

D4Sciences VREs case studies

- Eugenio Trumpy

IR0000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System
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Mission 4 “Education and Research” - Component 2: “From research to business” - Investment
3.1: “Fund for the realisation of an integrated system of research and innovation infrastructures”



Case studies

Spatial Data Infrastructure

- EGIP Pilot

EU projects internal communication

- DESCRAMBLE, GEMex, DeepU

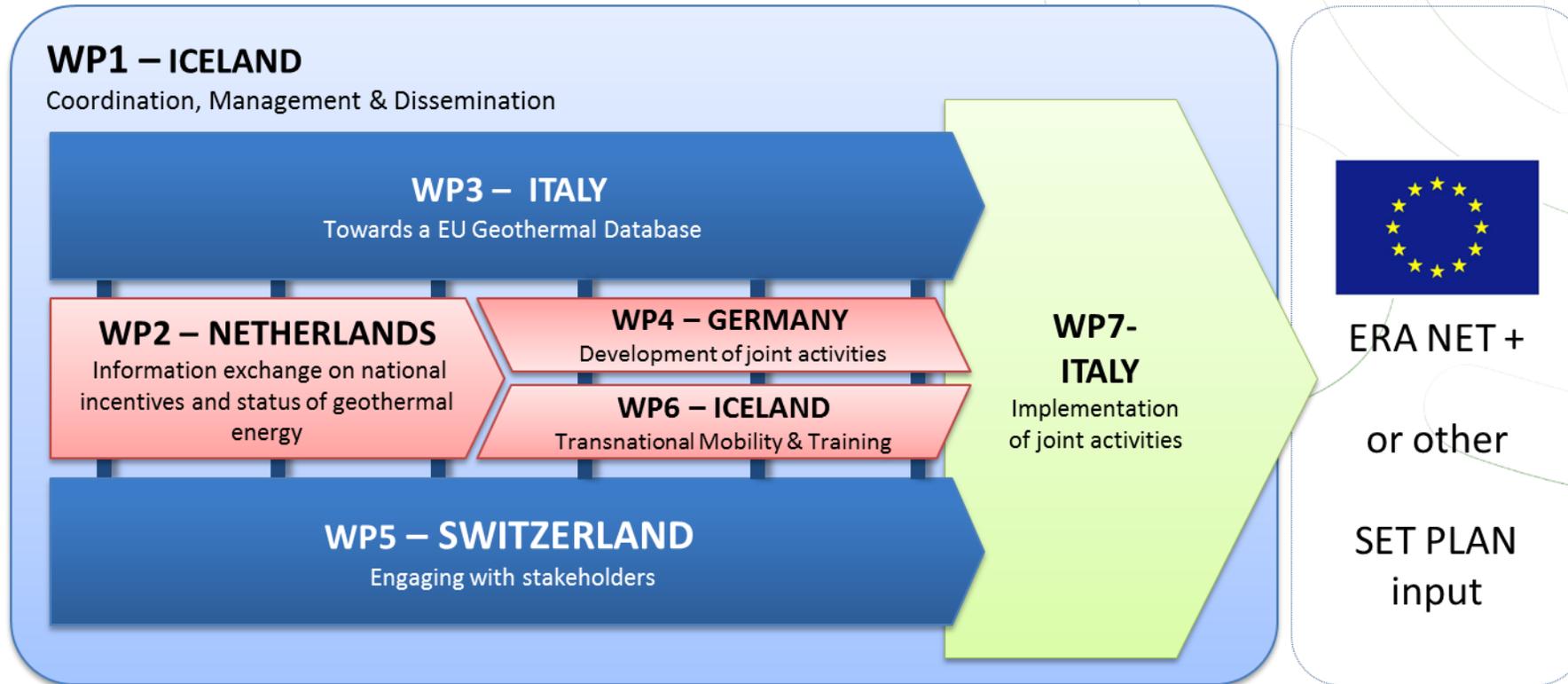
MaxEnt computation

- Using AI to predict global geothermal suitability for power generation

The logo features a green circular icon on the left, composed of a spiral that starts from the center and winds outwards. To the right of this icon, the text "EGIP" is written in a bold, green, sans-serif font, followed by the word "pilot" in a smaller, lowercase, green, sans-serif font. The entire logo is centered within a white rectangular box.

EGIP pilot

Geothermal ERA-NET



□ 2012 - 2016

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**



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 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.

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?

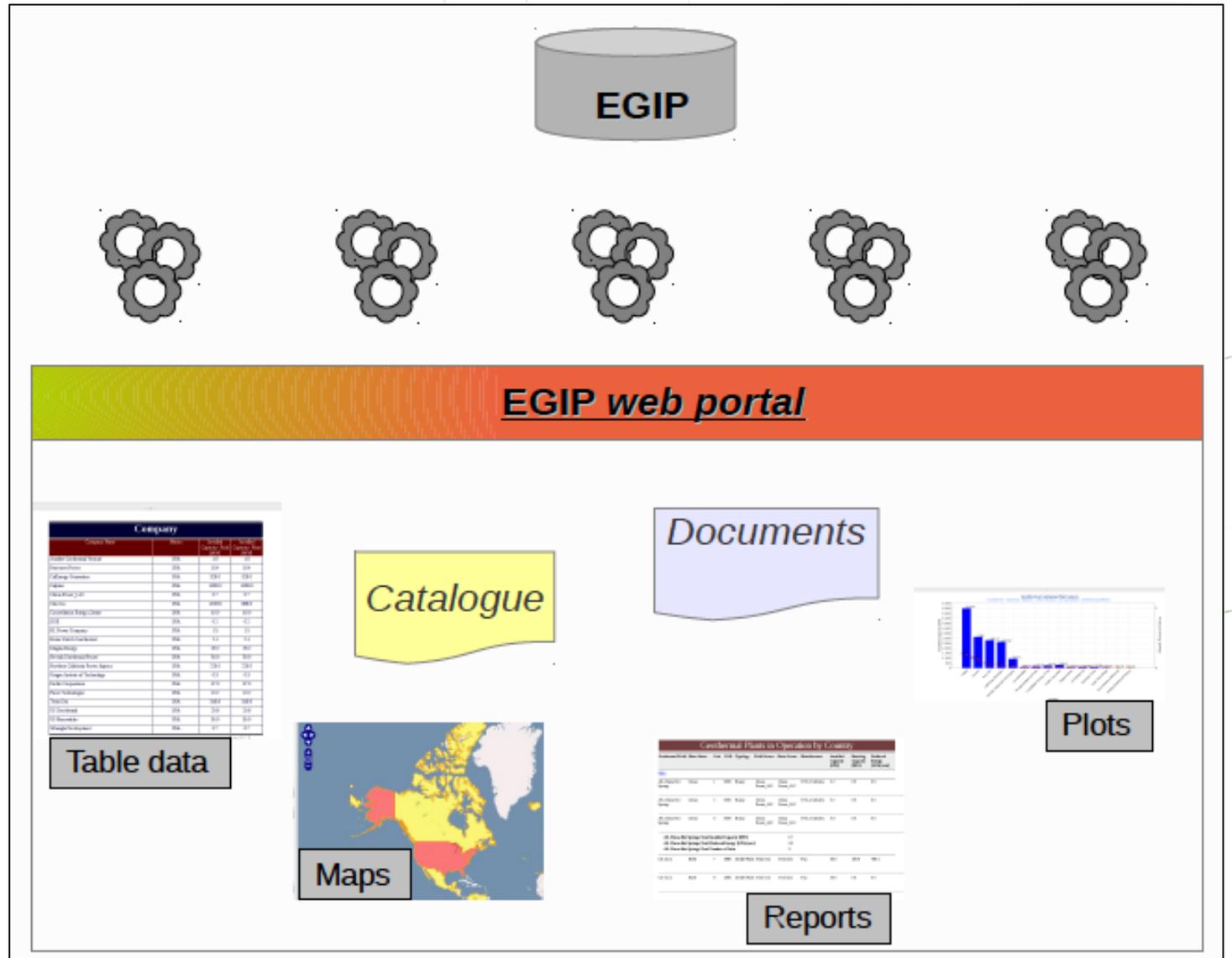
Step-by-step plan:

- *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***

Case I

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 Architecture overview I

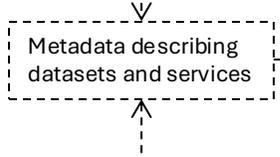
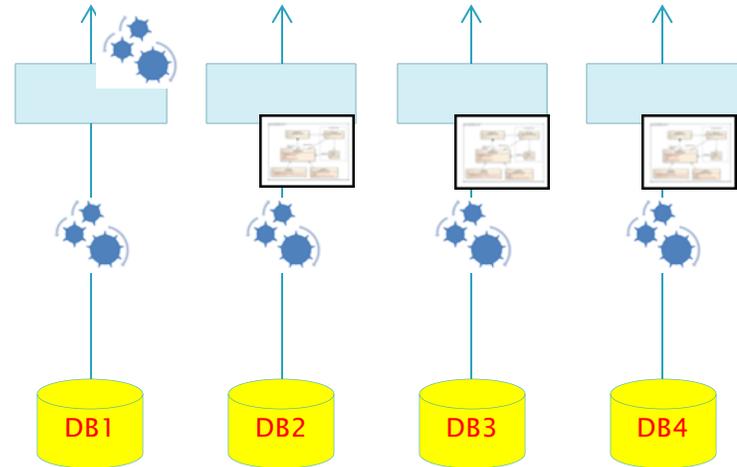


Common rules for:

1. Metadata (INSPIRE)
2. Web Services:
 - View
 - Access (download)
 - Process
3. Common data model, used by services to deliver and process data



« European products »



Catalogue service (CSW)



Each provider delivers a piece of the puzzle:

Which can be map or data

8			8
20			20
20	50	50	20
20	50	50	20
20	50	50	20
20	50	50	20
20	50	50	20
20	50	50	20
20	50	50	20
20	50	50	20



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

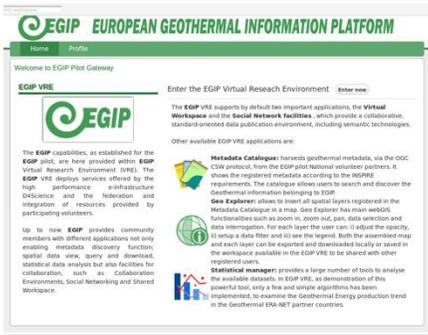
The EGIP @ national level:

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



Case I

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 

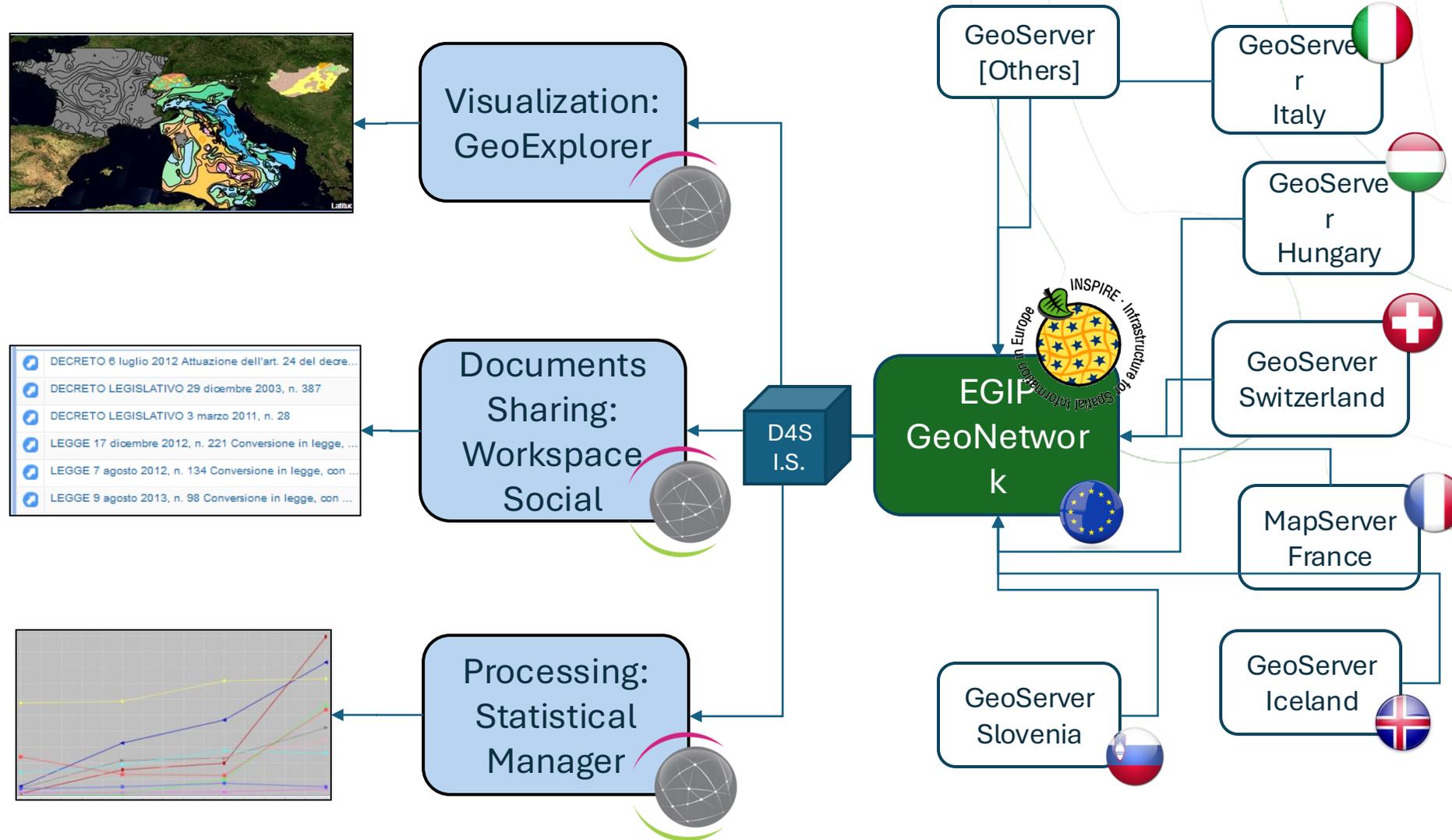


StatCube applications make up analytical tools:



