D4Sciences VREs case studies

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Italiadomani

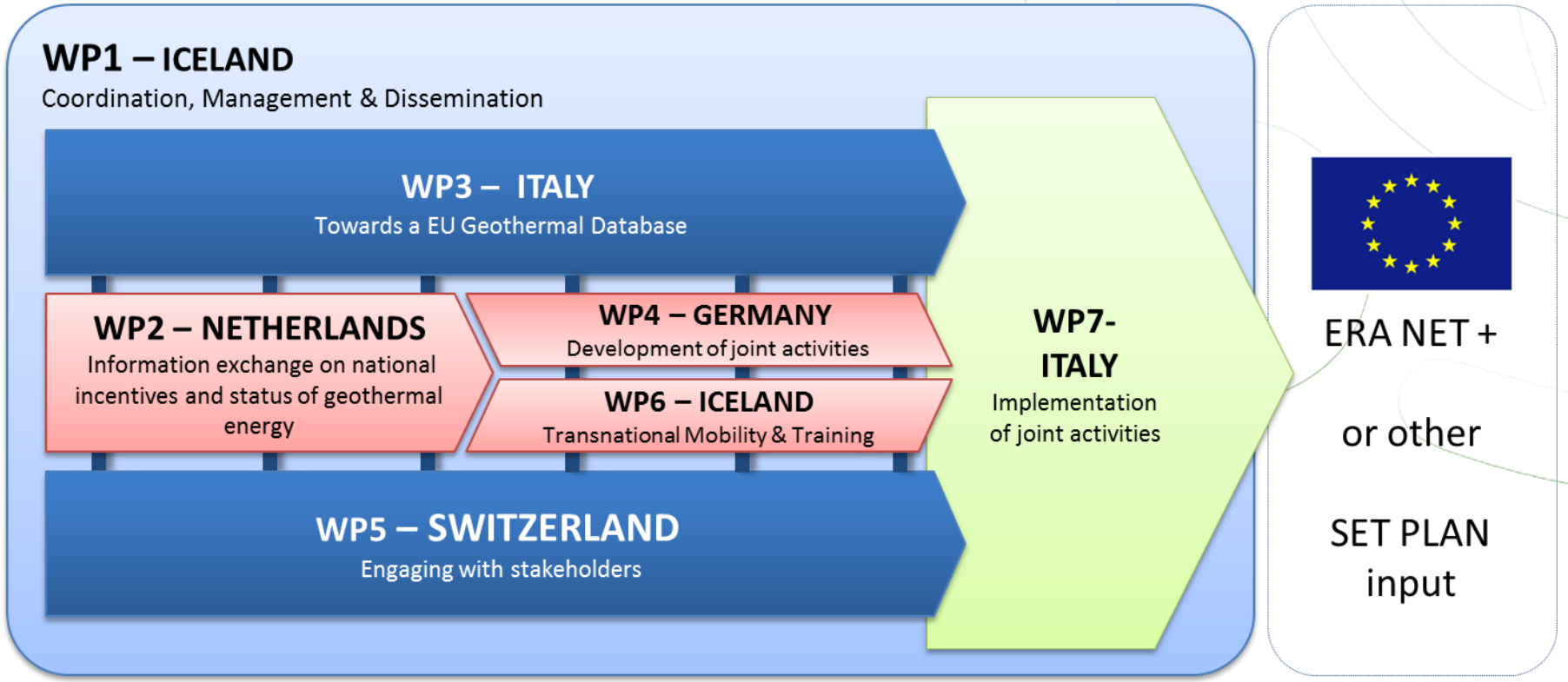
Case studies

- Spatial Data Infrastructure
  - EGIP Pilot
- EU projects internal communication
  - DESCRAMBLE, GEMex, DeepU
- MaxEnt computation
  - Using AI to predict global geothermal suitability for power generation


EGIP pilot

Case I

Geothermal ERA-NET



- 2012 - 2016

Background

High fragmentation, databases and data-sharing systems are mostly based at a *national level*, provided in the local language, and are **suitable** for **local or specialized applications**

Different kind of information are managed by different stakeholders

European Geothermal Information Platform

- ❑ reduce information fragmentation
- ❑ simplify data provision
- ❑ reduce project risks (economic aspects)
- ❑ Raise awareness about geothermal energy by providing an overview of its application at the European scale
- ❑ increase the focus on and investments in geothermal energy.

Case I

Towards a Geothermal European Information Platform EGIP – **state of the art**

	International DB	National DB	Project DB
Different DB	 New IRENA (renewable energy database), etc…	 Geothopica – Italian National Geothermal Database, etc…	 Geoelect, geoDH, …
Different Application			

Case I

EGIP: why?

1. Specifically **mentioned** in the EU Commission Call [Topic ENERGY.2011.10.2-2, FP7-ERANET-2011-RTD] which led to the current GEO ERA-NET Project
2. To **foster** geothermal energy development in Europe, the organization and sharing of geothermal data play an important role
3. To **minimize data fragmentation**, databases and data-sharing systems are mostly based at at a national level, provided in the local language, and are suitable for local or specialized applications

Case I

EGIP: aims?

- ✓ simplify **data provision**
- ✓ reduce **project risks** (economic aspects)
- ✓ **Raise awareness** about geothermal energy by providing an overview of its application at the European scale
- ✓ **increase** the focus on and **investments** in geothermal energy.

Case I

EGIP: for who?

- potential **international** energy users (international **operators** and **funding agencies** interested in launching new geothermal projects)
- any geothermal stakeholder
- to respond to the **increasing concerns** of non-geothermal sector stakeholders that geothermal applications are too confusing and difficult to manage

EGIP: what is?

- **distributed system**: each (national) data provider delivers its data according to a common standard data model and common services
- **Not only scientific data** from underground
- Information are catalogued and served following the **INSPIRE directives**
- A **EU portal** will request all national service providers to deliver their part of the European puzzle

Case I

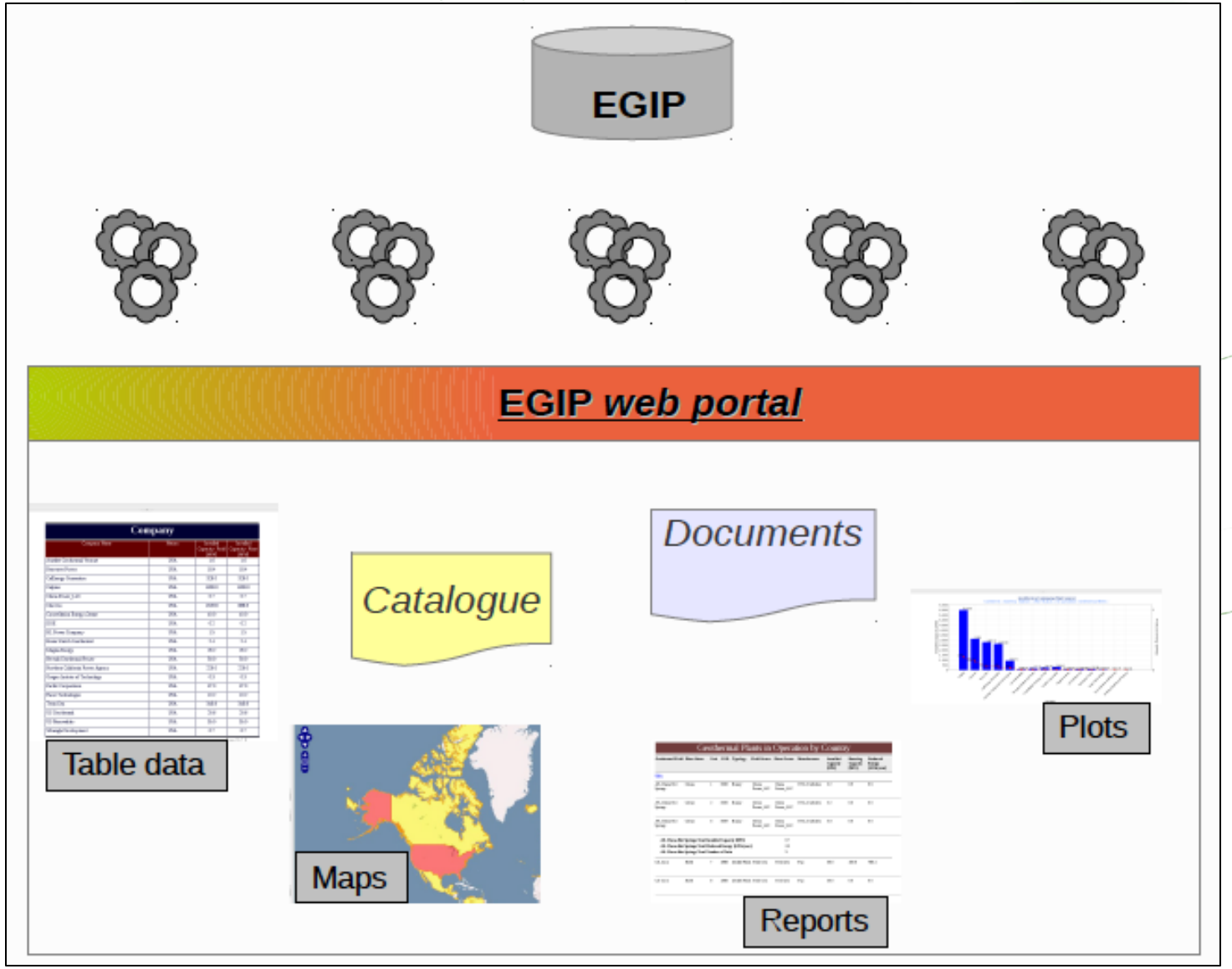
EGIP: how?

Step-by-step plan:

- *First step* - ***Stage 0***: map the links and documents where geothermal information is currently provided at a national level
- *Short term* – ***Stage 1:*** implemented as Joint Activity in GEO ERA-NET
- *Medium term* – ***Stage 2***
- *Long term* – ***Stage 3***

EGIP Functionalities overview

EGIP tools have to guarantee a 360° data browsing (e.g., browsing from a catalogue to a document, from a document to a tabled info or spatial data) and **allowing a deep survey into the geothermal knowledge**.



Case I

EGIP pilot concepts:

The aim of this early stage is to prove the **effectiveness** and **efficiency** of **EGIP**

The initial development of the pilot project involved setting up a geothermal **common data model** and the management and optimization of **services**

EGIP is designed to fully satisfy the end-user by providing easy and useful *data retrieval* and *cost containment*, in compliance with **INSPIRE** rules for building a (spatial) Data Infrastructure

Case I

Set-up EGIP pilot:

Startup conference call with BRGM 02/04/2014

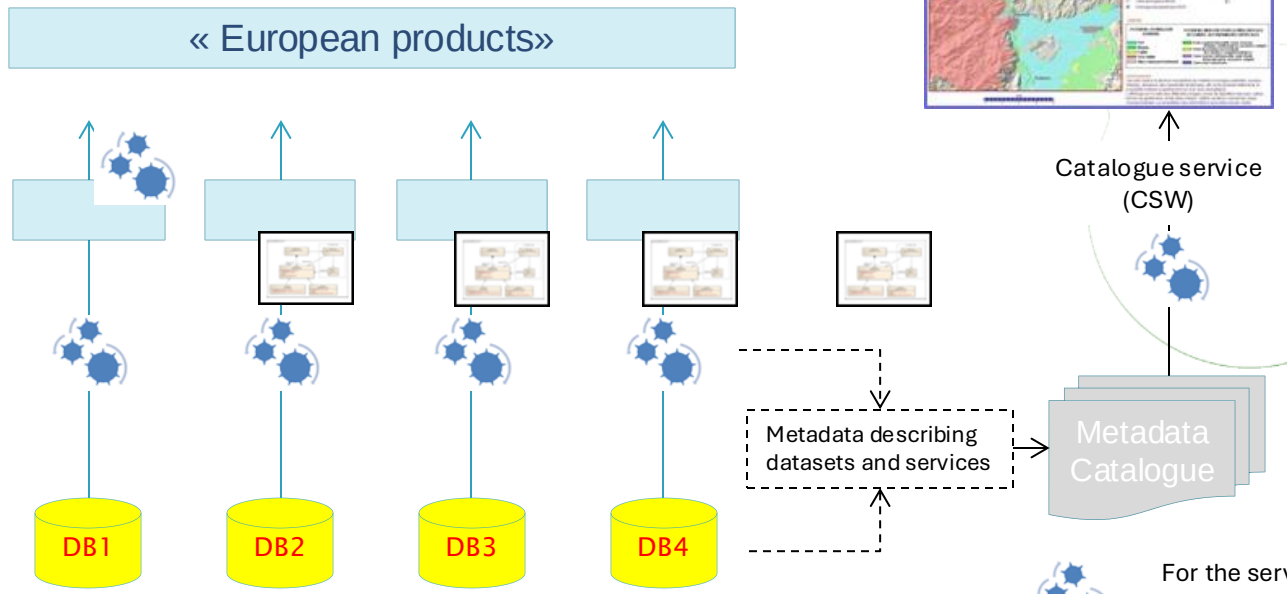
Produced documents:

- *EGIP.xsd*
- EGIP_Pilot_data_model_1.0.pdf
- *EGIP-Pilot_Implementation_Games_Rules.pdf*

- ***Conference call minute with volunteer partners:***
  - ✓ Conf #1 01/07/2014
  - ✓ Conf #2 16/07/2014
  - ✓ Conf #3 31/07/2014
  - ✓ Conf #4 06/08/2014
  - ✓ Conf #5 25/08/2014
  - ✓ Conf #6 04/09/2014

Case I

EGIP Architecture overview I



Common rules for:

1. Metadata (INSPIRE)

2. Web Services:
   - View
   - Access (download)
   - Process

3. Common data model, used by services to deliver and process data

Each provider delivers a piece of the puzzle:

Which can be map or data

For the services:
- View and access/download services are well specified in INSPIRE
- Process services have to be compliant with a general framework only

For the common data model to be used by the access, download and process services:
- to specify this data model : input from existing DB, and INSPIRE requirements
- Development of vocabularies (code-lists)

Case I

EGIP Architecture overview II

The EGIP @ national level:

1. Collecting/preparing the data
2. Data mapping (if needed)
3. Creating catalogue of the metadata (following the INSPIRE rules)
4. Implementing discovery, view, download services

The EGIP @ EU level:

1. Preparation of the xsd file and EGIP data model documentation
2. Web portal implementation
3. Setting up the portal the web services retrieved from the confederate national portals
4. Checking the EU-portal functionalities

EGIP pilot – Stage 1: list of data

Step-by-step plan:

- *First step* - ***Stage 0***:
- *Short term* – ***Stage 1***
- *Medium term* – ***Stage 2***
- *Long term* – ***Stage 3***

Table 1: List of information to include in EGIP Pilot.

Data number	Information	Format	Spatial	Typology Definition	INSPIRE topic category	INSPIRE theme category
1	*Temperature maps*	Structured	YES	Map coverage (i.e. 2D grid format. This is **preferred**) or vector format	Geoscientific information	Energy Resources
2	*Surface Heat Flow*	Structured	YES	Map coverage (i.e. 2D grid format. This is **preferred**) or vector format	Geoscientific information	Energy Resources
3	*Exploration and production licenses and (projected) power production*	Structured	YES	Map (vector)	*Exploration and production licenses*	Area management / restriction / regulation zones
4	*Environmental impact laws*	Un-Structured	NO Country	Document	Environment	-
5	*Licencing regulations (exploration/exploitation)*	Un-Structured	NO Country	Document	Planning cadastre	-
6	*Legal conditions for grid access*	Un-Structured	NO Country	Document	Structure	-
7	*Geothermal roadmaps*	Un-Structured	NO Country	Document	Economy	-
8	*Insurance*	Un-Structured	NO Country	Document	Economy	-
9	*Royalties & taxes, support scheme (feed-in tariffs, grants, …)*	Un-Structured	NO Country	Document	Economy	-
10	*List of education & research institutes*	List	YES	Map (vector)	Structure	-
11	*List of Industries*	List	YES	Map (vector)	Structure	*Production and industrial facilities*

Case I

The EGIP consortium:

The volunteers participating countries up to now:

- National Research Council of ITALY
- Bureau de Recherches Géologiques et Minières - FRANCE
- Swiss Federal Office of Energy (with Swiss Geological Survey)
- Magyar Foldtani és Geofizikai Intézet – HUNGARY
- OS Orkustofnun - ICELAND
- Slovenia Geological survey

Case I

How does EGIP work?

pilot initiative deploy a **data infrastructure** aimed at facilitating open access, the sharing of data, collaborative analysis, processing and mining processing, as well as the dissemination of newly generated knowledge.

The EGIP pilot offers a flexible and secure **web-based**, **community-centric** platforms, so geothermal stakeholders can work together on common challenges

The EGIP platform uses a specific Virtual Research Environment (**VRE**) set-up exploiting some of the **D4Science** infrastructure capabilities, which are developed and operated employing the **gCube** technology

The EGIP follows the **INSPIRE** specification and deploy **OGC** standard services

Powered by:

Case I

What does EGIP exploit?

EGIP pilot is exploiting a **Hybrid Data Infrastructure** combining over 500 software components into a coherent and centrally managed system of hardware, software, and data resources

Infrastructure: key characteristics

- ✓ Efficient and tailored **storage technologies**
- ✓ **Computational environments** dealing with the volume of the data
- ✓ **Elastic management** of the resources, monitoring, alerting, recovery
- ✓ **Collaborative environment** to support scientific communities
- ✓ **Rich portfolio of applications** to perform access, validation, enriching, processing, sharing, and mash-up of data

Case I

The EGIP apps

application in EGIP belongs three different domains

ConnectCube applications are a comprehensive suite of tools, which support a **collaborative**, standards-oriented data publication environment:

- Shared workspace
- Social Network facilities

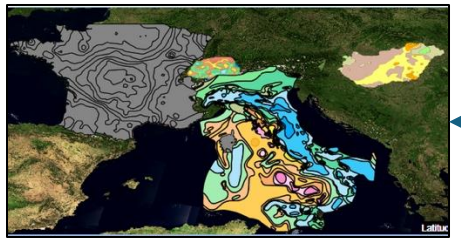
GeosCube applications help practitioners dealing with geospatial information to properly **access** and **consume**:

- Geospatial Data Discovery 
- Metadata catalogue 

StatCube applications make up analytical tools:

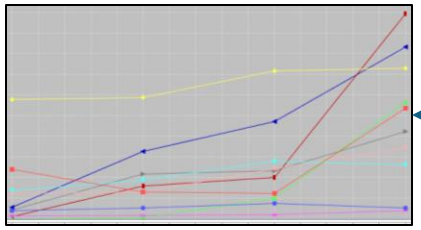
 Statistical manager

Case I



Visualization: GeoExplorer

Documents Sharing: Workspace Social



Processing: Statistical Manager

D4S I.S.

