Hydrogeological processes and geological settings over Europe controlling dissolved geogenic and anthropogenic elements in groundwater of relevance to human health and the status of dependent ecosystem

Deliverable 3-1

Database for concentrations of dissolved elements and associated parameters and harmonized terminology to define thermal and mineral water (Database and associated technical report)

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1 INTRODUCTION

This deliverable is part of the Work Package 3 (WP3) in the Horizon2020 GeoERA project HOVER running from 2018 – 2022 with the title: Hydrogeological processes and Geological settings over Europe controlling dissolved geogenic and anthropogenic elements in groundwater of relevance to human health and the status of dependent ecosystems. The HOVER project addresses groundwater management issues related to drinking water, human and ecosystem health across Europe in relation to both geogenic elements and anthropogenic pollutants by data sharing, technical and scientific exchange between European Geological Survey Organizations (GSO).

HOVER WP3 deals with Hydrogeochemistry and health: Mapping groundwater characteristics for the management of aquifers naturally enriched in dissolved elements. WP3 consists of five tasks:

3.1 Harmonization of terminology, inventory of available information on mineral, thermal and highly mineralized groundwater.
3.2 Defining lithological/geological water families based on information available at EU Scale.
3.3 Proposing a common methodology to calculate the national concentration of dissolved.
elements based on lithological/geological families taking into account possible anthropogenic influences.
3.4 Natural background levels and health – determination and selection of indicators for GW management.
3.5 Preparing and producing maps, web map service and associated explanatory Information.

An overview of participating countries/regions is found in Figure 1.

Aims of Task 3.1:

1- To build up a **harmonized terminology for characterising natural mineral waters and thermal waters** as there exist different national classifications.
The terminology will take account of water temperature, outflow, pressure, mineralization (also highly mineralized groundwaters) including gas content, purity, residence time and utilization.
2- To build an **overview on the national approaches concerning the definition of geogenic anomalies of dissolved elements in groundwater**. Therefore, parameters and data existing in each country should be listed. The result will be an inventory of available data.
3- To create a **harmonized nomenclature for the „GeoERA Information Platform", WP4 „Semantic harmonization issues" with focus on natural mineral water and thermal waters**.

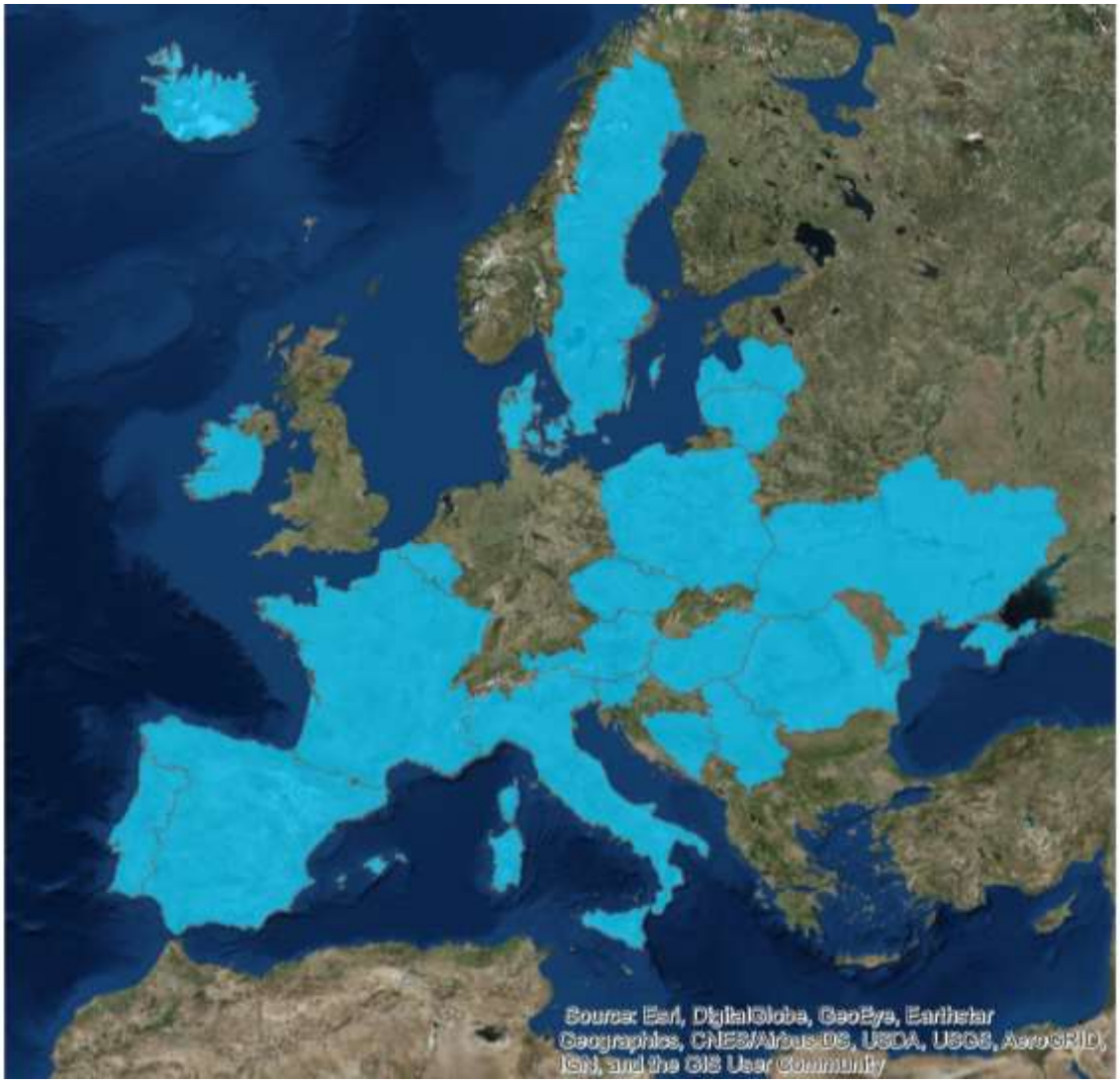

Figure 1: Overview of participating countries in HOVER WP3.

2 WORK FLOW

According to the proposal, it is aimed to conduct an investigation based on sending out questionnaires and additional personal contacts in order to clarify open questions.

In detail, the following work flow is realized:

1- To conduct a **specific WP3 questionnaire** in addition to the WP3 general questionnaire **to investigate used terminologies and available data in participating countries/regions**.
See chapter 3, appendix 7.1 and attachment A1

   a. To **provide an overview of available information on natural mineral and thermal waters.** This will be realized from the evaluation of the specific questionnaire.
   See chapter 3.1, chapter 3.2 and attachment A1
   b. To **provide an overview of available hydrochemical data (main and trace elements) for observation wells and springs**. This will be realized from the evaluation of the specific questionnaire.
   See chapter 3.3 and attachment A1

2- To **propose a database structure for the collection of data on natural mineral waters and thermal waters** based upon the results from the specific questionnaire. Hereby, **harmonization of data is most important**. Remarks from participating surveys to the suggested database structure have to be considered
See chapter 4.1 and attachment A2.

3- To start **data collection on natural mineral waters and thermal waters** based on
   a. the proposed **database structure**
   See chapter 4.2, 7.2 and attachment A2.
   b. and **brief written overviews** (approx. 500 words) about natural mineral water and thermal water resources in each participating country/region. Those include national definitions, quantitative and qualitative information and descriptions of hydrogeological settings.
   See chapter 5

3 RESULTS FROM SPECIFIC QUESTIONNAIRE

The respond rate to the specific questionnaire was excellent, 100 % of the participating surveys contributed to the questionnaire. See Appendix 6.1. for the questions.

3.1 Natural mineral waters in participating countries

3.1.1 General information

Natural mineral waters may be distinguished from ordinary drinking water by their purity at source and their constant level of minerals. Directive 2009/54/EC (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2009.164.01.0045.01.ENG&toc=OJ:L:2009:164:TOC, accessed on 26.06.2019) regulates the marketing and exploitation of natural mineral waters. Natural mineral waters may be treated at source to remove unstable elements and some undesirable constituents in compliance with the provisions laid down in Article 4 of Directive 2009/54/EC (see below). Treatments other than filtration or decanting with possible oxygenation have to be assessed and authorised at EU level prior to their use by industry. Commission Regulation (EU) No 115/2010 lays down the conditions for use of activated alumina for the removal of fluoride from natural mineral waters and spring waters.
The list of Natural mineral waters recognised by EU member states (https://ec.europa.eu/food/sites/food/files/safety/docs/labelling-nutrition_mineral-waters_list_eu-recognised.pdf, accessed on 26.06.2019) comprises the majority of Natural mineral waters in countries that participate in HOVER WP3. One Natural mineral water source recognized by Iceland is listed since Iceland belongs to the European Economic Area (EEA). Exceptions are Malta (Natural mineral waters are not found), Serbia and Ukraine. However, three sources in Serbia are recognized by United Kingdom.

Article 4 of directive 2009/54/EC

1) Natural mineral water, in its state at source, may not be the subject of any treatment other than:
   a) the separation of its unstable elements, such as iron and sulphur compounds, by filtration or decanting, possibly preceded by oxygenation, in so far as this treatment does not alter the composition of the water as regards the essential constituents which give it its properties;
   b) the separation of iron, manganese and sulphur compounds and arsenic from certain natural mineral waters by treatment with ozone-enriched air in so far as such treatment does not alter the composition of the water as regards the essential constituents which give it its properties, and provided that:
      i) the treatment complies with the conditions for use to be laid down by the Commission following consultation of the European Food Safety Authority, established by Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety (8);
      ii) the treatment is notified to, and specifically controlled by, the competent authorities;

c) the separation of undesirable constituents other than those specified in points (a) or (b), in so far as this treatment does not alter the composition of the water as regards the essential constituents which give it its properties, and provided that:
   i) the treatment complies with the conditions for use to be laid down by the Commission following consultation of the European Food Safety Authority;
   ii) the treatment is notified to, and specifically controlled by, the competent authorities;
d) the total or partial elimination of free carbon dioxide by exclusively physical methods.

The measures referred to in points (b)(i) and (c)(i), designed to amend non-essential elements of this Directive by supplementing it, shall be adopted in accordance with the regulatory procedure with scrutiny referred to in Article 14(2).