Statistical manager

Case I

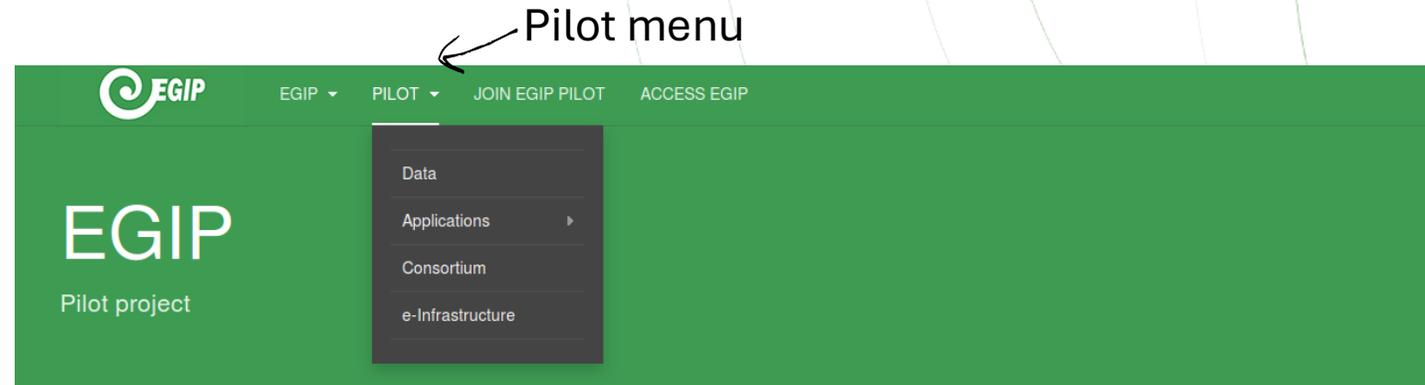


Case I

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



EGIP EGIP ▾ PILOT ▾ **JOIN EGIP PILOT** ACCESS EGIP

This are the instructions for preparing data, contact us for details:

National Research Council of Italy - CNR
1, G. Moruzzi street
56124 Pisa, Italy
P: (+39) 050 621 2324

CNR - IGG
e.trumpy at igg.cnr.it

Title	Author	Hits
EGIP data model	Written by Super User	Hits: 23
Games rules	Written by Super User	Hits: 17
egip.xsd	Written by Super User	Hits: 17

You are here: [Home](#) / [Join EGIP pilot](#)

Links

-  [European Commission](#)
-  [7th Framework program](#)
-  [Geothermal ERA-NET](#)
-  [INSPIRE](#)

Pilot consortium

- CNR - National Research Council of Italy
- BRGM - Bureau de Recherches Geologiques et Minières
- SFOE - Swiss Federal Office of Energy (with Swiss Geological Survey)
- MFGI - Magyar Földtani és Geofizikai Intézet

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Acknowledgement:
All the graphs have been realized by [Lorenzo Gori](#) - CNR

Case I

EGIP web site IV

Search workspace

EGIP EUROPEAN GEOTHERMAL INFORMATION PLATFORM

Home Profile

Welcome to EGIP Pilot Gateway

EGIP VRE

The **EGIP** capabilities, as established for the **EGIP** pilot, are here provided within **EGIP** Virtual Research Environment (VRE). The **EGIP** VRE deploys services offered by the high performance e-Infrastructure D4Science and the federation and integration of resources provided by participating volunteers.

Up to now **EGIP** provides community members with different applications not only enabling metadata discovery function; spatial data view, query and download, statistical data analysis but also facilities for collaboration, such as Collaboration Environments, Social Networking and Shared Workspace.

Enter the EGIP Virtual Research Environment

The **EGIP** VRE supports by default two important applications: the **Virtual Workspace** and the **Social Network facilities**, which provide a collaborative, standard-oriented data publication environment, including semantic technologies.

Other available EGIP VRE applications are:

- Metadata Catalogue:** harvests geothermal metadata, via the OGC CSW protocol, from the EGIP pilot National volunteer partners. It shows the registered metadata according to the INSPIRE requirements. The catalogue allows users to search and discover the Geothermal information belonging to EGIP.
- Geo Explorer:** allows to insert all spatial layers registered in the Metadata Catalogue in a map. Geo Explorer has main webGIS functionalities such as zoom in, zoom out, pan, data selection and data interrogation. For each layer the user can: i) adjust the opacity, ii) setup a data filter and iii) see the legend. Both the assembled map and each layer can be exported and downloaded locally or saved in the workspace available in the EGIP VRE to be shared with other registered users.
- Statistical manager:** provides a large number of tools to analyse the available datasets. In EGIP VRE, as demonstration of this powerful tool, only a few and simple algorithms has been implemented, to examine the Geothermal Energy production trend in the Geothermal ERA-NET partner countries.

EGIP EUROPEAN GEOTHERMAL INFORMATION PLATFORM

EGIP Administration Data Catalog Geo Explorer Statistical Manager Calendar

Annotations:
- "Click here to enter" points to the "Enter now" button.
- "Spatial data discovery, view and download" points to the "Data Catalog" link.
- "Dataset analysis" points to the "Statistical Manager" link.
- "Platform home page" points to the "EGIP" link.
- "Metadata catalogue" points to the "Data Catalog" link.

Case I

EGIP platform: Data Catalogue

The Geonetwork web application is accessible through the portal

CS-W catalogue:

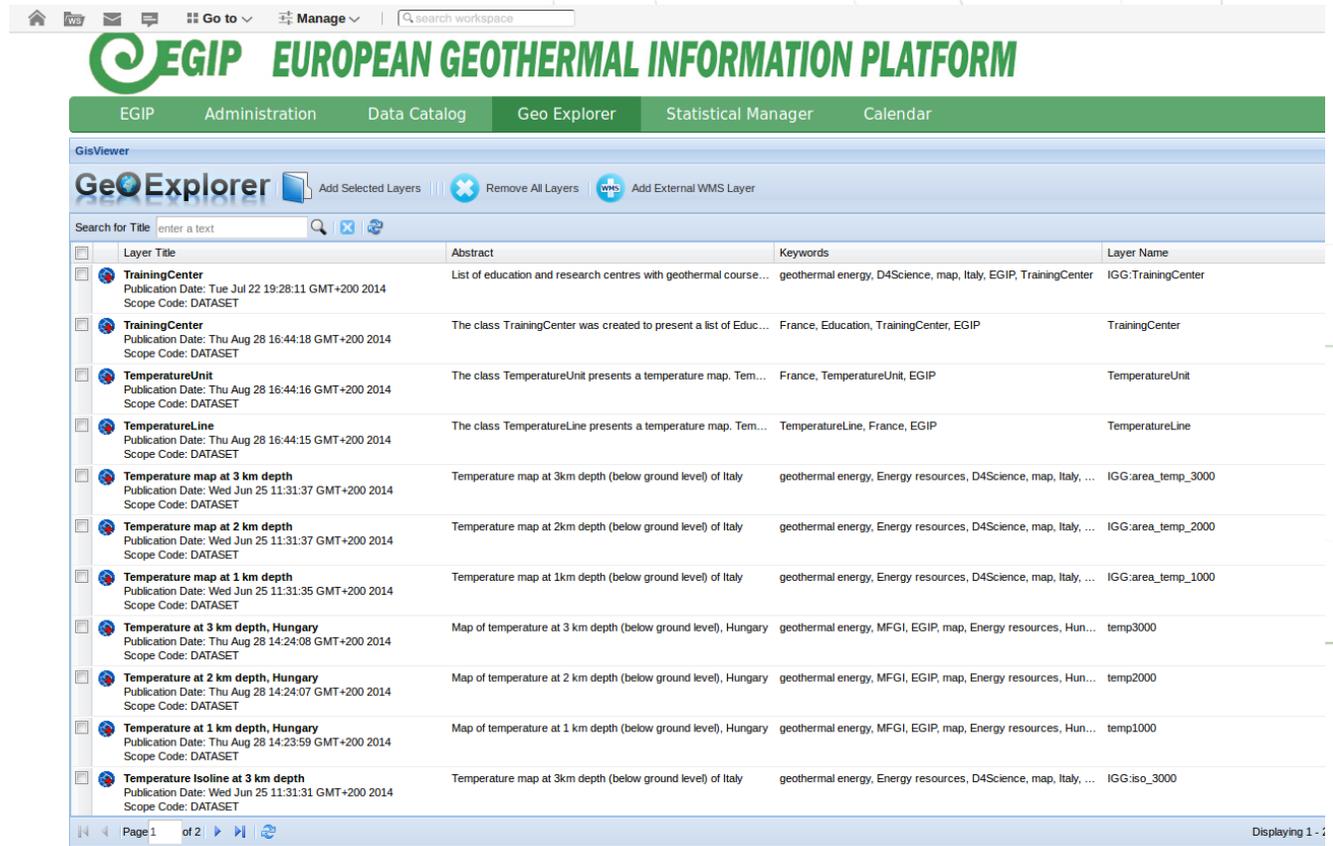
- Harvests the metadata from partners metadata catalogues
- Metadata collection for spatial dataset
- Metadata collection for documents
- INSPIRE Standard ISO-19139
- Dublin-core
- Spatial search
- Text search

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



The screenshot displays the EGIP (European Geothermal Information Platform) GeoExplorer interface. The top navigation bar includes 'EGIP', 'Administration', 'Data Catalog', 'Geo Explorer', 'Statistical Manager', and 'Calendar'. The main interface features a search bar, a list of layers, and a table of metadata.

Layer Title	Abstract	Keywords	Layer Name
TrainingCenter Publication Date: Tue Jul 22 19:28:11 GMT+200 2014 Scope Code: DATASET	List of education and research centres with geothermal course...	geothermal energy, D4Science, map, Italy, EGIP, TrainingCenter	IGG:TrainingCenter
TrainingCenter Publication Date: Thu Aug 28 16:44:18 GMT+200 2014 Scope Code: DATASET	The class TrainingCenter was created to present a list of Educ...	France, Education, TrainingCenter, EGIP	TrainingCenter
TemperatureUnit Publication Date: Thu Aug 28 16:44:16 GMT+200 2014 Scope Code: DATASET	The class TemperatureUnit presents a temperature map. Tem...	France, TemperatureUnit, EGIP	TemperatureUnit
TemperatureLine Publication Date: Thu Aug 28 16:44:15 GMT+200 2014 Scope Code: DATASET	The class TemperatureLine presents a temperature map. Tem...	TemperatureLine, France, EGIP	TemperatureLine
Temperature map at 3 km depth Publication Date: Wed Jun 25 11:31:37 GMT+200 2014 Scope Code: DATASET	Temperature map at 3km depth (below ground level) of Italy	geothermal energy, Energy resources, D4Science, map, Italy, ...	IGG:area_temp_3000
Temperature map at 2 km depth Publication Date: Wed Jun 25 11:31:37 GMT+200 2014 Scope Code: DATASET	Temperature map at 2km depth (below ground level) of Italy	geothermal energy, Energy resources, D4Science, map, Italy, ...	IGG:area_temp_2000
Temperature map at 1 km depth Publication Date: Wed Jun 25 11:31:35 GMT+200 2014 Scope Code: DATASET	Temperature map at 1km depth (below ground level) of Italy	geothermal energy, Energy resources, D4Science, map, Italy, ...	IGG:area_temp_1000
Temperature at 3 km depth, Hungary Publication Date: Thu Aug 28 14:24:08 GMT+200 2014 Scope Code: DATASET	Map of temperature at 3 km depth (below ground level), Hungary	geothermal energy, MFGI, EGIP, map, Energy resources, Hun...	temp3000
Temperature at 2 km depth, Hungary Publication Date: Thu Aug 28 14:24:07 GMT+200 2014 Scope Code: DATASET	Map of temperature at 2 km depth (below ground level), Hungary	geothermal energy, MFGI, EGIP, map, Energy resources, Hun...	temp2000
Temperature at 1 km depth, Hungary Publication Date: Thu Aug 28 14:23:59 GMT+200 2014 Scope Code: DATASET	Map of temperature at 1 km depth (below ground level), Hungary	geothermal energy, MFGI, EGIP, map, Energy resources, Hun...	temp1000
Temperature isoline at 3 km depth Publication Date: Wed Jun 25 11:31:31 GMT+200 2014 Scope Code: DATASET	Temperature map at 3km depth (below ground level) of Italy	geothermal energy, Energy resources, D4Science, map, Italy, ...	IGG:iso_3000