EGIP GeoNetwork

GeoServer [Others]

GeoServer Italy

GeoServer Hungary

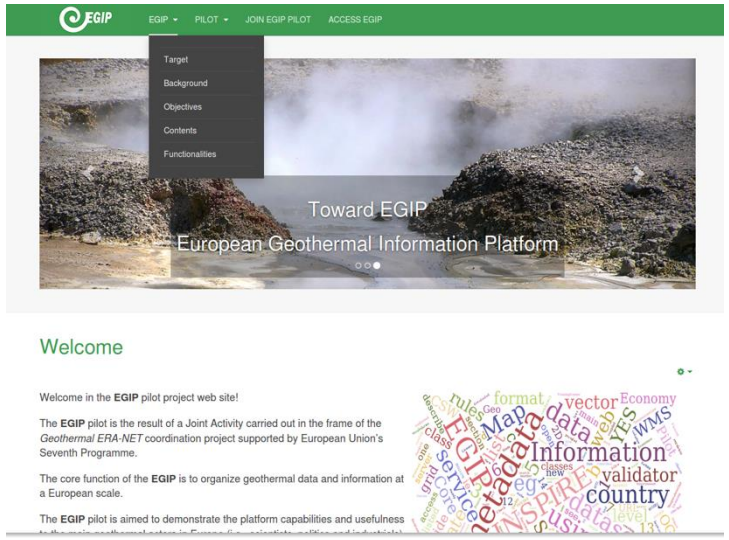
GeoServer Switzerland

MapServer France

GeoServer Iceland

GeoServer Slovenia

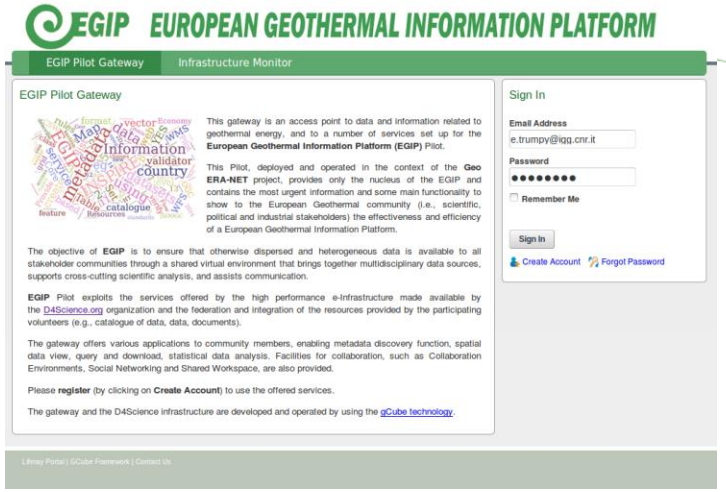
Case I



EGIP pilot website

Access EGIP

Registration and access



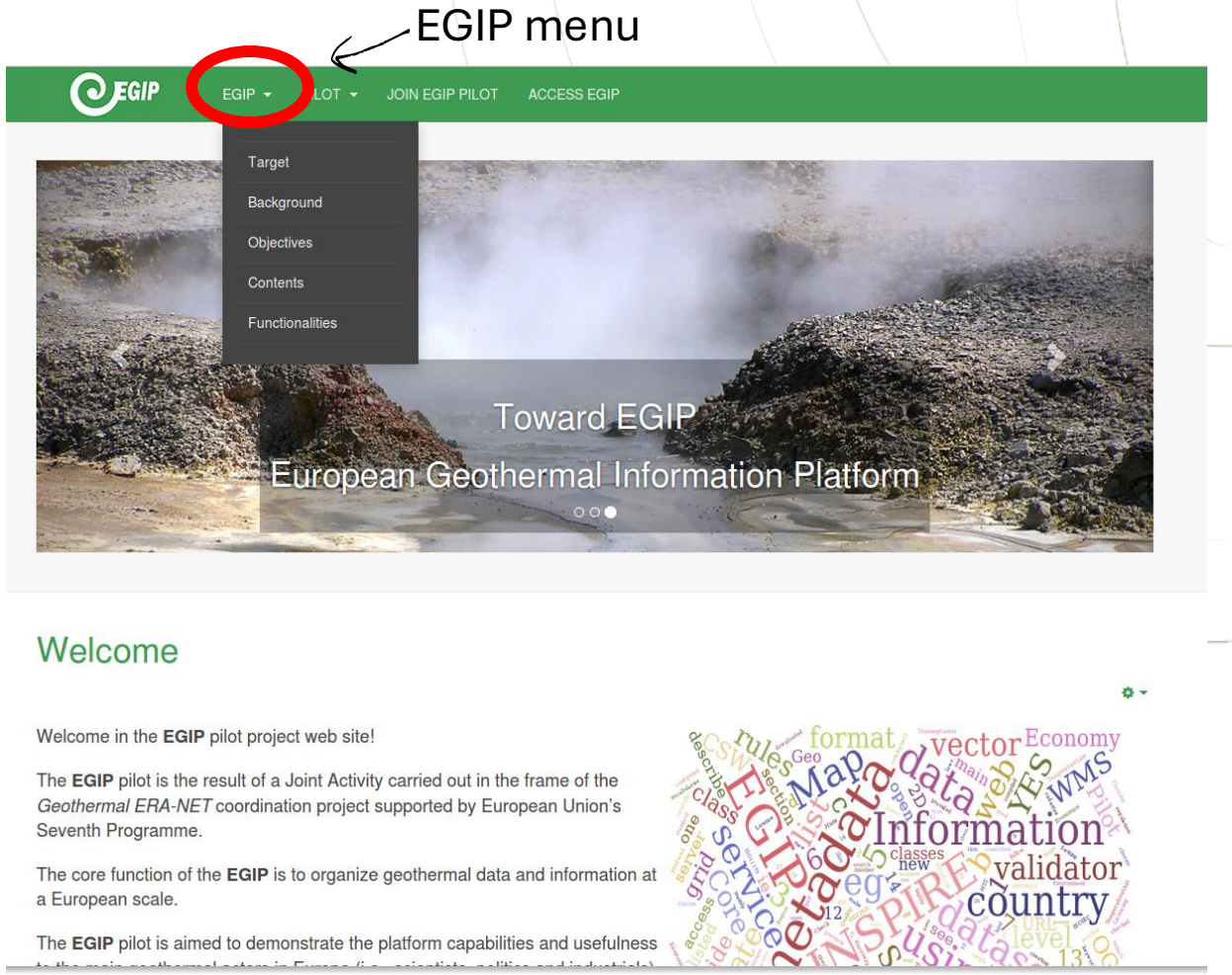
EGIP pilot platform

Case I

EGIP web site I

EGIP menu:

- Target
- Background
- Objectives
- Contents
- Functionalities

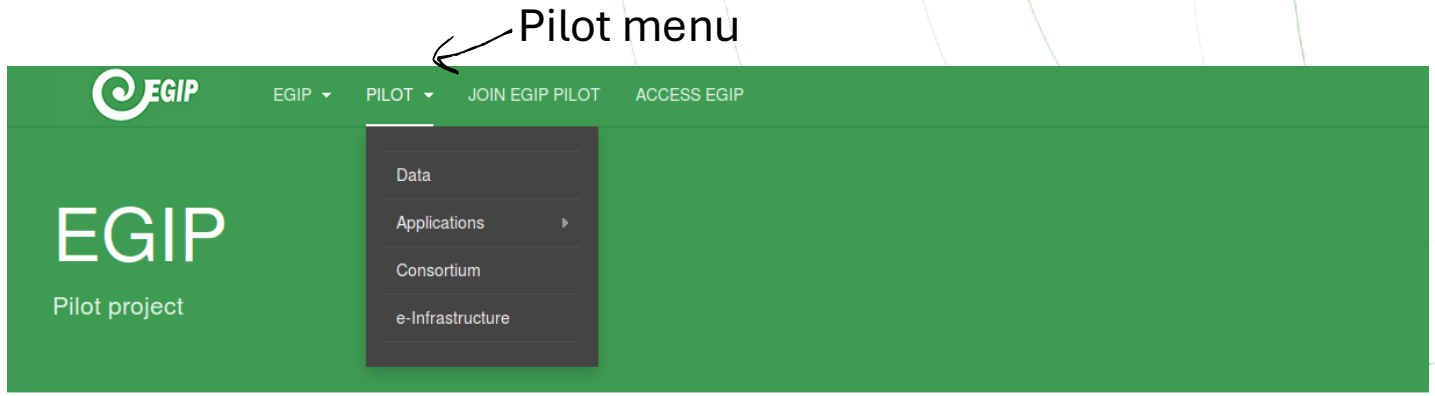


Case I

EGIP web site II

Pilot menu:

- Data
- Applications
  - connectCube
  - geosCube
  - statCube
- Consortium
- E-infrastructure



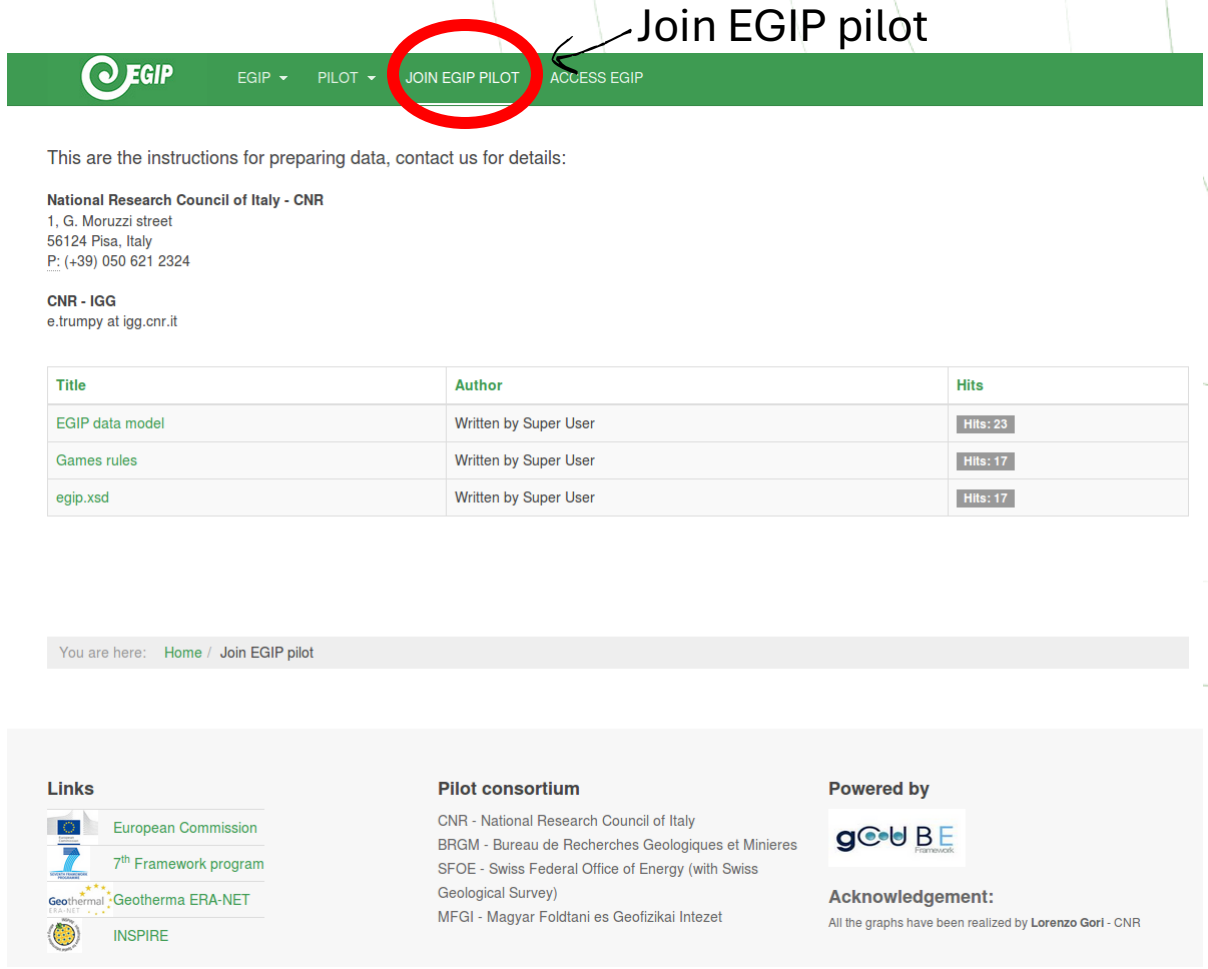
Pilot project

This is the portal of the European Geothermal Information Platform (EGIP) pilot project, offering a number of services, information and data specially set up for the Geothermal ERA-NET project. EGIP pilot exploits the services offered by the high performance e-Infrastructure made available by D4Science.org organization [see the detailed description] and the federation and integration of the resources provided by the participating volunteers (e.g., Catalogue of data, data, web services and documents).
This pilot provides only the nucleus of the EGIP and contains only the most urgent information and some main functionality to prove to the European Geothermal community the effectiveness and efficiency of a European Geothermal Information Platform.
When you **ACCESS** the available applications allow you to enable metadata discovery function; spatial data view, query and download, statistical data analysis. Facilities for collaboration, such as Collaboration Environments, Social Networking and Shared Workspace are also provided.
Please register to use the offered services

Case I

EGIP web site III

- Contact references
- Documents describing how to join in EGIP pilot



Case I

EGIP web site IV

Click here to enter

Spatial data discovery, view and download

Dataset analysis

Platform home page

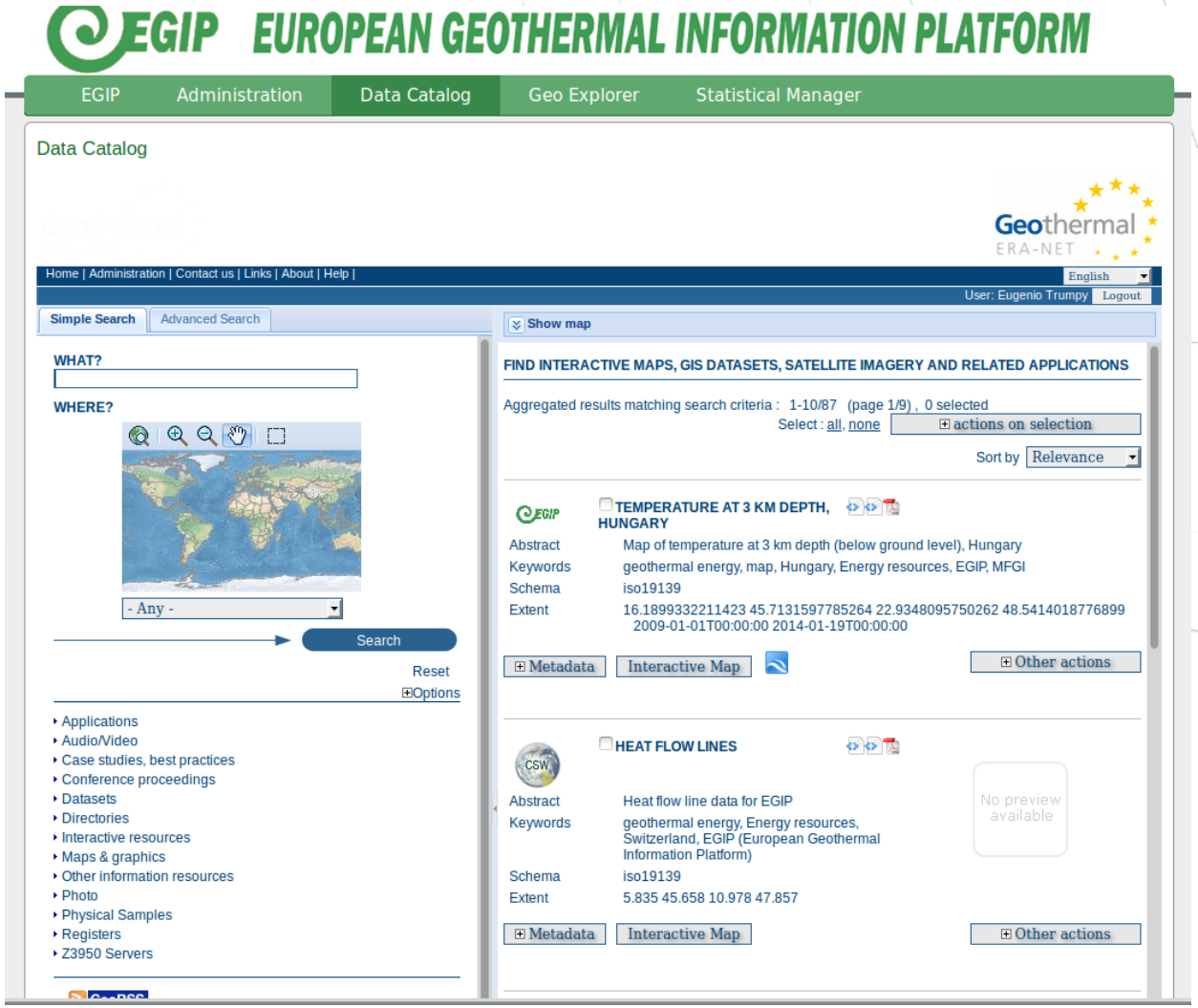
Metadata catalogue

EGIP platform: Data Catalogue

The Geonetwork web application is accessible through the portal

CS-W catalogue:

- Harvests the metadata from partners metadata catalogues
- Metadata collection for spatial dataset
- Metadata collection for documents
- INSPIRE Standard ISO-19139
- Dublin-core
- Spatial search
- Text search