The first subparagraph shall not constitute a bar to the utilisation of natural mineral waters and spring waters in the manufacture of soft drinks.

2) Natural mineral water, in its state at source, may not be the subject of any addition other than the introduction or the reintroduction of carbon dioxide under the conditions laid down in Annex I, Section III.
3) Any disinfection treatment by whatever means and, subject to paragraph 2, the addition of bacteriostatic elements or any other treatment likely to change the viable colony count of the natural mineral water, shall be prohibited.

Specific hydrochemical characteristics are listed in Article 9 – Annex III. The indications listed in this Annex shall be authorised if they meet the relevant criteria.

Table 1: Indications and Criteria for natural mineral waters - Annex III of Article 9 in Directive 2009/54/EC.

Indications	Criteria
Low mineral content	Mineral salt content, calculated as a fixed residue, not greater than 500 mg/l
Very low mineral content	Mineral salt content, calculated as a fixed residue, not greater than 50 mg/l
Rich in mineral salts	Mineral salt content, calculated as a fixed residue, greater than 1 500 mg/l
Contains bicarbonate	Bicarbonate content greater than 600 mg/l
Contains sulphate	Sulphate content greater than 200 mg/l
Contains chloride	Chloride content greater than 200 mg/l
Contains calcium	Calcium content greater than 150 mg/l
Contains magnesium	Magnesium content greater than 50 mg/l
Contains fluoride	Fluoride content greater than 1 mg/l
Contains iron	Bivalent iron content greater than 1 mg/l
Acidic	Free carbon dioxide content greater than 250 mg/l
Contains sodium	Sodium content greater than 200 mg/l
Suitable for the preparation of infant food	—
Suitable for a low-sodium diet	Sodium content less than 20 mg/l
May be laxative	—
May be diuretic	—

3.1.2 *National laws or rules regulating natural mineral waters in WP3 participating countries/regions*

Relevant national laws or rules regulating natural mineral waters in WP3 participating countries are listed below (investigated with WP3 specific questionnaire):

- **Austria:** Mineralwasser- und Quellwasserverordnung, BGBl. II Nr. 309/1999 idgF. *see chapter 5.1.1 for more details*
- **Belgium**: Royal decision of 8 Februari 1999 concerning natural mineral waters and source waters, adapted by Royal decision of 15 December 2003.
- **Bosnia and Herzegovina**: Waters Act - Rulebook on natural mineral water, spring water and table water (Official Gazzette of the Bosnia and Herzegovina No. 26/10, 40/10).
- **Czech Republic:** no information.
- **Denmark:** Bekendtgørelse om naturligt mineralvand, kildevand og emballeret drikkevand BEK nr 38 af 12/01/2016 (Ministerial Order on Natural mineral water, Spring. *see chapter 5.3.1 for more details*
- **France:** Decree No 2007-49 of 11 January 2007 on the safety of water intended for human consumption.
- **Hungary:** 65/2004. (IV. 27.) FVM-ESZCSM-GKM; 74/1999. (XII. 25.) EüM; 59/2006. (VIII.14.) FVM-EüM-SZMM; 2009/54/EK direktíva, 80/777/EGK tanácsi irányelv, 96/70/EK irányelv.
- **Iceland:** 2003/40/EC, "Natural mineral water is water from a groundwater resource that emerges in one or more springs and can be characterized by stable physical properties such as temperature and pH and concentrations of dissolved solids and carbondioxide"; Legislation on natural mineralwater and bottled spring water (405/2004).
- **Ireland:** European Union (Drinking Water) (Amendment) Regulations 2017 (S.I. No. 464 of 2017).
- **Italy:** Italian Legislative Decree N.176 of 8 october 2011 adopts the EU Directive 2009/54/EC.
  see chapter 5.7.1 for more details
- **Latvia:** 2015.gada 15.decembra Ministru kabineta noteikumi Nr.736 "Noteikumi par dabīgo minerālūdeni un avota ūdeni".
- **Lithuania:** Requirements for use and marketing of natural mineral and spring waters.
- **Malta:** not relevant.
- **Poland:** Act of 25 August 2006 on Food and Nutrition Safety - Jour. of Law 2006 No 171 item 1255 (Ustawa z nia 25 sierpnia 2006 r. o bezpieczeństwie żywnosci i żywienia - Dz. U. 2006 Nr 171 poz. 1255); Regulation of the Minister of Health of 31 March 2011 on natural mineral water, spring water and table water - Jour. of Law 2011 No 85 item 466 (Rozporządzenie Ministra Zdrowia z dnia 31 marca 2011 r. w sprawie naturalnych wód mineralnych, wód źródlanych i wód stołowych - Dz.U. 2011 nr 85 poz. 466) .
- **Portugal:** Law n.º 54/2015 of 22 June (“Geological Resources Law”) and specific regulations Decree-Law no. 86/90 of 16 March (natural mineral waters) and Decree-Law no. 84/90 of 16 March (spring water).
- **Romania:** GD No.1.020 of 1 September 2005 for the approval of the Technical Norms for the exploitation and marketing of natural mineral waters.

- **Serbia:** Regulation on Quality and Other Requirements for Natural mineral water, Spring Water and Bottled Drinking Water (Official Gazzete of Serbia and Montenegro, number 53/05) and Regulation on the Hygienic Acceptability of Potable Water (Official Gazzete of FRY, number 42/98 and 44/99). Requirement: Mineral water is all groundwater with higher content of dissolved minerals (> 1 g/l) or higher content of certain specific components (CO2, H2S, Rn, Fe, Br, J etc.) as well as groundwater with higher temperatures.
- **Slovenia:** the Water Act = Zakon o vodah (Official Gazzette of the Rep. of Slovenia No. 67/02, 2/04 – ZZdrI-A, 41/04 – ZVO-1, 57/08, 57/12, 100/13, 40/14, 56/15) with subrdinate Rules on natural mineral water, spring water and table water = Pravilnik o naravni mineralni vodi, izvirski vodi in namizni vodi (Official Gazzette of the Rep. of Slovenia No. 50/04, 75/05 in 45/08 – ZKme-1).
  See chapter 5.13.1 for more details
- **Spain:** RD 1798/2010, of December 30, regulating the exploitation and commercialization of natural mineral waters and bottled spring waters for human consumption.
  See chapter 5.14.1 for more details
- **Sweden:** no information.
- **Ukraine:** The Law of Ukraine on Environmental protection, The Subsoil Code of Ukraine, The Water Code of Ukraine, The Law of Ukraine on approval the Whole-State Program for development of Mineral resource base of Ukraine for the period to the year 2030; Requirement: Natural mineral waters in Ukraine can be defined as natural groundwaters within sites (groundwater deposits) characterized by a certain and constant physico-chemical composition, biologically active components and compounds in accordance with the standards assigned for each site (groundwater deposit area) and can be consumed without special treatment that can affect chemical composition and microbiological properties.

3.1.3 Data availability of natural mineral waters in WP3 participating countries/regions

Results from the specific questionnaire showed that most involved surveys can provide data (e.g. location of sources, hydrochemistry and aquifer information) for natural mineral waters (see Figure 2).

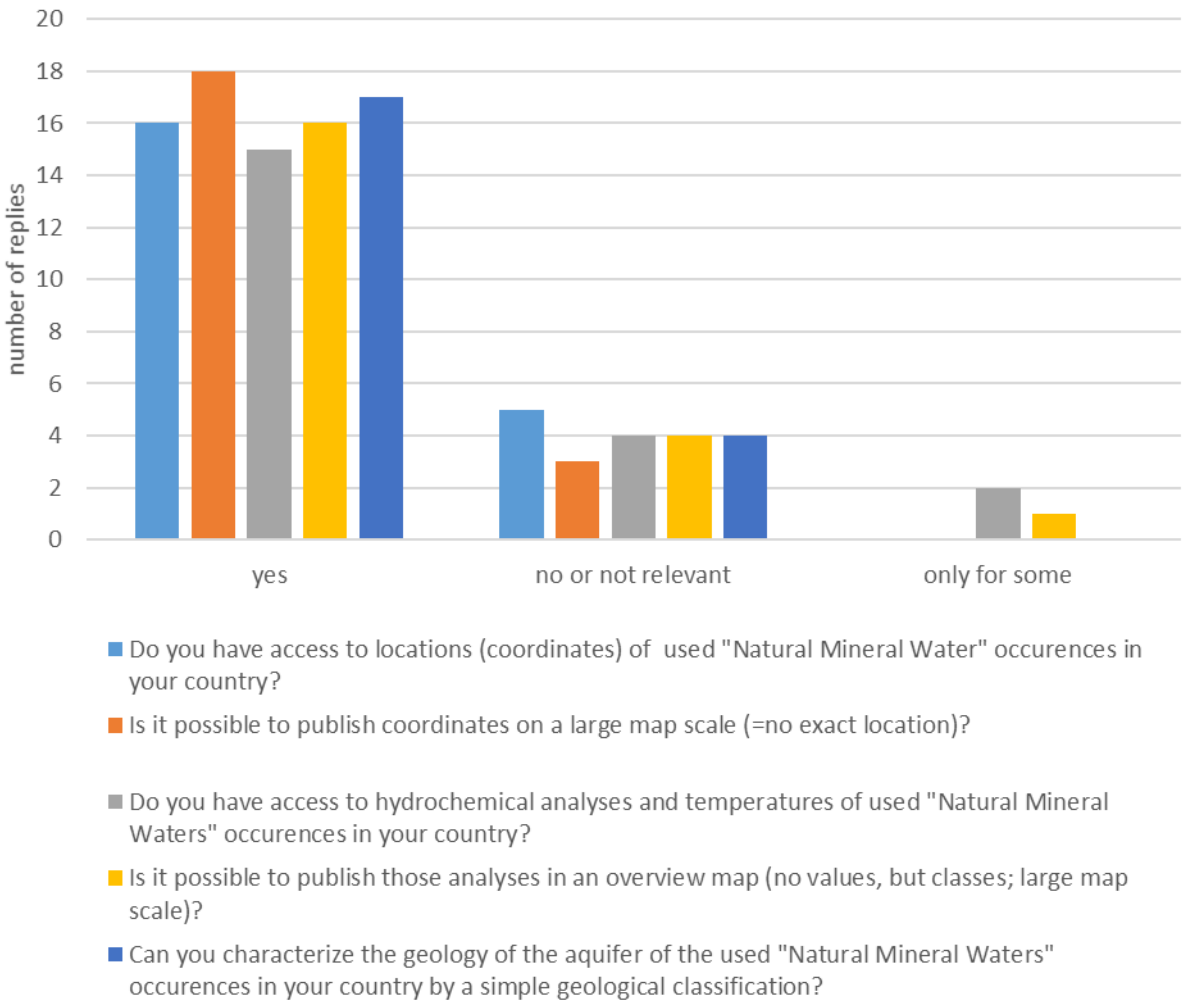

Figure 2: Availability of data on natural mineral waters in participating countries.

