datasets in an easy and complete way. Therefore, mechanisms of organizing, searching, discovering, viewing and exploring data are fundamental. The visualization of data from different sources with different structures was a challenge, and still is, and therefore the GIS interface was designed and developed based on recommendations provided by end-users.

After a brief introduction, the GA infrastructure is described, along with tools that are already available as Web Processing

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[1] http://www.irena.org

Services. The demo paper is finished with some conclusions and a brief explanation on the demonstration that will be provided.

2. System architecture

The GA platform is based open standards developed by the Open Geospatial Consortium (OGC) and on open source software in order to be fully interoperable. Standards such as OGC Catalog Service for the Web (CSW) [3], Web Map Service (WMS) [4], Web Feature Service (WFS) [5], Web Processing Service (WPS) [6] and Style Layer Descriptor (SLD) [7] are implemented. As any SDI framework, the system architecture is distributed and composed by three major and fundamental components: Data, Catalogue and GIS Interface as shown in Figure 1. These components allow users to search for available datasets based on categories, metadata, theme, among other options, preview each dataset, and import and combine them into the GIS Interface component.

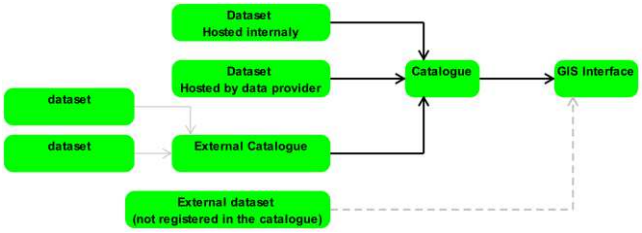

Figure 1 - System architecture

Data: The data component includes all relevant datasets in solar and wind energy with local, regional and global coverage. Whenever it is possible those datasets remain in their original location but the framework has also the possibility to host data from partners that do not have their own infrastructure.

Figure 2 - Catalog OGC CSW

Catalogue[2] **(**Figure 2): This is the key component that organizes all the datasets and metadata and also provides search and preview functionalities. It has the capability to harvest remote spatial data servers and also other catalogues and synchronize the metadata for stored datasets. The catalogue references the URL's of the GA data providers, and links to major data collection initiatives targeted at energy and environment applications. In that respect, the catalog is registered among the resources of the Group on Earth Observation (GEO) coordinating the development of GEOSS (Global Earth Observation System of Systems). The catalog content is also listed as a resource serving the United Nation Environment Program (UNEP) Live. Both initiatives are targeting energy and environment related resources in their global scope. The catalog is delivering a consequent subset of those energy and environment resources thanks to the respect of international recommendation on standards and interoperability. The catalog currently contains around 500 references to solar and wind datasets and is continuously expanding.

GIS interface[3] **(**Error! Reference source not found.**)**: The GIS Interface has all the usual tools for zooming, panning, measuring, etc., and provides WPS tools hosting capacity. Basic users can easily overlay information and preform local analysis. A major innovation of the initiative is the capability to search the data catalogue from the GIS interface, integrate resultant datasets, and therefore create user-defined maps that can be stored, retrieved and shared through a map library. Users can add local or remote data servers to access and manipulate the information. This

[2] http://geocatalog.webservice-energy.org

[3] http://irena.masdar.ac.ae

functionality allows the integration of user's own data that is not registered in the catalogue. Online video tutorials are designed to train basic and advanced users.

Beyond the GIS Interface, accessible using any supported browser, data registered in the catalogue is also available in the form of Web services allowing users to use their own GIS client application to access them. The infrastructure is therefore fully interoperable and data is freely and openly accessible. Specific intellectual property restrictions, negotiated with IRENA, can be taken into account by restricting the access or use of the data in the catalog and/or GIS tools.

Some energy assessment related tools operated as WPS services are already available for demonstration in the GIS Interface and more are planned to be developed in the future. In the current version, existing tools only work with a specific subset of the available datasets as a consequence of the heterogeneity of data types supported by the Interface.