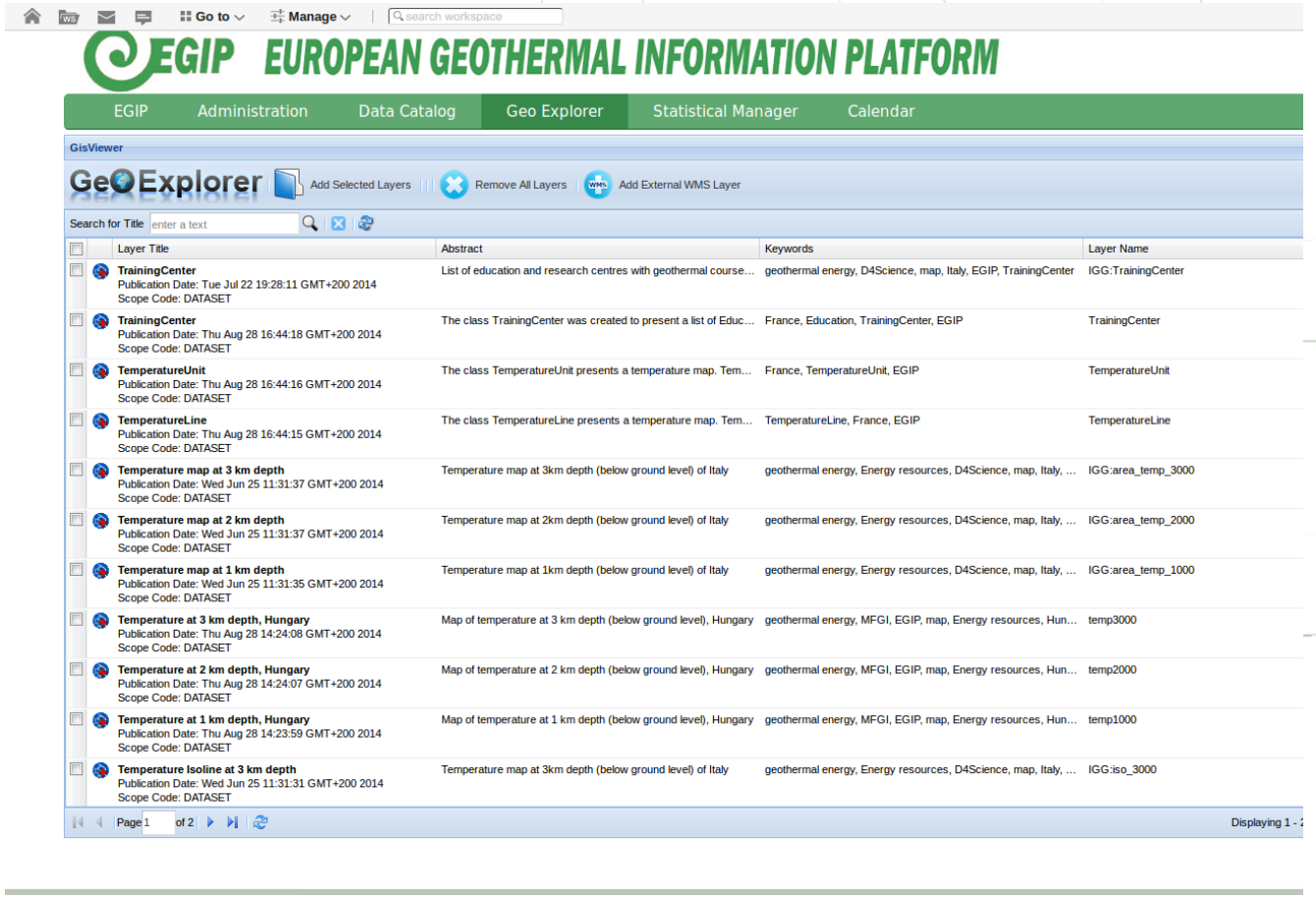


Case I

EGIP platform: GeoExplorer

Geo-explorer capabilities:

- Harvest the spatial dataset from partners
- Show spatial layers
- Browse map: zoom, pan
- Query spatial layer
- Manage the layer opacity
- Save & Share the layers and maps
- Metadata outlook

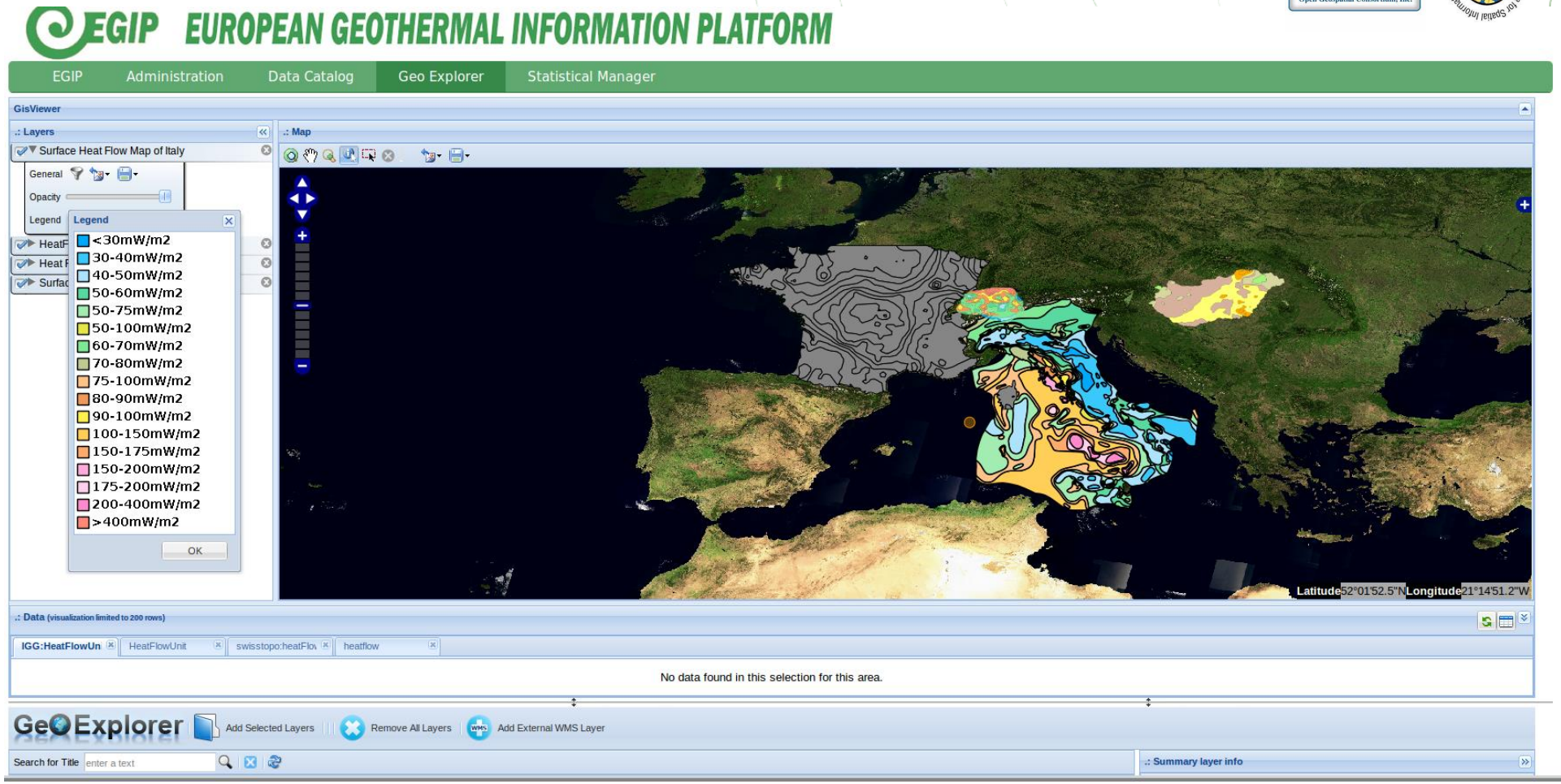


Case I

EGIP platform: GeoExplorer

- HeatFlowUnit among volunteer's participants

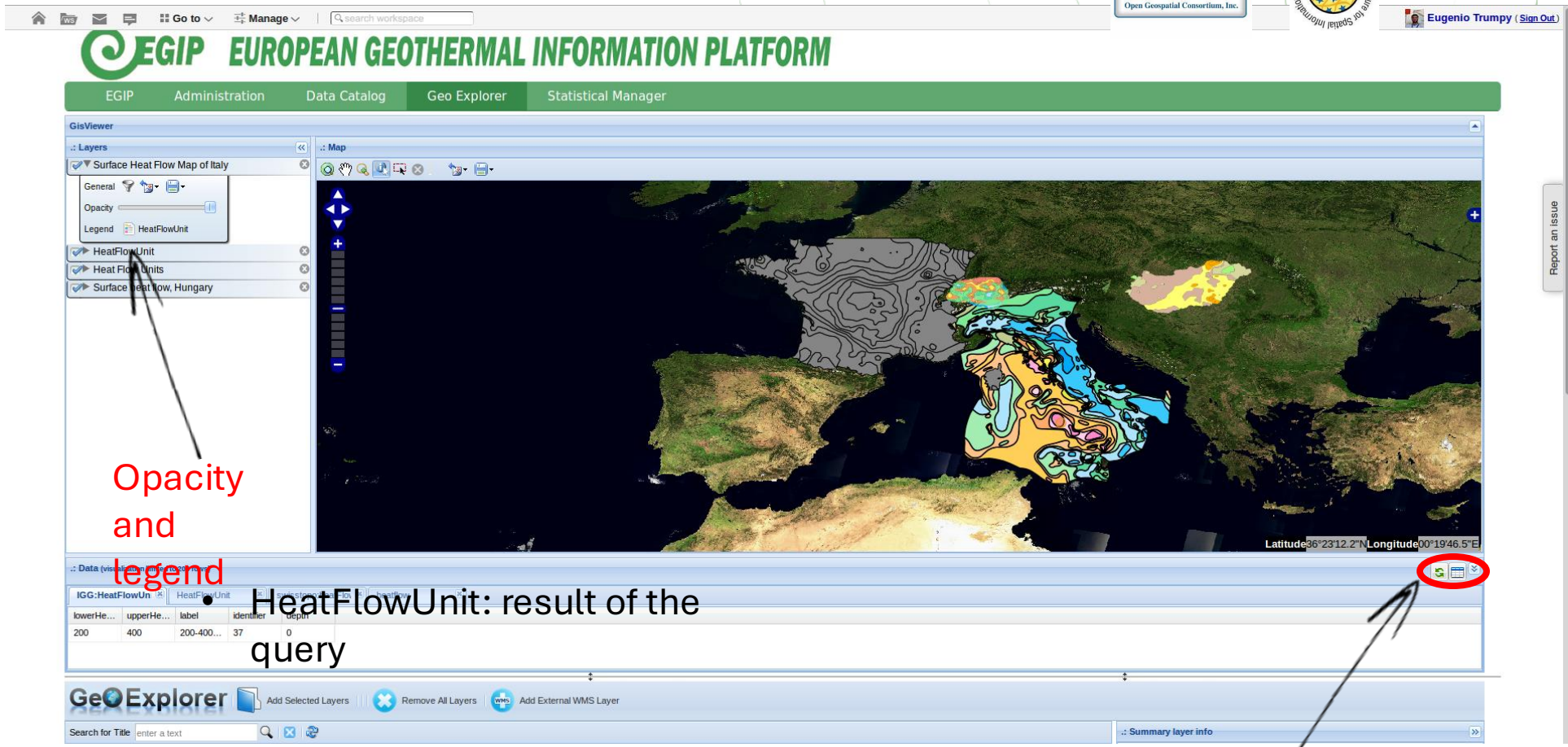
- Visualize the Temperature and Heat Flow maps of the contributors
- Inspect contents
- Get a summary of the metadata



Case I

EGIP platform: GeoExplorer

- HeatFlowUnit among volunteers participants



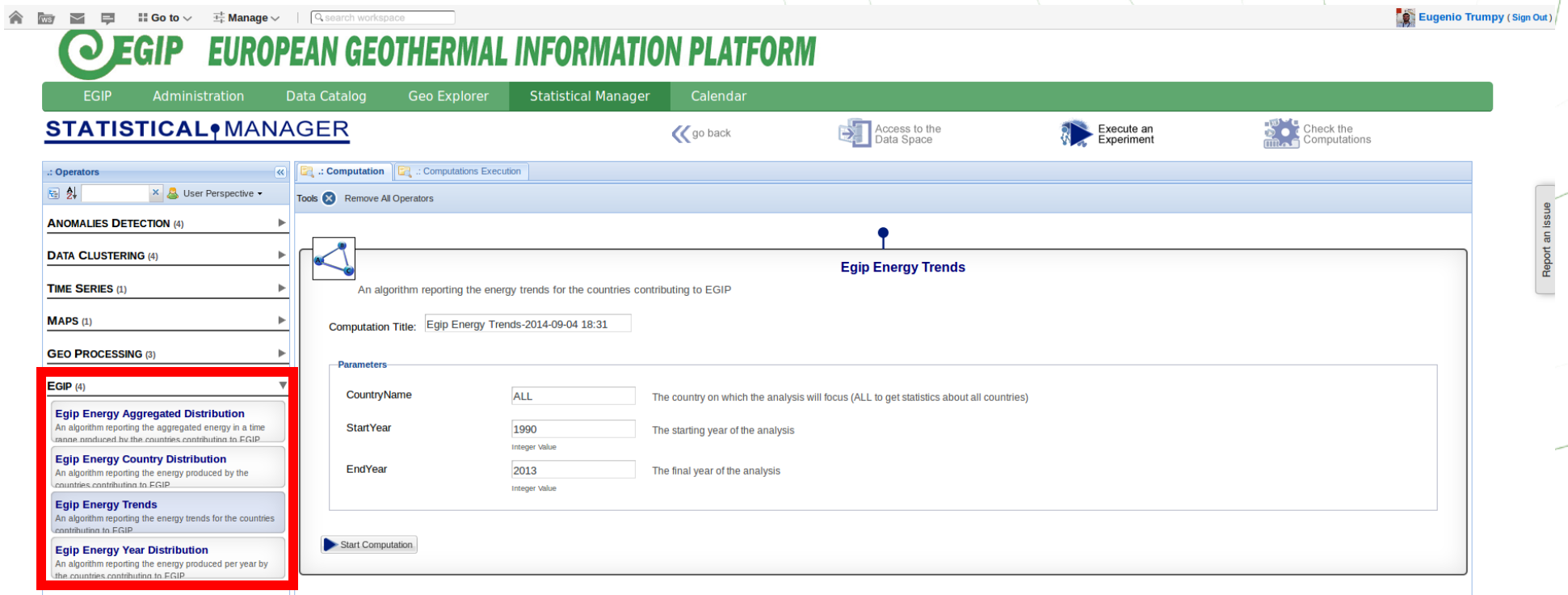
Opacity and legend

- HeatFlowUnit: result of the query

Download dataset

Case I

EGIP platform: Statistical Manager



Statistical analysis:

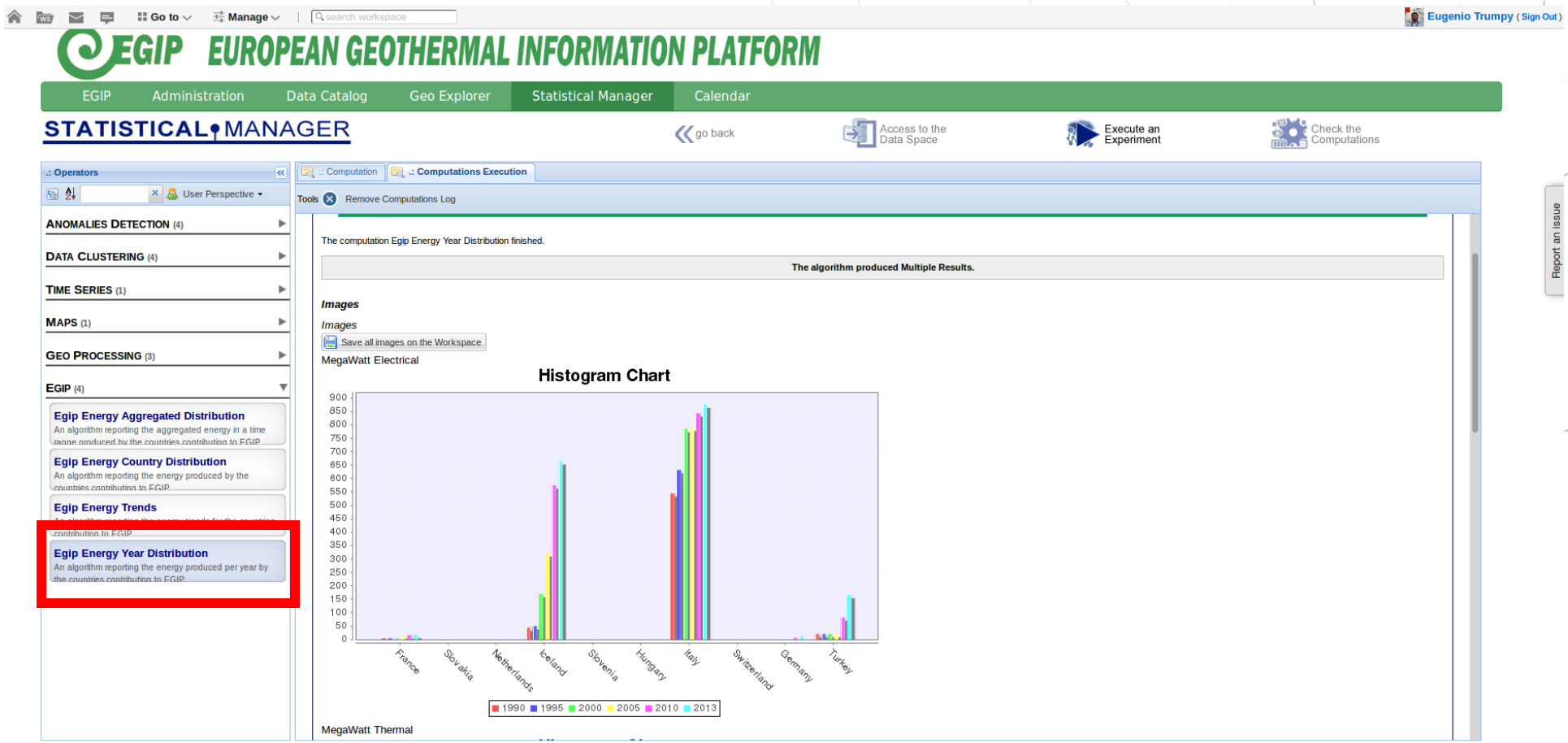
- Analysis served by WPS
- Import dataset
- Define analysis name

- Manage series
- Execute and get results as different chart & plot
- Share your analysis

Case I

EGIP platform: Statistical Manager

- Collect and aggregate Information
- Energy Production Trends per country and year