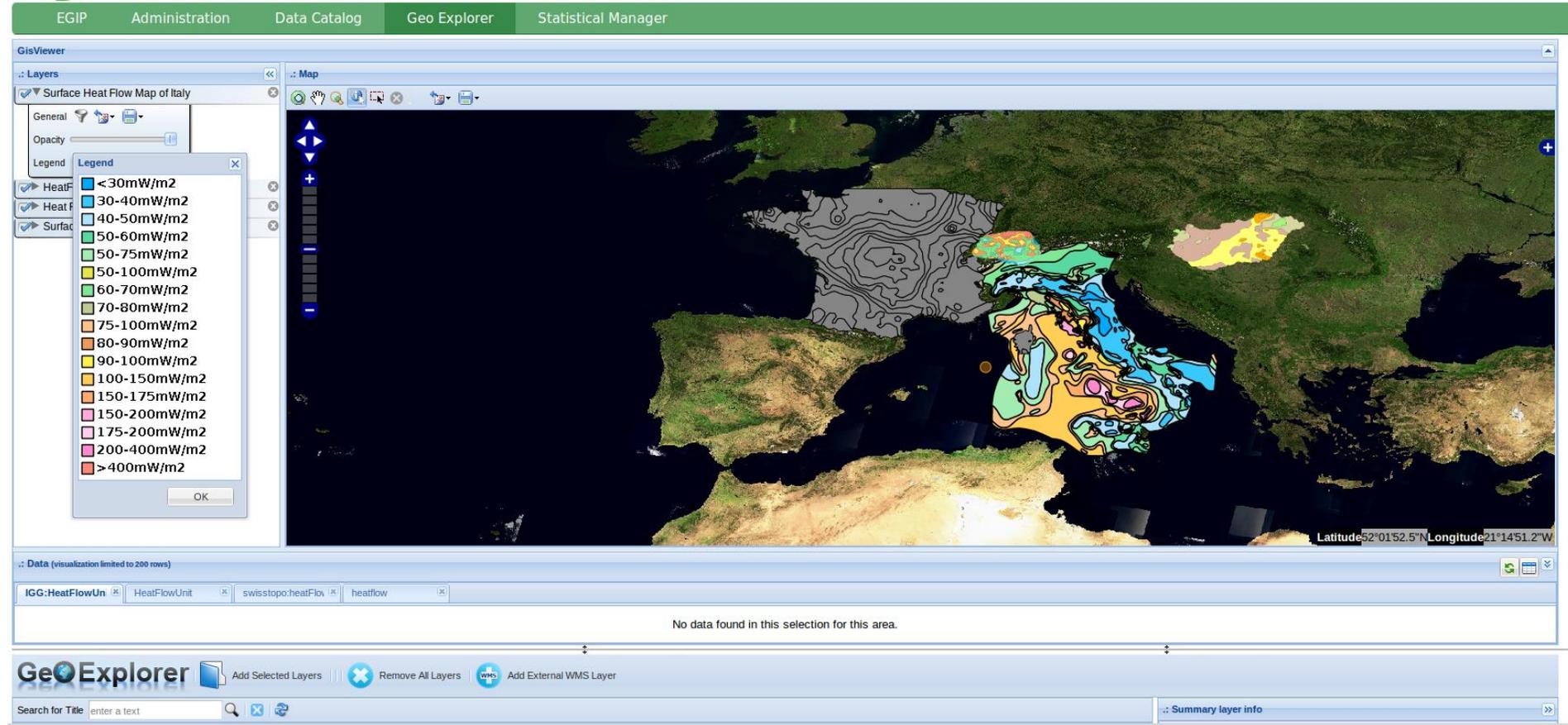
Case I

EGIP platform: GeoExplorer

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

- HeatFlowUnit among volunteer's participants

EGIP EUROPEAN GEOTHERMAL INFORMATION PLATFORM



Case I

EGIP platform: GeoExplorer

- HeatFlowUnit among volunteers participants

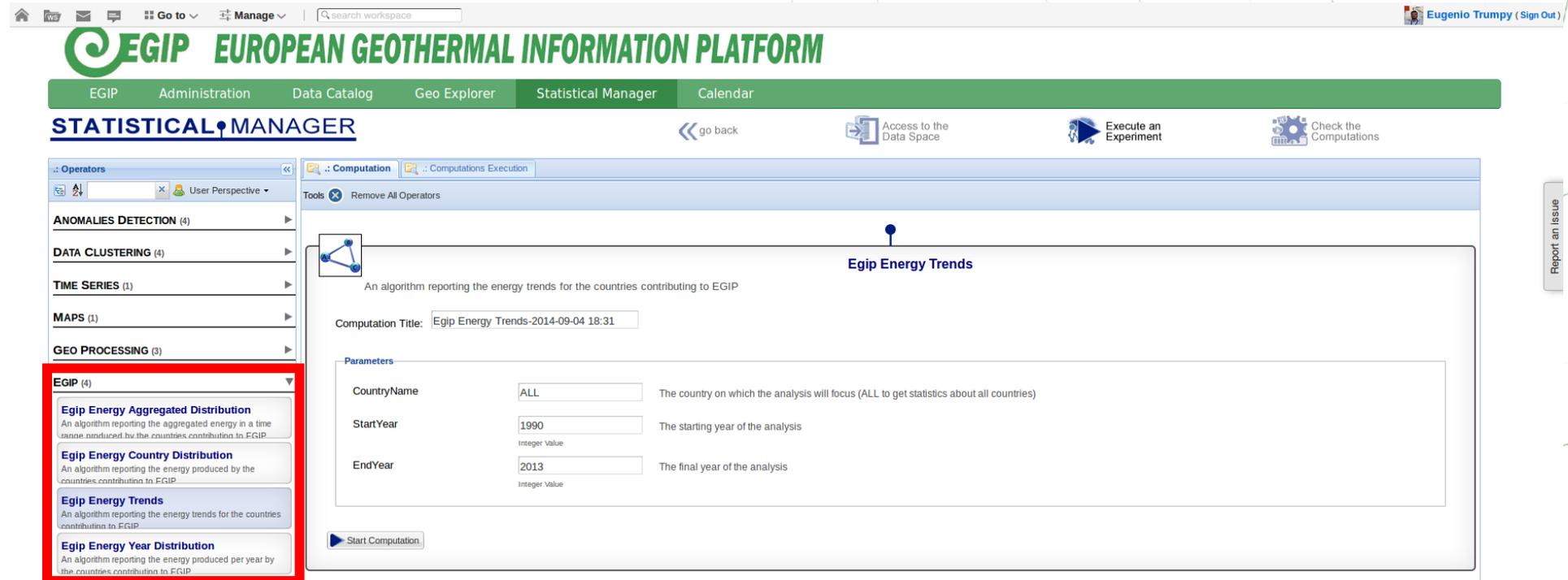
Opacity
and
legend

• 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

The screenshot displays the EGIP Statistical Manager interface. The main content area shows a histogram chart titled "Histogram Chart" with the subtitle "MegaWatt Electrical". The chart displays energy production trends per country and year. The Y-axis represents energy production in MegaWatt Electrical, ranging from 0 to 900. The X-axis lists countries: France, Slovakia, Netherlands, Iceland, Slovenia, Hungary, Italy, Switzerland, Germany, and Turkey. The legend indicates the years 1990, 1995, 2000, 2005, 2010, and 2013. The chart shows that Italy and Turkey have the highest energy production, with Italy's production increasing significantly over the years. The text "The computation Egip Energy Year Distribution finished." and "The algorithm produced Multiple Results." is displayed above the chart.

Country	1990	1995	2000	2005	2010	2013
France	~5	~5	~5	~5	~5	~5
Slovakia	~5	~5	~5	~5	~5	~5
Netherlands	~5	~5	~5	~5	~5	~5
Iceland	~5	~5	~5	~5	~5	~5
Slovenia	~5	~5	~5	~5	~5	~5
Hungary	~5	~5	~5	~5	~5	~5
Italy	~550	~650	~750	~800	~850	~880
Switzerland	~5	~5	~5	~5	~5	~5
Germany	~5	~5	~5	~5	~5	~5
Turkey	~5	~5	~5	~5	~5	~5

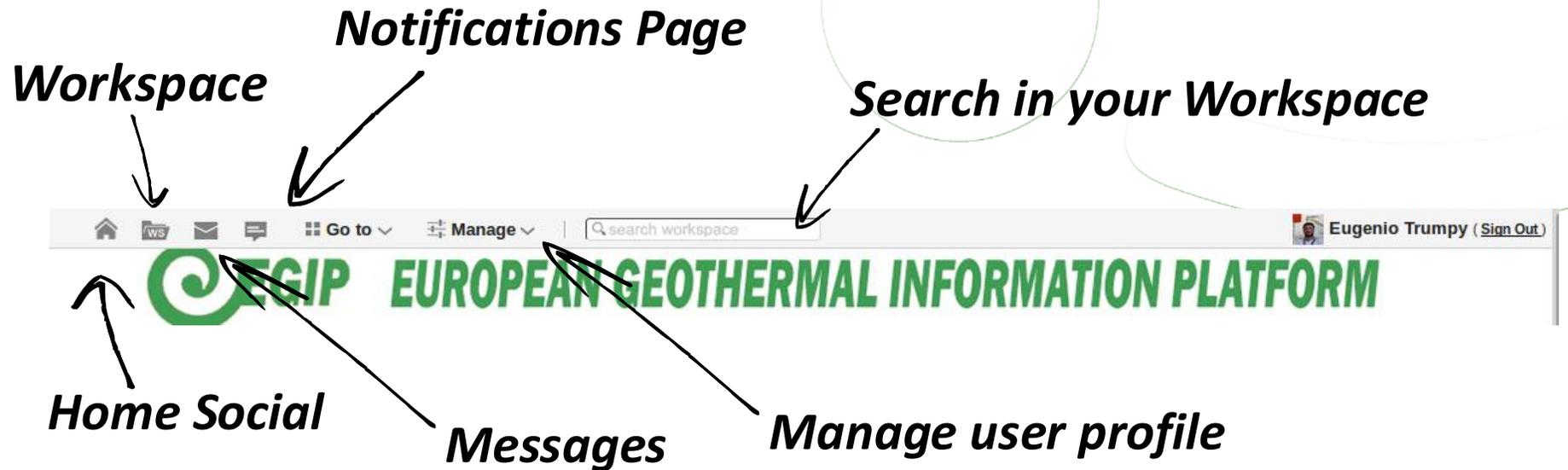
- Collect and aggregate Information
- Energy Production Trends per country and year

Case I

EGIP platform: Collaborative environment

A single place to

- Manage all the portal extension

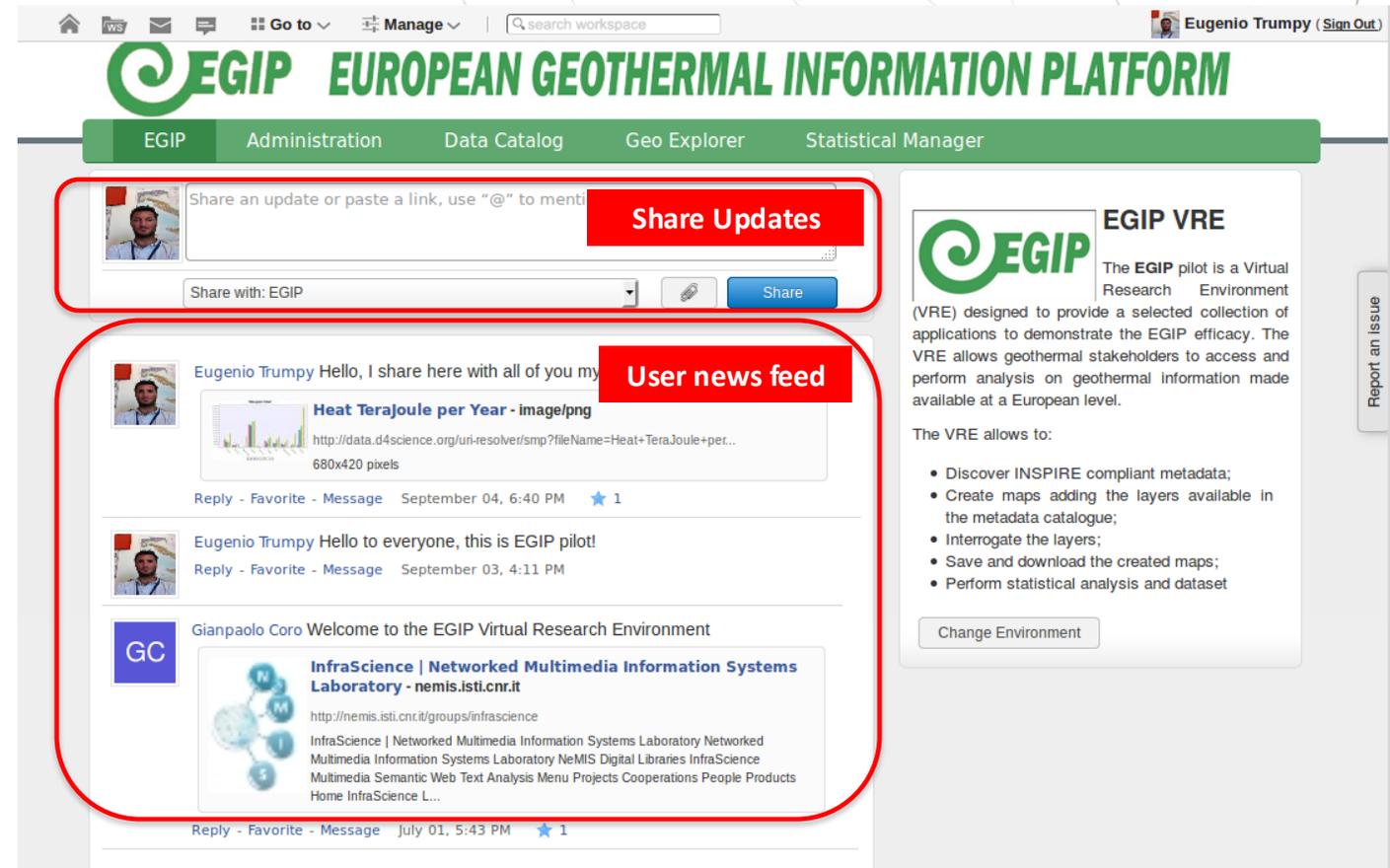


Case I

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.



