

Database on environmental matters

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Author(s): Annick Loschetter¹, Julie Maury¹, Camille Maurel¹, Jérémie Treil¹, Auður Agla Óladóttir², Árni Ragnarsson², Steinunn Hauksdóttir², Guillaume Ravier³

Author'(s) affiliation: ¹BRGM, France; ²ISOR, Island, ³ES-G

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Executive summary

This document aims at presenting the online database developed in the framework of H2020-GEOENVI project. The object of this database is to organise the information collected in work package 2 of this project. The decision was made to produce an online database to diffuse it more largely.

The database contains information about environmental matters regarding deep geothermal. When looking at these environmental concerns users can be looking for two types of information:

- A list of general environmental concern related to deep geothermal
- Information regarding the environmental concern of a specific geothermal site

That is why this database is organised in two parts, one part about general information, regrouping the work done in the other tasks of this work package and one part on specific site information that aims at being fed continuously by the deep geothermal community.

In the general part, the work of other tasks of this work package (Manzella et al., 2020; Ragnarsson et al., 2020) are regrouped and organised in a more user-friendly way, making links between topics and allowing classification with filters.

The site database contains site information that can be classified by filters. These site data are general information on sites as well as links or documents on environmental concerns such as impact assessment or life-cycle analysis (LCA).

Introduction

The objective of this report is to present the main features of the database that is published online (<https://geoenvi.brgm.fr/>) and is the core of deliverable D2.4. The database will summarize the collection of data presented in other deliverables of WP2. It is comprised of different tabs that will be filled out during the GEOENVI project and onward.

The main content of the database is contained in two tabs: a) a site database, and b) a generic database on environmental matters.

The preliminary version of the database includes data from the sites selected for LCA purposes of the GEOENVI project. Input of data into the database will be completed during the lifetime of the GEOENVI project where geothermal developers will be encouraged to add information on present and new deep geothermal sites. For each site, there is the possibility to enter a summary of the operation as well as technical information. Furthermore, environmental documents such as life cycle studies or environmental impact assessments can be uploaded. Since some of these documents will be in the language of the relevant country where the site is located, a summary of these documents can be added in English. Very little information is mandatory for adding a new document so not to discourage people from adding sites.

The results from deliverables from the work done in tasks 2.1 and 2.2 of WP2 of the GEOENVI project (Manzella et al., 2020; Ragnarsson et al., 2020) is presented in tabs for information on environmental aspects. The content is though organised in a way that is more appropriate for a website, with filters and links to other pages. To date, only the basic structure is presented here but, a summary of the information from D2.1 (Ragnarsson et al, 2020) will be added as specific pages for each subject.

The homepage of the database presents briefly the project and its objectives and refers to the GEOENVI website for further information (Figure 1).



Figure 1: Homepage of the site database with the different tabs.

Further information is provided in sheets accessible with tabs that are available at the top of the page (Figure 1).

Besides the main contents mentioned previously, the site database and information on environmental aspects, there is a sheet with information on perception of some of the environmental risks and impacts described.