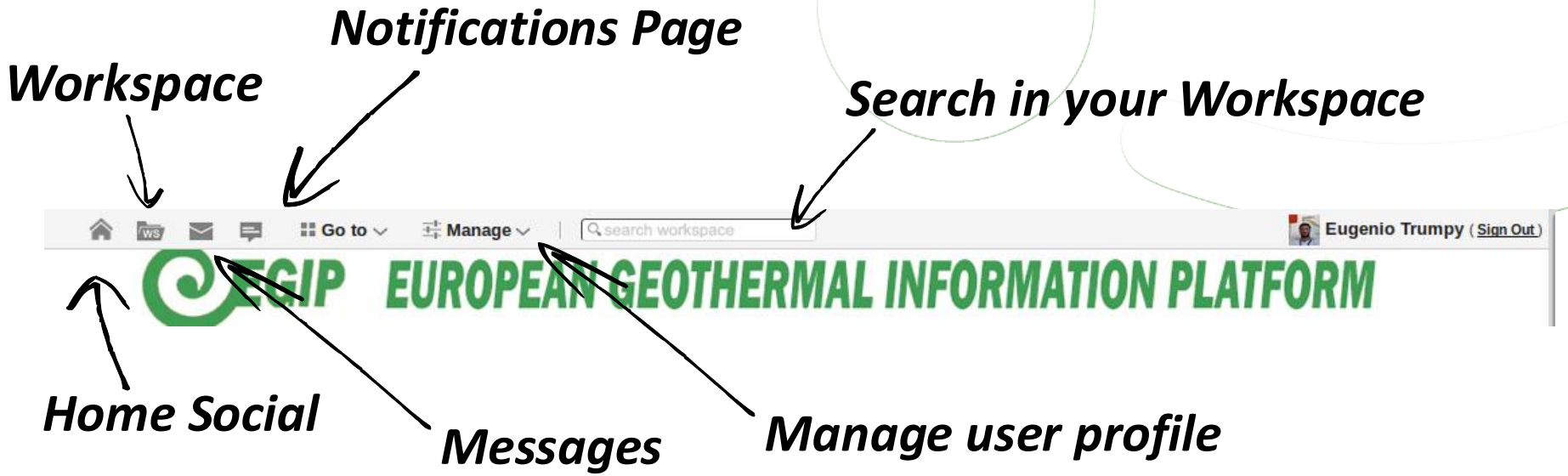


Case I

EGIP platform: Collaborative environment

A single place to

- Manage all the portal extension



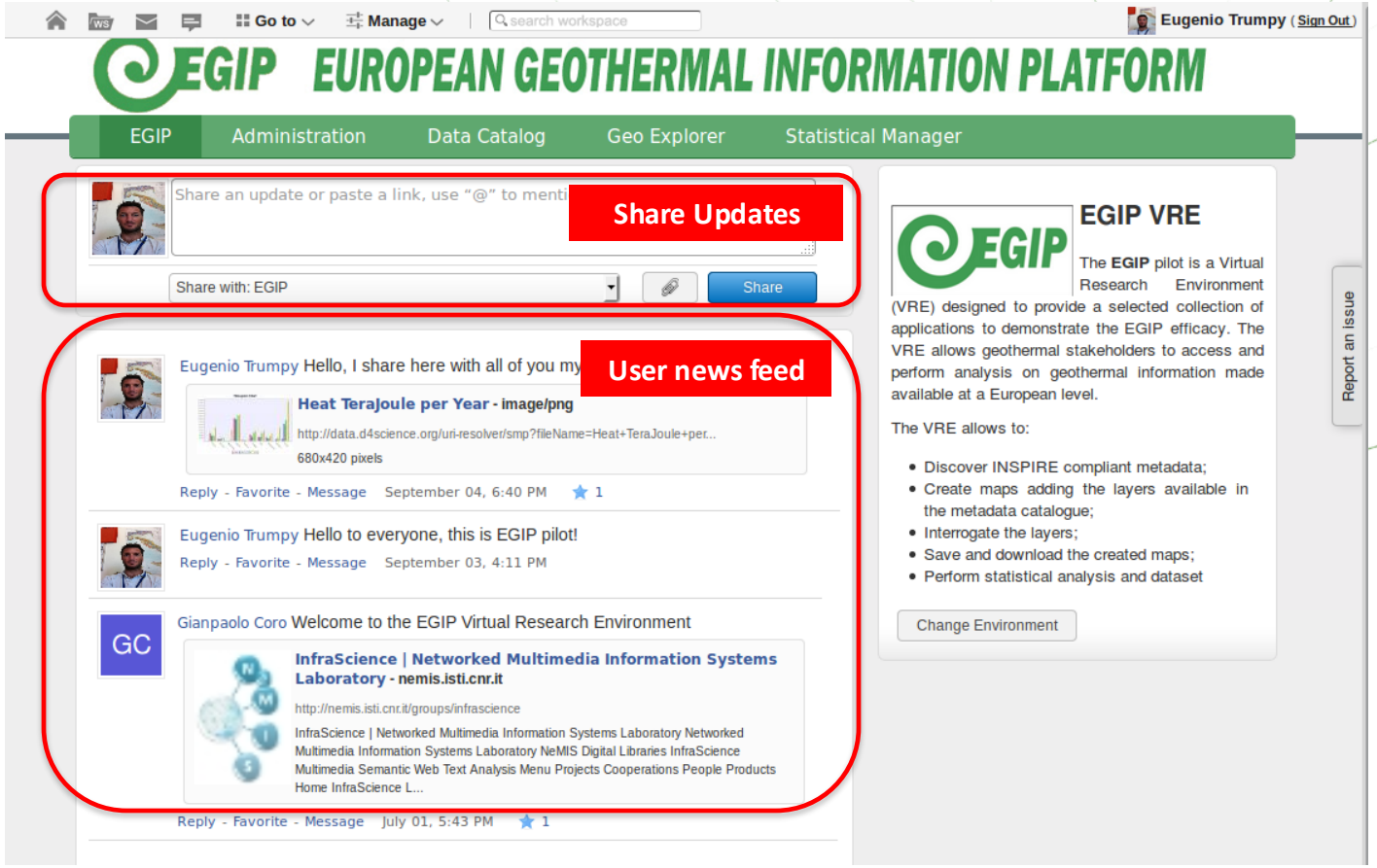
Case I

EGIP platform: Collaborative environment, Social facilities

A single place to

- Get status and updates from applications and other users

- Get notifications about messages, jobs completion, new generated products, etc.



Case I

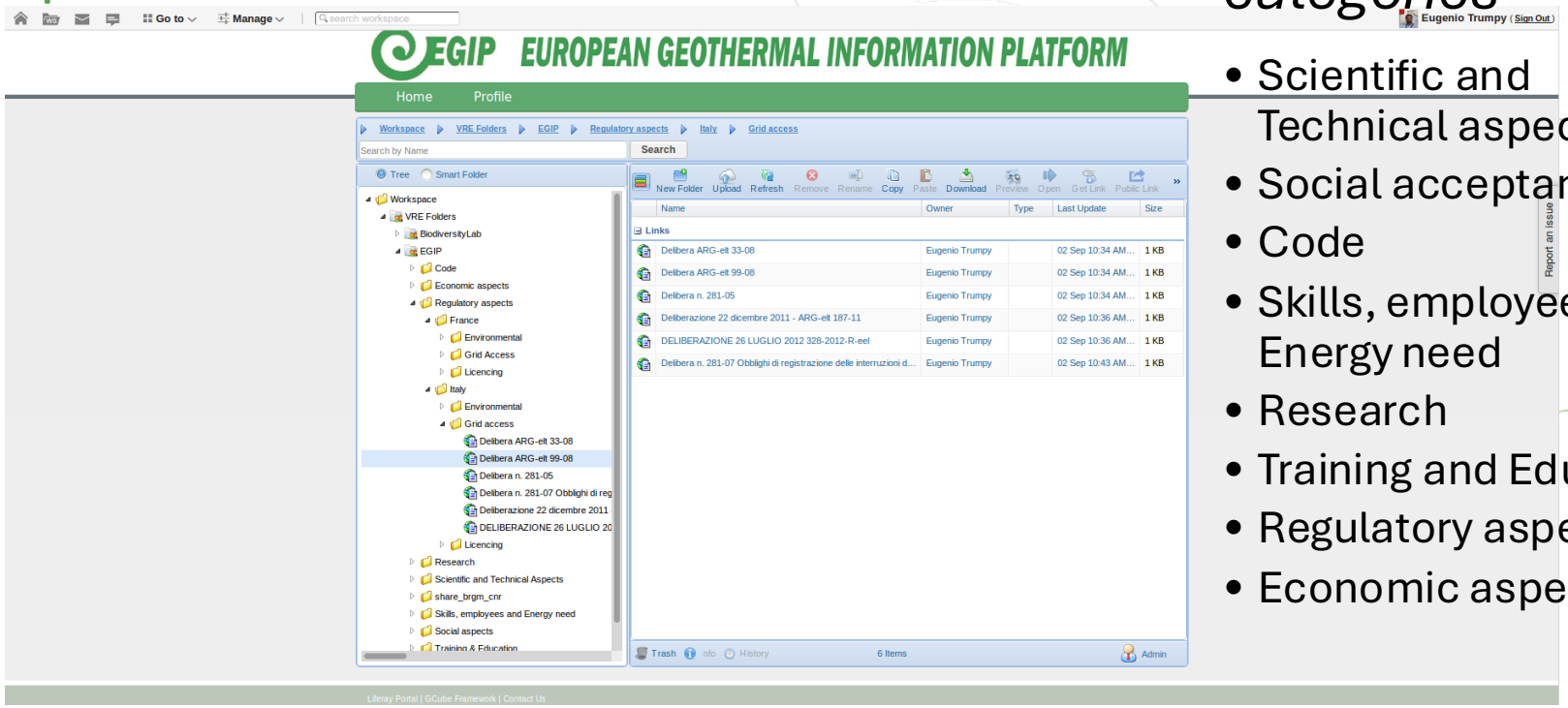
EGIP platform: Collaborative environment Workspace

Document metadata – Standard Dublin Core

A single place to

- Manage data, store and preserve
- Share data
- Share your analysis & Maps

- The **workspace** is used to broadcast documents
- Documents have metadata described according to the INSPIRE directives



EGIP documents categories

- Scientific and Technical aspects
- Social acceptance
- Code
- Skills, employees and Energy need
- Research
- Training and Education
- Regulatory aspects
- Economic aspects

Case I

EGIP pilot benefit:

- Guaranteed data interoperability: retrieval, viewing and access of information from partners (via WMS, WFS e.g. TemperatureUnit, HeatFlowline, …)
- Harmonized geothermal domain at a European level
- **Efficiency**, thanks to the multiplicity of data sources, the latter being directly related to national databases
- Guaranteed ownership: data **belong** to and **stay** in the country they are related to
- Durability and maintainability
- Economically viable, requiring only coordination with respect to what each country would need to develop independently
- Productivity, by covering all published data in the long term

Case I

EGIP pilot

http://egip.igg.cnr.it


• DESCRAMBLE
• GEMex
• DeepU

EU supports e-infrastructures

"Human Network"

EC communication: EUR-Lex - 52009DC0108

- highlights the **strategic** role of ICT infrastructures for research and innovation policies
- calls on Member States and the scientific communities for a reinforced and coordinated **effort** to foster e-Infrastructures, to pave the way for the scientific discoveries of the 21st century.

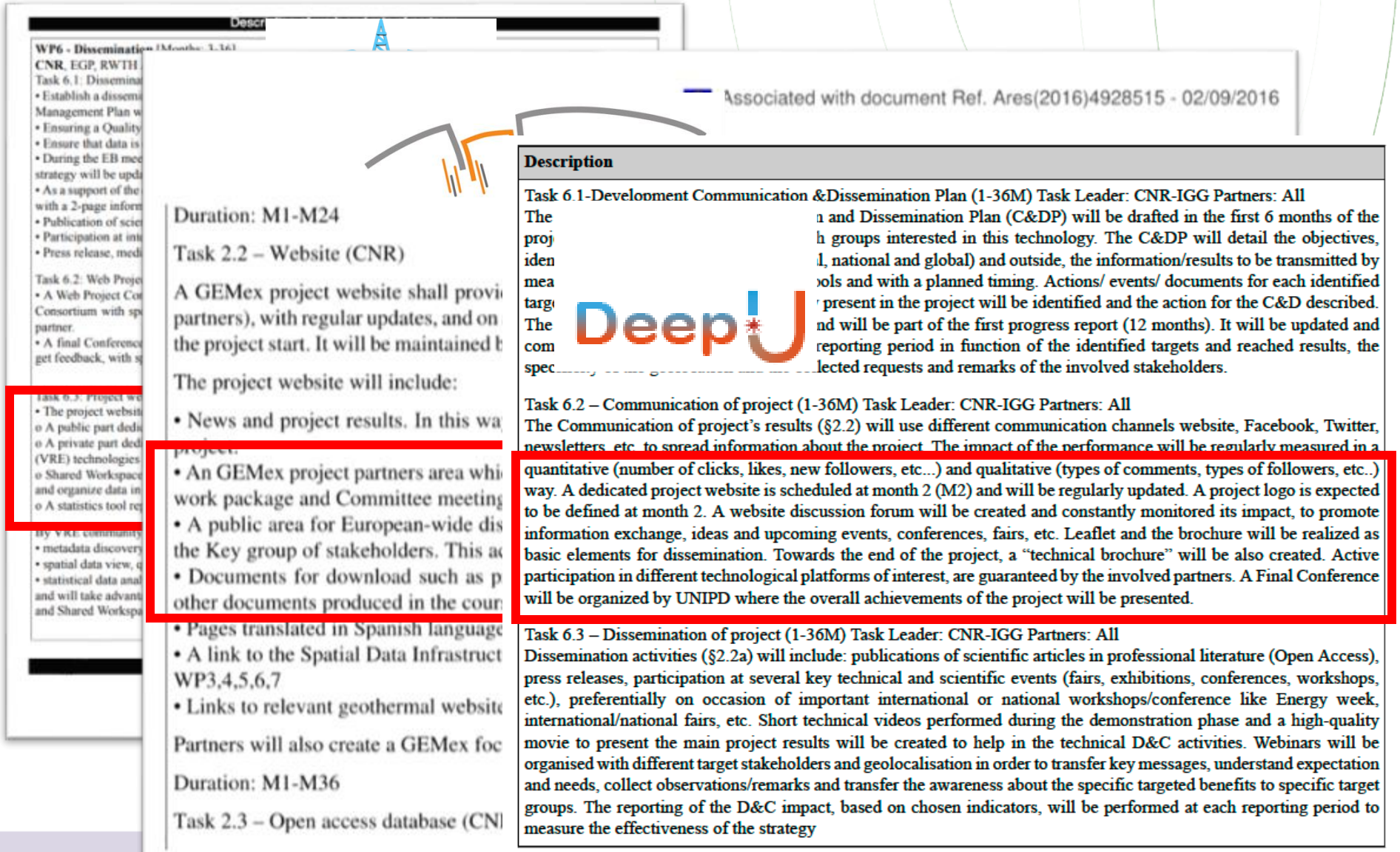
"e-Infrastructure"

The European Commission's Framework Programme for Research and Technological Development has **promoted the development and deployment of e-Infrastructures**, in order to **strengthen scientific excellence**, and to promote **innovation** and **industrial competitiveness**.

Scientific data necessitates new tools and methods. Projects are being developed in Europe so that all scientific content resources are accessible through e-Infrastructure services.

Case III

Internal EU project communication



Associated with document Ref. Ares(2016)4928515 - 02/09/2016

Duration: M1-M24

Task 2.2 – Website (CNR)

A GEMex project website shall provi
partners), with regular updates, and on
the project start. It will be maintained b

The project website will include:

• News and project results. In this wa
• An GEMex project partners area whi
work package and Committee meeting
• A public area for European-wide dis
the Key group of stakeholders. This a
• Documents for download such as p
other documents produced in the cour
• Pages translated in Spanish language
• A link to the Spatial Data Infrastruct
WP3,4,5,6,7
• Links to relevant geothermal websit

Partners will also create a GEMex foc

Duration: M1-M36

Task 2.3 – Open access database (CN

Description

Task 6.1-Development Communication &Dissemination Plan (1-36M) Task Leader: CNR-IGG Partners: All
The n and Dissemination Plan (C&DP) will be drafted in the first 6 months of the proj h groups interested in this technology. The C&DP will detail the objectives, iden l, national and global) and outside, the information/results to be transmitted by mea ols and with a planned timing. Actions/ events/ documents for each identified targ present in the project will be identified and the action for the C&D described. The nd will be part of the first progress report (12 months). It will be updated and com reporting period in function of the identified targets and reached results, the spec lected requests and remarks of the involved stakeholders.

Task 6.2 – Communication of project (1-36M) Task Leader: CNR-IGG Partners: All
The Communication of project's results (§2.2) will use different communication channels website, Facebook, Twitter, newsletters, etc. to spread information about the project. The impact of the performance will be regularly measured in a quantitative (number of clicks, likes, new followers, etc...) and qualitative (types of comments, types of followers, etc..) way. A dedicated project website is scheduled at month 2 (M2) and will be regularly updated. A project logo is expected to be defined at month 2. A website discussion forum will be created and constantly monitored its impact, to promote information exchange, ideas and upcoming events, conferences, fairs, etc. Leaflet and the brochure will be realized as basic elements for dissemination. Towards the end of the project, a "technical brochure" will be also created. Active participation in different technological platforms of interest, are guaranteed by the involved partners. A Final Conference will be organized by UNIPD where the overall achievements of the project will be presented.