The screenshot displays the EGIP (European Geothermal Information Platform) interface. At the top, the navigation bar includes 'EGIP', 'Administration', 'Data Catalog', 'Geo Explorer', and 'Statistical Manager'. A user profile for 'Eugenio Trumpy' is visible in the top right corner. The main content area is divided into two sections:

- Share Updates:** A red-bordered box highlights a text input field with the placeholder 'Share an update or paste a link, use "@" to mention...' and a 'Share Updates' button. Below it is a 'Share with: EGIP' dropdown and a 'Share' button.
- User news feed:** A red-bordered box highlights a list of user posts. The first post is from Eugenio Trumpy, dated September 04, 6:40 PM, with 1 star. It includes a profile picture, a text message 'Hello, I share here with all of you my', and a link to a 'Heat Terajoule per Year' image. The second post is also from Eugenio Trumpy, dated September 03, 4:11 PM, with the text 'Hello to everyone, this is EGIP pilot!'. The third post is from Gianpaolo Coro, dated July 01, 5:43 PM, with 1 star, featuring a 'GC' logo and a link to 'InfraScience | Networked Multimedia Information Systems Laboratory'.

On the right side, there is a section titled 'EGIP VRE' (Virtual Research Environment) with a list of capabilities: 'Discover INSPIRE compliant metadata;', 'Create maps adding the layers available in the metadata catalogue;', 'Interrogate the layers;', 'Save and download the created maps;', and 'Perform statistical analysis and dataset'. A 'Change Environment' button is located below this list. A vertical 'Report an issue' button is on the far right edge.

Case I

EGIP platform: Collaborative environment Workspace



Document metadata – Standard Dublin Core



*EGIP documents
categories*

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

The screenshot shows the EGIP workspace interface. At the top, there is a navigation bar with 'Home' and 'Profile' tabs. Below it, a breadcrumb trail reads 'Workspace > VRE Folders > EGIP > Regulatory aspects > Italy > Grid access'. A search bar is located above the main content area. On the left, a file tree shows the following structure:

- Workspace
 - VRE Folders
 - BiodiversityLab
 - EGIP
 - Code
 - Economic aspects
 - Regulatory aspects
 - France
 - Environmental
 - Grid Access
 - Licensing
 - Italy
 - Environmental
 - Grid access
 - Delibera ARG-et 33-08
 - Delibera ARG-et 99-08
 - Delibera n. 281-05
 - Delibera n. 281-07 Obblighi di reg
 - Deliberazione 22 dicembre 2011
 - DELIBERAZIONE 26 LUGLIO 20
 - Licensing
 - Research
 - Scientific and Technical Aspects
 - share_brgm_cnr
 - Skills, employees and Energy need
 - Social aspects
 - Training & Education

The main content area displays a table of documents:

Name	Owner	Type	Last Update	Size
Delibera ARG-et 33-08	Eugenio Trumpy		02 Sep 10:34 AM...	1 KB
Delibera ARG-et 99-08	Eugenio Trumpy		02 Sep 10:34 AM...	1 KB
Delibera n. 281-05	Eugenio Trumpy		02 Sep 10:34 AM...	1 KB
Deliberazione 22 dicembre 2011 - ARG-et 187-11	Eugenio Trumpy		02 Sep 10:36 AM...	1 KB
DELIBERAZIONE 26 LUGLIO 2012 328-2012-R-eel	Eugenio Trumpy		02 Sep 10:36 AM...	1 KB
Delibera n. 281-07 Obblighi di registrazione delle interruzioni d...	Eugenio Trumpy		02 Sep 10:43 AM...	1 KB

At the bottom of the screenshot, there is a footer with the text: 'Liferay Portal | GCube Framework | Contact Us'.

- 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



pilot

<http://egip.igg.cnr.it>



- 
- The background of the slide is the flag of the European Union, featuring a circle of twelve gold stars on a blue field. In the center of the flag, there is a list of three items, each preceded by a white bullet point.
- 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”

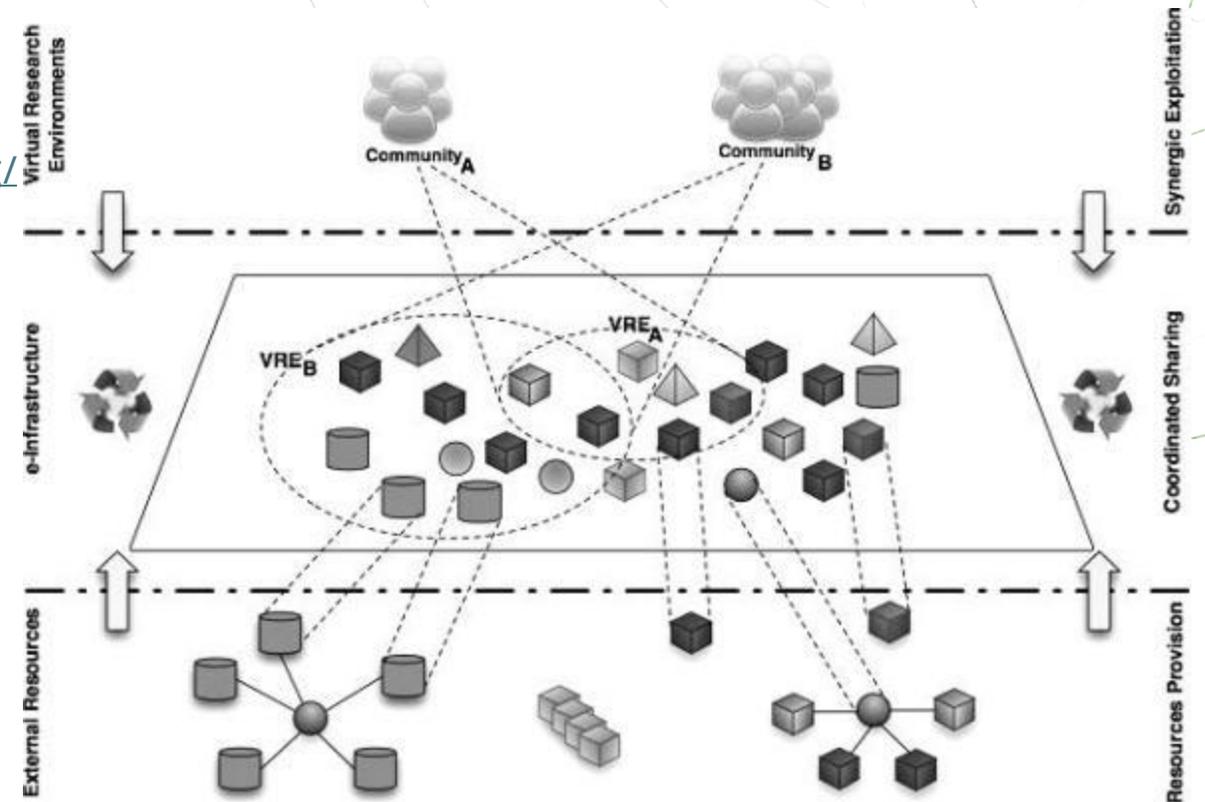
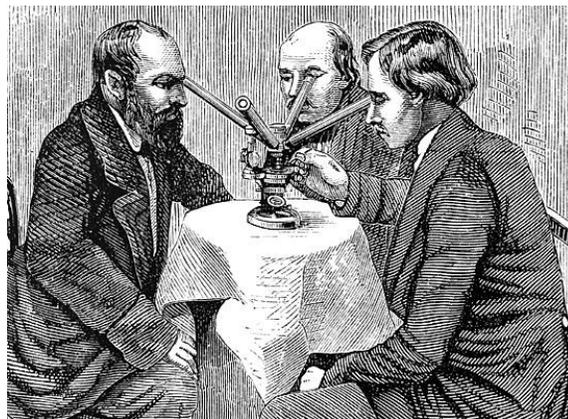
The European Commission’s Framework Programme for Research and Technological Development has **promoted the development and deployment of e-Infrastructures**, in order to **strengthen scientific excellence**, and to promote **innovation** and **industrial competitiveness**.

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.

“**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:

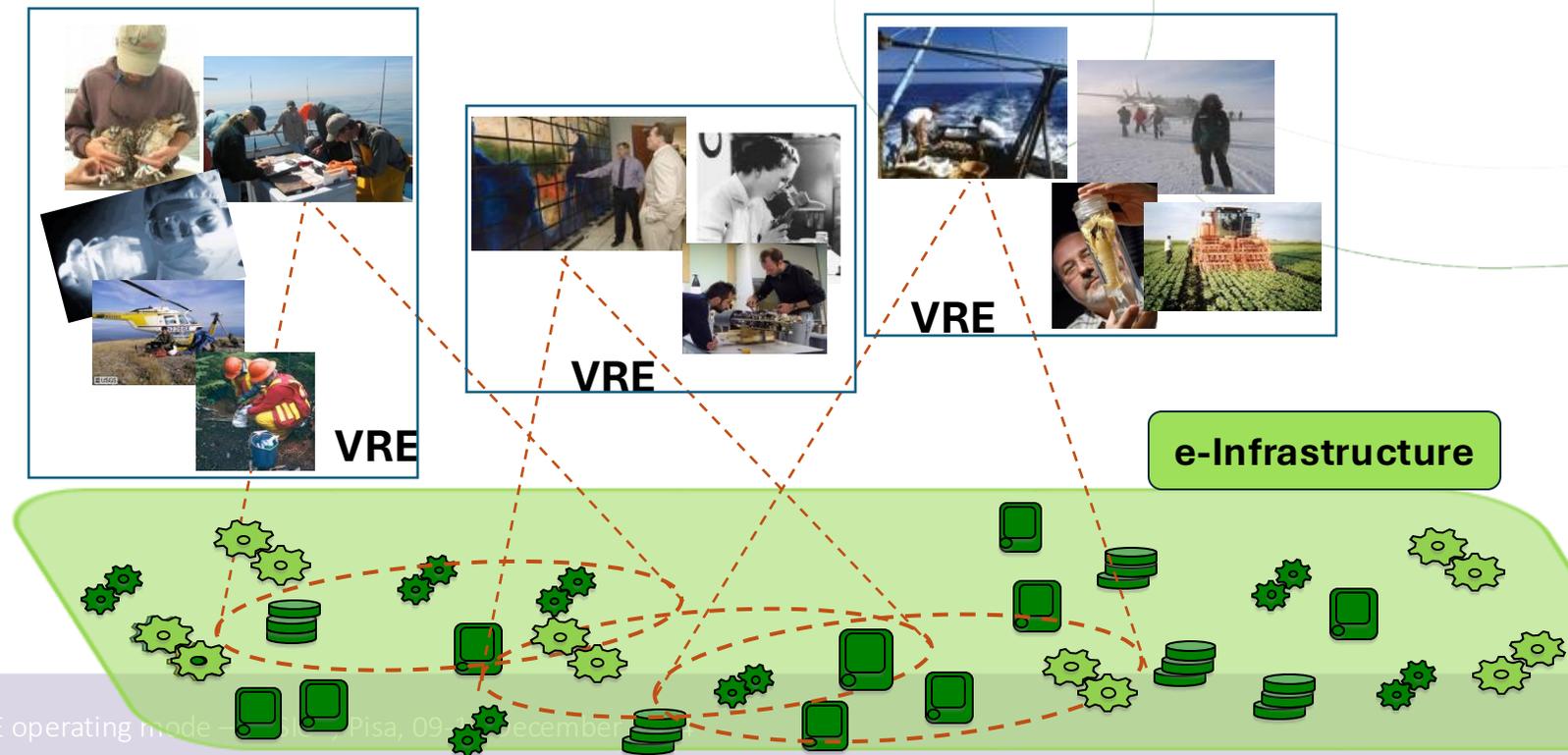
*Belief, <http://www.beliefproject.org/>
 OpenAire, <http://www.openaire.eu/>
 i-Marine, <http://www.i-marine.eu/>
 EU-Brazil OpenBio, <http://www.eubrazilopenbio.eu/>



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



Powered by D4SCIENCE INFRASTRUCTURE

DESCRAMBLE Project Gateway Explore Virtual Research Environments gCube 4.0

Go to [User] [adele manzella]

About DESCRAMBLE Project Gateway

This gateway is an access point to a Virtual Research Environment (VRE) deployed and operated in the context of **DESCRAMBLE EU-project** to support participants in data and information management and collaboration.

The Virtual Research Environments are "systems" per-se aiming at providing their users with a web-based working environment offering the entire spectrum of applications and facilities (including services, data and computational facilities) needed to accomplish a given task. They offer specialized functionalities for the management, processing, and visualization of scientific data and textual content.

The DESCRAMBLE dedicated VRE is used as working platform by the project partners to facilitate discussion, collaboration, data sharing and general project management, providing a comprehensive suite of tools, which support a collaborative, standards oriented data publication environment.

This gateway exploits the services offered by the high performance e-Infrastructure made available by the federation and integration of the resources provided by the DESCRAMBLE consortium (e.g., catalogue of data).

The gateway offers various applications to community members and facilities for collaboration, such as Collaborative Shared Workspace. Please **register** (by clicking on **Create Account**) to use the offered services.

The gateway and the D4Science infrastructure are developed and operated by using the gCube technology.

Contact Us | Terms of Use | Cookies Policy | Privacy Policy

Statistics

Your Stats in DESCRAMBLE

POSTS 0 GOT 0

Share updates

Share an update or a link, use "@" to mention

Share with: DESCRAMBLE + Notification to members

News feed

RB Ruggiero Bertani test of dummy T&P tool last week we placed the dummy tool @

MP maddalena pennisi Sampling of the Larc Zuccantine wells, performed by the lgg-

Recent Documents

- DESCRAMBLE-presentation-tem... readme.txt
- Veloc-poster-29-7-2016.pdf
- TUBAF_veloc_model_08_05_201...
- Project factsheet 640573-DE...
- visual_aids.zip

Show all ...