3.2 Thermal waters in participating countries

National laws or directives have to be considered to find a shared terminology. According to the results of the specific WP3 questionnaire, thermal waters are not relevant in 4 of 21 countries or regions. However, 10 of 17 remaining countries do have national laws or directives that regulate thermal waters and 3 of 17 don't have any (see below). It has to be mentioned that not all surveys where thermal waters are present replied to this question (4 of 17).

3.2.1 National laws or rules regulating thermal waters in WP3 participating countries/regions

National laws or directives in participating countries which regulate thermal waters:

- **Austria:** there are laws in each state of Austria except in Vorarlberg, but the definition for "thermal water" is always the same. See"Heilvorkommen- und Kurortegesetze der

Bundesländer".
see chapter 5.1.1 for more details

- **Belgium**: Not relevant.
- **Bosnia and Herzegovina**: Waters Act - Rolebook on the categorization, classification, the budget reserve of ground water and management of records about them (Official Gazzette of the Bosnia and Herzegvoina No. 47/11).
  see chapter 5.2.1 for more details
- **Czech Republic:** No information.
- **Denmark:** Not relevant.
- **France:** National regulations, based on article R. 1322-52 of the Public Health Code
- **Hungary:** No information.
- **Iceland:** Not defined.
- **Ireland:** Not defined.
- **Italy:** Governmentala Law N.323 of 24 october 2000
  see chapter 5.7.1 for more details
- **Latvia:** No information.
- **Lithuania:** Not defined.
- **Malta:** Not relevant.
- **Poland:** Act of 9 June 2011, Geological and Mining Law - Jour. of Law 2018 item 1563 (Ustawa z dnia 9 czerwca 2011 r. Prawo geologiczne i górnicze - Dz.U. 2018 poz. 1563).
- **Portugal:** Not defined.
- **Romania:** Governmental Decision no. 1154/2004
- **Serbia:** Regulation on Quality and Other Requirements for Natural mineral water, Spring Water and Bottled Drinking Water (Official Gazzete of Serbia and Montenegro, number 53/05)
- **Slovenia:** Waters Act (Official Gazzette of the Republic Slovenia No. 67/02, 2/04 – ZZdrI-A, 41/04 – ZVO-1, 57/08, 57/12, 100/13, 40/14 and 56/15) in its 7th article
  see chapter 5.13.1 for more details
- **Spain:** Law 22/1973 of July 21, of Mines and RD 2857/1978, of August 25, which approves the General Regulation for the Mining Regime.
  See chapter 5.14.1 for more details
- **Sweden:** Not relevant
- **Ukraine:** No information

3.2.2 Definition of thermal water according to the temperature

Most definitions for thermal water are based on water temperatures at the outlet. For example, JORDAN & WEDER (1988) introduced the following classification for thermal waters in Central Europe:

Table 2: Classification of thermal waters in Central Europe by JORDAN & WEDER, 1988[1])

Thermal water		Temperature (°C)
low-thermal	Warm	20-37
thermal	Hot	37-70
High-thermal	Very hot	70-100
steam-thermal	overheated	>100

Results from the conducted questionnaire show, that the majority of countries (7 of 17) define a thermal water by a minimum temperature of 20 °C. However, definitions by temperature don't exist in several countries (5 of 17), also other minimum temperatures are often present (see Figure 3).
Due to the heterogeneity of definitions, it is suggested to introduce the following detailed temperature classes at the outlet to describe thermal waters on an European level:
<15 °C, 15-20 °C, 20-30 °C, 30-40 C, 40-50 °C, 50-60 °C, 60-70 °C, 70-80 °C, °80-90 °C, 90-100 °C, >100 °C.

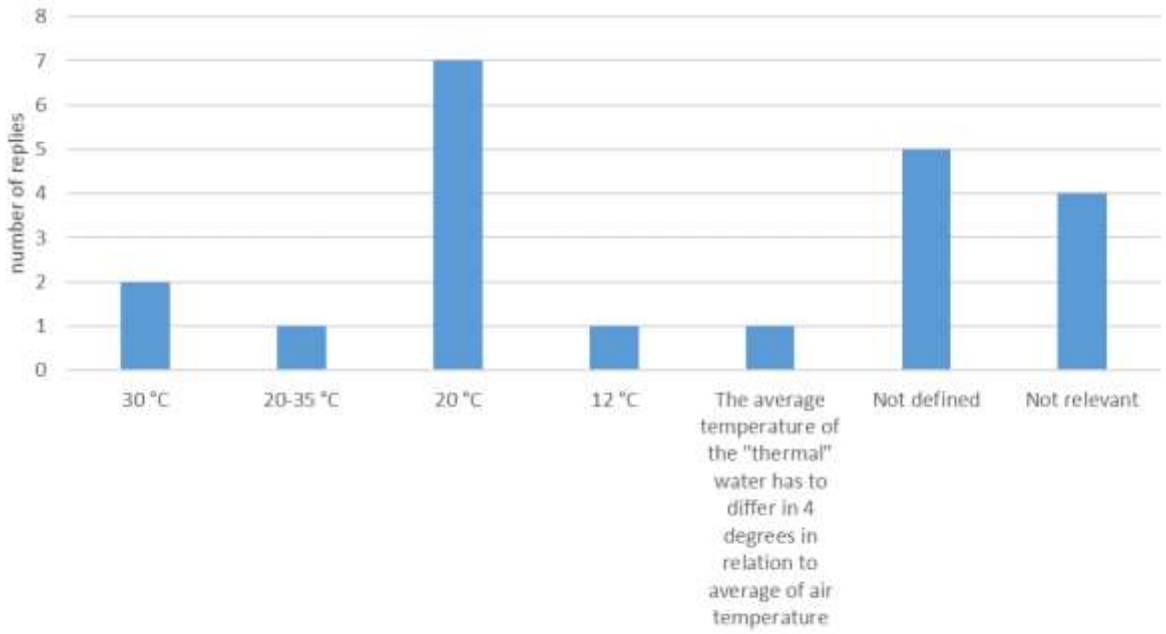

Figure 3: Minimum water temperatures (°C) to define thermal water in participating countries or regions.

3.2.3 Data availability for thermal waters in WP3 participating countries/regions

Figure 4 shows that most participating surveys can contribute data for thermal waters, especially locations of known sources can be shared. Providing aquifer information, hydrochemical analysis and technical borehole data (drilling depth) is also possible in many cases.

[1] JORDAN, H. & WEDER, H.J. (1988): Hydrogeologie. – 444 S., Leipzig.

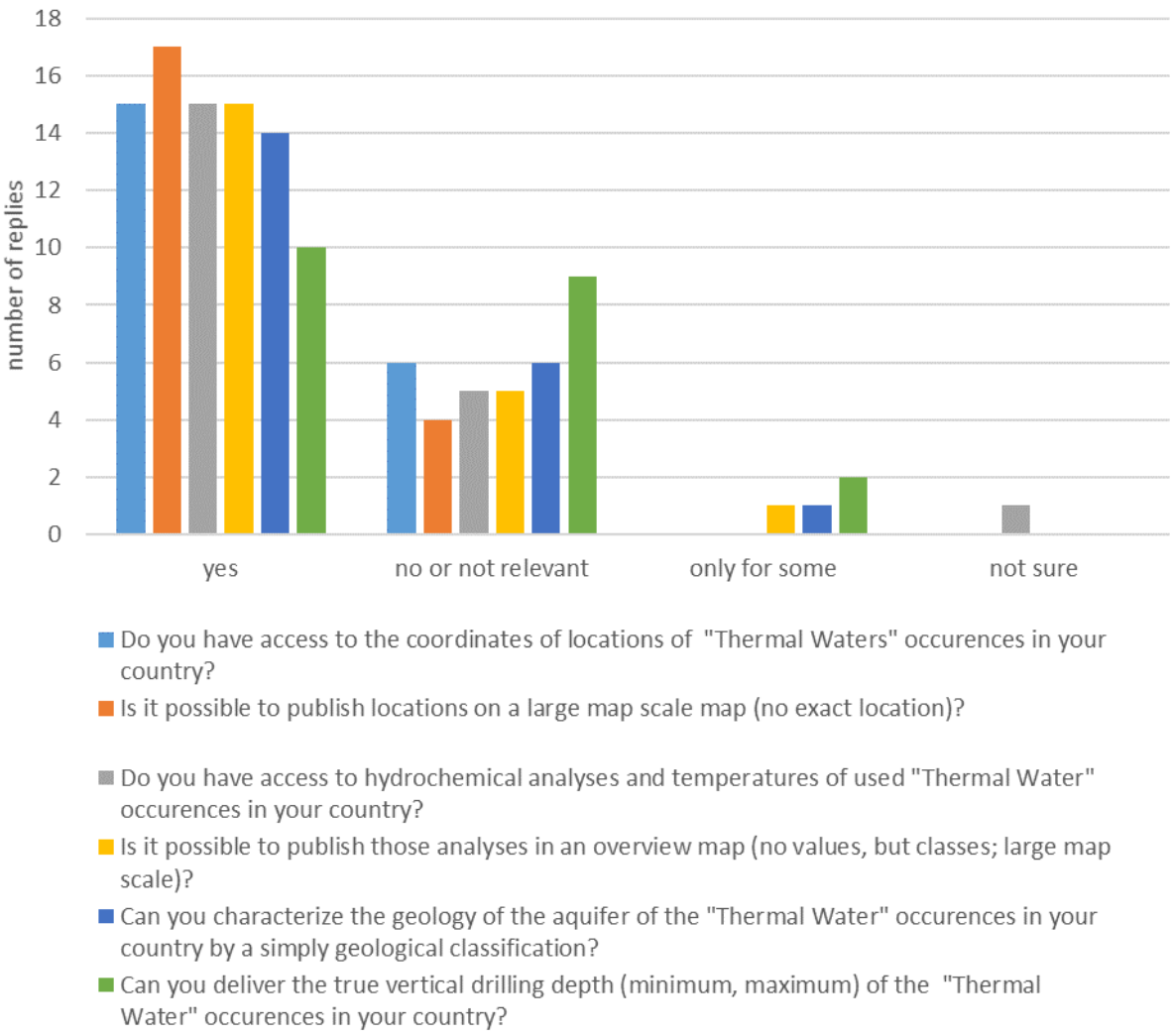

Figure 4: Availability of data on thermal waters in participating countries or regions.