Task 6.3 – Dissemination of project (1-36M) Task Leader: CNR-IGG Partners: All
Dissemination activities (§2.2a) will include: publications of scientific articles in professional literature (Open Access), press releases, participation at several key technical and scientific events (fairs, exhibitions, conferences, workshops, etc.), preferentially on occasion of important international or national workshops/conference like Energy week, international/national fairs, etc. Short technical videos performed during the demonstration phase and a high-quality movie to present the main project results will be created to help in the technical D&C activities. Webinars will be organised with different target stakeholders and geolocalisation in order to transfer key messages, understand expectation and needs, collect observations/remarks and transfer the awareness about the specific targeted benefits to specific target groups. The reporting of the D&C impact, based on chosen indicators, will be performed at each reporting period to measure the effectiveness of the strategy

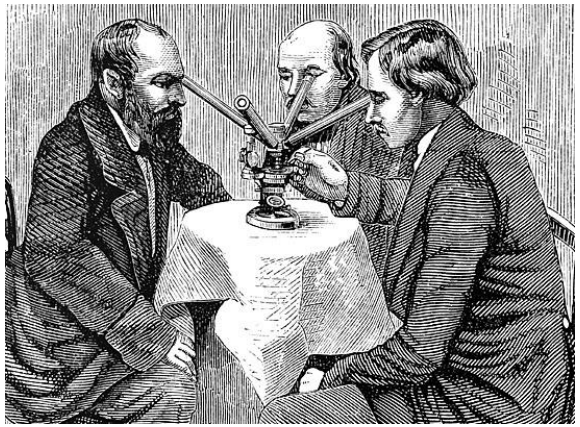
Case III

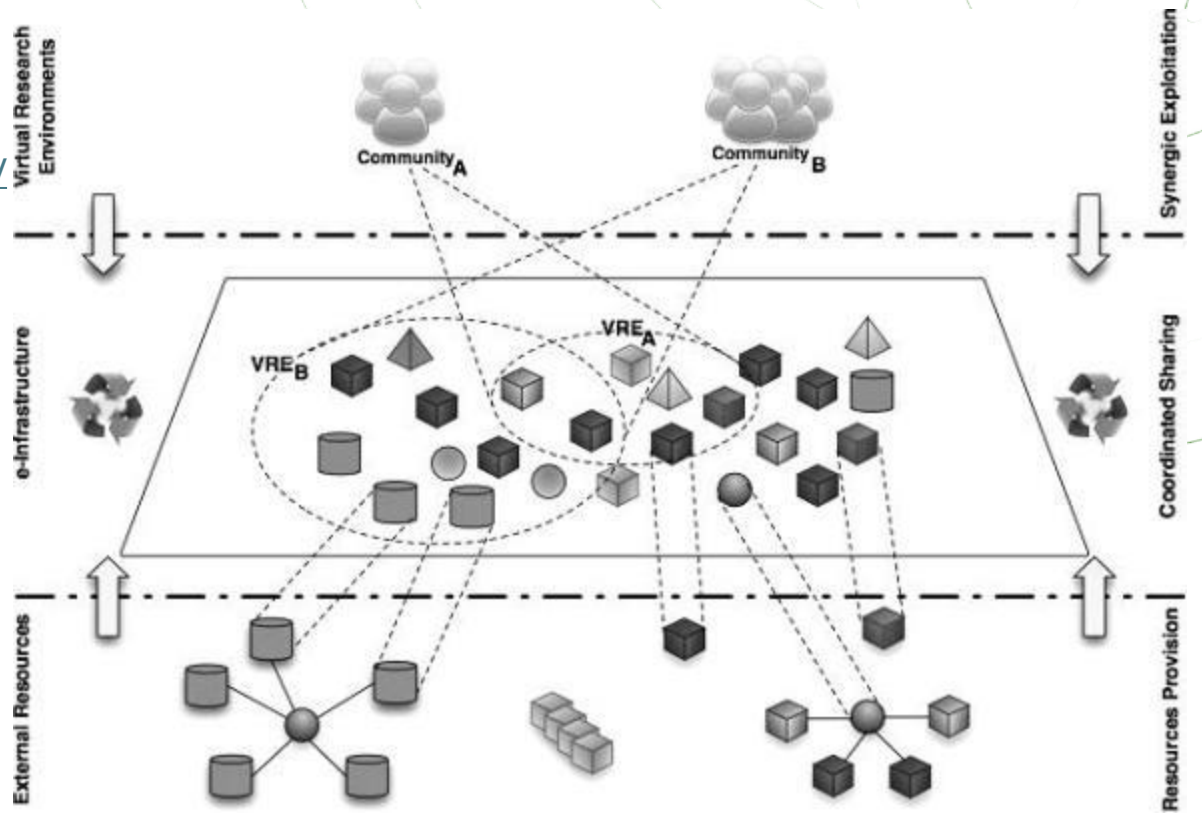
Digital Infrastructure

"**e-Infrastructures** enable researchers in **different locations across the world** to collaborate in the context of their home institutions or in national or multinational scientific initiatives. They can work together by having **shared access** to unique or **distributed scientific facilities** (including data, instruments, computing and communications)*."

Examples:

*Belief, http://www.beliefproject.org/
OpenAire, http://www.openaire.eu/
i-Marine, http://www.i-marine.eu/
EU-Brazil OpenBio, http://www.eubrazilopenbio.eu/



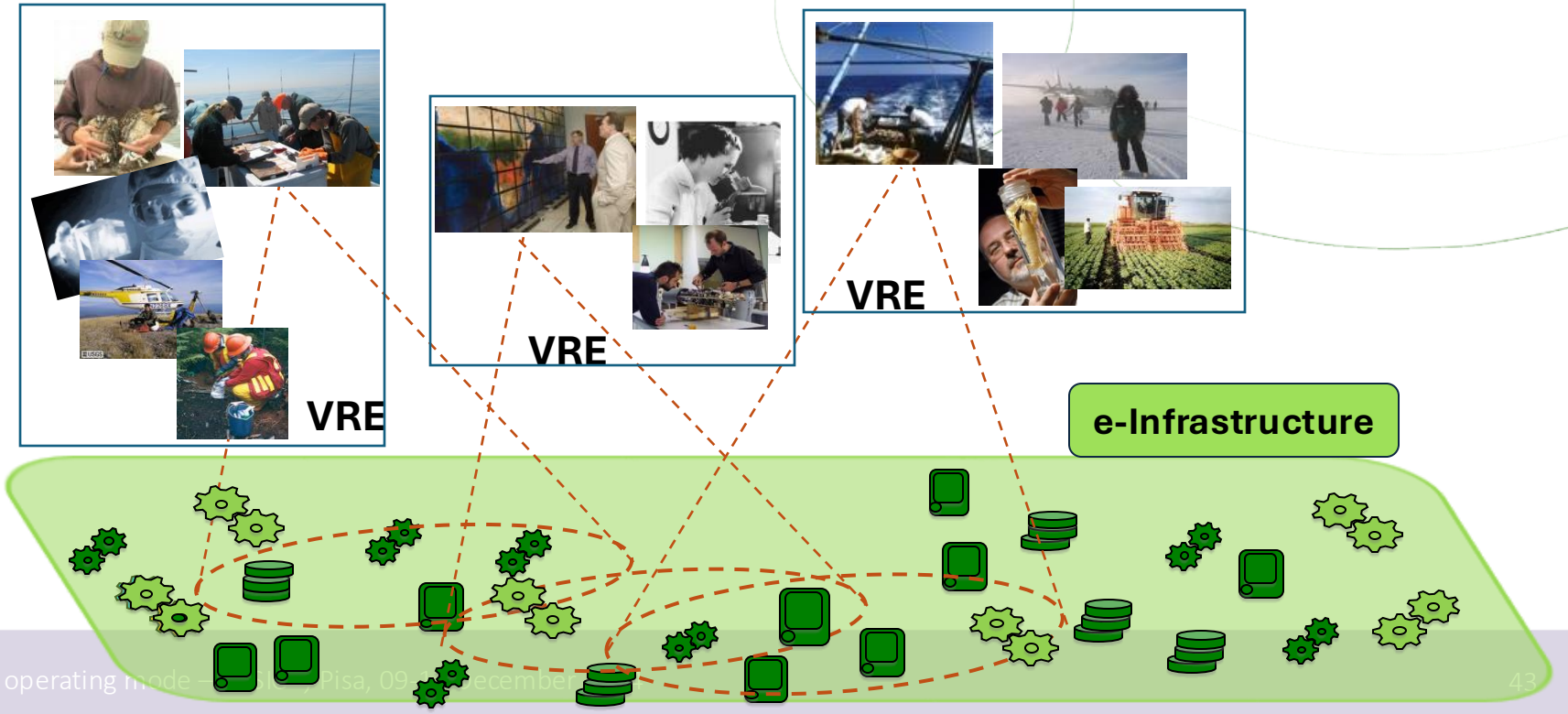


Case III

Virtual Research Environment

Virtual Research Environments: virtual organizations of communities of researchers for helping them collaborating.

- Define sub-communities inside an e-Infrastructure;
- Allow temporary dedicated assignment of computational, storage, and data resources to a group of people;
- Very important in fields where research is carried out in several teams which span institutions and countries.

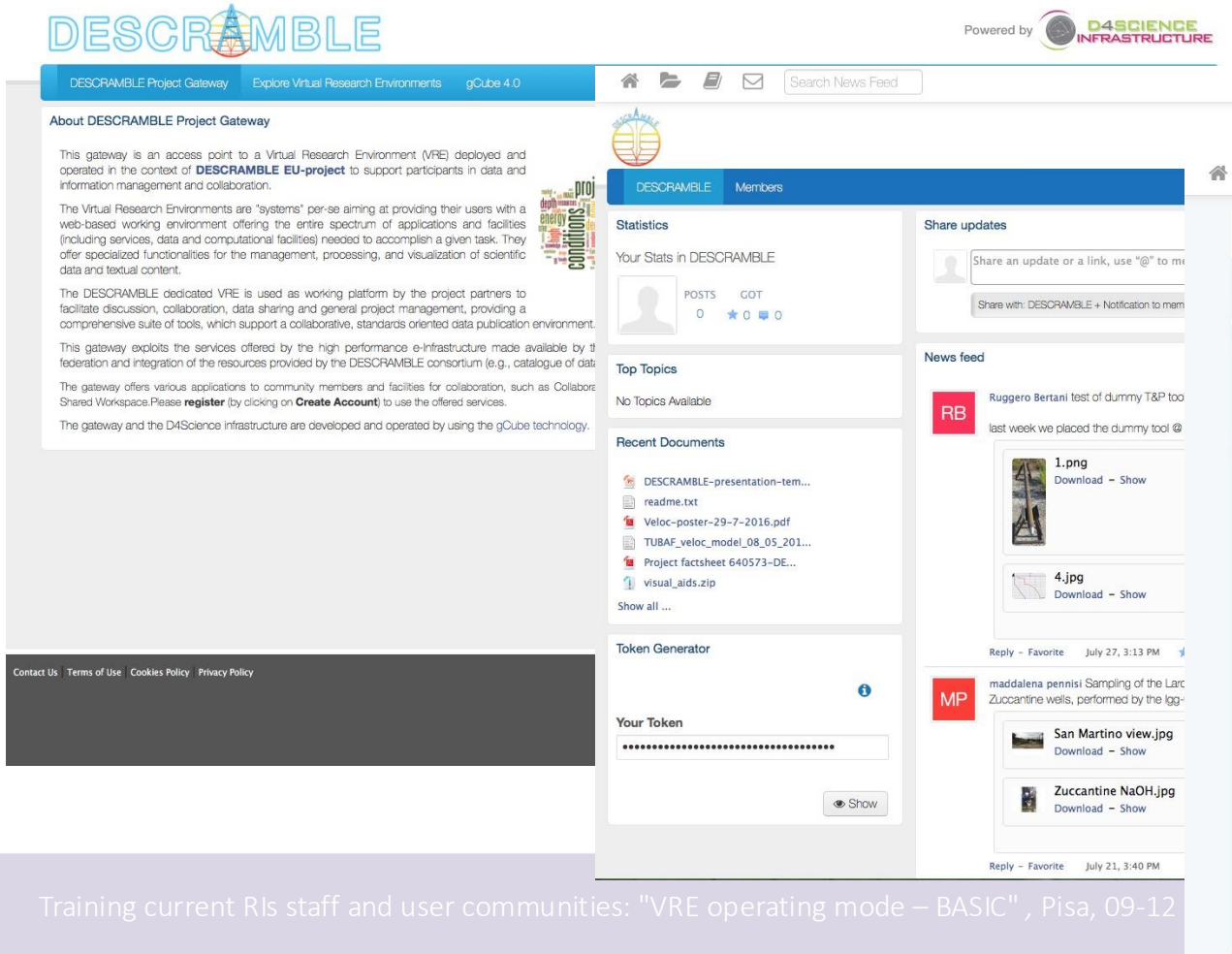


VRE utilization

- To create a web-site **private part**
- To facilitate internal project **communication**
- To provide a data/document **sharing** system
- To make available a **forum** to discuss project topics/results
- To share **events** or field works
- To monitor VRE **usage**
- To deal with **confidential data**

Case III

DESCRAMBLE & DeepU

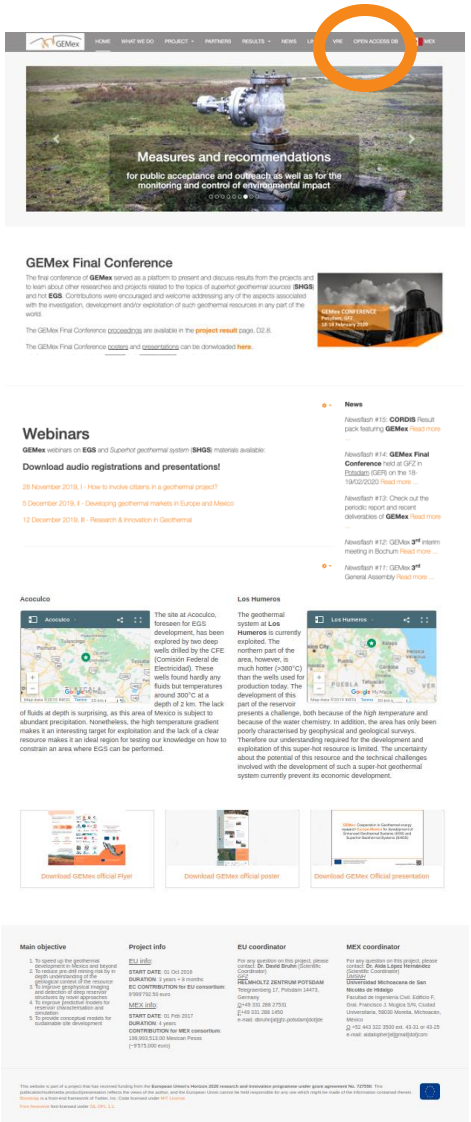


Training current RIs staff and user communities: "VRE operating mode – BASIC" , Pisa, 09-12