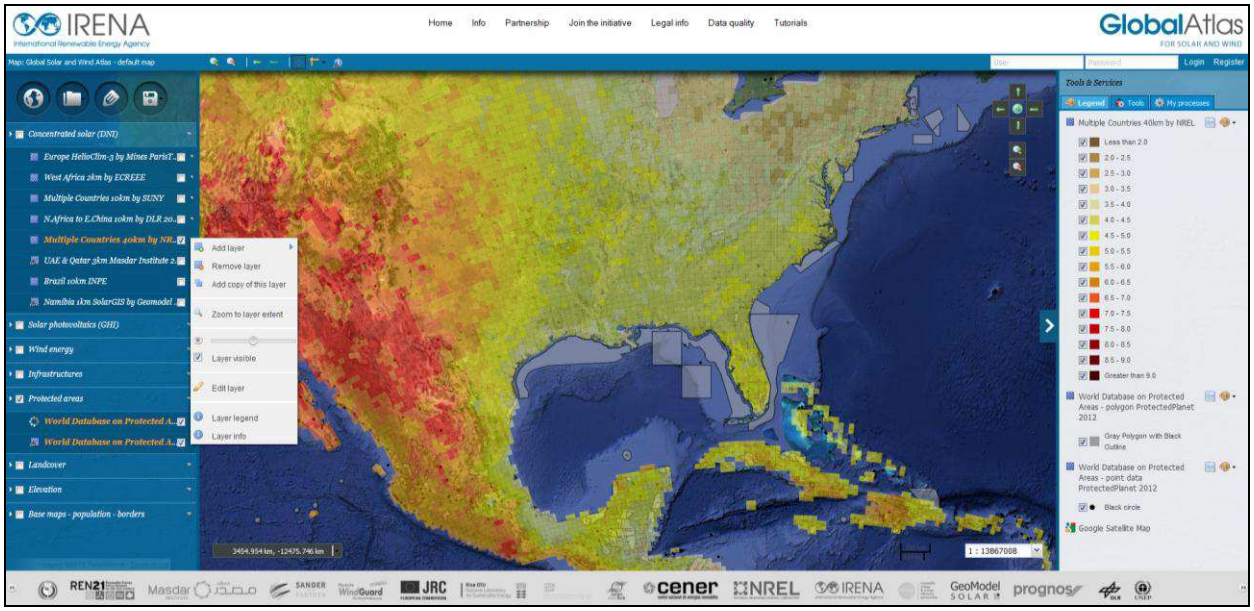

Figure 3 - GIS Interface

For the moment, three analysis tools are available in the interface:

- **Solar Site Ranking Service**: Developed by the German Aerospace Center (DLR)[4] for the EnerGEO[5] project and adapted to be included in the Global Atlas, this service provides a spatial decision-support tool for solar power plants by calculating a solar site ranking for continental Europe. The service is based on a Weighted Linear Combination (WLC) and Boolean overlays.
- **Available Renewable Energy Resources**: Developed by the National Renewable Energy Laboratory (NREL)[6], this tool aims at comparing a variety of datasets describing solar and wind resources for a user selected area.
- **Helioclim1 Point Data**: Developed by the MINES ParisTech[7], this tool provides a way to retrieve Helioclim1 radiation time series data [3].

3. CONLUSIONS

The Global Atlas initiative has been developed to bridge the gap between nations having access to the necessary funding, technologies and expertise to evaluate their national potentials in terms of solar and wind renewable energy. The core of the initiative is a free and open GSDI hosting solar and wind resource maps supplied by a large international partnership. The GSDI has no equivalent so far, and brings an immense value to the renewable energy community by making available and accessible a large amount of information in an interactive format. It also provides powerful Web-GIS tools to perform local analyses of technical renewable energy potentials. This international collaboration was only made possible thanks to the OGC standards. It provides a unique data network dedicated to support the growth of renewable energy worldwide.

Although standards for sharing geospatial data, provided by OGC, are used, there are still some challenges regarding the visualization of data with diverse structures (e.g. different units, different attributes, etc.). Therefore, ways to integrate those datasets in common visualization tools need to be investigated. Another consequence of using data from several different sources is data quality and research is undergoing to develop ways to provide users with useful information on this regard.

4. DEMONSTRATION

For the demonstration we are planning to show the geospatial catalogue and the GIS interface. Regarding the geospatial catalogue we intend to show the search and preview capabilities and how the information is organized. Concerning the GIS interface, the interaction with maps, data, and other

[4] http://www.dlr.de

[5] http://www.energeo-project.eu

[6] http://www.nrel.gov/

[7] http://www.mines-paristech.eu/

functionalities, including the available analysis tools and the link between the catalogue and the GIS interface, will be demonstrated interactively. The infrastructure can be accessed at http://www.irena.org/globalatlas/, the geospatial catalogue through http://geocatalog.webservice-energy.org and the GIS Interface at http://irena.masdar.ac.ae.

DEVELOPMENT PARTNERSHIP

This GDSI has been developed and is operationally maintained by international institutes into an international partnership including IRENA, Masdar Institute of Science and Technology (MIST), DLR, NREL and MINES ParisTech.

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