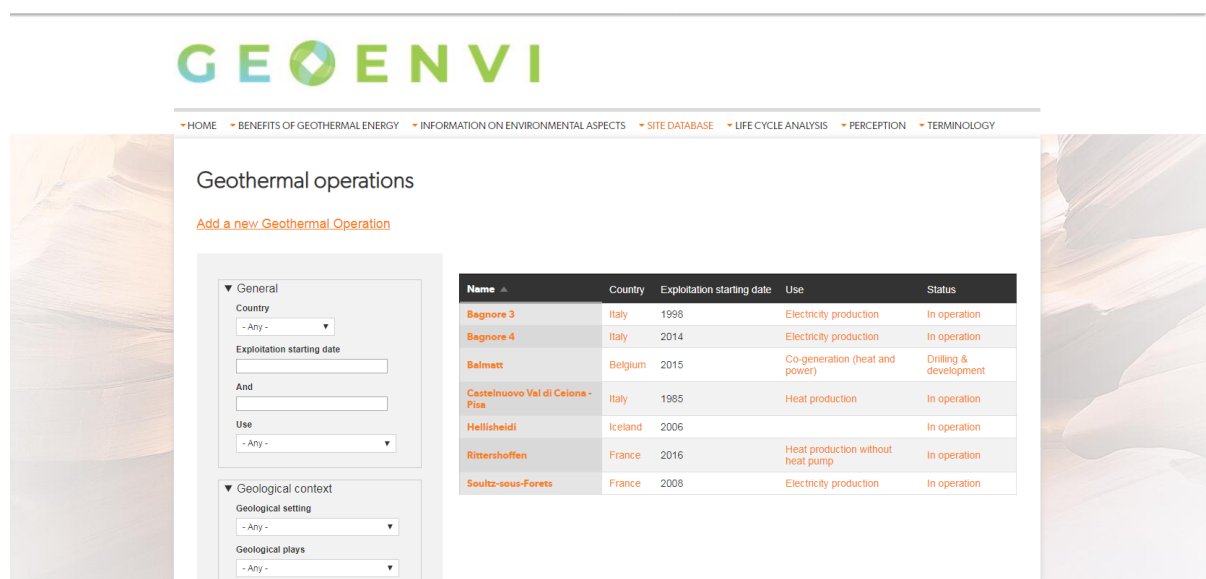
Another sheet is describing the main benefits of deep geothermal energy, based on published information to date.

Finally, a sheet on terminology is present containing the glossary from the D2.1 report (Ragnarsson et al, (2020). Its aim is to explain the technical terms used.

In this report, the following chapters will present each sheet with screenshot from the website database.

Site database

The site database (<https://geoenvi.brgm.fr/operations>) currently features information on the sites selected for LCA in the GEOENVI project (Figure 2). It consists of a list of sites and the filters available on the left to restrain the search are related to general information, geology of the area, reservoir characteristics or operations.



The screenshot shows the GEOENVI website interface. At the top, there is a navigation menu with links: HOME, BENEFITS OF GEOTHERMAL ENERGY, INFORMATION ON ENVIRONMENTAL ASPECTS, SITE DATABASE (highlighted), LIFE CYCLE ANALYSIS, PERCEPTION, and TERMINOLOGY. Below the menu, the page title is 'Geothermal operations'. There is a link 'Add a new Geothermal Operation'. On the left, there are filters under 'General' and 'Geological context'. The 'General' filters include 'Country' (dropdown menu), 'Exploitation starting date' (text input), 'And' (text input), 'Use' (dropdown menu), and 'Status' (dropdown menu). The 'Geological context' filters include 'Geological setting' (dropdown menu) and 'Geological plays' (dropdown menu). On the right, there is a table of geothermal sites.

Name	Country	Exploitation starting date	Use	Status
Bagnore 3	Italy	1998	Electricity production	In operation
Bagnore 4	Italy	2014	Electricity production	In operation
Balmatt	Belgium	2015	Co-generation (heat and power)	Drilling & development
Castelnuovo Val di Celona - Pisa	Italy	1985	Heat production	In operation
Hellisheidl	Iceland	2006	Heat production without heat pump	In operation
Rittershoffen	France	2016	Heat production without heat pump	In operation
Soultz-sous-Forêts	France	2008	Electricity production	In operation

Figure 2: Site database tab with the sites selected for WP3. Filters are available on the left-hand side of the webpage

By clicking on the name for each site, it is possible to access further information (Figure 3), as well as upload environmental documents publicly available. These documents are generally in the language of the country where the site is located. Furthermore, links to published articles on environmental matters concerning these sites are also provided.

Rittershoffen

General information about the site

Description of the geothermal plant

The heat plant of Rittershoffen has been developed in order to supply Roquette Frères Company, a bio-refinery, with geothermal heat for their industrial processes. This industrial user, located in Beinheim, France, totals 100 MW_{th} of thermal needs. The geothermal heat plant, with an installed capacity of 24 MW_{th}, is then providing the totality of its heat production to this company via an isolated heating transport loop of 15 km length. The geothermal brine is produced at a temperature of 170°C from a production well, GRT-2 at 2700 m depth, penetrated into Triassic sedimentary layers and the top crystalline fractured basement interface. The geothermal brine is flowing through a system of twelve consecutive tubular heat exchangers and is fully reinjected without additional pumps at 80°C into one injection well, GRT-1, at 2500 m depth. The reinjection temperature is linked to the return temperature of the transport loop. The flow rate of the brine is regulated at 70-75 kg/s by a Downhole production Line Shaft Pump. The geothermal plant has been successfully producing heat since June 2016 under commercial conditions.