3.3 Availability of hydrochemical data for observation wells and springs

The following inventory of available hydrochemical data from participating HOVER WP3 surveys provides a valuable background information to tackle the following WP3 objectives:

- To propose a common methodology to identify the main geological factors and hydrogeological processes regulating the distribution of natural concentrations (NBL - natural background level) of selected dissolved elements including Potentially Toxic Geogenic Trace Elements (PTGTE).
- To produce pan European information layers of indicators of chemical anomalies of natural origin (natural background level determination).

Results show that general data for observation wells and springs including location of sources, depth of wells, depth to water tables, discharges during hydrochemical sampling and types of hydrochemical sampling is available in most WP3 participating countries/regions (see Figure 5). Chosen main parameters of hydrochemical analysis except eH and oxygen are also commonly

available (see Table 3). In several cases, data has to be derived from third parties (see attachment A1 for details). In some cases, data might be available but can't be published (e.g. Hungary, Poland). Data availability on relevant trace elements is found in the following chapters 3.3.1 to 3.3.21.

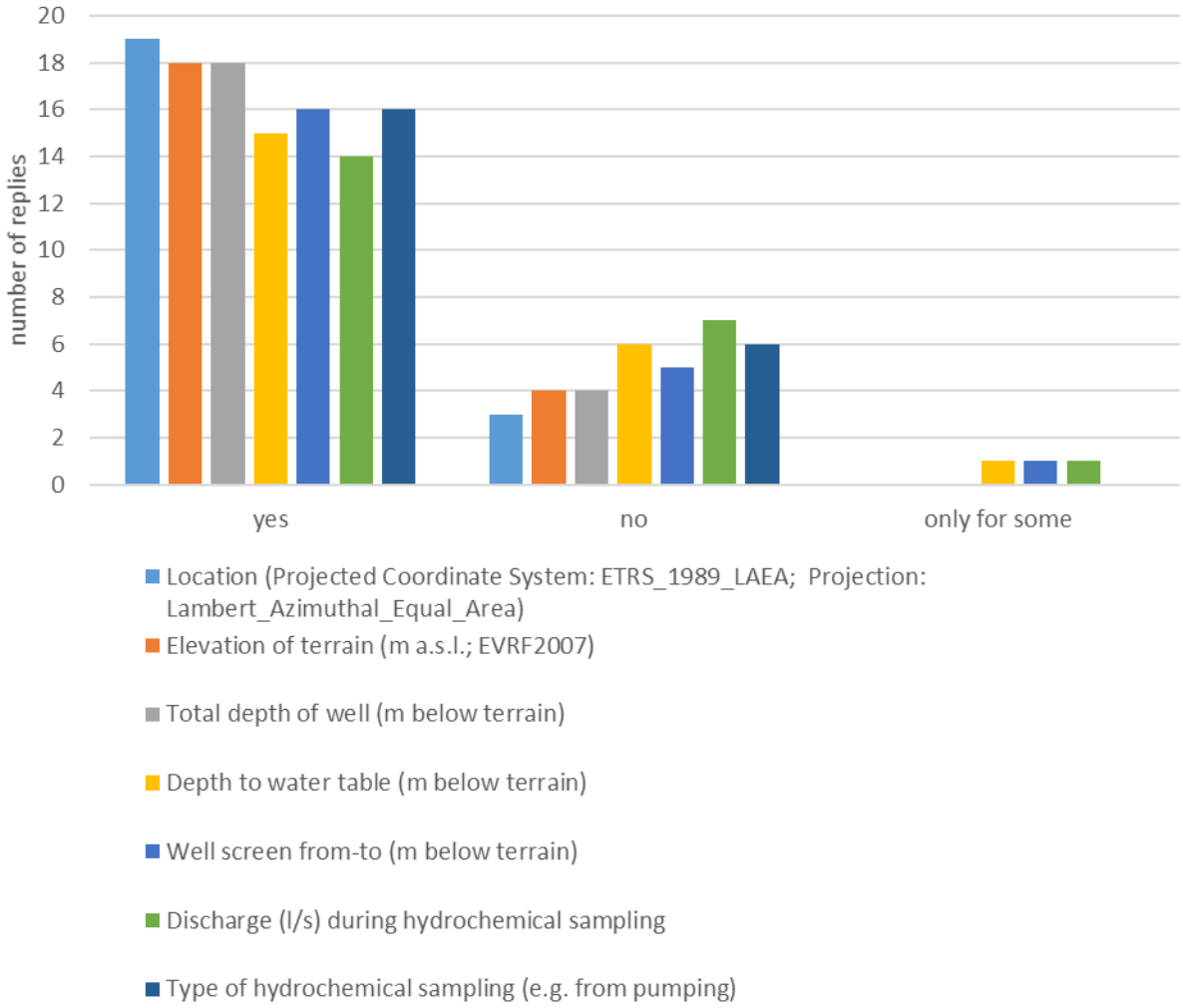

Figure 5: Available hydrochemical data from participating surveys: General information.

Table 3: Available hydrochemical data from participating surveys: Main ions and field parameters.

Number of replies	Yes	no	only for some
Groundwater temperature (°C)	20	2	-
EC (µS/cm, 25 °C)	17	5	-
eH (mV)	11	10	1
O_2 (mg L^{-1})	14	8	-
Ca (mg L^{-1})	18	4	-
Mg (mg L^{-1})	missed in specific questionnaire		
K (mg L^{-1})	18	4	-
Na (mg L^{-1})	19	3	-

NH_4 (mg L^{-1})	19	3	-
Cl (mg L^{-1})	19	3	-
HCO_3 (mg L^{-1})	18	4	-
SO_4 (mg L^{-1})	19	3	-
NO_3 (mg L^{-1})	18	4	-
NO_2 (mg L^{-1})	16	6	-

3.3.1 Aluminium

Table 4: Aluminium in groundwater – Overview of data availability in participating countries/regions.

Aluminium	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?
yes	9	11	11
some	0	2	2
not sure	0	0	1
no	5	3	3
no information provided	8	6	5

Table 5: Aluminium in groundwater – Data availability in participating countries/regions.

Aluminium in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Austria	Not set (drinking water); 0,2 (indicator parameter)	Yes	Yes	2.837	H20-fachdatenbank (third party), up to 4 measurements/year	Whole country	Yes	-
Belgium	-	-	-	-	-	-	-	-
Bosnia and Herzegovina	0,2 drinking water	Not investigated	Yes	Little	No, there are individual studies; no systematic analyses	The entity federation of bosnia and herzegovina	No	No
Czech Rep	0,2	Yes	Partly yes	Thousands of samples (archive data)	The data falls under the management of another organization, it would probably be possible to get it	Whole country	Yes	-
Denmark	0,2	Yes	Yes	1.187	Yes, approx. Every 2-3 years	Whole country	No	-
France	0,05 (guide value) 0,2 (maximum acceptable concentration)	Yes	Plenty of information available on the ades and infoterre websites	Plenty of information available on the ades and infoterre websites	Plenty of information available on the ades and infoterre websites	Plenty of information available on the ades and infoterre websites	Plenty of information available on the ades and infoterre websites	-
Hungary	DW: 0.2, but only indicator value and not treshold limit value	Not investigated, but not likely	Not applicable.	Sparse	Not for the last 5 years. Mostly yearly sampling; for thermal waters can be up to 1/6 years.	-	No.	-
Iceland	0,2	No	In some cases	Not known	Yes, varies	No, distributed sampling points	No	-
Ireland	0,2 (indicator parameter)	Yes, 97% < threshold	No	300	Yes, 3 times per year	Whole country	Yes	-

Aluminium in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Italy	-	-	-	-	-	-	-	This topics are not in the assignments of the Geological Survey of Italy of ISPRA
Latvia	0,2 mg/l from DW law Annex	Not checked	No	Not checked	Yes, not checked	Not checked	No	-
Lithuania	-	-	-	-	-	-	-	-
Malta	-	-	-	-	-	-	-	-
Poland	0,2(drinking water)	Yes	Yes	Approx. 1300 (groundwater monitoring network) and some special groundwater's intakes	Yes, sampling every 1-3 years (groundwater monitoring network)	Whole country	No	--
Portugal	0,2	-	Yes	The groundwater monitoring network consists of about 1.037 points and its distribution in the country is not uniform. The frequency of sampling is by-annual. The parameters monitored are not the same at all points.	The Portuguese Environment Agency is responsible for the groundwater quality monitoring network. LNEG does not currently have access to this data. However LNEG will try to obtain this data and their authorization to make them available to the project partners.	Yes. The Groundwater quality monitoring network cover the whole country	No	In the case of natural spring water (as well as water for human consumption) the levels of physical-chemical parameters are established by the Decree-Law no.152/2017. For the natural mineral water this element is not subject to maximum admissible values.
Romania	0,2 (drinking water)	Yes, in thermal water.	Yes	None	No	Only in areas with concession licenses for natural mineral water and in areas with monitoring wells for drinking water	No	Elevated concentration in some thermal water
Serbia	0,2	-	-	-	-	-	-	-
Slovenia	0,2 mg/l for drinking water	Not investigated	Yes	Little	No, unsystematic, only for research purposes	Specific, mineral and thermal waters with concessions and some natural springs all over Slovenia	No	No
Spain	0,2 mg/l for drinking water and natural mineral water. Not set for spring water	Yes	Yes	714	Yes. Sampling frequency varies depending on the region	They cover the whole country, although there are significant differences in the number of observations between regions	No	-
Spain (Catalonia)	-	Anomalous natural concentration of Al has been detected in very specific areas in the Pyrenees (> 2	Yes	In general, approximately 350 points with regular frequency, and other points not regularly sampled.	Yes in some of them. At the East basins of Catalonia, the network has 350 points yearly sampling. At the West of Catalonia (Ebro basin) there is	No. Primarily the most productive or priority aquifer in terms of vulnerability.	No	-

Aluminium in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
		ppm) where exist moderated acid waters in high-mountain lakes		Mostly yearly sampling.	information but not regularly sampled			
Sweden	-	-	-	20.000	Yes; see comment	Yes, but few analyses from nothern Sweden	No	-
Ukraine	≤0,1-0,2	Should be examined properly	Yes, if is determined	A lot of wells, the number can be determined by database sampling if necessary	Yes, at least for the period 2010-2018	Yes	No	-

3.3.2 Antimony

Table 6: Antimony in groundwater – Overview of data availability in participating countries/regions.