Case III

GEMex

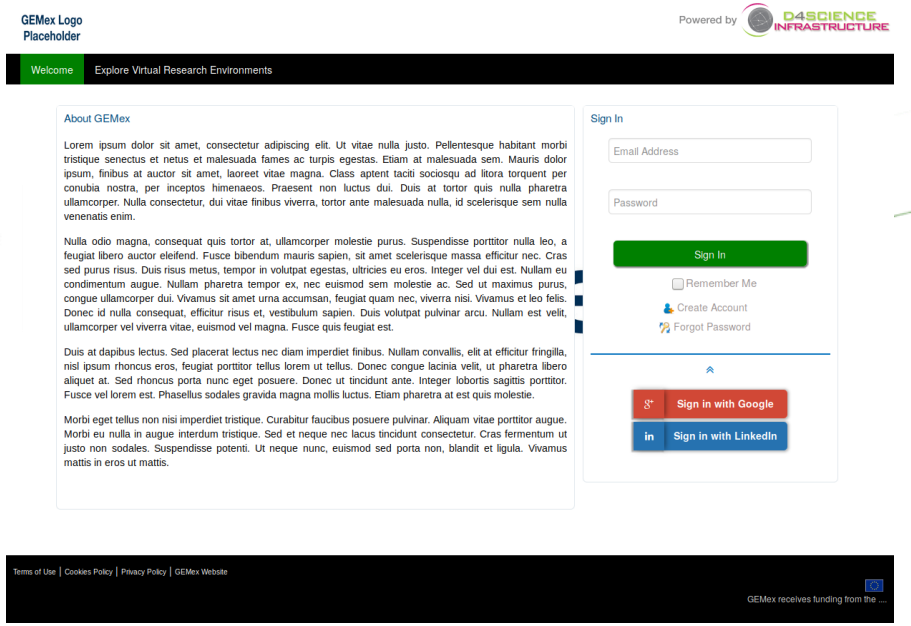
GEMex website



Access Partners' platform - VRE

Registration and access

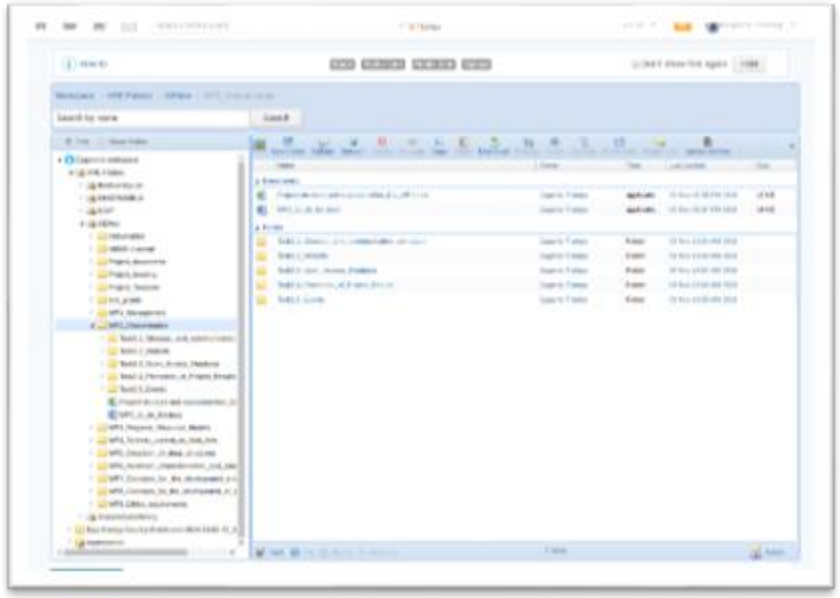
GEMex partners' platform



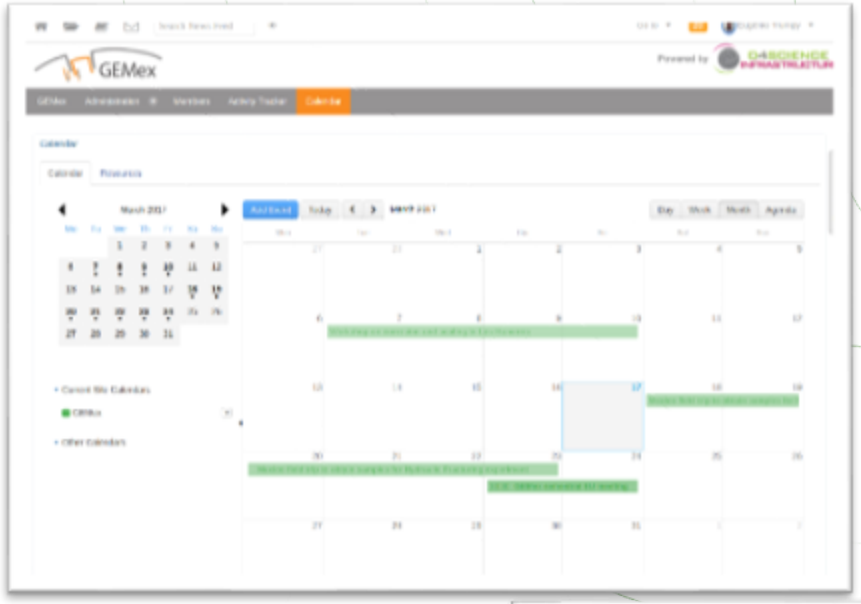
Case III

GEMex VRE

Workspace to upload, share and organize documents



Calendar to insert events, field works, meetings

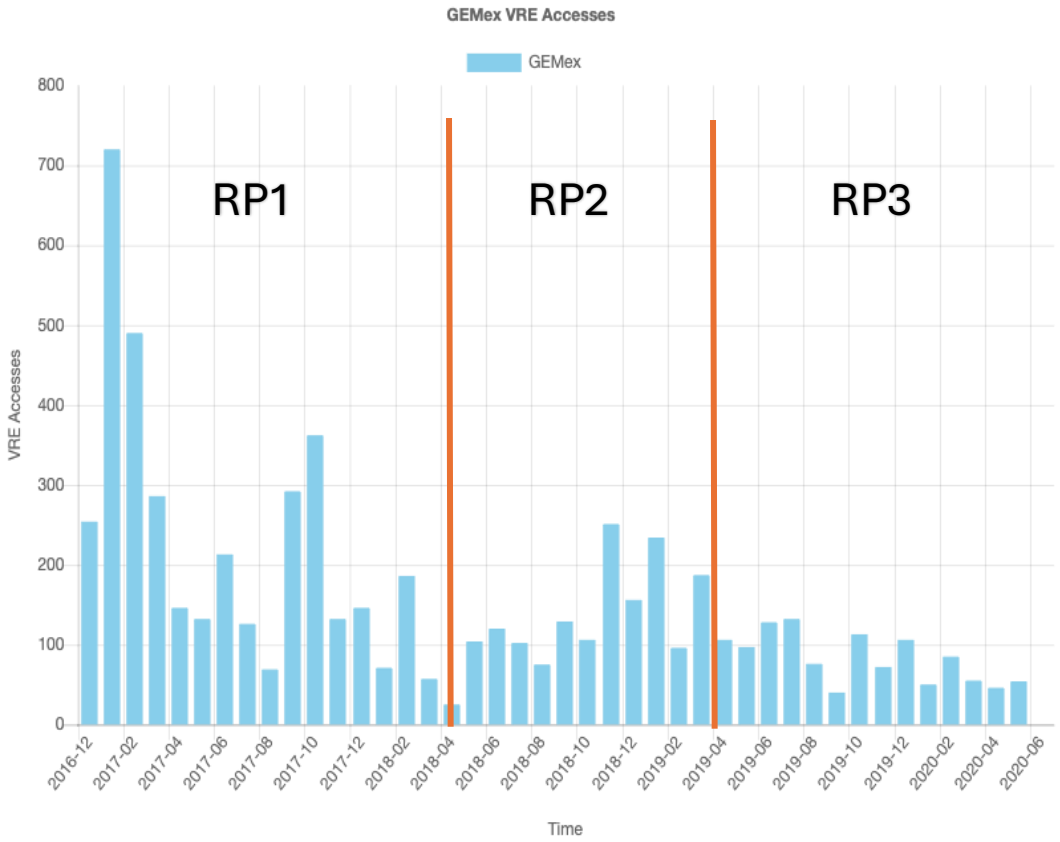


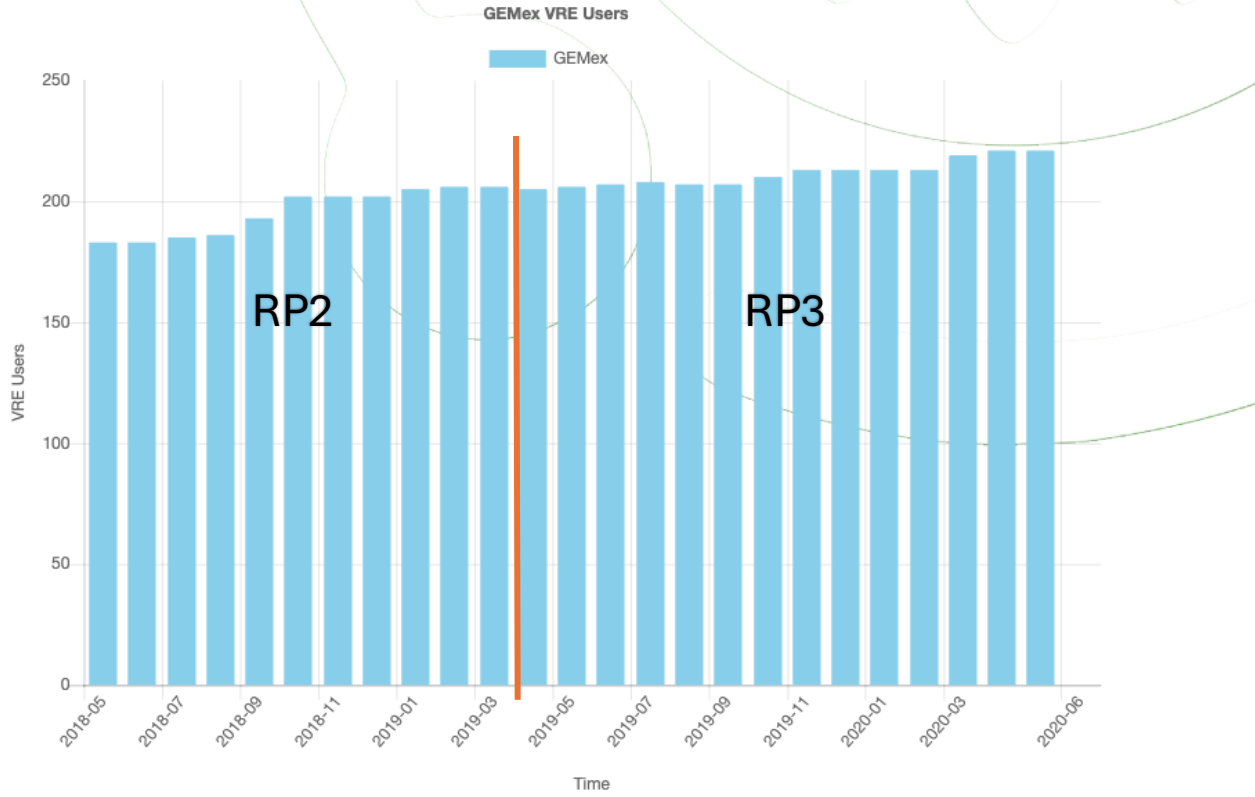
- Currently **221** registered persons (**52** Mex)

VRE social wall with photos, documents, ideas, discussions, news, …

Case III

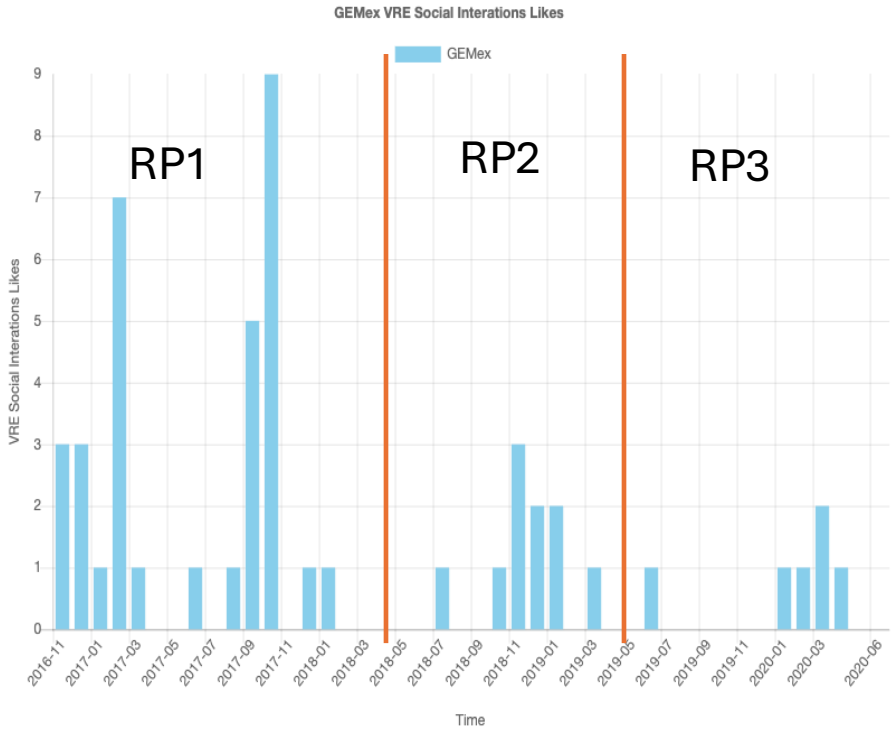
VRE statistics:

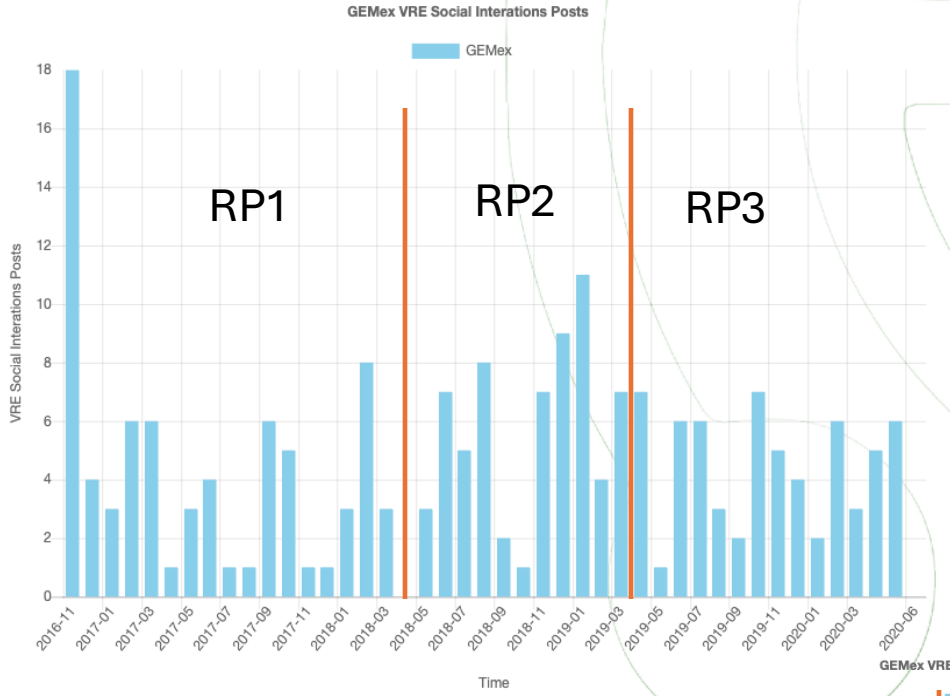




Case III

VRE statistics:





GEMex – restricted VRE

- This GEMex Virtual Research Environment (VRE) is meant to act as **private data storage accessible** to only **one person** per institution who have signed the Cooperation and confidentiality agreement. All the petrophysical, geophysical and geological data from CFE are stored in this **private VRE** until the end of GEMex project. After which the data will be automatically deleted. To access the data go to the workspace and browse within Private GEMex folders.

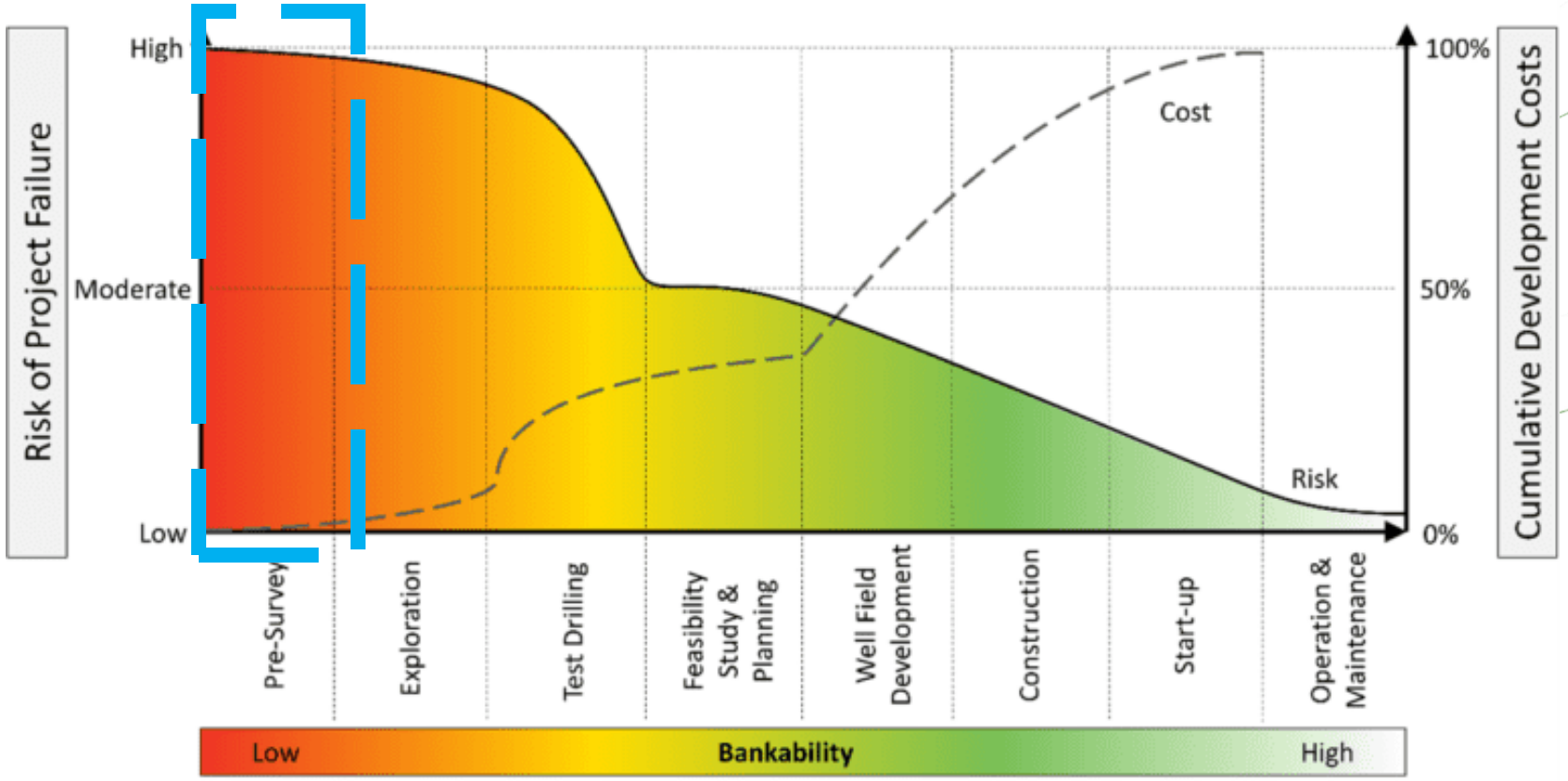
- The persons who are granted access to the GEMex private VRE use the data stored under their responsibility.

- The GEMex private VRE allows to:
  - Organize and manage data and documents;
  - Download data and documents
  - Monitor data download

Using AI to predict global geothermal suitability for power generation

Eugenio Trumpy, Gianpaolo Coro

Geothermal project stages



Methodology

DIVA – interpolation:

- is largely used in oceanography to produce uniform distributions from punctual data and, as first step, it estimates the spatial correlation between the data. This correlation was calculated for all our punctual data and was used as input to **IDW** and **kernel density**

Maximum Enthropy (MaxEnt) – ecological modelling, for example to forecast species distributions:

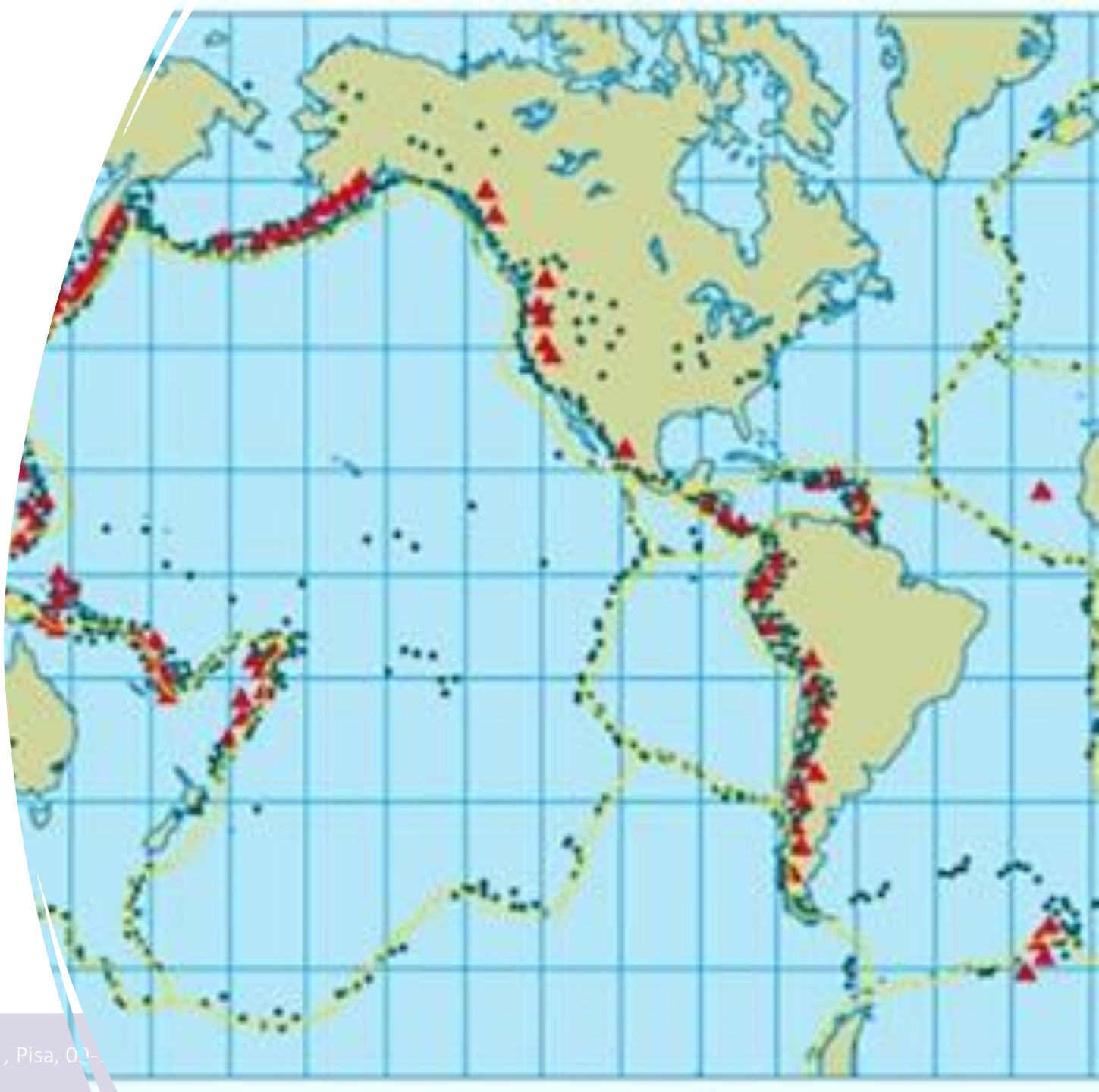
- MaxEnt is applicable to general problems where a probability function **π** ($\bar{x}$) should be approximated, based on real-valued vectors. For example, the $\bar{x}$ vectors may refer to the environmental parameters correlated to a species presence or a phenomenon occurrence

$$H(\hat{\pi}) = -\sum_{x \in X} \hat{\pi}(x) \ln \hat{\pi}(x)$$

Case II

Maximum Entropy

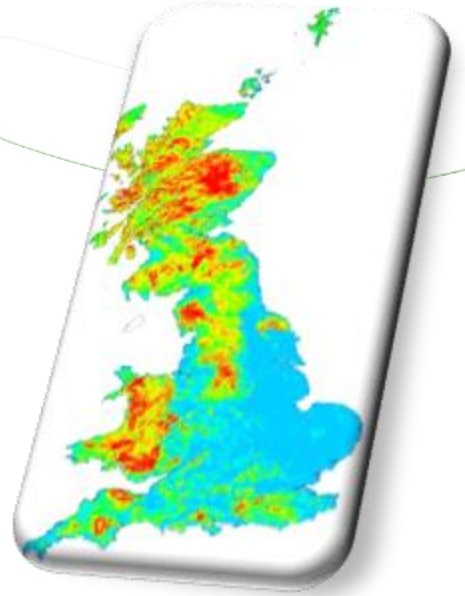
- Considering **geothermal site suitability** as the phenomenon to model, the geothermal power plants currently *in operation* were treated as **positive examples to train** the model
- **Environmental parameters** were the input datasets
- The model builds a complex relation function that embeds a **linear combination** of the parameters, where the **coefficients** of the combination are changed to reflect the influence of each variable in predicting the training set locations (percent contribution)
- The **training algorithm** also records the dependency of the model's performance on the permutation of a variable values among the training vectors (permutation importance)