Presentation of the site



General documentation and bibliography

Mouchot, J., Ravier, G., Seibel, O. & Pratiwi, A. Deep Geothermal Plants Operation in Upper Rhine Graben: Lessons Learned. Eur. Geotherm. Congr. 2019, Den Haag, Netherlands, 11-14th June 2019 11-14 (2019).

Baujard, C., Genter, A., Cuenot, N., Mouchot, J., Maurer, V., Hehn, R., Ravier, G., Seibel, O., Vidal, J. Experience learnt from a successful soft stimulation and operational feedback after 2 years of geothermal power and heat

Environmental related documents

Life cycle analysis

Bibliography on LCA

Baujard, C., Genter, A., Graff, J.-J., Maurer, V. & Dalmais, E. ECOGI, a New Deep EGS Project in Alsace, Rhine Graben, France. World Geotherm. Congr. 2015 6 (2015).

Pratiwi, A. S., Ravier, G., Genter, A. & Le, B. Innovative Tool for Life-cycle CO₂ Emissions Calculation of Geothermal Plants in Upper Rhine Valley. GRC 31-44 (2018).

Pratiwi, A., Ravier, G. & Genter, A. Life-cycle climate-change impact assessment of enhanced geothermal system plants in the Upper Rhine Valley. Geothermics 75, 26-39 (2018).
<https://www.sciencedirect.com/science/article/pii/S0375650517302912>

Environment impact assessments

Environment impact assessments files

[Etude d'Impact Rittershoffen summary.pdf](#)

[Etude d'Impact Rittershoffen.pdf](#)

Reservoir characteristics

Depth of top reservoir formation (m b.g.l.): 1900

Average reservoir thickness (m): 1000.00

Reservoir temperature (°C): 170.00

Reservoir pressure at datum (bars): 191.80

Reference depth for pressure (m b.g.l.): 1848.00

Productivity index (m³/h/bar): 12.50000

Figure 3: Description of Rittershoffen site. Environmental documents in pdf format are available.

How to add a new plant in the database

To add a new site the following environmental information is required:

- Information about site location, site name and nearest town
- Environmental information regarding the site: results for LCA, environmental impact study, environmental risk analysis, etc. This information may be a document (pdf format) to be uploaded or a link to a published article, report...)
- Optionally (but recommended) more detailed information on the geothermal site such as description, type of operation, reservoir characteristics, geology, etc.

Before a new site is added an account must be created. This account will then be validated by an administrator. This step was implemented to avoid robot adding non-relevant information, but not barring that anyone can create an account.

Once an account has been created and the relevant person is logged in, the link “add a new site” will appear on the site database sheet. By clicking on this link, a form will be appear where information and documents can be added (Figure 4). This new addition will be validated before being published. This includes the verification that the environmental information is relevant to a specific site (e.g. published article, impact assessment that is a requirement of the licensing...). This process is explained in more detail in the tab “How to add a new site” on the website.

Create Geothermal operation ☆

Home > Node > Add content

GENERAL *

Name of operation site *

Source of information

Privacy

- None -

Country *

- Select a value -

Location *

(e.g. town, region)

Language used for documentation

- None -

Albanian

Austro-Bavarian

Bulgarian

Exploitation starting date

(e.g. 1985)

Use

- None -

User

- None -

Information filling date

Figure 4: Form to add a new site. Red stars indicate mandatory information.

Information on environmental aspects

Information on environmental aspects (https://geoenvi.brgm.fr/environmental_aspects) is a database containing generic information on deep geothermal concerns. Environmental concerns from geothermal development can be categorized in various ways. In this report and in general for the GEOENVI project, environmental concerns have been categorized based on safeguard subjects, i.e., endpoint indicators, emphasizing environmental burdens. Any environmental phenomena, risk or impact, can be represented by a sequence of events, which consist of:

1. An initiating mechanism, located upstream and constituting a cause of the modifications;
2. An impacting phenomenon resulting from this cause that can harm people or the environment;
3. The potential effects on people or the environment.