Antimony	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?
yes	6	8	10
some	1	2	2
not sure	0	0	1
no	4	4	3
no information provided	11	8	6

Table 7: Antimony in groundwater – Data availability in participating countries/regions.

Antimony in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Austria	0,005 (drinking water)	Yes	Yes	2.844	Yes, h20-fachdatenbank (third party), up to 4 measurements/year	Whole country	No, but data is available	-
Belgium	-	-	-	-	-	-	-	-
Bosnia and Herzegovina	0,005 mg/l for drinking water	Not investigated	Yes	Little	No, there are individual studies data, there is no systematic testing	The entity federation of bosnia and herzegovina	No	No
Czech Rep	0,005	Yes	Partly yes	Thousands of samples (archive data)	The data falls under the management of another organization, it would probably be possible to get it	Whole country	Yes	-
Denmark	0,005	No	-	31	Yes, approx. every 5 years	Only very few data	No	-

Antimony in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
France	0,01 (maximum acceptable concentration) 0,005 (parametric value - Corrigendum to Official Journal of the European Union of L111 of 20 April 2001)	Yes	Plenty of information available on the ADES and infoterre websites	Plenty of information available on the ADES and infoterre websites	Plenty of information available on the ADES and infoterre websites	Plenty of information available on the ADES and infoterre websites	Yes, maps of high natural background risk zones in traces elements	BRGM public report: Sectors identified during the national study - Delimitation of high natural background risk zones in traces elements
Hungary	0,005 (drinking water)	Not investigated, but not likely.	Not applicable.	Sparse.	Not for the last 5 years. Mostly yearly sampling; for thermal waters can be up to 1/6 years.	-	No	-
Iceland	0,005	No	In some cases	unknown	Yes, Varies	No. Distributed sampling points	No	-
Ireland	0,005	Yes, 97% < threshold	No	300	Yes, 3 times per year	Whole country	Yes	-
Italy	-	-	-	-	-	-	-	This topics are not in the assignments of the Geological Survey of Italy of ISPRA
Latvia	0,005 (drinking water)	Not checked	No	Not checked	Yes, not checked	Not checked	No	-
Lithuania	-	-	-	-	-	-	-	-
Malta	Not applicable	-	-	-	-	-	-	-
Poland	0,005 (drinking water and natural mineral water))	No	-	Approx. 1300 (groundwater monitoring network) and some special groundwater's intakes	Yes, sampling every 1-3 years (groundwater monitoring network)	Whole country	No	--
Portugal	0,005	-	Yes	The groundwater monitoring network consists of about 1.037 points and its distribution in the country is not uniform. The frequency of sampling is by-annual. The parameters monitored are not the same at all points.	The Portuguese Environment Agency is responsible for the groundwater quality monitoring network. LNEG does not currently have access to this data. However LNEG will try to obtain this data and their authorization to make them available to the project partners.	Yes. The Groundwater quality monitoring network cover the whole country	No	In the case of natural spring water (as well as water for human consumption) the levels of physical-chemical parameters are established by the Decree-Law no.152/2017. For the natural mineral water this element is subject to maximum admissible values Decree-law no. 72/2004.
Romania	0,005	No information	-	None	No	Only in areas with concession licenses for natural mineral water and in areas with monitoring wells for	No	-

Antimony in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
						drinking water.		
Serbia	0.05	-	-	-	-	-	-	-
Slovenia	0.0050 mg/l for drinking and NMW	Some are suspected	Yes	Little	Thermal waters are tested in year 1, year 3 and then every 6th year (mostly years 2016-2018-2024), mineral waters can be different frequency	Specific, mineral and thermal waters with concessions and some natural springs all over Slovenia	No	Usually it is connected to coal seams in Slovenia
Spain	0,005 mg/l for drinking water and natural mineral water. Not set for spring water	Yes	Yes	200	Yes. Sampling frequency varies depending on the region	They cover the whole country, althougt there are significative differences in the number of observations between regions	No	-
Spain (Catalonia)	0,005 mg/l (RD 140/2003 drinking waters) 0,005 mg/l (RD 1798/2010 Natural mineral water)	-	Yes	In general, approximately 350 points with regular frequency, and other points not regularly sampled. Mostly yearly sampling.	Yes in some of them. At the East basins of Catalonia, the network has 350 points yearly sampling. At the West of Catalonia (Ebro basin) there is information but not regularly sampled	No. Primarily the most productive or priority aquifer in terms of vulnerability	No	-
Sweden	0,005	Yes	No	15000	-	Yes, but few analyses from nothern Sweden	No	-
Ukraine	-	Should be examined properly	Yes, if is determined	A lot of wells, the number can be determined by database sampling if necessary	Yes, at least for the period 2010-2018	Yes	No	-

3.3.3 Arsenic

Table 8: Arsenic in groundwater – Overview of data availability in participating countries/regions.

Arsenic	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?
yes	13	14	12
some	2	3	2
not sure	0	0	3
no	1	2	2
no information provided	6	3	3

Table 9: Arsenic in groundwater – Data availability in participating countries/regions.

Arsenic in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Austria	0,01 (drinking water)	Yes	Yes	2.837	Yes, H20-Fachdatenbank (third party), up to 4 measurements/year	Whole country	Yes	-
Belgium	0,01 - 0,046	Yes, for example Campine region, Polders and Massif of Brabant	Sandy aquifers with acid water, clayey-sandy deposits with salty/brackish water - rich of organic matter, fissured rock aquifer	2.000 (4000 screens)	Yes, sampling frequency once or twice per year (depending on monitoring network)	Yes	Not yet	Discussion whether concentrations are natural or anthropogenic influenced
Bosnia and Herzegovina	0,010 (drinking water)	Not investigated	Yes	10-15 wells	No, there are individual studies data, is no systematic testing	the entity Federation of Bosnia and Herzegovina	No	To appear in a large number of mineral and thermomineral waters
Czech Rep	0,01	Yes	Partly yes	Thousands of samples (archive data)	The data falls under the management of another organization, it would probably be possible to get it	Whole country	Yes	-
Denmark	0,005	Yes	Yes	6.609	Yes, approx. every 3 years	Whole country	Yes	-
France	0,05 (maximum acceptable concentration) 0,01 (parametric value - Corrigendum to Official Journal of the European Union of L111 of 20 April 2001)	Yes	Plenty of information available on the ADES and infoterre websites	Plenty of information available on the ADES and infoterre websites	Plenty of information available on the ADES and infoterre websites	Plenty of information available on the ADES and infoterre websites	Yes, maps of high natural background risk zones in traces elements	BRGM public report: Sectors identified during the national study - Delimitation of high natural background risk zones in traces elements
Hungary	0,01 (drinking water)	Yes	Yes	Few hundreds	Not for the last 5 years. If needed, probably it can be accessed through third party. Mostly yearly sampling; for termal waters can be up to 1/6 years.	-	Maps not, but values on groundwater body levels yes.	Not just monitoring data, but results of reseach investigations also exist (eg. Great hungarian plain).
Iceland	0,01	No	In some cases	unknown	Yes, varies	No distributed sampling points	No	-
Ireland	0,01	Yes, 97% < threshold	No, research ongoing	300	Yes, 3 times per year	Whole country	Yes	-
Italy	-	-	-	-	-	-	-	This topics are not in the assignments of the Geological Survey of Italy of ISPRA
Latvia	0,01 (drinking water)	Not checked	No	Not checked	Yes, not checked	Not checked	No	-
Lithuania	-	-	-	-	-	-	-	-
Malta	0,0075	Yes	Yes	Three 18 groundwater quality stations from the MSL	Yes - Twice a year	Specific - North-Western Region of the Gozo MSLA Why Gozo?	No	-
Poland	0,01 (drinking water and natural mineral water)	Yes	Yes	Approx. 1300 (groundwater monitoring network) and some special	Yes, sampling every 1-3 years (groundwater monitoring network)	Whole country	No	--

Arsenic in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
				groundwater's intakes				
Portugal	0,01	In the north of Portugal was detected some points above the threshold value.	Yes, due to interaction water/rock or associated with fracture filling, sulphide mineralisation or old abandoned mine	26 points, but only one sampling (LNEG field inventory) and groundwater monitoring network data	The Portuguese Environment Agency is responsible for the groundwater quality monitoring network. LNEG does not currently have access to this data. However LNEG will try to obtain this data and their authorization to make them available to the project partners.	Yes. The Groundwater quality monitoring network cover the whole country	No	In the case of natural spring water (as well as water for human consumption) the levels of physical-chemical parameters are established by the Decree-Law no.152/2017. For the natural mineral water this element is subject to maximum admissible values Decree-law no. 72/2004.
Romania	0,01	Some area with mineral and thermal water are suspected	Yes	None	No	Only in areas with concession licenses for natural mineral water and in areas with monitoring wells for drinking water	No	If arsenic concentration in some mineral and thermal water is elevated the water is treated befor to be use
Serbia	0,01	Yes, all north part of Serbia, part of Pannonian basin	Deep sediments of Pleistocene	-	-	-	-	-
Slovenia	0,01 (drinking water)	Some are suspected	Yes	Approx. 30 sites with 50 wells	Thermal waters are tested in year 1, year 3 and then every 6th year (mostly years 2016-2018-2024), mineral waters can be different frequency	Specific, mineral and thermal waters with concessions and some natural springs all over Slovenia	No	Is of geogenic origin in NE Slovenia
Spain	0,01 mg/l for drinking water and natural mineral water. Not set for spring water	Yes	Yes	1.281	Yes. Sampling frequency varies depending on the region	They cover the whole country, although there are significant differences in the number of observations between regions	No	-
Spain (Catalonia)	0,01 mg/l (RD 140/2003 drinking waters)	Yes in some areas, with geogenetic origin where exists mineralization of sulphurs, also in areas where existed old mine activities, and in areas with hydro-geothermal manifestations.	Yes	In general, approximately 350 points with regular frequency, and other points not regularly sampled. Mostly yearly sampling.	Yes in some of them. At the East basins of Catalonia, the network has 350 points yearly sampling. At the West of Catalonia (Ebro basin) there is information but not regularly sampled	No. Primarily the most productive or priority aquifer in terms of vulnerability	No	-

Arsenic in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Sweden	0,01	-	-	20.000	Yes; see comment	Yes, but few analyses from nothern Sweden	No	-
Ukraine	0,01	Should be examined properly	Yes, if is determined	A lot of wells, the number can be determined by database sampling if necessary	Yes, at least for the period 2010-2018	Yes	No	-

3.3.4 Barium

Table 10: Barium in groundwater – Overview of data availability in participating countries/regions.