Token Generator

Your Token

.....

Show

Documents

Name	Owner	Type	Last Update	Size
Grant Agreement-640573-DESCRAMBLE.pdf	Eugenio Trumpy	application/pdf	24 Jun 04:14 PM 2015	5,788 KB
gant.pdf	Eugenio Trumpy	application/pdf	24 Jun 04:30 PM 2015	111 KB
DESCRAMBLE_Consortium Agreement.pdf	Ruggiero Bertani	application/pdf	25 Jun 10:11 AM 2015	1,825 KB
DESCRAMBLE report - word template.docx	Eugenio Trumpy	application/...	13 Jan 05:15 PM 2016	1,321 KB
DESCRAMBLE report - word template.dot	Eugenio Trumpy	application/...	13 Jan 05:15 PM 2016	1,388 KB
DESCRAMBLE-presentation-template.pptx	adele manzella	application/...	31 Aug 11:01 AM 2016	208 KB

Folders

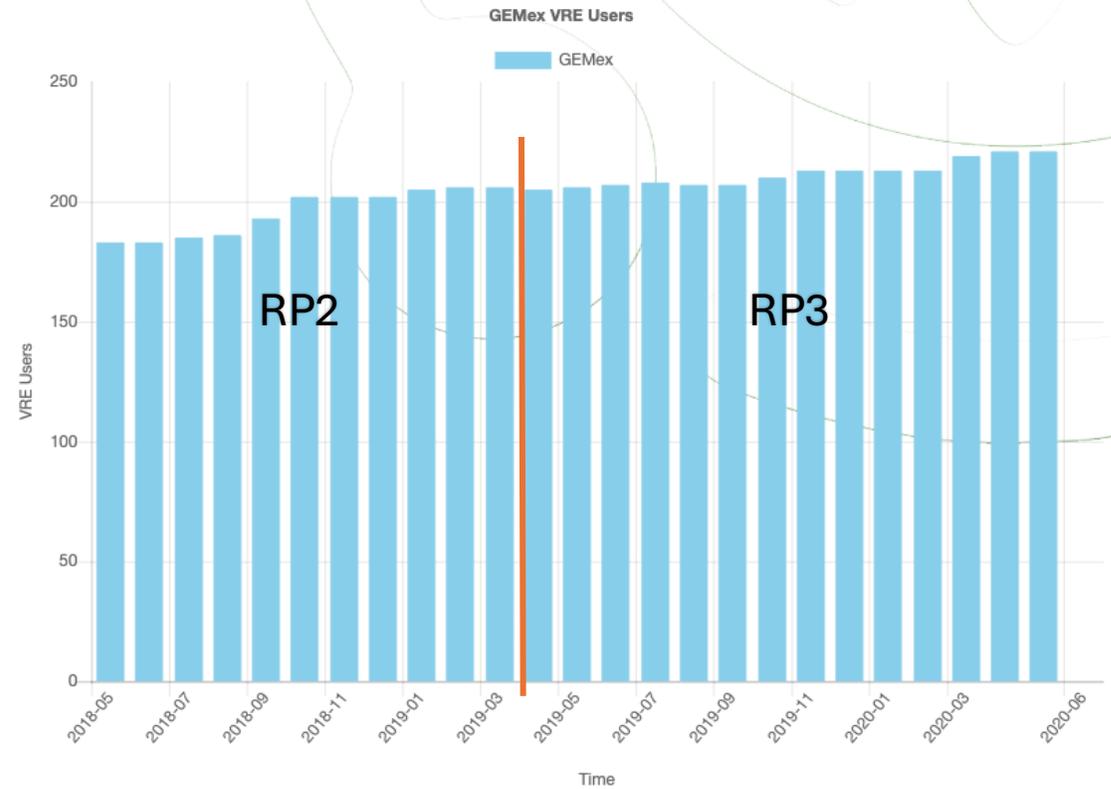
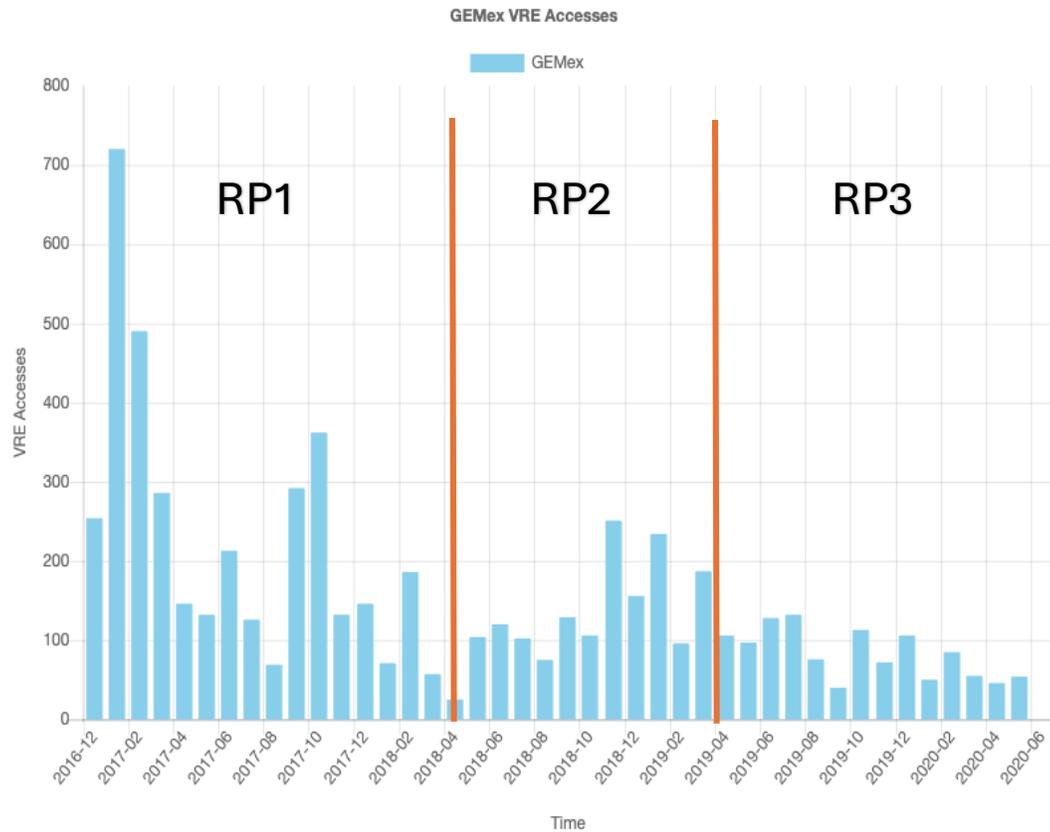
Name	Owner	Type	Last Update
GA_single_parts	Eugenio Trumpy	FOLDER	24 Jun 04:15 PM 2015
NDA	Eugenio Trumpy	FOLDER	24 Jun 04:22 PM 2015
logos	Eugenio Trumpy	FOLDER	24 Jun 04:28 PM 2015
Proposal	Ruggiero Bertani	FOLDER	25 Jun 10:20 AM 2015
Financing	Ruggiero Bertani	FOLDER	25 Jun 10:24 AM 2015

Tree

- adele's workspace
 - VRE Folders
 - DESCRAMBLE
 - Deliverables
 - H2020 material
 - Project_documents
 - WP1_Management
 - WP2_Well Drilling
 - WP3_Special_instruments_tools
 - WP4_Reservoir_characterization
 - WP5_Reservoir_modelling
 - WP6_Dissemination
 - EGIP

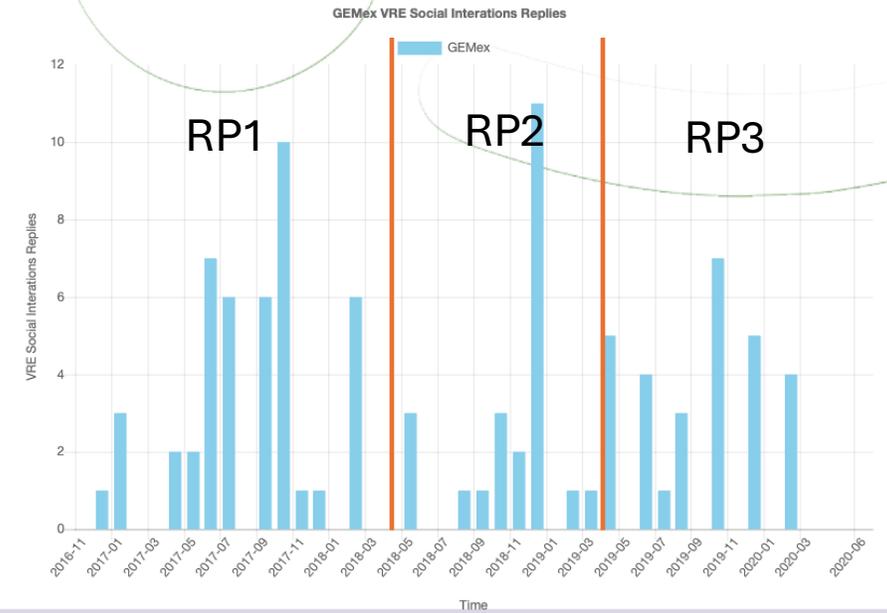
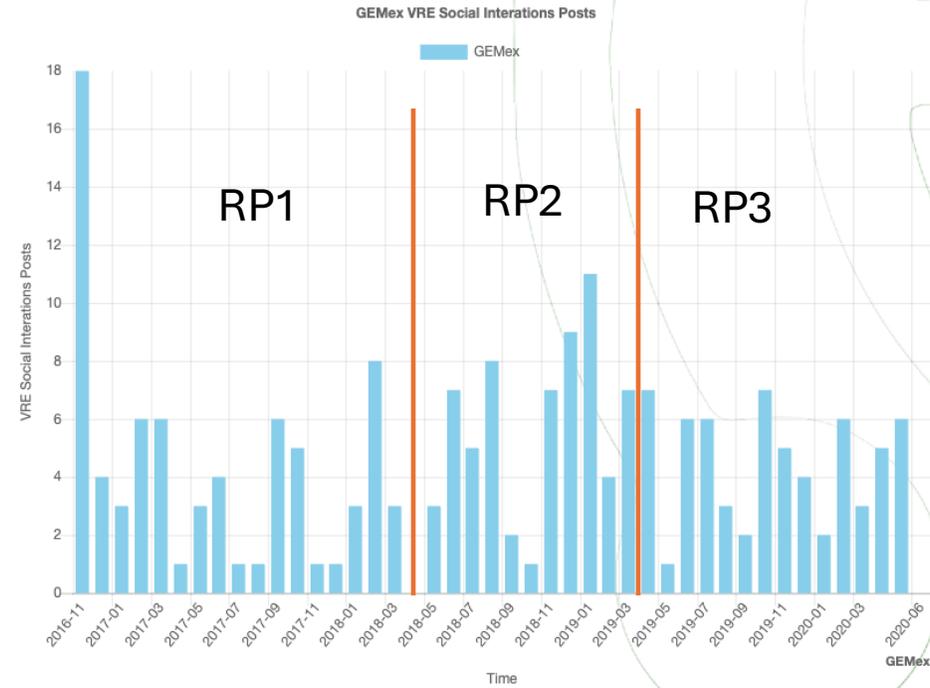
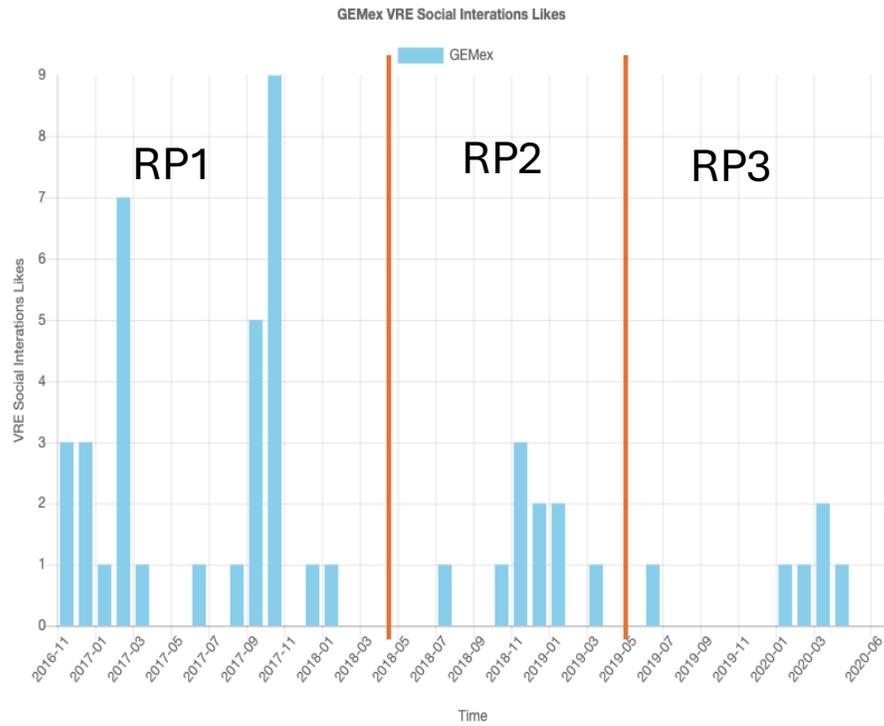
Case III