The whole chain of events is represented with three lines (Figure 5). The top line concerns the potential causes, the middle line contains the environmental events or impacting phenomena and the bottom line contains the potential environmental consequences.

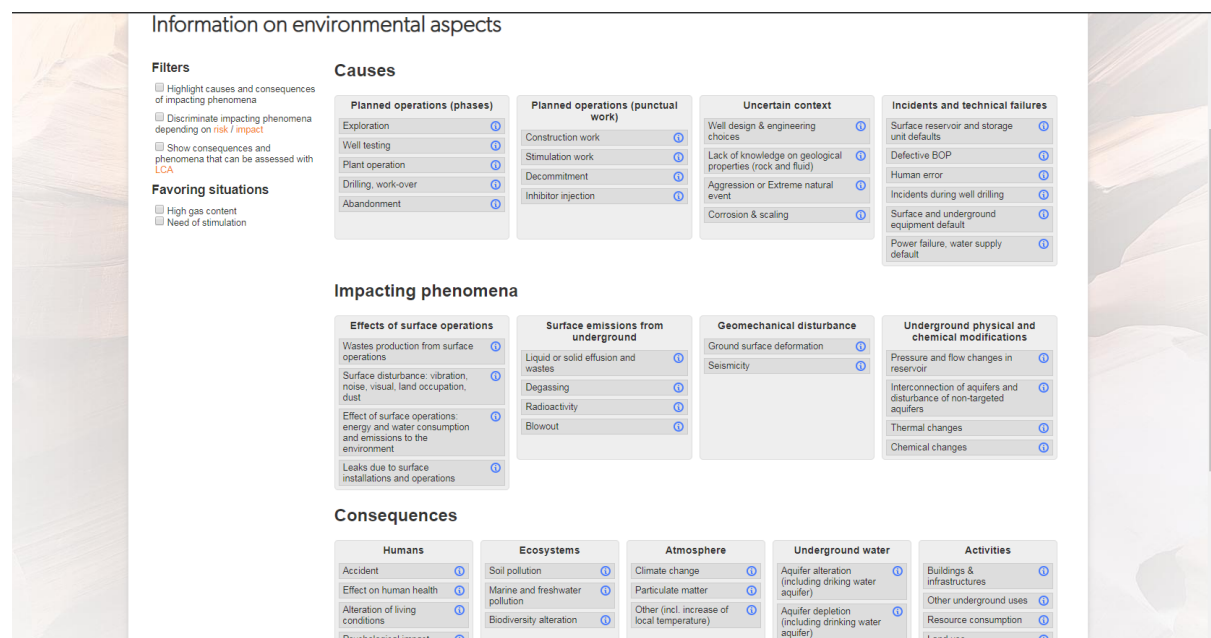

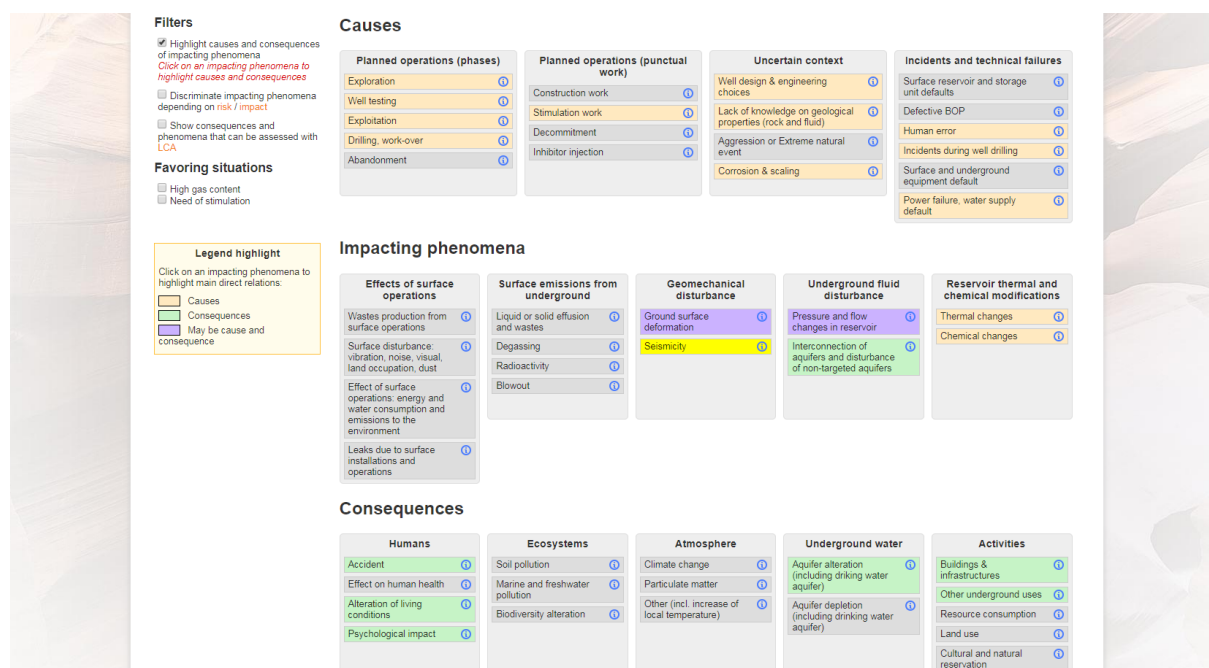


Figure 5: Environmental aspects, representing the potential causes, events and consequences.

By clicking on  a page containing information on the corresponding topic will appear, once it has been filled. It will contain a summary of information provided in D2.1 (Ragnarsson et al 2020) and D2.2 (Manzella et al 2020).

Using the filter “Highlight causes and consequences of impacting phenomena”, and by clicking on an impacting phenomena, it is possible to see its causes and consequences if nothing is done to prevent or control it (Figure 6).



Filters

- ☒ Highlight causes and consequences of impacting phenomena
- ☐ Discriminate impacting phenomena depending on risk / impact
- ☐ Show consequences and phenomena that can be assessed with LCA

Favoring situations

- ☐ High gas content
- ☐ Need of stimulation

Legend highlight

Click on an impacting phenomena to highlight main direct relations:

- Causes
- Consequences
- May be cause and consequence

Causes

- Planned operations (phases)**
 - Exploration
 - Well testing
 - Exploitation
 - Drilling, work-over
 - Abandonment
- Planned operations (punctual work)**
 - Construction work
 - Stimulation work
 - Decommissioning
 - Inhibitor injection
- Uncertain context**
 - Well design & engineering choices
 - Lack of knowledge on geological properties (rock and fluid)