Case II

MaxEnt model

compounds	atomic no.	melting point	VE	radii	EN	lattice const.(ang)
AlN	10	498	4	1.135	-1.21	3.11
AlP	14	625	4	0.435	-0.68	5.47
AlAs	23	1011.5	4	0.26	-0.63	5.66
AlSb	32	918.5	4	-0.09	-0.5	6.14
GaN	19	182.5	4	1.155	-1.15	3.16
GaP	23	309.5	4	0.455	-0.62	5.45
GaAs	32	545	2.5	0.28	-0.57	5.65
GaSb	41	603	4	-0.07	-0.44	6.1
InN	28	246	4	1.51	-1.22	3.54

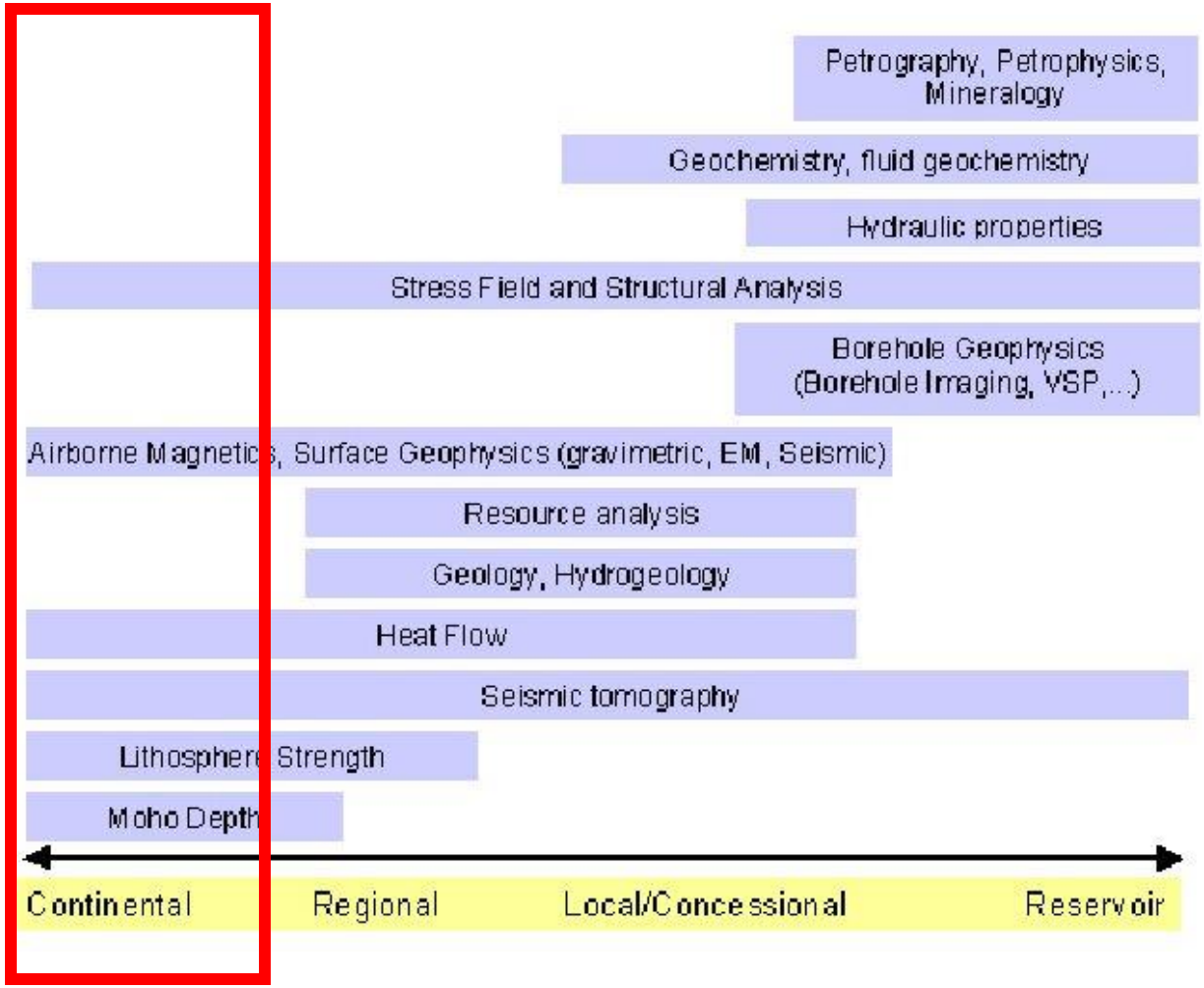


Open Science approach

- ✓ **R**eproducibility, **R**epeatability, and **R**e-usability
- ✓ **D4Science** e-Infrastructure, a network of hardware and software resources that offers OS-compliant services for data publication and processing
- ✓ **D4Science** allows re-using processes from several domains through Web interfaces and allows making them available to groups of scientists through **Virtual Research Environments**
- ✓ it offers a high-availability distributed storage system to host and publish data and a cloud computing system to process large amounts of data
- ✓ **importing** raw data from the sources
- ✓ **applying** data preparation processes (e.g. DIVA)
- ✓ **publishing** data under OGC representational standards through Web services and user interfaces

Case II

Environmental parameters



- Carbon Dioxide (gC/m^2/day) [*Copernicus Atm. Monit. Sys.]*
- Elevation (m) [*United Stated National Geophysical Data Center*]
- Depth (m) [*United Stated National Geophysical Data Center*]
- Global Heat flow (mW m^{-2}) [*Davies 2013*]
- Sediment thickness (km) [*Laske 1997*]
- Surface air temperature (K) [*NASA*]
- Precipitation (kg m^{-2}s^{-1}) [*NASA*]
- Groundwater resources (MW year^{-1}) [*WHYMAP*]
- Earthquake depth (m) [*Centennial Earthquake Catalog*]
- Earthquake magnitude (M) [*Centennial Earthquake Catalog*]
- Earthquake density (N. per 0.5° cell) [*Centennial Earthquake Catalog*]
- Distance from: convergent line, transform line, diffuse line, ridge line [*USGS*]
- Geothermal power plant (operative, planned/operative) – **training set** [*Global Geothermal Energy Database - 2015*]

Processed maps

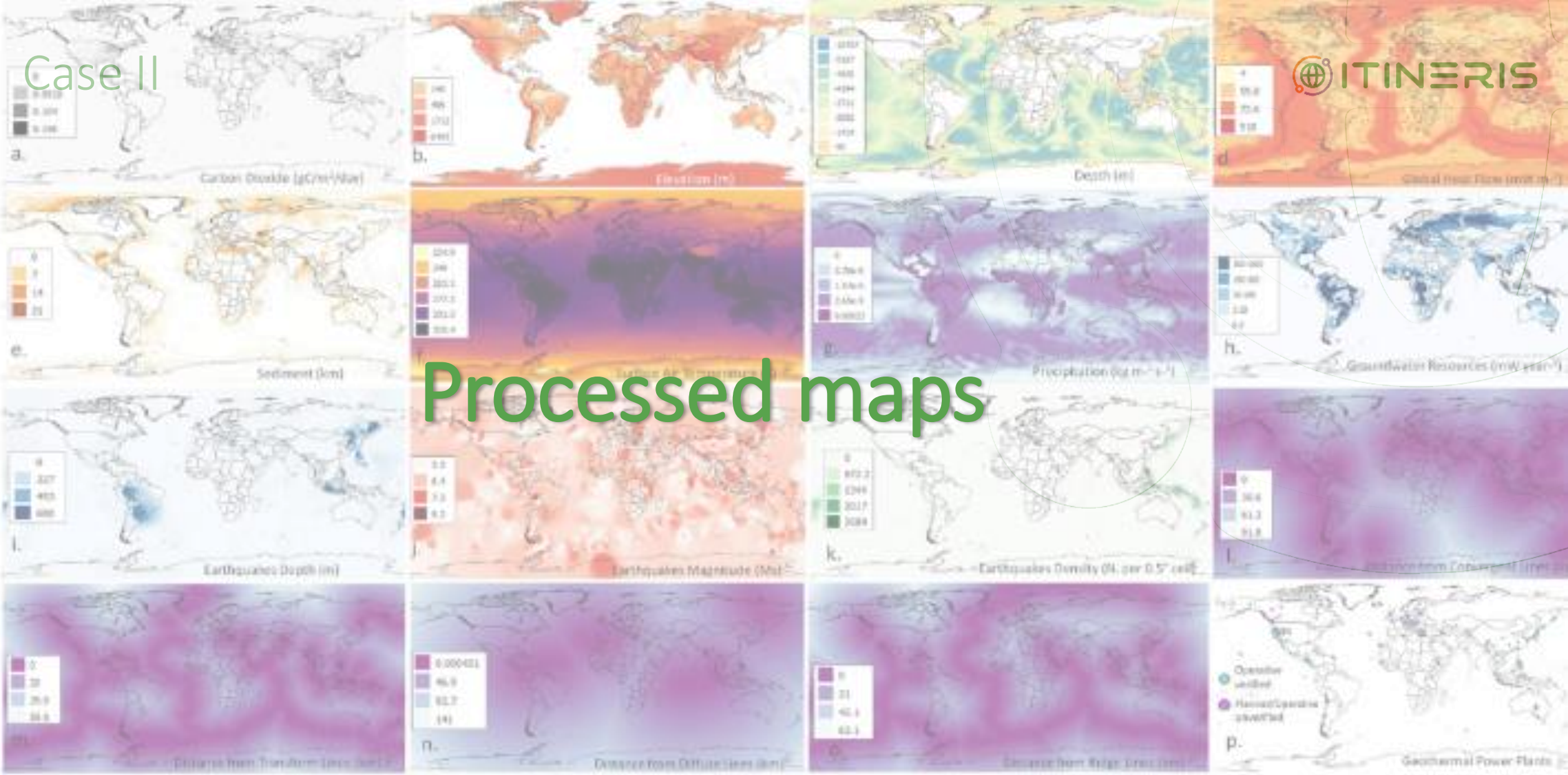
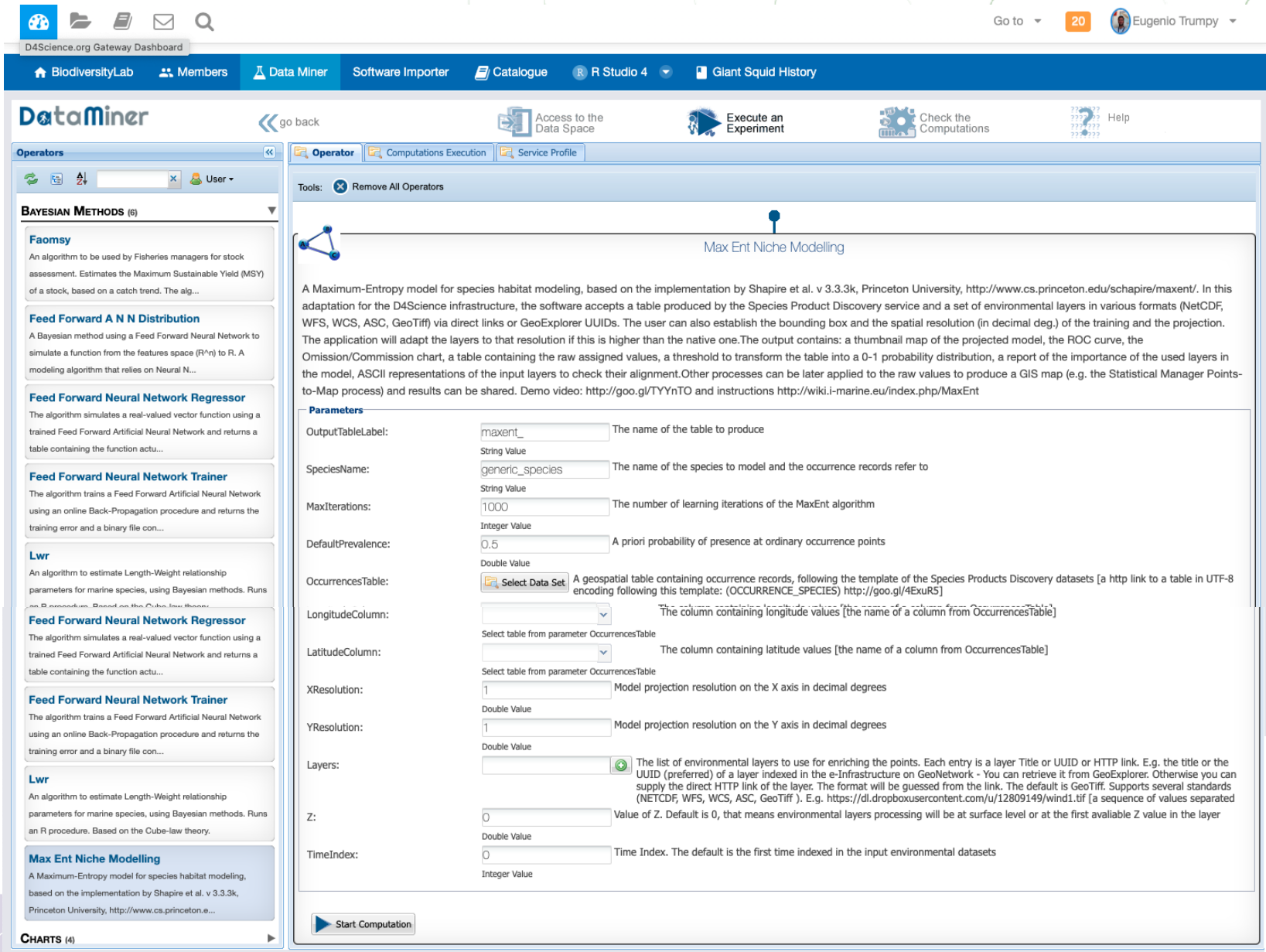


Fig. 1. Visual comparison of the global data used in our model: (a) carbon dioxide, (b) elevation, (c) depth, (d) global heat flow, (e) sediment thickness, (f) surface air temperatu
(g) precipitation, (h) groundwater resources, (i) earthquake depth, (j) magnitude, and (k) density, distance from (l) convergent, (m) transform, and (n) diffuse lines, (o) operative a
planned geothermal power plants.

