Towards a European Geothermal Information Platform, the EGIP pilot

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ABSTRACT

Organising and sharing geothermal data was recognized by the Geothermal ERA-NET partner countries as playing an important role in facilitating geothermal energy development in Europe. In particular, one of the aims of the Geothermal ERA-NET project[1] is dedicated to an assessment and feasibility study of the implementation of ***a European Geothermal Information Platform*** (EGIP). The envisaged EGIP is endowed with a web-portal access, by means of which European geothermal information can be accessed, retrieved and queried using modern ICT technologies, in particular collaborative e-Infrastructures. EGIP is a virtual platform, created through harmonized information, which goes beyond pure data sharing: it also involves the way and form how information and data are displayed, examined, and compared. A subset of the EGIP plan was implemented under the form of a pilot system (the EGIP pilot portal) and is the focus of this paper.

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1. INTRODUCTION

Many geothermal databases (GDBs) are currently developed either on national (local, regional and national GDB), e.g., Geotis (Agemar et al., 2014), Geothopica (CNR-IGG, 2012), or on international scales, e.g. the GDBs developed in projects such as GEOELEC (Dumas and Angelino 2013a), GEODH (Dumas and Angelino 2013b), TransEnergy (Nádor et al. 2013) and the IGA GDB on energy production (International Geothermal Association 2015; Trumpy et al. 2015a). These mostly manage underground data and resource features (e.g. well data, heat flow, geophysical and geochemical data) or exploitation parameters (e.g. installed capacity, produced energy) (Khan, Rasul, and Khan 2004).

However, exploiting and managing geothermal energy entail not only knowing the underground conditions and technologies, but also understanding (i) regulatory, economic and social (including environmental) aspects, (ii) research roadmaps and training, (iii) energy demand and market requirements. Existing current data and information systems depict a complex picture, in which information is heterogeneous and poorly connected. Data are often available online, but spread over different databases, data formats, platforms or web pages. Thus, they do not constitute a complete and coherent set of information (Trumpy et al., 2015b).

The data sets and services produced in this heterogeneous scenario usually address national stakeholders, and are provided in regional language

with specialized applications. Managing a large quantity of heterogeneous data (e.g. geothermal maps, well data, regulatory documents, monitoring data, list of training courses) requires a structured data organisation, information analysis and recovery systems that produce results quickly and efficiently (Trumpy et al., 2015b).

In this paper, we describe a prototype for a European Geothermal Information Platform (EGIP) that collects and aggregates data sets from different European contributors that have harmonized data according to the INSPIRE requirements and technical recommendations (EU Commission 2010) for this purpose.

This pilot is the result of the first completed Joint Activity performed by some of the countries participating to the Geothermal ERA-NET project, and is operative since September 2014 (http://egip.igg.cnr.it). The main objective is to demonstrate the platform capabilities and its usefulness to the main potential geothermal stakeholders in Europe, i.e. scientists, policy makers and industries.

Current EGIP pilot contributors come from Italy (Institute of Geosciences and Earth Resources of the National Research Council, IGG-CNR), Hungary (Magyar Földtani és Geofizikai Intézet, MFGI), Switzerland (Swiss Federal Office of Topography, swisstopo), France (Bureau de Recherches Géologiques et Minières, BRGM), and Iceland (National Energy Authority of Iceland, Orkustofnun), Slovenia (Geological Survey of Slovenia, GeoZS).

2. METHOD

The EGIP pilot was realised by means of a data and computational e-Infrastructure (D4Science) aimed at facilitating open access, data sharing, collaborative analysis, processing and data mining, as well as disseminating the newly generated knowledge in the geothermal domain (Candela, Castelli, and Pagano 2009).

The architecture of the EGIP e-Infrastructure is strongly based on the usage of standards recommended by the INSPIRE European directive (INSPIRE directive 2007), the Open Geospatial Consortium and the Dublin Core description for metadata. These standards are used to describe datasets, services interfaces, social networking, data visualisation facilities and documents descriptions and are the basis to enable collaboration between remote partners.

3. DATA CONTENT

Regarding the content of the data provided by EGIP, partners were asked to share at least, if available / existing, the following information: (i) temperature maps at 1, 2, 3 km depth; (ii) surface heat flux; (iii) licencing areas; (iv) national geothermal roadmaps; (v) insurances specifications; (vi) environmental legal regulations; (vii) grid access and licencing; (viii) training centres and (ix) industries. Partners structured and shared this information according to a commonly agreed data model and eventually supplied it via web services hosted at national level.

4. E-INFRASTRUCTURE

We defined and set up an e-Infrastructure and adapted its visualization, access and processing tools to manage, share and reuse the EGIP data sets. The e-infrastructure provides data and service catalogue based on a network of geospatial services in order to organize the information provided by the different EGIP contributors.