 - Aggression or Extreme natural event
 - Corrosion & scaling
- Incidents and technical failures**
 - Surface reservoir and storage unit defaults
 - Defective BOP
 - Human error
 - Incidents during well drilling
 - Surface and underground equipment default
 - Power failure, water supply default

Impacting phenomena

- Effects of surface operations**
 - Wastes production from surface operations
 - Surface disturbance: vibration, noise, visual, land occupation, dust
 - Effect of surface operations: energy and water consumption and emissions to the environment
 - Leaks due to surface installations and operations
- Surface emissions from underground**
 - Liquid or solid effusion and wastes
 - Degassing
 - Radioactivity
 - Blowout
- Geomechanical disturbance**
 - Ground surface deformation
 - Seismicity
- Underground fluid disturbance**
 - Pressure and flow changes in reservoir
 - Interconnection of aquifers and disturbance of non-targeted aquifers
- Reservoir thermal and chemical modifications**
 - Thermal changes
 - Chemical changes

Consequences

- Humans**
 - Accident
 - Effect on human health
 - Alteration of living conditions
 - Psychological impact
- Ecosystems**
 - Soil pollution
 - Marine and freshwater pollution
 - Biodiversity alteration
- Atmosphere**
 - Climate change
 - Particulate matter
 - Other (incl. increase of local temperature)
- Underground water**
 - Aquifer alteration (including drinking water aquifer)
 - Aquifer depletion (including drinking water aquifer)
- Activities**
 - Buildings & infrastructures
 - Other underground uses
 - Resource consumption
 - Land use
 - Cultural and natural reservation

Figure 6: Causes and consequences of seismicity.