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

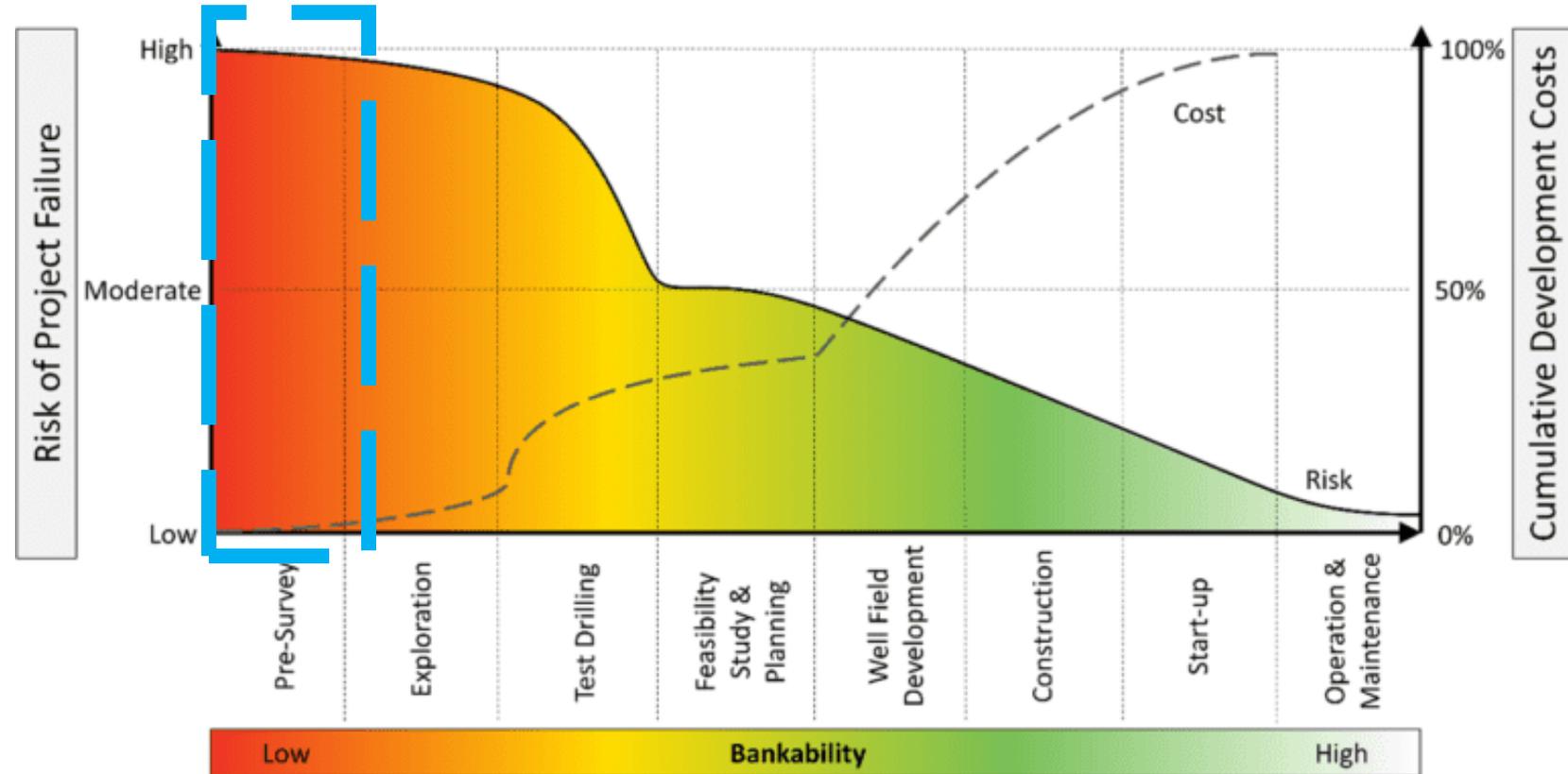


Using AI to predict global geothermal suitability for power generation

Eugenio Trumpy, Gianpaolo Coro

Case II

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

- MaxEnt is applicable to general problems where a probability function $\pi(\bar{x})$ 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

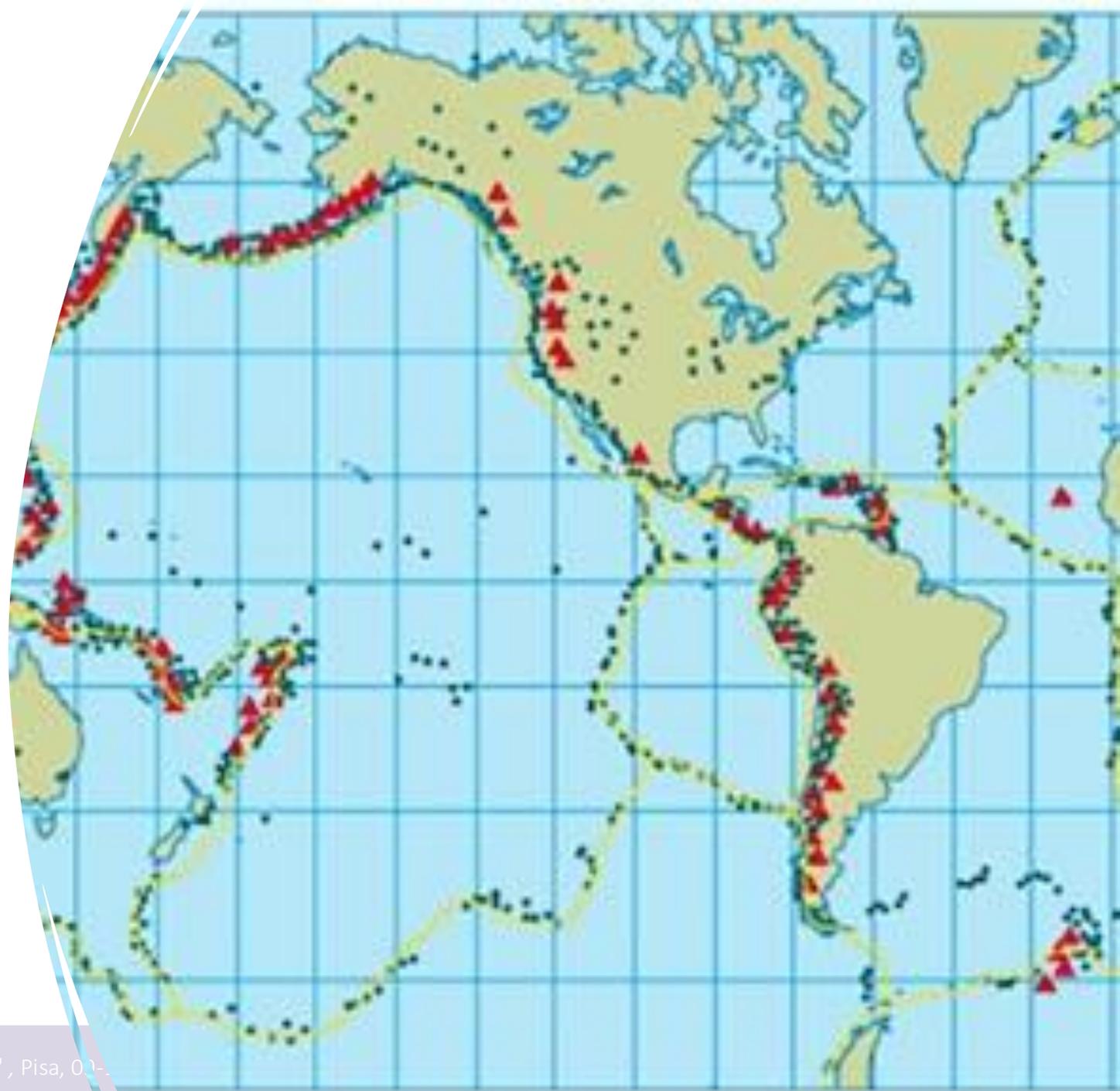


$$H(\hat{\pi}) = - \sum_{x \in X} \hat{\pi}(x) \ln \hat{\pi}(x)$$

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.(angstrom)
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



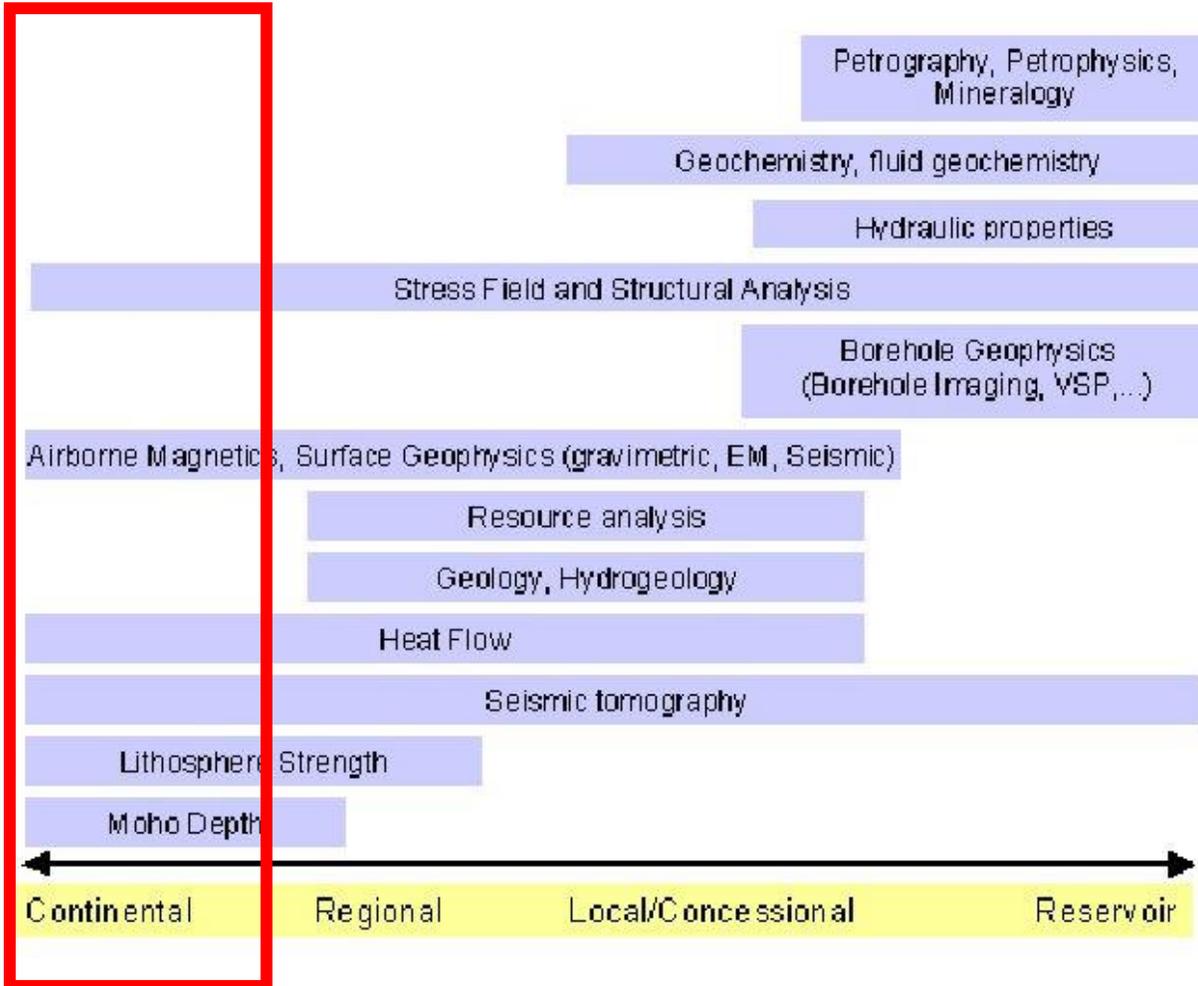
Open Science approach



- ✓ **Reproducibility, Repeatability, and Re-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