The role of the e-infrastructure was to seamlessly and automatically gather the web services, harvest, aggregate and harmonise datasets and to enable data access and sharing (Fig. 1).

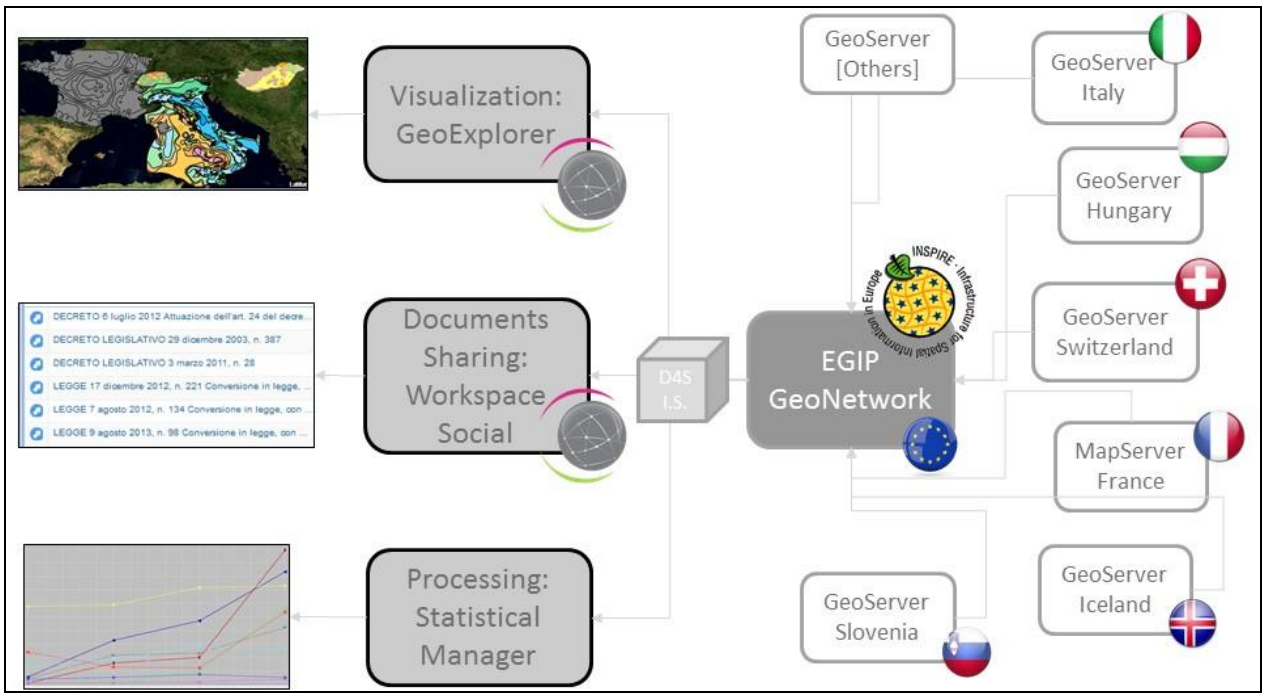


Figure 1: Conceptual schema of the EGIP platform.

Through a web portal interface, the e-Infrastructure offers various applications to the EGIP community members and gives a whole and complete view of the European geothermal information gathered so far. Relying on representation standards, a common data model and a collaborative e-Infrastructure, was the key to make EGIP achieve an effective and beneficial result for his contributors.

In order to support EGIP, we used the following facilities: (i) Geospatial services: to connect to a distributed data and service catalogue; (ii) a Web portal (D4Science for EGIP, egip.d4science.org) that acts as a unique information access point for applications and data catalogues; (iii) a distributed computational system, to process data and create aggregated representations of the energetic scenarios of the contributing countries; (iv) visualization tools, to allow users access to data sets, GIS layers and processing results; (v) social networking facilities, to allow users to share results and data sets with other colleagues.

4.1 Visualization

The GeoExplorer portlet (CNR 2015b), is a Web application through which users can discover and interact with spatial layers. It interacts with the infrastructure metadata catalogue (GeoNetwork) in order to explore the spatial information available. In order to get the list of layers and to search for a layer name, GeoExplorer sends CSW requests to GeoNetwork. When a user selects a layer, the corresponding service (e.g. a Geoserver) hosting the layer is invoked via WMS and is visualized. When the user clicks on a specific location, GeoExplorer uses the WFS standard to extract features (i.e. attached information) for that location and then it visualizes them as a table.

Overall, the GeoExplorer portlet provides the following facilities: layer exploration (preview, sorting, filtering, multi-selection); visual combination of several overlying layers; CQL visual filters of one or more layers; tabular spatial data retrieval of one or more layers; transect chart production; a rich set of base layers; and visualization of external WMS layers.