Case II

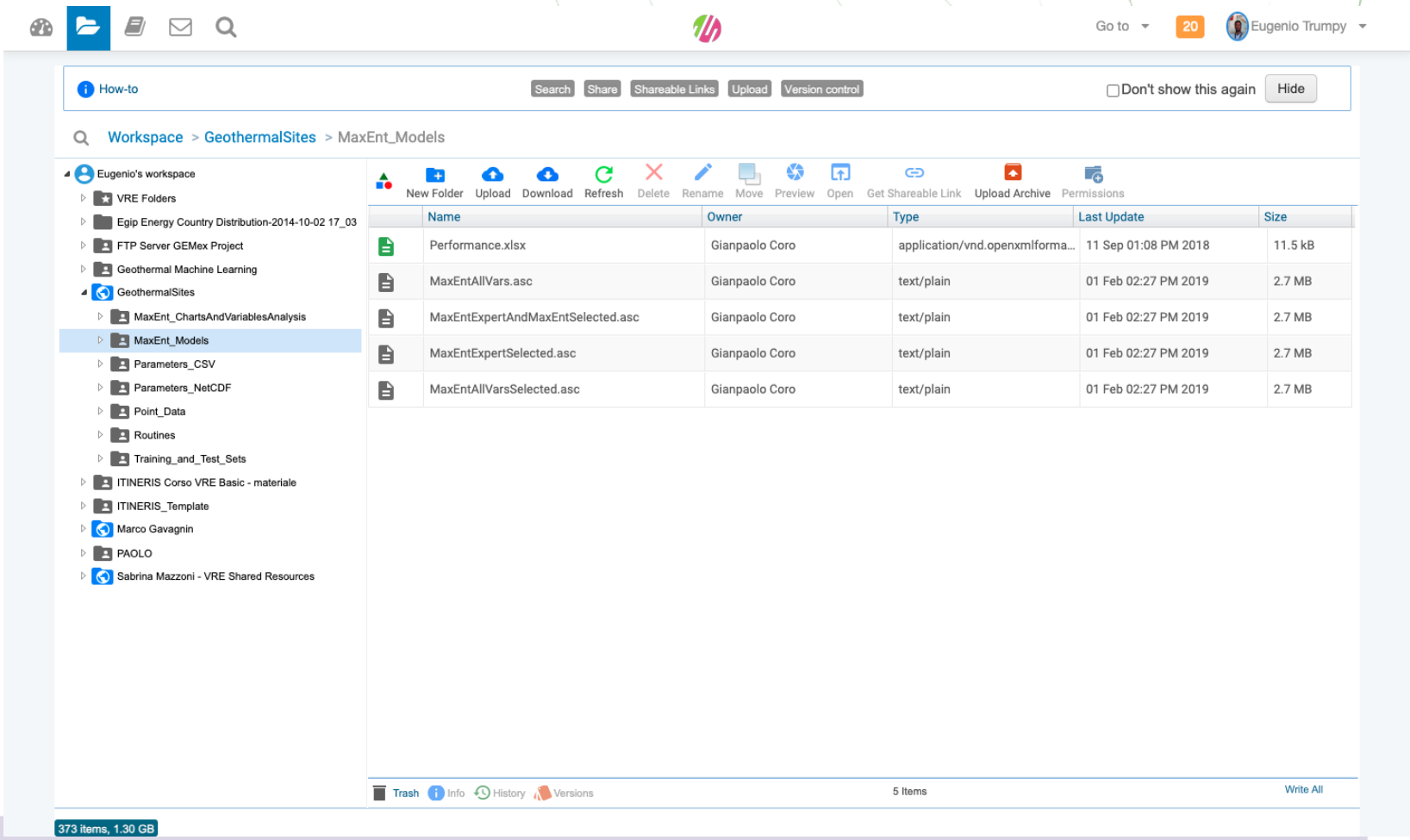
Biodiversity Lab

- **Data miner**
- Workspace



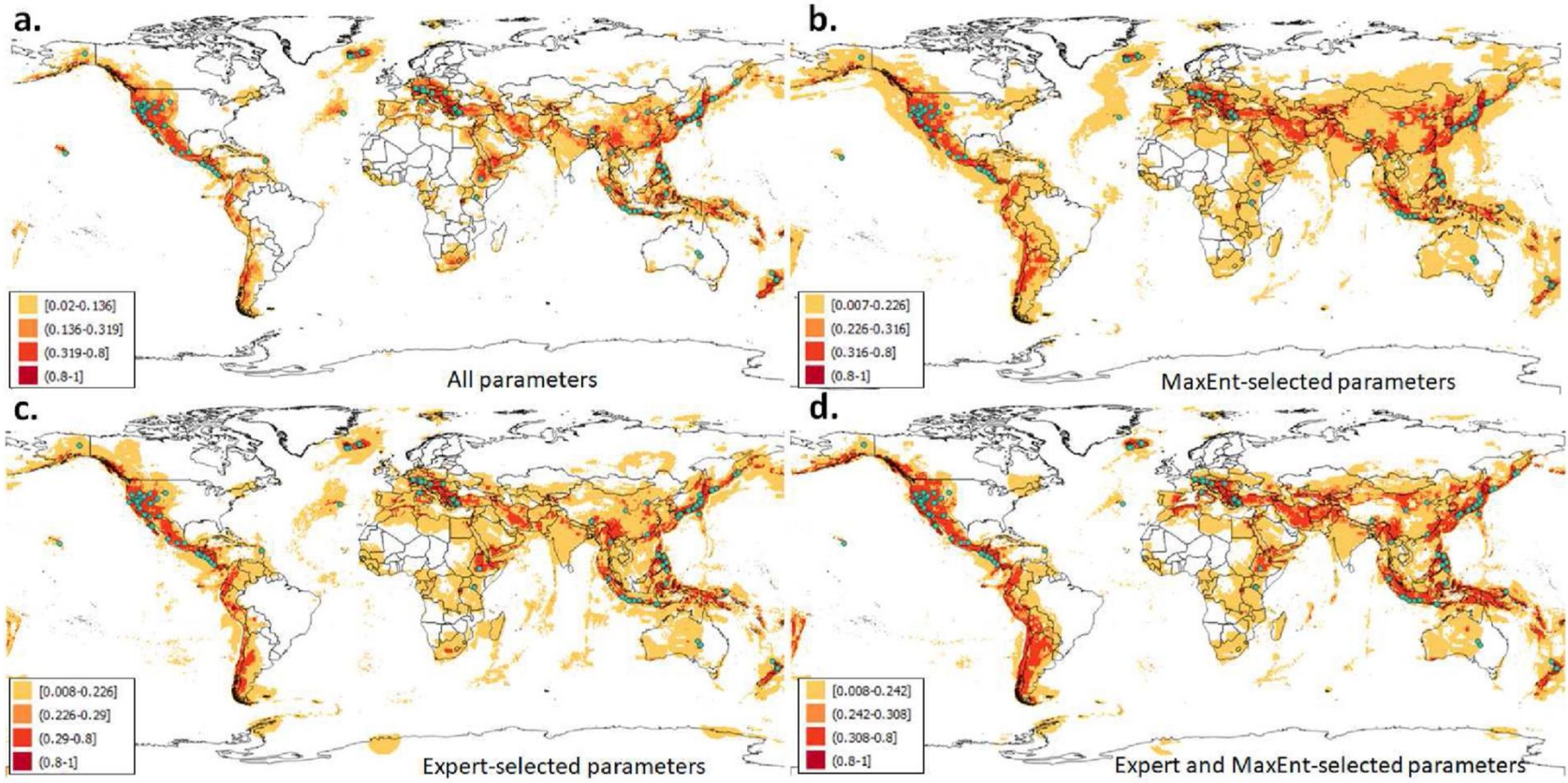
BiodiversityLab

- Data miner
- **Workspace**



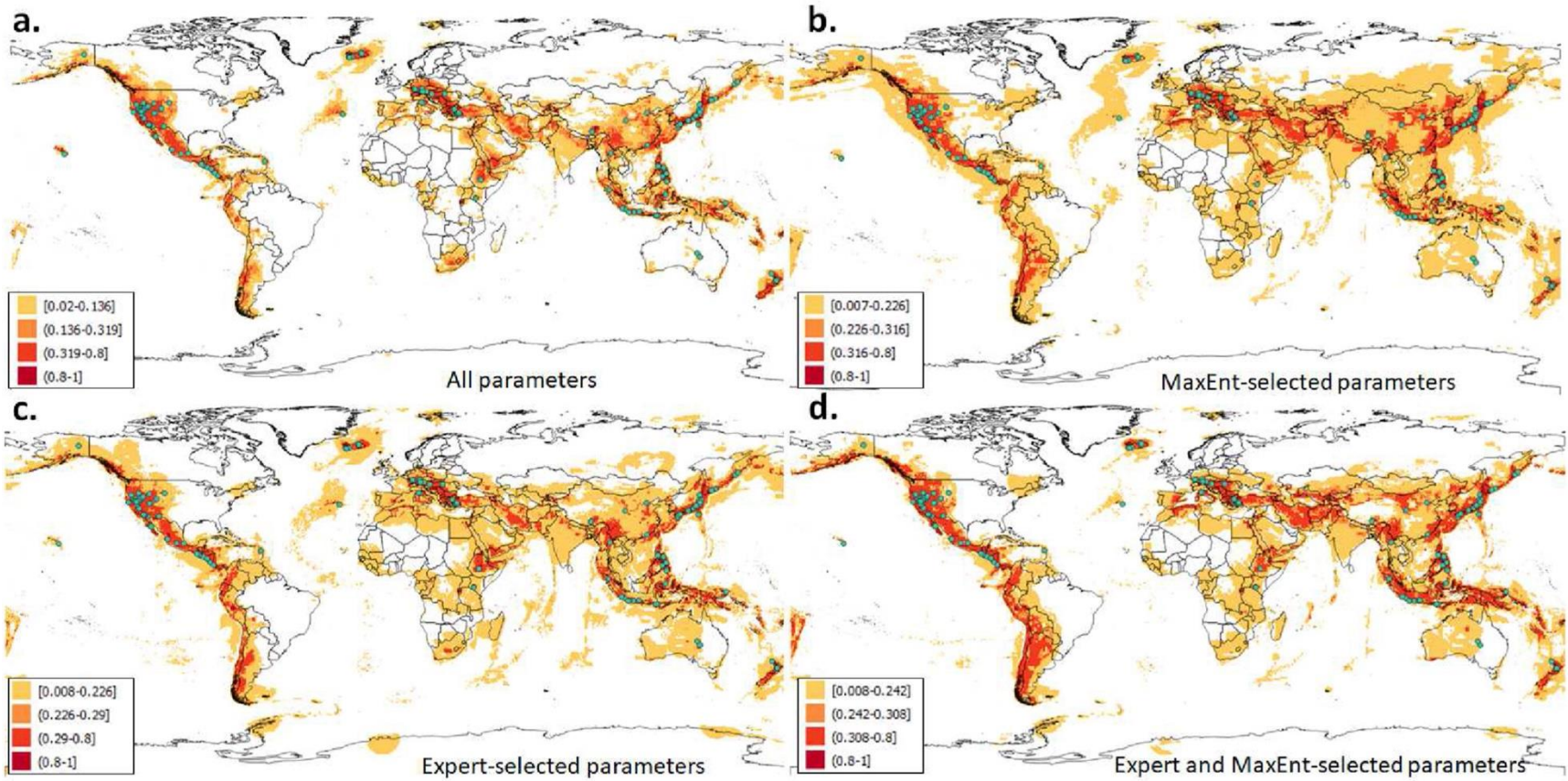
Models

a. All parameters
b. Parameters selected using MaxEnt as filter (>5%)
c. Parameters selected by an expert on geothermal energy
d. Intersection between the MaxEnt-selected and the expert selected parameters



Results

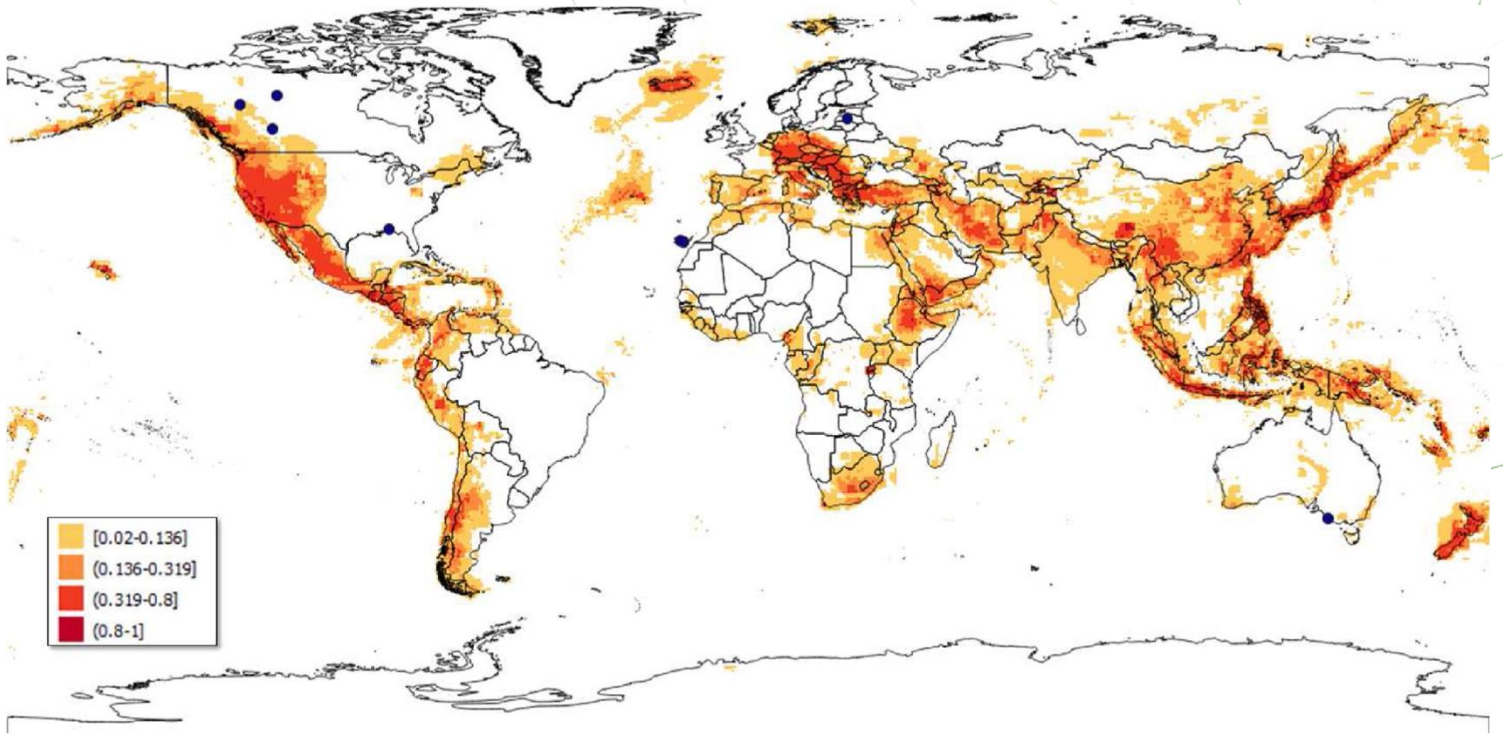
- ✓Similar patterns but several discrepancies
- ✓Suitability score range in the maps are different
- ✓b. and c. overestimate respect the other models
- ✓d. underestimates



Results

- a. 52 well predicted test-set geothermal plants and 8 are not foreseen by the model

Accuracy using balanced threshold
76.2%
73.3%
72.4%
72.4%



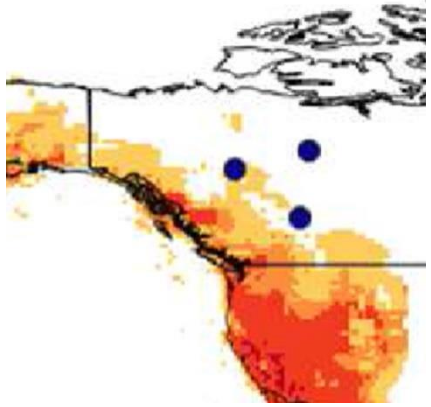
Case II

Discarded sites

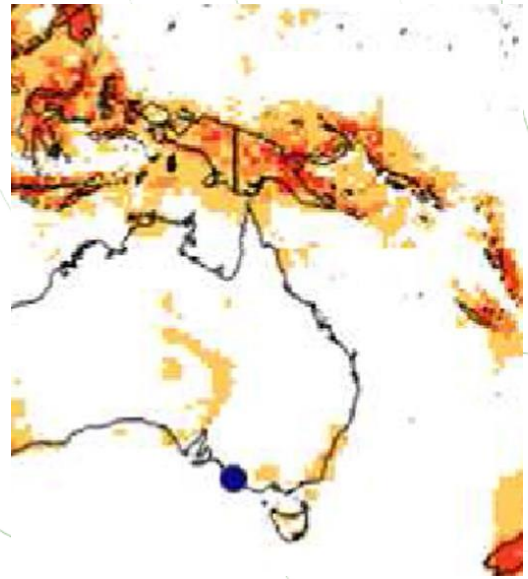
Canada: Ft. Liard; Con Mine; Alberta

- lower - elevation / CO2 presence / earthquake magnitudes
- much lower heat flow
- higher groundwater resources level
- longer distance from transform and ridge lines

➢ very low energy production (about 0.2/0.3 MW), which is consistent with a low suitability indication by our model



Australia: Penola



- more distant from diffuse lines
- more groundwater resources / precipitation
- lower surface / air temperature / earthquake density

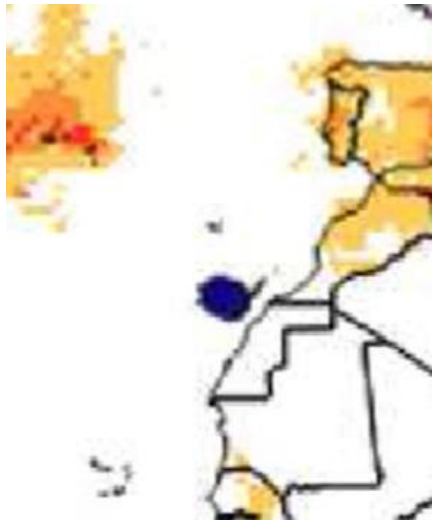
➢ low permeability resulted by the demonstration project

Discarted sites

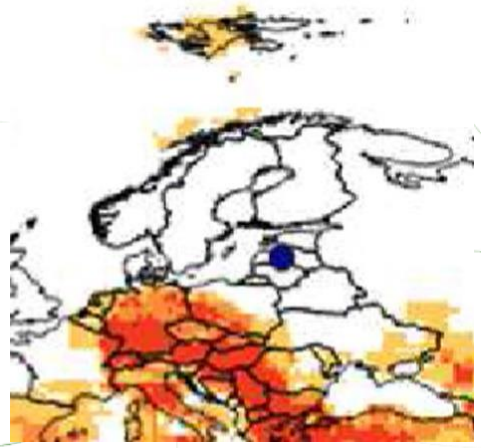
Canary Islands: Gran Canaria, Tenerife

- lower earthquake depth / magnitude / density / precipitation quantity / surface air temperature

feasibility is still under evaluation, thus comparison with our map is not possible



Latva: Riga



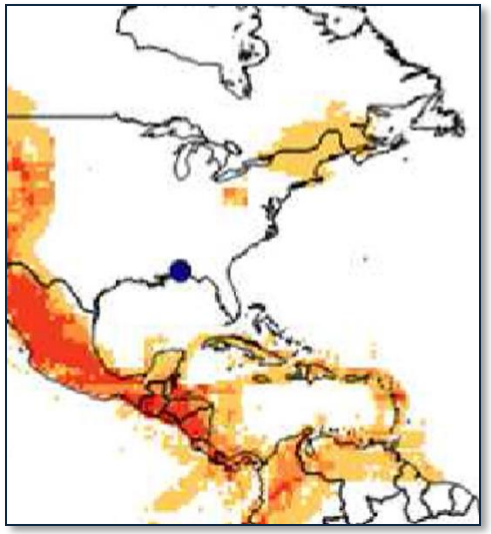
- lower heat flow / CO2
- longer distance from convergent lines
- higher earthquake magnitude

Discarted sites

Florida: Joy Florida

- higher sediment presence
- lower heat flow and elevation
- is closer to diffuse lines
- more distant from transform lines
- has more higher groundwater resources / higher surface air temperature
- much lower earthquake magnitudes and density

➢ Co-production power plant is planned - use oil and gas wells and thus is not purely geothermal



Well predicted power plant

52 planned power plant well predicted, locations falls in high suitability areas (>60%)

- Imperial valley California: there are 2 planned projects falling in a 84% suitable zone
- Western Iceland: 4 planned projects 73% score
- Latera (Italy): hosted in the 90's an operative power plant in an area of 65%

Case II

Paper: Coro & Trumpy 2020

Conclusions

Datasets repository

The **global-scale** map of the suitability of areas suitable to geothermal energy production and plant installation

Geospatial data correlated with geothermal site suitability are processed through **DIVA** and **MaxEnt**

The reliability of the map is **tested** against currently **active** and **planned** geothermal power plants.

An **Open Science-compliant tool** is proposed to allow stakeholders to increase the map resolution and revise parameters.

This research aims at increasing the transparency of the assessment of geothermal sites, speed-up siting for exploration

THANKS!

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Ministero dell'Università e della Ricerca
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