Barium	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?
yes	3	10	9
some	0	2	2
not sure	0	0	1
no	11	3	4
no information provided	8	7	6

Table 11: Barium in groundwater – Data availability in participating countries/regions.

Barium in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Austria	Not set	Not relevant	Yes	2.837	Yes, h20-fachdatenbank (third party), up to 4 measurements/year	Whole country	No, but data is available	-
Belgium	-	-	-	-	-	-	-	-
Bosnia and Herzegovina	1,00 (natural mineral water)	Not investigated	Yes	Little	No, There are individual studies data, is no systematic testing	entity Federation of Bosnia and Herzegovina	No	No
Czech Rep	Not specified	-	Partly yes	Thousands of samples (archive data)	The data falls under the management of another organization, it would probably be possible to get it	Whole country	Yes	-
Denmark	-	-	Yes	5.940	Yes, approx. every 3 years	Whole country	No	-
France	0,1 (guide value)	Yes	Plenty of information available on the ades and	Plenty of information available on the ades and	Plenty of information available on the	Plenty of information available on the ades and	Yes, maps of high natural background risk zones in	Brgm public report: sectors identified during the

Barium in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
			infoterre websites	infoterre websites	ades and infoterre websites	infoterre websites	traces elements	national study - delimitation of high natural background risk zones in traces elements
Hungary	1 (natural mineral water); Not set (drinking water)	Not investigated, but not likely	Not applicable	Sparse	Not for the last 5 years. Mostly yearly sampling; for thermal waters can be up to 1/6 years.	-	No	-
Iceland	-	No	In some cases	unknown	Yes, varies	No, distributed sampling points	No	-
Ireland	-	-	-	300	Yes, 3 times per year	Whole country	Yes	-
Italy	-	-	-	-	-	-	-	This topics are not in the assignments of the Geological Survey of Italy of ISPRA
Latvia	No	Not checked	No	Not checked	Yes, not checked	Not checked	No	-
Lithuania	-	-	-	-	-	-	-	-
Malta	Not applicable	-	-	-	-	-	-	-
Poland	1,0 (natural mineral water			Approx. 1300 (groundwater monitoring network) and some special groundwater's intakes	Yes, sampling every 1-3 years (groundwater monitoring network)	Whole country	No	--
Portugal	Not set	Not monitored	Yes	The groundwater monitoring network consists of about 1037 points and its distribution in the country is not uniform. The frequency of sampling is by-annual. The parameters monitored are not the same at all points.	Not monitored	Yes. The groundwater quality monitoring network cover the whole country	No	No treshold value defined in portuguese legislation
Romania	1 (set for mineral natural water)	No information.	-	None	No	Only in areas with concession licenses for natural mineral water and in areas with monitoring wells for drinking water	No	-
Serbia	-	-	-	-	-	-	-	-
Slovenia	Not set for drinking water,1.0 mg/l for natural mineral water	Not investigated	Yes	Approx. 30 sites with 50 wells	Thermal waters are tested in year 1, year 3 and then every 6th year (mostly years 2016-2018-2024), mineral waters can be different frequency	Specific, mineral and thermal waters with concessions and some natural springs all over Slovenia	No	Very rarely analysed
Spain	1 mg/l for natural mineral water. Not set for drinking	Yes	Yes	68	Yes. Sampling frequency varies depending on the region	They cover the whole country, althougt there are significative	No	-

Barium in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
	water and spring water					differences in the number of observations between regions		
Spain (Catalonia)	Not set (RD 140/2003 drinking waters) 1 mg/l (RD 1798/2010 Natural mineral water)	-	Yes	In general, approximately 350 points with regular frequency, and other points not regularly sampled. Mostly yearly sampling.	Yes in some of them. At the East basins of Catalonia, the network has 350 points yearly sampling. At the West of Catalonia (Ebro basin) there is information but not regularly sampled	No. Primarily the most productive or priority aquifer in terms of vulnerability	No	-
Sweden	-	-	-	250	-	No	No	-
Ukraine	≤0,1	Should be examined properly	Yes, if is determined	A lot of wells, the number can be determined by database sampling if necessary	Yes, at least for the period 2010-2018	Yes	No	-

3.3.5 Boron

Table 12: Boron in groundwater – Overview of data availability in participating countries/regions.

Boron	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?
yes	8	12	10
some	0	2	2
not sure	0	0	1
no	7	2	3
no information provided	7	6	6

Table 13: Boron in groundwater – Data availability in participating countries/regions.

Boron in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Austria	1,0 (drinking water); not set (indicator parameter)	Yes	Yes	2.837	Yes, h20-fachdatenbank (third party), up to 4 measurements/year	Entire country	No, but data is available	-
Belgium	-	-	-	-	-	-	-	-
Bosnia and Herzegovina	Not set (Natural mineral water);	Not investigated	Yes	Little	No, There are individual studies data, no systematic testing	No, the entity Federation of Bosnia and Herzegovina	No	No

Boron in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
	1.0 (drinking water)							
Czech Rep	1	-	Partly yes	Thousands of samples (archive data)	The data falls under the management of another organization, it would probably be possible to get it	Whole country	No	-
Denmark	1	Yes	Yes	6.615	Yes, approx. Every 3 years	Whole country	No	-
France	1 (guide value)	Yes	Plenty of information available on the ades and infoterre websites	Plenty of information available on the ades and infoterre websites	Plenty of information available on the ades and infoterre websites	Plenty of information available on the ades and infoterre websites	Yes, maps of high natural background risk zones in traces elements	Brgm public report: sectors identified during the national study - delimitation of high natural background risk zones in traces elements
Hungary	Not set (Natural mineral water) 1 (drinking water)	Not investigated; Higher values might occur in thermal waters.	Yes.	Sparse.	Not for the last 5 years. Mostly yearly sampling; for thermal waters can be up to 1/6 years.	-	No.	-
Iceland	1	No	In some cases	unknown	Yes, varies	No. Distributed sampling points	No	-
Ireland	1	No (99.9% < threshold)	N/A	300	Yes, 3 times per year	Whole country	Yes	-
Italy	-	-	-	-	-	-	-	This topics are not in the assignments of the Geological Survey of Italy of ISPRA
Latvia	1 (drinking water)	Not checked	No	Not checked	Yes, not checked	Not checked	No	-
Lithuania	No information	No information	No information	No information	No information	No information	No information	No information
Malta	0,6	No	-	-	-	-	-	-
Poland	1,0 (drinking water)/5,0 (natural mineral water)	Yes	Yes	Approx. 1300 (groundwater monitoring network) and some special groundwater's intakes	Yes, sampling every 1-3 years (groundwater monitoring network)	Whole country	No	--
Portugal	1	-	Yes	The groundwater quality monitoring network consists of about 700 points and its distribution in the country is not uniform. The frequency of sampling is by-annual. The parameters monitored are not the same at all points.	The Portuguese Environment Agency is responsible for the groundwater quality monitoring network. LNEG does not currently have access to this data. However LNEG will try to obtain this data and their authorization to make them available to the project partners.	Yes. The Groundwater quality monitoring network cover the whole country	No	In the case of natural spring water (as well as water for human consumption) the levels of physical-chemical parameters are established by the Decree-Law no.152/2017. For the natural mineral water this element is not subject to maximum admissible values.
Romania	Not set.	No information.	-	None.	No.	Only in areas with concession licenses for natural mineral water and in areas with	No.	-

Boron in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
						monitoring wells for drinking water.		
Serbia	1	Yes, in drinking water of Pannonian basin and some thermal water	Deep sediments of Pleistocene; granite gruss	-	-	-	-	-
Slovenia	Not set (Natural mineral water), 1,0 (drinking water)	Yes, some mineral and thermomineral waters	Yes	Approx. 30 sites with 50 wells	Thermal waters are tested in year 1, year 3 and then every 6th year (mostly years 2016-2018-2024), mineral waters can be different frequency	Specific, mineral and thermal waters with concessions and some natural springs all over Slovenia	No	Elevated in some mineral and thermal waters
Spain	1 (drinking water), 1 (Natural mineral water), Not set (spring water)	Yes	Yes	3.495	Yes. Sampling frequency varies depending on the region	They cover the whole country, althougt there are significative differences in the number of observations between regions	No	-
Spain (Catalonia)	1 (RD 140/2003 drinking waters) 1 (RD 1798/2010 Natural mineral water)	-	Yes	In general, approximately 350 points with regular frequency, and other points not regularly sampled. Mostly yearly sampling.	Yes in some of them. At the East basins of Catalonia, the network has 350 points yearly sampling. At the West of Catalonia (Ebro basin) there is information but not regularly sampled	No. Primarily the most productive or priority aquifer in terms of vulnerability	No	-
Sweden	1	-	-	200	-	No	No	-
Ukraine	0,5	Should be examined properly	Yes, if is determined	A lot of wells, the number can be determined by database sampling if necessary	Yes, at least for the period 2010-2018	Yes	No	-

3.3.6 Bromine

Table 14: Bromine in groundwater – Overview of data availability in participating countries/regions.