The upper right part of the interface displays maps, whereas the upper left part provides ordering and transparency settings of the layers loaded (Fig. 2). The toolbar at the top of the map allows panning, zooming, and extracting information. Below the map panel extracted information is reported. The lower left panel contains a list of data sets, which can be filtered using a search box. To the right a metadata of the selected data sets are visualized together with a thumbnail map (Fig. 3).

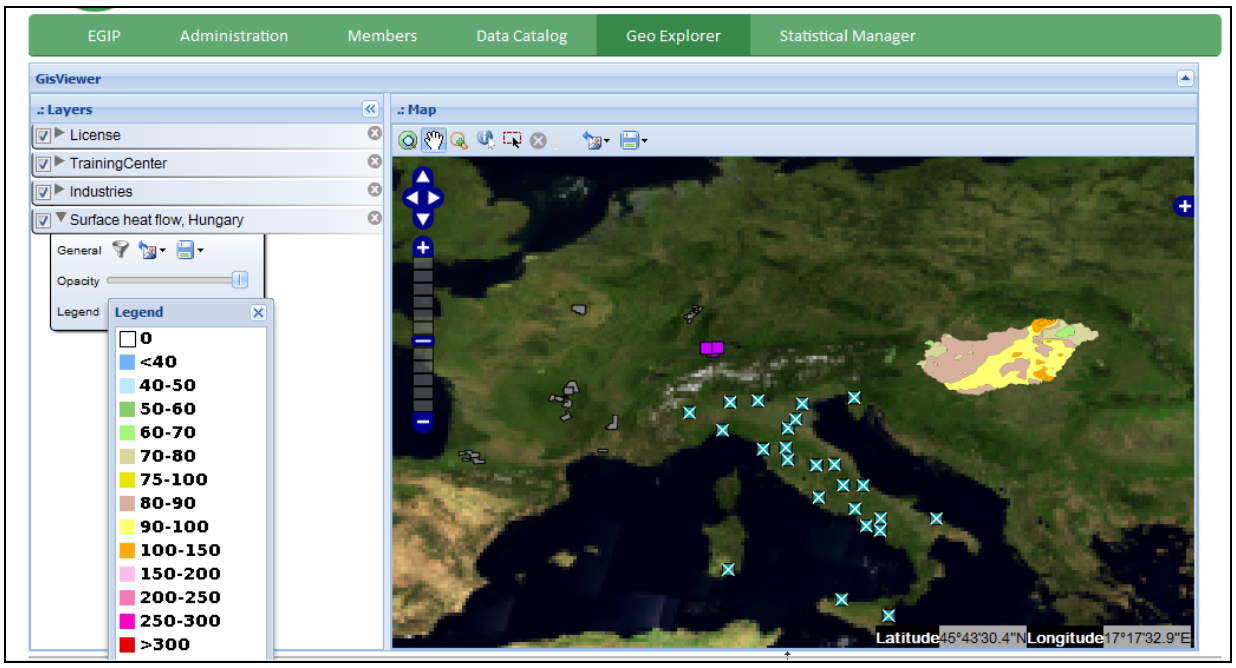


Figure 2: The D4Science GeoExplorer portlet, used to visualize heterogeneous data in the EGIP data catalogue.