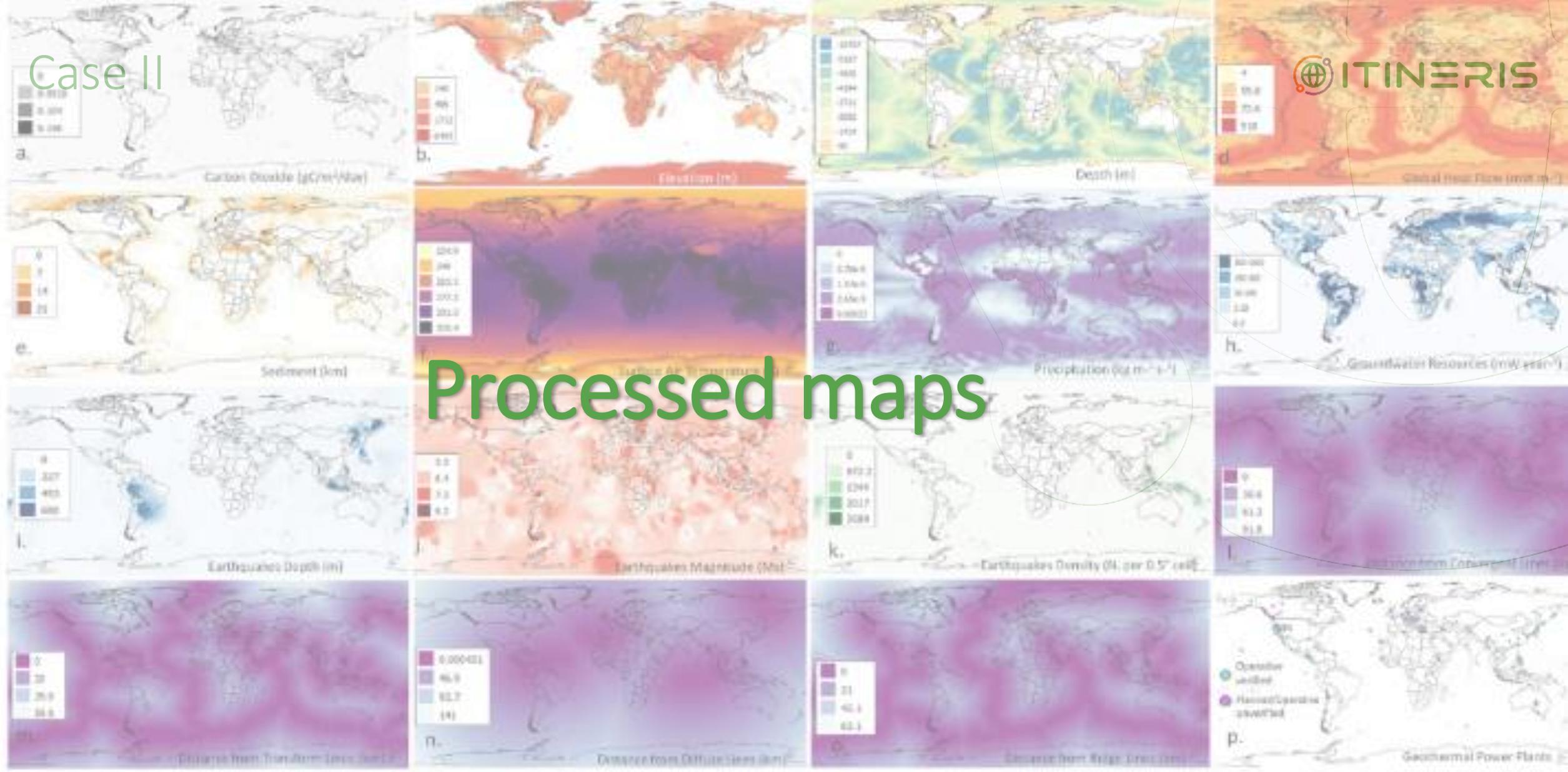
Case II

Environmental parameters



- Carbon Dioxide ($\text{gC/m}^2/\text{day}$) [*Copernicus Atm. Monit. Sys.*]
- Elevation (m) [*United States National Geophysical Data Center*]
- Depth (m) [*United States National Geophysical Data Center*]
- Global Heat flow (mW m^{-2}) [*Davies 2013*]
- Sediment thickness (km) [*Laske 1997*]
- Surface air temperature (K) [*NASA*]
- Precipitation ($\text{kg m}^{-2}\text{s}^{-1}$) [*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*]

Case II



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 temperature, (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 and planned geothermal power plants. communities: "VRE operating mode – BASIC", Pisa, 09-12 December 2024

Case II

Biodiversity Lab

- Data miner
- Workspace

The screenshot shows the D4Science.org Gateway Dashboard. The top navigation bar includes 'BiodiversityLab', 'Members', 'Data Miner', 'Software Importer', 'Catalogue', 'R Studio 4', and 'Giant Squid History'. The 'Data Miner' section is active, displaying a list of operators on the left and a detailed configuration page for 'Max Ent Niche Modelling' on the right.

Operators List:

- BAYESIAN METHODS (6)**
 - Faomsy**: An algorithm to be used by Fisheries managers for stock assessment. Estimates the Maximum Sustainable Yield (MSY) of a stock, based on a catch trend. The alg...
 - Feed Forward A N N Distribution**: A Bayesian method using a Feed Forward Neural Network to simulate a function from the features space (R^n) to R. A modeling algorithm that relies on Neural N...
 - Feed Forward Neural Network Regressor**: The algorithm simulates a real-valued vector function using a trained Feed Forward Artificial Neural Network and returns a table containing the function actu...
 - Feed Forward Neural Network Trainer**: The algorithm trains a Feed Forward Artificial Neural Network using an online Back-Propagation procedure and returns the training error and a binary file con...
- Lwr**: An algorithm to estimate Length-Weight relationship parameters for marine species, using Bayesian methods. Runs an R procedure. Based on the Cube-law theory.
- Feed Forward Neural Network Regressor**: The algorithm simulates a real-valued vector function using a trained Feed Forward Artificial Neural Network and returns a table containing the function actu...
- Feed Forward Neural Network Trainer**: The algorithm trains a Feed Forward Artificial Neural Network using an online Back-Propagation procedure and returns the training error and a binary file con...
- Lwr**: An algorithm to estimate Length-Weight relationship parameters for marine species, using Bayesian methods. Runs an R procedure. Based on the Cube-law theory.
- Max Ent Niche Modelling**: A Maximum-Entropy model for species habitat modeling, based on the implementation by Shapire et al. v 3.3.3k, Princeton University, <http://www.cs.princeton.e...>

Max Ent Niche Modelling Configuration:

Parameters:

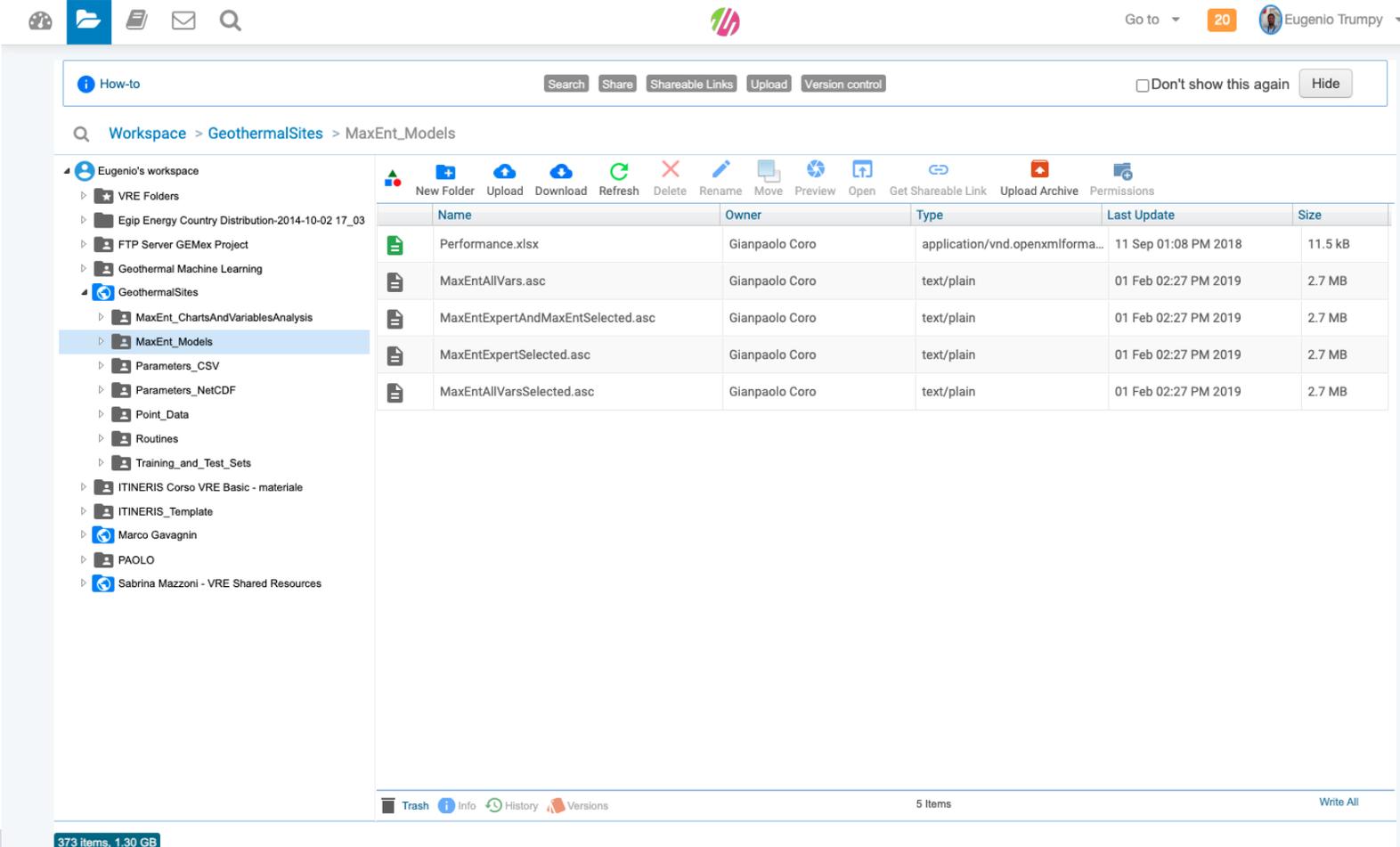
- OutputTableLabel:** maxent_ (String Value) The name of the table to produce
- SpeciesName:** generic_species (String Value) The name of the species to model and the occurrence records refer to
- MaxIterations:** 1000 (Integer Value) The number of learning iterations of the MaxEnt algorithm
- DefaultPrevalence:** 0.5 (Double Value) A priori probability of presence at ordinary occurrence points
- OccurrencesTable:** [Select Data Set] A geospatial table containing occurrence records, following the template of the Species Products Discovery datasets [a http link to a table in UTF-8 encoding following this template: (OCCURRENCE_SPECIES) <http://goo.gl/4ExuRS>]
- LongitudeColumn:** [Select table from parameter OccurrencesTable] The column containing longitude values [the name of a column from OccurrencesTable]
- LatitudeColumn:** [Select table from parameter OccurrencesTable] The column containing latitude values [the name of a column from OccurrencesTable]
- XResolution:** 1 (Double Value) Model projection resolution on the X axis in decimal degrees
- YResolution:** 1 (Double Value) Model projection resolution on the Y axis in decimal degrees
- Layers:** [Select] The list of environmental layers to use for enriching the points. Each entry is a layer Title or UUID or HTTP link. E.g. the title or the UUID (preferred) of a layer indexed in the e-Infrastructure on GeoNetwork - You can retrieve it from GeoExplorer. Otherwise you can supply the direct HTTP link of the layer. The format will be guessed from the link. The default is GeoTiff. Supports several standards (NETCDF, WFS, WCS, ASC, GeoTiff). E.g. <https://dl.dropboxusercontent.com/u/12809149/wind1.tif> [a sequence of values separated by ;]
- Z:** 0 (Double Value) Value of Z. Default is 0, that means environmental layers processing will be at surface level or at the first available Z value in the layer
- TimeIndex:** 0 (Integer Value) Time Index. The default is the first time indexed in the input environmental datasets

Start Computation

Case II

BiodiversityLab

- Data miner
- **Workspace**



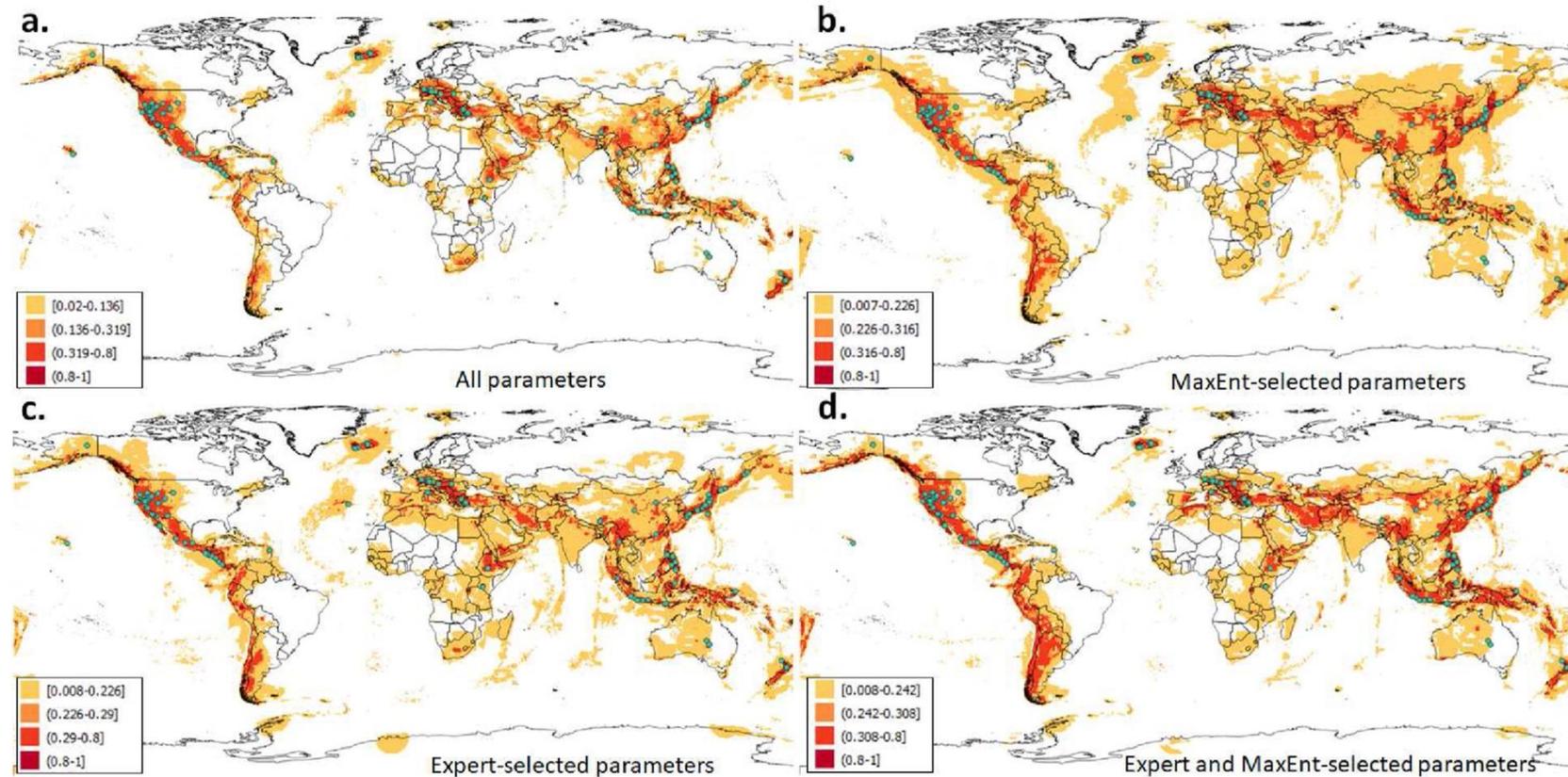
The screenshot shows a cloud workspace interface. On the left is a file explorer showing a tree structure under 'Eugenio's workspace'. The 'GeothermalSites' folder is expanded, and 'MaxEnt_Models' is selected. The main area displays a table of files with columns for Name, Owner, Type, Last Update, and Size.