Bromine	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?
yes	2	10	5
some	3	3	4
not sure	0	0	2
no	7	1	3
no information provided	10	8	8

Table 15: Bromine in groundwater – Data availability in participating countries/regions.

Bromine in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Austria	Not set	No	Yes	Few records	No, elevated values are known	Specific areas	No, limited data available	-
Belgium	-	-	-	-	-	-	-	-
Bosnia and Herzegovina	Not set (Natural mineral water and drinking water)	Not investigated	Yes	Little	No, There are individual studies data,is no systematic testing	No, the entity Federation of Bosnia and Herzegovina	No	No
Czech Rep	0,01	-	Partly yes	Thousands of samples (archive data)	The data falls under the management of another organization, it would probably be possible to get it	Whole country	No	-
Denmark	No set	Unknown	Yes	146	Yes, approx. Every 3 years	Very few data, sparse coverage	No	-
France	0,01 (parametric value - Corrigendum to Official Journal of the European Union of L111 of 20 April 2001)	-	-	-	-	-	-	-
Hungary	Not set (Natural mineral water); 0,01 (drinking water)	Not investigated; Higher values might occur in thermal waters.	Yes.	Sparse.	Not for the last 5 years. Mostly yearly sampling; for termal waters can be up to 1/6 years.	-	No.	Beside sparse monitoring data, some research investigations involved Br samplings in the aquifers of the Great Hungarian Plain.
Iceland	0,01	No	In some cases	?	Yes. Varies	No. Distributed sampling points	No	-
Ireland	0,01 (bromate)	None / limited records	None / limited records	None / limited records	None / limited records	None / limited records	No	-
Italy	-	-	-	-	-	-	-	This topics are not in the assignments of the Geological Survey of Italy of ISPRA
Latvia	0,01 (drinking water)	Not checked	No	Not checked	Yes, not checked	Not checked	No	-
Lithuania	No information	No information	No information	No information	No information	No information	No information	No information
Malta	Not applicable	-	-	-	-	-	-	-
Poland	0,01 (as bromate in drinking water)	-Yes	-Yes	Approx. 1300 (groundwater monitoring network) and some special groundwater's intakes	Yes, sampling every 1-3 years (groundwater monitoring network)-	Whole country -	No	--
Portugal	0,001 (bro_2)	-	Yes	-	The Portuguese Environment Agency is responsible for the groundrinking waterater quality	Yes. The Groundrinking waterater quality monitoring network cover the whole country	No	No value defined for Bromine in Portuguese legislation, only for bro_2 - 0,001 mg/L

Bromine in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
					monitoring network. LNEG does not currently have access to this data. However LNEG will try to obtain this data and their authorization to make them available to the project partners.			
Romania	Not set	Yes, in some therapeutic mineral water	Yes	None	No	Only in areas with concession licenses for natural mineral water and in areas with monitoring wells for drinking water.	No	Elevated concentration in some therapeutic mineral water(concentration higher than 5 mgl^{-1})
Serbia	-	-	-	-	-	-	-	-
Slovenia	Not set (Natural mineral water), 0,010 (drinking water)	Yes, some mineral and thermomineral waters	Yes	Approx. 30 sites with 50 wells	Thermal waters are tested in year 1, year 3 and then every 6th year (mostly years 2016-2018-2024), mineral waters can be different frequency	Specific, mineral and thermal waters with concessions and some natural springs all over Slovenia	No	Elevated in some mineral and thermal waters in NE Slovenia
Spain	Not set	Yes	Yes	485	Yes. Sampling frequency varies depending on the region	They cover the whole country, althougt there are significative differences in the number of observations between regions	No	-
Spain (Catalonia)	0,01 (RD 140/2003 drinking waters) 0,003 (RD 1798/2010 Natural mineral water)	High concentration in some zones with an important geothermal water activity	Yes	A little	No, unsystematic.	No	No	-
Sweden	-	-	-	0	-	No	No	-
Ukraine	0,2	Should be examined properly	Yes, if is determined	A lot of wells, the number can be determined by database sampling if necessary	Yes, at least for the period 2010-2018	Yes	No	-

3.3.7 Chromium

Table 16: Chromium in groundwater – Overview of data availability in participating countries/regions.

Chromium	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?
yes	4	10	13
some	0	3	2
not sure	0	0	1
no	5	1	2
no information provided	13	8	4

Table 17: Chromium in groundwater – Data availability in participating countries/regions.

Chromium in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Austria	0,05 (drinking water); not set (indicator parameter)	Yes, but probably anthropogenic	Yes	2.837	Yes, h20-fachdatenbank (third party), up to 4 measurements/year	Whole country	Yes	-
Belgium	-	-	-	-	-	-	-	-
Bosnia and Herzegovina	0.050 (drinking water and Natural mineral water)	Not investigated	Yes	Little	No, there are individual studies data, is no systematic testing	No, the entity federation of bosnia and herzegovina	No	No
Czech Rep	0,05	-	Partly yes	Thousands of samples (archive data)	The data falls under the management of another organization, it would probably be possible to get it	Whole country	Yes	-
Denmark	0,05	No	Yes	103	Yes, approx. Every 4 years	Very few data, sparse coverage	No	-
France	0,05 (maximum acceptable concentration)	Yes	Plenty of information available on the ades and infoterre websites	Plenty of information available on the ades and infoterre websites	Plenty of information available on the ades and infoterre websites	Plenty of information available on the ades and infoterre websites	Yes, maps of high natural background risk zones in traces elements	Brgm public report: sectors identified during the national study - delimitation of high natural background risk zones in traces elements
Hungary	0.05 (Natural mineral water); 0.05 (drinking water)	Not investigated, but not likely.	Not applicable.	Sparse.	Not for the last 5 years. Mostly yearly sampling; for termal waters can be up to 1/6 years.	-	No.	-
Iceland	0,05	No	In some cases	?	Yes. Varies	No. Distributed sampling points	No	-
Ireland	0,05	No (99% < threshold)	N/A	300	Yes, 3 times per year	Whole country	Yes	-
Italy	-	-	-	-	-	-	-	This topics are not in the assignments of the Geological Survey of Italy of ISPRA

Chromium in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Latvia	0,05 (drinking water)	Not checked	No	Not checked	Yes, not checked	Not checked	No	-
Lithuania	No information	No information	No information	No information	No information	No information	No information	No information
Malta	Not applicable	-	-	-	-	-	-	-
Poland	0,05 (Natural mineral water), 0,05 (drinking water)	Yes (drinking water)	Yes	Ca. 1.300 (drinking water)/a few (Natural mineral water)	Yes, sampling every 1-3 years (drinking water)	The whole country (drinking water)	No	-
Portugal	0,05 (drinking water and natural mineral water)	Yes	Yes	Approx. 1300 (groundwater monitoring network) and some special groundwater's intakes	Yes, sampling every 1-3 years (groundwater monitoring network)	Whole country	No	-
Romania	0,05	No information.	-	None.	No.	Only in areas with concession licenses for natural mineral water and in areas with monitoring wells for drinking water.	No.	-
Serbia	0,05	-	-	-	-	-	-	-
Slovenia	0,05 (drinking water and Natural mineral water)	Not investigated	Yes	Approx. 30 sites with 50 wells	Thermal waters are tested in year 1, year 3 and then every 6th year (mostly years 2016-2018-2024), mineral waters can be different frequency	Specific, mineral and thermal waters with concessions and some natural springs all over Slovenia	No	Not investigated
Spain	0,05 (drinking water, Natural mineral water and spring water)	Yes	Yes	1.494	Yes. Sampling frequency varies depending on the region	They cover the whole country, althougt there are significative differences in the number of observations between regions	No	-
Spain (Catalonia)	0.05 (RD 140/2003 drinking waters) 0.05 (RD 1798/2010 Natural mineral water)	-	Yes	In general, approximately 350 points with regular frequency, and other points not regularly sampled. Mostly yearly sampling.	Yes in some of them. At the East basins of Catalonia, the network has 350 points yearly sampling. At the West of Catalonia (Ebro basin) there is information but not regularly sampled	No. Primarily the most productive or priority aquifer in terms of vulnerability	No	-
Sweden	0,05	-	-	15.000	Yes; see comment	Yes, but few analyses from northern Sweden	No	-
Ukraine	0,05	Should be examined properly	Yes, if is determined	A lot of wells, the number can be determined by database sampling if necessary	Yes, at least for the period 2010-2018	Yes	No	-

3.3.8 Copper

Table 18: Copper in groundwater – Overview of data availability in participating countries/regions.

Copper	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?
yes	4	10	10
some	2	3	1
not sure	1	0	2
no	5	1	4
no information provided	10	8	5

Table 19: Copper in groundwater – Data availability in participating countries/regions.