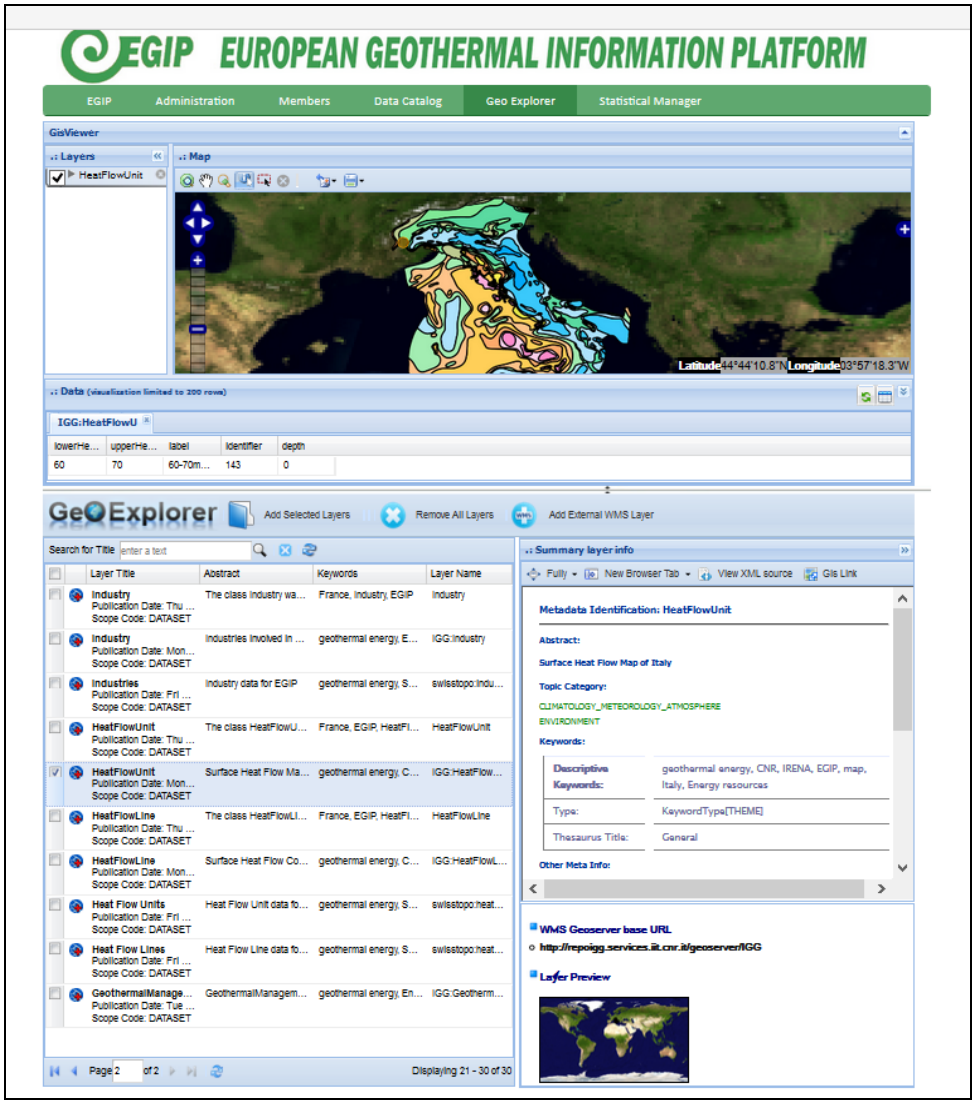


Figure 3: Access to EGIP data through the GeoExplorer portlet.

4.2 Processing

D4Science offers a dynamic web interface for data processing to perform statistical analysis (Fig. 4). The interface allows users to select the algorithms, execute them, and monitor their execution via a plain web browser. The list of capabilities grouped according to a user-oriented perspective is shown on the left-hand side. In the right hand panel, the web interface automatically generates the required fields from the inputs of the algorithm and displays them with the proper format.

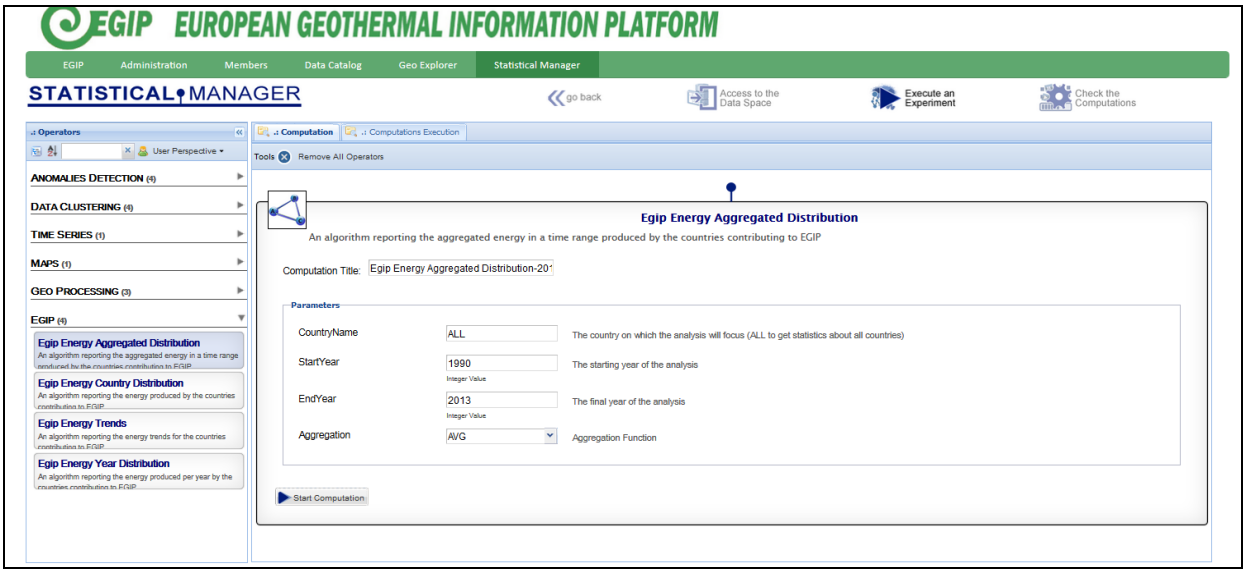


Figure 4: The D4Science interface for data processing and experiments setup.