The filter “Discriminate impacting phenomena depending on risk / impact” allows to see which impacting phenomena is a risk and which one is an impact or if it can be both (Figure 7). The definition of risk and impact is given in the terminology tab.

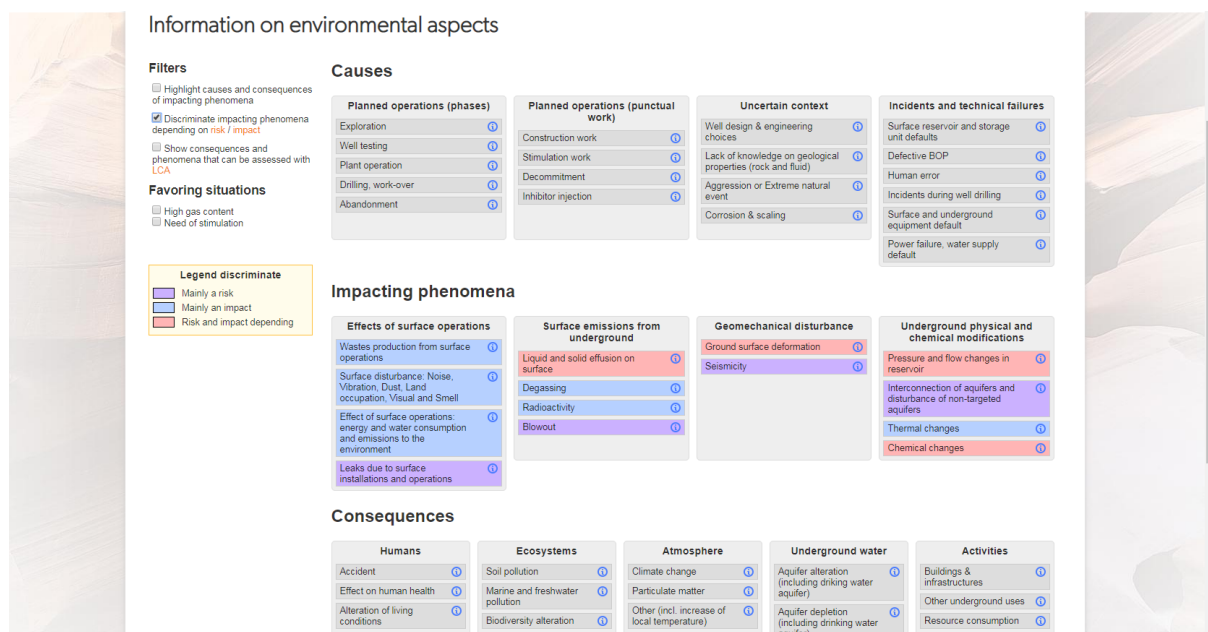


Figure 7: Identification of risks and impacts.

Finally, the filter “Show consequences and phenomena that can be assessed with LCA” show the items that are assessed during the process of LCA (details are given in D3.1) (Figure 8).