Name	Owner	Type	Last Update	Size
Performance.xlsx	Gianpaolo Coro	application/vnd.openxmlforma...	11 Sep 01:08 PM 2018	11.5 kB
MaxEntAllVars.asc	Gianpaolo Coro	text/plain	01 Feb 02:27 PM 2019	2.7 MB
MaxEntExpertAndMaxEntSelected.asc	Gianpaolo Coro	text/plain	01 Feb 02:27 PM 2019	2.7 MB
MaxEntExpertSelected.asc	Gianpaolo Coro	text/plain	01 Feb 02:27 PM 2019	2.7 MB
MaxEntAllVarsSelected.asc	Gianpaolo Coro	text/plain	01 Feb 02:27 PM 2019	2.7 MB

At the bottom of the interface, it shows '373 items, 1.30 GB' and '5 Items' in the trash.

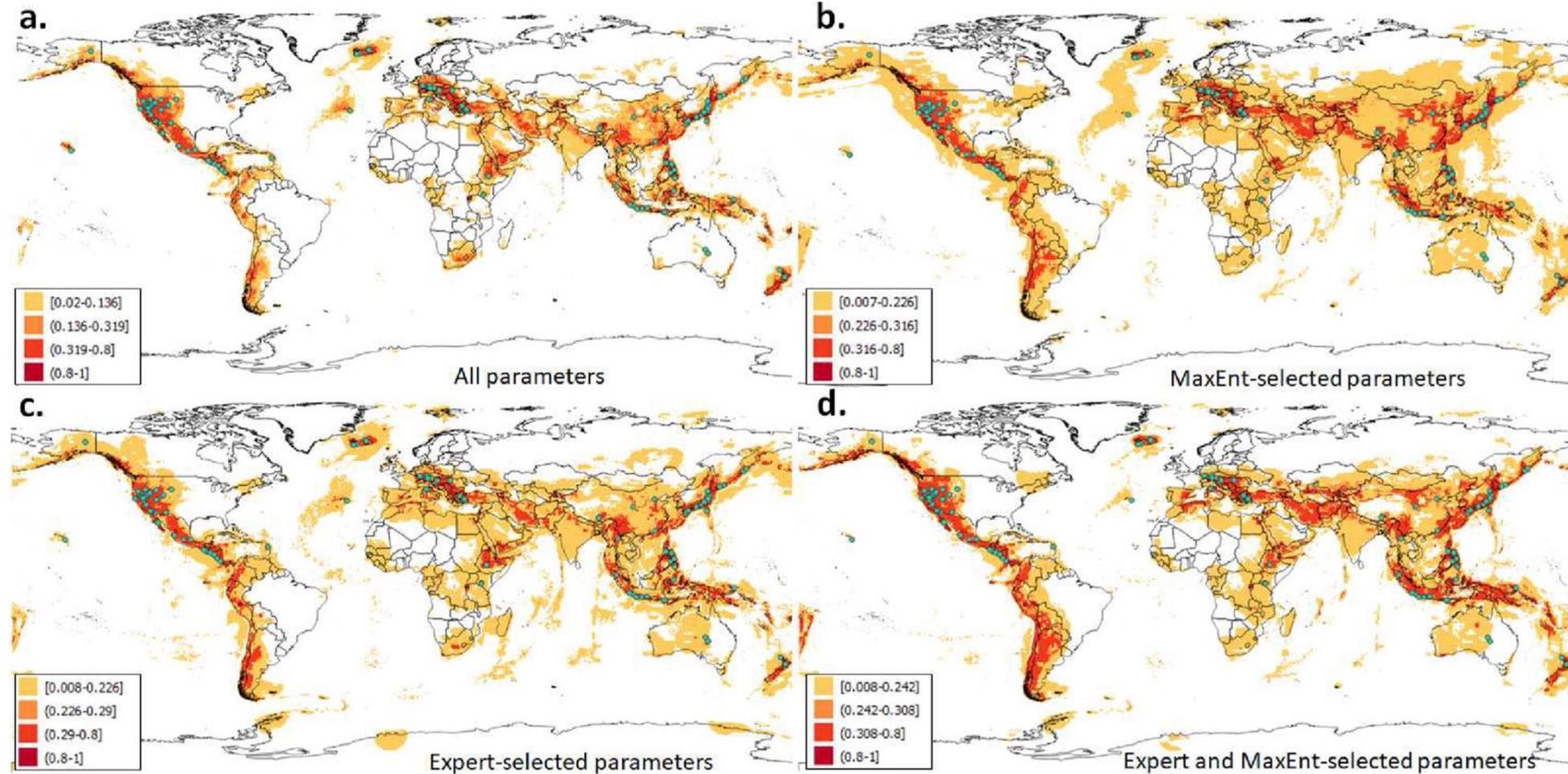
Models

- 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

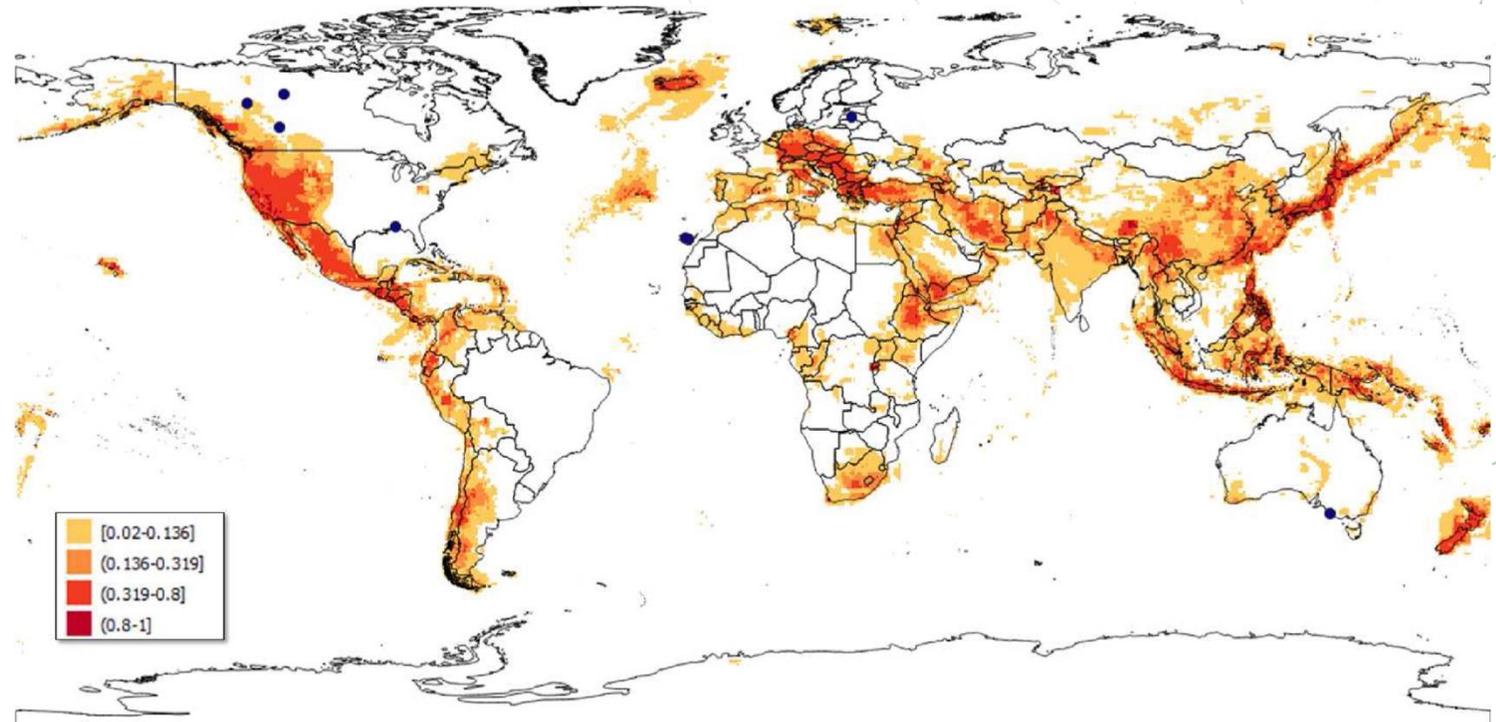


Results

- 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%

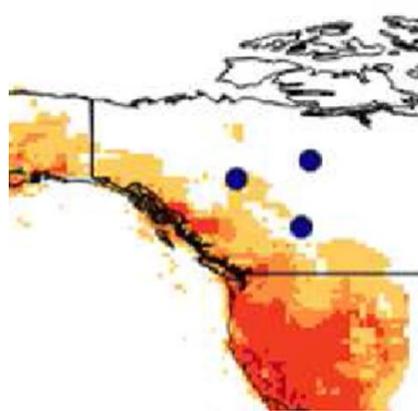


Case II

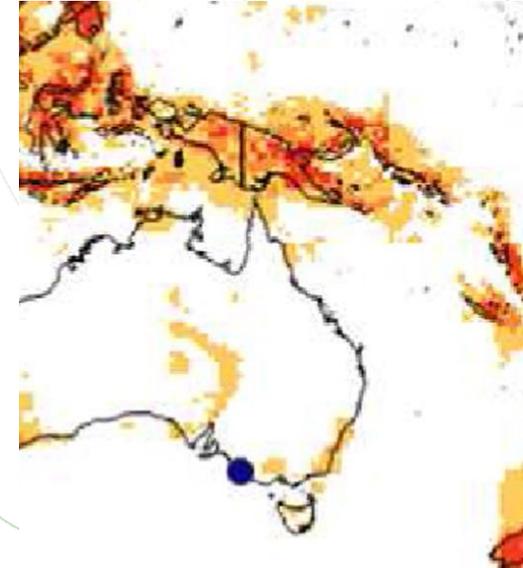
Discarded sites

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



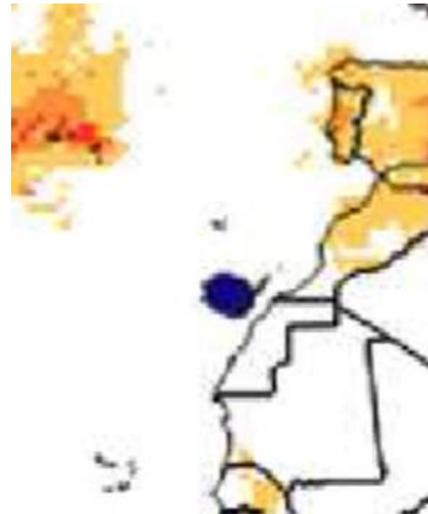
- more distant from diffuse lines
- more groundwater resources / precipitation
- lower surface / air temperature / earthquake density
- low permeability resulted by the demonstration project

Case II

Discarded sites

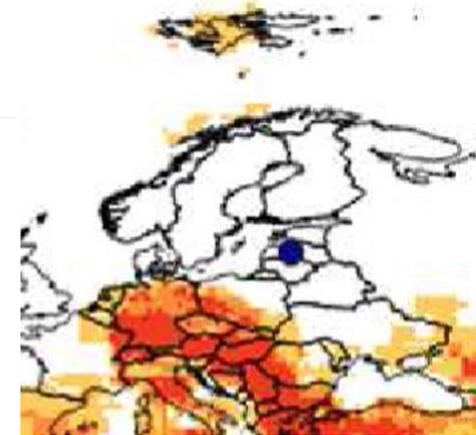
Canary Islands: Gran Canaria, Tenerife

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



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

Latvia: Riga



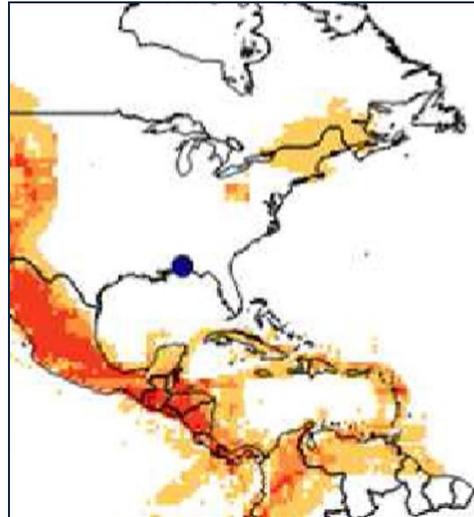
- lower heat flow / CO₂
- longer distance from convergent lines
- higher earthquake magnitude

Case II

Discarded 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!

IR0000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System
(D.D. n. 130/2022 - CUP B53C22002150006) Funded by EU - Next Generation EU PNRR-
Mission 4 "Education and Research" - Component 2: "From research to business" - Investment
3.1: "Fund for the realisation of an integrated system of research and innovation infrastructures"