Within the Virtual Research Environment (VRE), we developed a processing service that produces a summary of the information provided by the contributors in the form of a table. The summary table contains one row for each country. For each row, a number of columns contain indications aggregated at a five-year resolution. This includes the following information for each country: (i) the available thermal power (in thermal megawatts, MWth); (ii) the heat produced (in Tera-Joules per year, TJ/y) and (iii) the electric power available (in electrical megawatts, MWe).

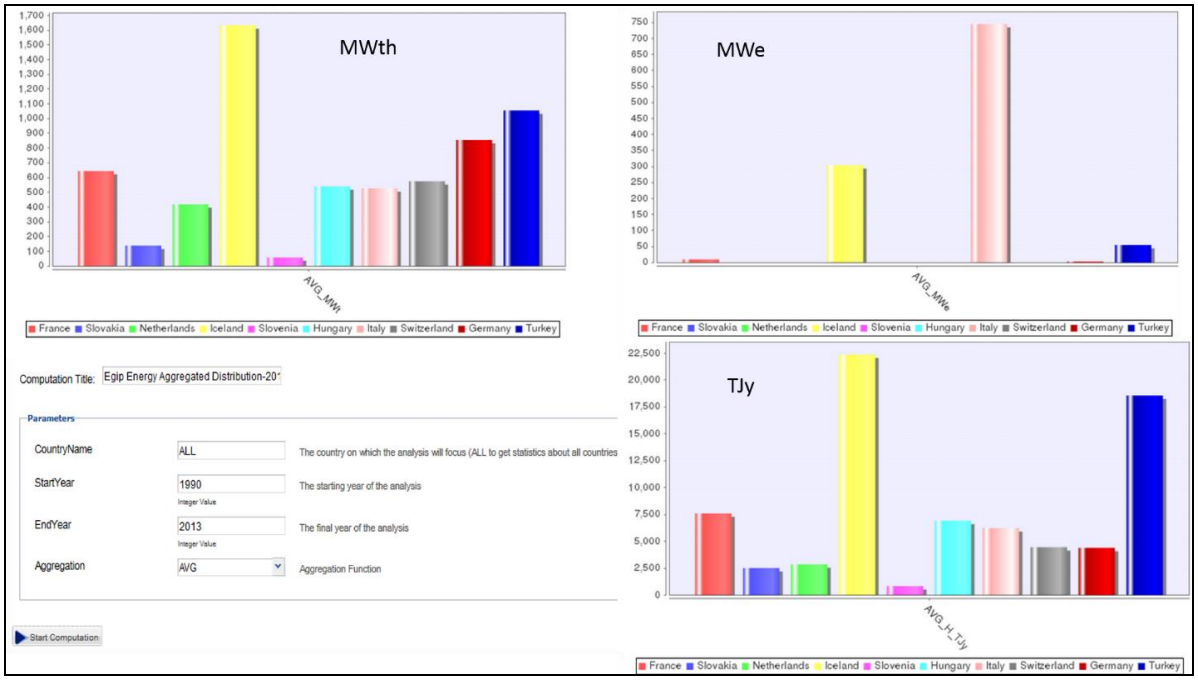


Figure 5 Example of the configuration of the aggregated energy distribution algorithm, with corresponding output.