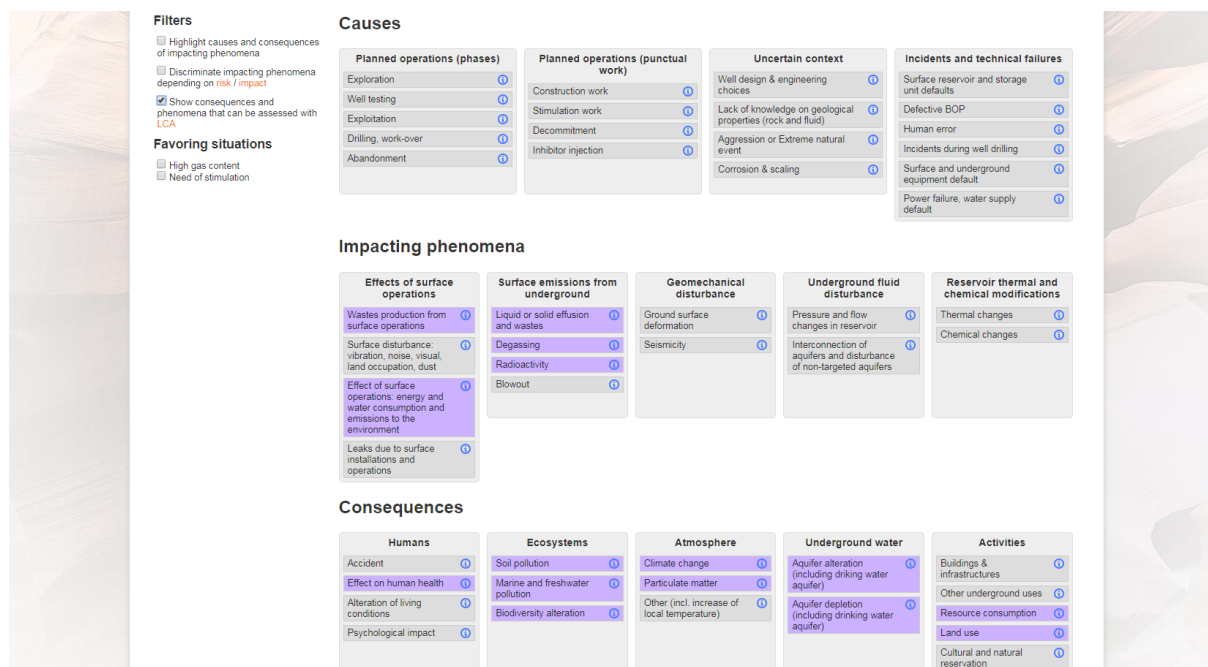


Figure 8: Consequences that are assessed during LCA.

Favoring situations will be added as a filter. This will allow for the impacting phenomena related to specific context (e.g. geology or technology) to be selected.

Benefits of geothermal energy

A sheet describing the benefits of geothermal energy (<https://geoenvi.brgm.fr/page/benefits-geothermal-energy>) is available on the homepage of the website in one of the tabs (Figure 9). It is a summary based on previously published documents where some of the many advantages of geothermal energy is described. The purpose of this is to have information about the benefits readily available, to complement the environmental concerns that are generally focusing on the disadvantages.



Figure 9: Benefits of geothermal energy.

Conclusion

This online database that is the deliverable D2.4 in WP2 is formed of two parts: a generic database on environmental concerns related to deep geothermal and a site-specific database. Exhaustive generic information on environmental concerns with related risks and impacts is available, covering all kind of contexts and this part of the database will later include information from the results of other WPs of the GEOENVI project. Information will be added into the site-specific database further on by deep geothermal actors but for now it has information about sites that are being studied within the GEOENVI project.

Various filters will later be implemented to be able to search these databases.

Bibliography

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- Ragnarsson, Á., Óladóttir, A.A., Hauksdóttir, S., Maury, J., Maurel, C., Manzella, A., Ámannsson, H., Drouin, V., Haraldsdóttir, S.H., Guðjónsdóttir, S.R., Guðgeirsdóttir, G., Bianchi, F., Bonini, B., Botteghi, S., Bustaffa, E., Cori, L., Del Ventisette, C., Giamberini, M.S., Gorini, F., Lelli, M., Montanari, D., Minichilli, F., Montegrossi, G., Scrocca, D., Chiarabba, C., Lattanzi, P., Pandeli, E., Manfrida, G., Fiaschi, D., Parisi, M.L., Tosti, L., Harcouet-Menou, V., Bos, S., Luchini, M., Lenzi, A., Montomoli, S., Paci, M., Taccone, R., Batini, F., Bosia, C., Cuenot, N., Maurer, V., Ravier, G., Dumas, P., Gök, O., Aksoy, N., Nador, A., 2020. Report on environmental concerns Overall state of the art on deep geothermal environmental data - GEOENVI projet (GEOENVI).



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