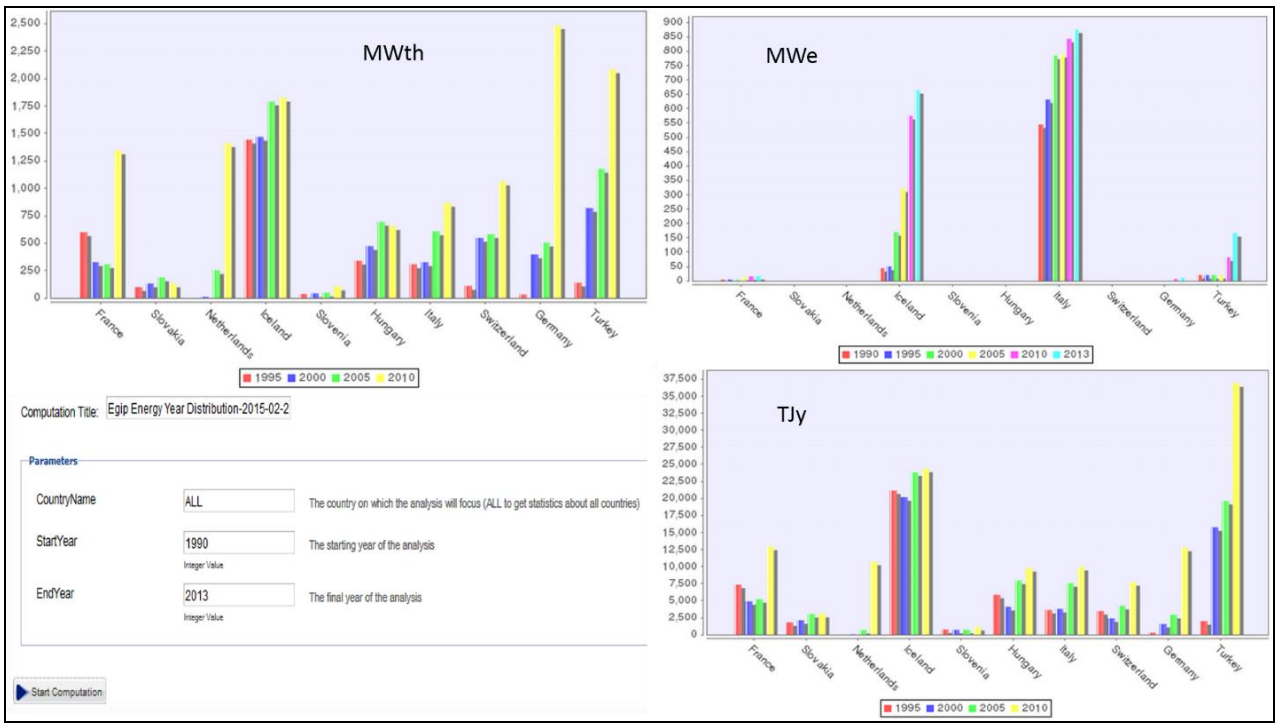


Figure 6: Example of configuration of the 5-years energy distribution algorithm.

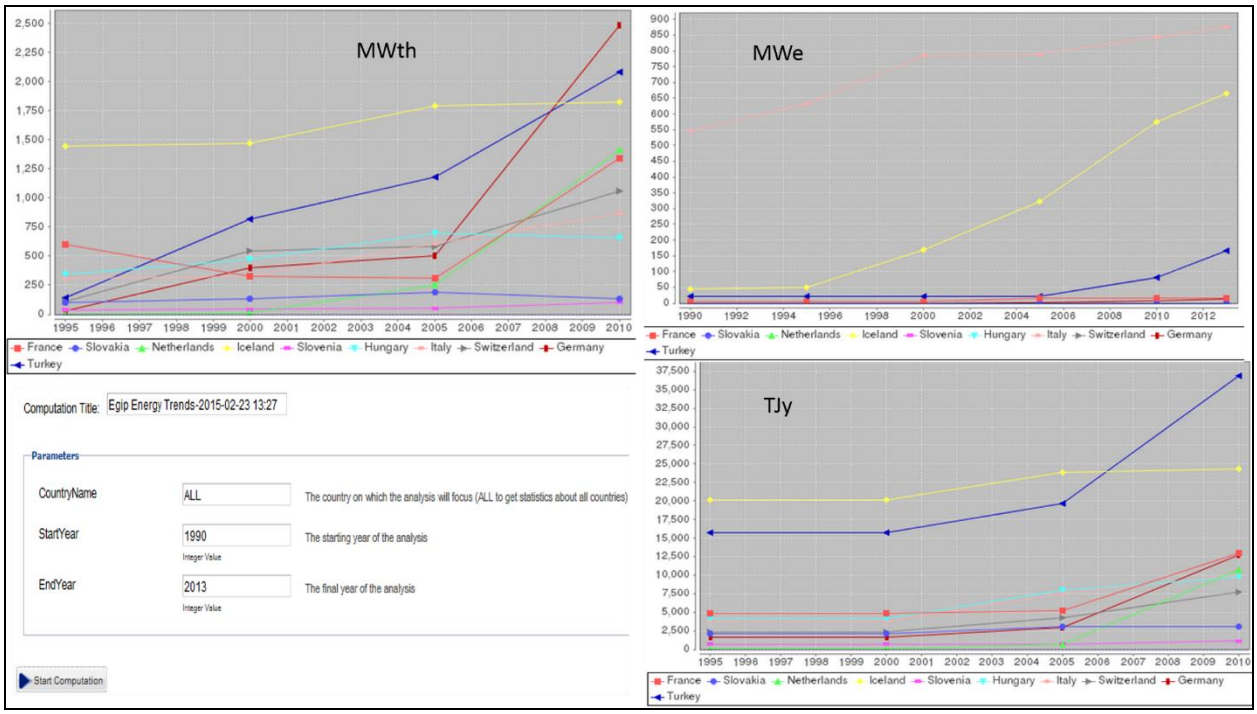


Figure 7: Example of configuration of the energy trends algorithm.

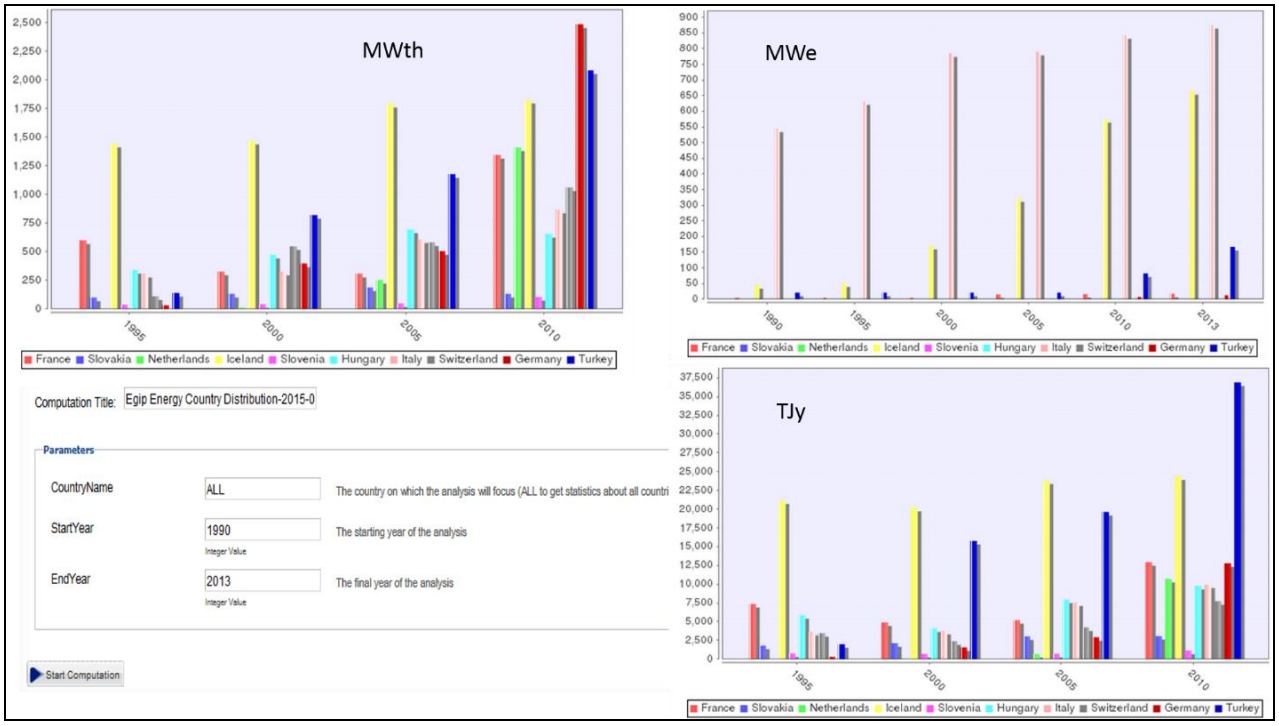
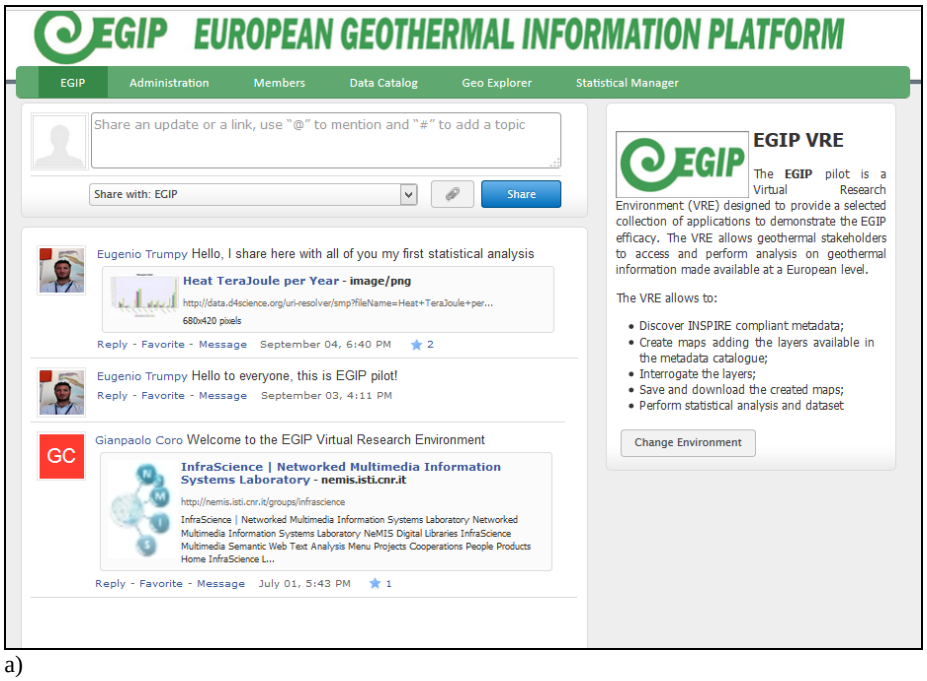
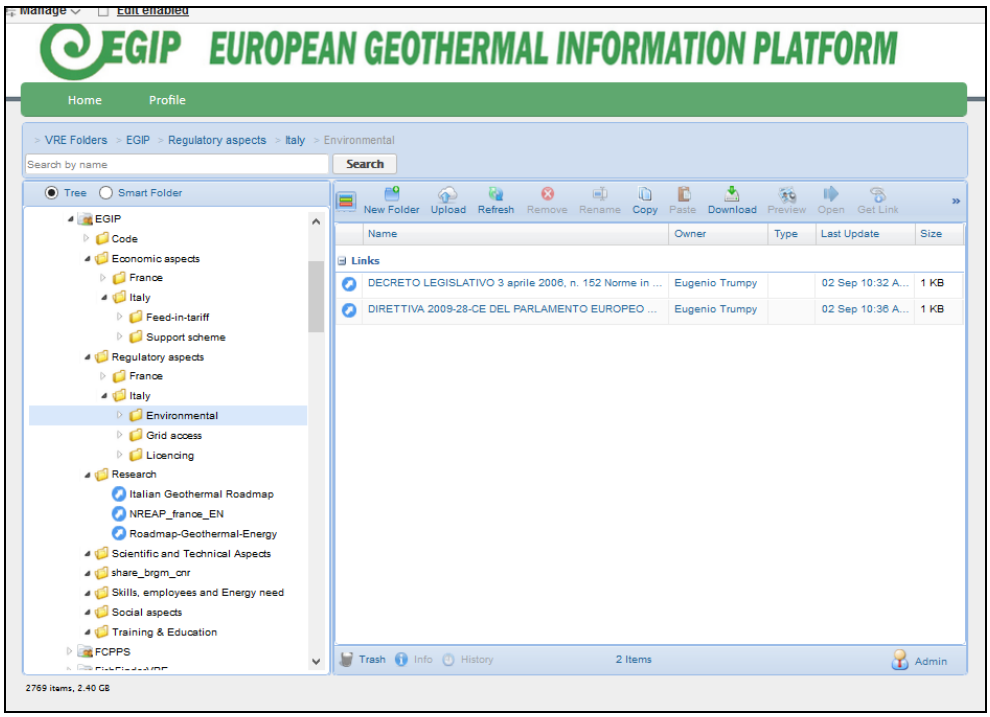


Figure 8: Example of configuration of the per-country energy distribution algorithm.

The EGIP data processing session uses the Cloud computing facilities provided by the D4Science e-Infrastructure. The objective of the processes hosted by this platform is to produce an aggregated visualization of the energy trends and the information provided by the contributors. In particular, the implemented processes are: (i) aggregated energy distribution that reports either the average (AVG) or the overall (SUM) energy available and produced by the EGIP contributors, in a certain year range (Fig. 5); (ii) 5-years energy distribution that reports the energy available and produced by the EGIP contributors, with details on each five-year period (Fig. 6); (iii) energy trends that reports the aggregated energy trends of the EGIP contributors (Fig. 7) and (iv) per-country energy distribution that reports the aggregated energy, focusing on the countries (Fig. 8).



a)



b)

Figure 9: View of the D4Science social networking facilities: (a) the list of user events and news, (b) file-system storage and sharing area (Workspace).

4.3 Sharing

The aim of the D4Science networking facilities (Assante et al. 2014) is to enhance collaboration between users. The EGIP e-Infrastructure hosts a VRE that has five key social networking tools: (i) a continuously updated list of events/news produced by users and applications (Figure 9(a)); (ii) a file system-like online area (Workspace, Figure 9(b)) for uploading and sharing of files, data sets and folders; (iii) a messaging facility for participants in the same VRE; (iv) a user profile interface, which can be connected to widely used social networks (e.g. Facebook and Twitter) and (v) a computational space for each user, containing the history of the computations that have been executed, along with the input parameters and the output.

5. CONCLUSIONS

We have defined and set up an e-Infrastructure to build a prototype European Geothermal Information Network and we have highlighted its main functionalities. As benefits for the contributing countries, the e-Infrastructure (i) favours the harmonization of geothermal information at a European level; (ii) guarantees data interoperability (information retrieval, visualization and access); (iii) enhances information access and retrieval; (iv) preserves the ownership of the data, that is, each country remains as the owner of its data, maintains them and decides on the publication policies; and (v) adds modularity and flexibility in the sense that it is easy for a new country to participate.

The aim of EGIP is to increase communication between international geothermal energy users. It provides national and supranational stakeholders (decision-makers, companies, regulators and scientists) a way to access geothermal information at a European scale. This exchange is expected to reduce information fragmentation, enhance data provisioning, promote the harmonization of the European geothermal sector and reduce economic risks in geothermal projects.

EGIP also aims to increase awareness on geothermal energy, by providing an overview of its applications at a European scale. A major expected consequence is the increase in investment in the geothermal energy sector. Nevertheless, all these aims are in line with the ECs efforts of building a European Energy Union.

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