Copper in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking wateraterby a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking wateraterobservation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Austria	2 (drinking water); not set (indicator parameter)	Yes, but probably anthropogenic	Yes	2.837	Yes, h20-fachdatenbank (third party), up to 4 measurements/year	Whole country	Yes	-
Belgium	-	-	-	-	-	-	-	-
Bosnia and Herzegovina	2,0 (drinking water) 1,0 (Natural mineral water)	Not investigated	Little	Little	No, there are individual studies data, is no systematic testing	No, the entity federation of Bosnia and Herzegovina	No	No
Czech Rep	1	-	Partly yes	Thousands of samples (archive data)	The data falls under the management of another organization, it would probably be possible to get it	Whole country	Yes	-
Denmark	2	No	Yes	804	Yes, approx. Every 2 years	Whole country	No	-
France	0,1 (guide value) 3 (maximum acceptable concentration) 2 (parametric value - Corrigendum to Official Journal of the European Union of L111 of 20 April 2001)	Yes	Plenty of information available on the ADES and infoterre websites	Plenty of information available on the ADES and infoterre websites	Plenty of information available on the ADES and infoterre websites	Plenty of information available on the ADES and infoterre websites	Yes, maps of high natural background risk zones in traces elements	BRGM public report: Sectors identified during the national study - Delimitation of high natural background risk zones in traces elements
Hungary	1 (Natural mineral water; 2 (drinking water)	Not investigated, but not likely, except former mining site.	Yes.	Sparse.	Not for the last 5 years. Mostly yearly sampling; for termal waters can be up to 1/6 years.	-	No.	-
Iceland	2	No	In some cases	?	Yes. Varies	No. Distributed sampling points	No	-
Ireland	2	No (99.9% < threshold)	N/A	300	Yes, 3 times per year	Whole country	Yes	-
Italy	-	-	-	-	-	-	-	This topics are not in the assignments of the Geological

Copper in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
								Survey of Italy of ISPRA
Latvia	2 (drinking water)	Not checked	No	Not checked	Yes, not checked	Not checked	No	-
Lithuania	No information	No information	No information	No information	No information	No information	No information	No information
Malta	2	No	-	-	-	-	-	-
Poland	2,0 (drinking water)/1,0 (natural mineral water)	Yes	Yes	Approx. 1300 (groundwater monitoring network) and some special groundwater's intakes	Yes, sampling every 1-3 years (groundwater monitoring network)	Whole country	No	-
Portugal	2	In the north of Portugal was detected in vicinity of abandoned gold mine	Yes/abandoned gold mine	1 point, but only one sampling (LNEG field inventory) and groundwater monitoring network data	The Portuguese Environment Agency is responsible for the groundwater quality monitoring network. LNEG does not currently have access to this data. However LNEG will try to obtain this data and their authorization to make them available to the project partners.	Yes. The groundwater quality monitoring network cover the whole country	No	In the case of natural spring water (as well as water for human consumption) the levels of physical-chemical parameters are established by the Decree-Law no.152/2017. For the natural mineral water this element is subject to maximum admissible values Decree-law no. 72/2004.
Romania	1 (Natural mineral water); 0,1 (drinking water)	No information.	-	None.	No.	Only in areas with concession licenses for natural mineral water and in areas with monitoring wells for drinking water.	No.	-
Serbia	2	-	-	-	-	-	-	-
Slovenia	1,0 (Natural mineral water), 2,0 (drinking water)	Not investigated	Yes	Little	No, unsystematic, only for research purposes	Specific, mineral and thermal waters with concessions and some natural springs all over Slovenia	No	Not investigated
Spain	2 (drinking water and spring water). 1 (Natural mineral water)	Yes	Yes	4.303	Yes. Sampling frequency varies depending on the region	They cover the whole country, althougt there are significative differences in the number of observations between regions	No	-
Spain (Catalonia)	2 (RD 140/2003 drinking waters) 2 (RD 1798/2010	-	Yes	In general, approximately 350 points	Yes in some of them. At the East basins of Catalonia,	No. Primarily the most productive or	No	-

Copper in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
	Natural mineral water)			with regular frequency, and other points not regularly sampled. Mostly yearly sampling.	the network has 350 points yearly sampling. At the West of Catalonia (Ebro basin) there is information but not regularly sampled	priority aquifer in terms of vulnerability		
Sweden	2	-	-	40.000	Yes; see comment	Yes, but few analyses from northern Sweden	No	Mostly tapwater (contamination from pipes)
Ukraine	1,0	Should be examined properly	Yes, if is determined	A lot of wells, the number can be determined by database sampling if necessary	Yes, at least for the period 2010-2018	Yes	No	-

3.3.9 Fluorine

Table 20: Fluorine in groundwater – Overview of data availability in participating countries/regions.

Fluorine	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?
yes	9	16	12
some	2	2	2
not sure	0	0	1
no	4	0	3
no information provided	7	4	4

Table 21: Fluorine in groundwater – Data availability in participating countries/regions.

Fluorine in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Austria	1,5 (drinking water); not set (indicator parameter)	Yes	Yes	2.844	Yes, h20-fachdatenbank (third party), up to 4 measurements/year	Whole country	No	-
Belgium	0,9 - 6,9	Yes, for example deeper aquifers of West- and East-Flanders (Landenian and	Sandy aquifer with partly salt/brackish water, fissured rock aquifer	350 (600 screens)	Yes, sampling frequency once per year	Yes	Not yet	-

Fluorine in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
		Massif of Brabant)						
Bosnia and Herzegovina	5,0 (Natural mineral water), 1,5 (drinking water)	Not investigated	Yes	Little	No, There are individual studies data,is no systematic testing	No, the entity Federation of Bosnia and Herzegovina	No	No
Czech Rep	1,5	-	Partly yes	Thousands of samples (archive data)	The data falls under the management of another organization, it would probably be possible to get it	Whole country	Yes	-
Denmark	1,5	Yes	Yes	5.969	Yes, approx. Every 3-4 years	Whole country	No	-
France	1,5 (maximum acceptable concentration)	Yes	Plenty of information available on the ades and infoterre websites	Plenty of information available on the ades and infoterre websites	Plenty of information available on the ades and infoterre websites	Plenty of information available on the ades and infoterre websites	Yes, maps of high natural background risk zones in traces elements	Brgm public report: sectors identified during the national study - delimitation of high natural background risk zones in traces elements
Hungary	5 (Natural mineral water); 1,5 (drinking water)	Yes.	Yes.	Sparse.	Not for the last 5 years. Mostly yearly sampling; for termal waters can be up to 1/6 years.	-	No.	Beside sparse monitoring data, some research investigations involved F samplings in the aquifers of the Great Hungarian Plain.
Iceland	1,5	No	In some cases	?	Yes. Varies	No. Distributed sampling points	No	-
Ireland	0,8 / 1.5	Yes (94% < threshold)	Yes	300	Yes, 3 times per year	Whole country	Yes	-
Italy	-	-	-	-	-	-	-	This topics are not in the assignments of the Geological Survey of Italy of ISPRA
Latvia	1,5 (drinking water)	Yes	Yes	Not checked	Yes, not checked	Not checked	No	-
Lithuania	No information	No information	No information	No information	No information	No information	No information	No information
Malta	2,75	No	-	-	-	-	-	-
Poland	1,5 (drinking water)/5,0 (natural mineral water)	Yes	Yes	Approx. 1300 (groundwater monitoring network) and some special groundwater's intakes	Yes, sampling every 1-3 years (groundwater monitoring network)	Whole country	No	
Portugal	1,5	-	Yes	The groundrinking waterater quality monitoring network consists of about 700 points and its distribution in the country is not uniform.	The Portuguese Environment Agency is responsible for the groundrinking waterater quality monitoring network. LNEG does not currently have access to this data. However LNEG will try to obtain this	Yes. The Groundwater quality monitoring network cover the whole country	No	In the case of natural spring water (as well as water for human consumption) the levels of physical-chemical parameters are established by the Decree-Law

Fluorine in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
				The frequency of sampling is by-annual. The parameters monitored are not the same at all points..	data and their authorization to make them available to the project partners.			no.152/2017. For the natural mineral water this element is subject to maximum admissible values (5mg/L)Decree-law no. 72/2004.
Romania	1,5 (Natural mineral water).The values of 5 are also accepted with the requirement to be included on the packaging label); 1,2 (set for drinking water)	No information.	Yes.	None.	No.	Only in areas with concession licenses for natural mineral water and in areas with monitoring wells for drinking water.	No.	-
Serbia	1,5	Some thermal water	Granite, schist	-	-	-	-	-
Slovenia	5,0 mg/l for Natural mineral water, 1,5 (drinking water)	Yes, some mineral and thermomineral waters	Yes	Approx. 30 sites with 50 wells	Thermal waters are tested in year 1, year 3 and then every 6th year (mostly years 2016-2018-2024), mineral waters can be different frequency	Specific, mineral and thermal waters with concessions and some natural springs all over Slovenia	No	Elevated in some mineral and thermal waters in NE Slovenia
Spain	1,5 (drinking water and and spring water). 5 (Natural mineral water)	Yes	Yes	2.777	Yes. Sampling frequency varies depending on the region	They cover the whole country, althougt there are significative differences in the number of observations between regions	No	-
Spain (Catalonia)	1,5 mg/l (RD 140/2003 drinking waters) 1.5 - 5 mg/l (RD 1798/2010 Natural mineral water)	Anomalies detected, in specific areas with mineralization's of philonitic or Skarn mineralization's with fluorite. High concentration in some zones with an important geothermal water activity or related to old mining activity.	Yes	A little	No, unsystematic.	No	No	-
Sweden	1,5	-	-	40.000	Yes; see comment	Yes	Yes	-
Ukraine	1,5	Should be examined properly	Yes, if is determined	A lot of wells, the number can be determined by database sampling if necessary	Yes, at least for the period 2010-2018	Yes	No	-

3.3.10 Iodine

Table 22: Iodine in groundwater – Overview of data availability in participating countries/regions.

Iodine	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?
yes	2	9	5
some	3	4	2
not sure	0	0	1
no	7	2	5
no information provided	10	7	9

Table 23: Iodine in groundwater – Data availability in participating countries/regions.

Iondine in grundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Austria	Not set	No since not set	Yes	Little, not a monitoring parameter	No	Mainly for special and thermal waters	No	-
Belgium	-	-	-	-	-	-	-	-
Bosnia and Herzegovina	Not set	Not investigated	Yes	Little	No, there are individual studies data, is no systematic testing	No, the entity federation of bosnia and herzegovina	No	No
Czech Rep	Not specified	-	Partly yes	Thousands of samples (archive data)	The data falls under the management of another organization, it would probably be possible to get it	Whole country	Not specified	-
Denmark	Not set	-	Yes	16	Yes, every 5 years	Very sparse data	No	-
France	-	-	-	-	-	-	-	-
Hungary	Not set (Natural mineral water); not set (drinking water)	No reference value.	Not applicable.	Sparse	Not for the last 5 years. Mostly yearly sampling; for termal waters can be up to 1/6 years.	-	No.	Beside sparse monitoring data, some research investigations involved I samplings in the aquifers of the Great Hungarian Plain.
Iceland	-	No	In some cases	?	Yes. Varies	No. Distributed sampling points	No	-
Ireland	Not set	None / limited records	None / limited records	None / limited records	No	None / limited records	No	-
Italy	-	-	-	-	-	-	-	This topics are not in the assignments of the Geological Survey of Italy of ISPRA

Iondine in grundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Latvia	No	Not checked	No	Not checked	Yes, not checked	Not checked	No	-
Lithuania	-	-	-	-	-	-	-	-
Malta	-	-	-	-	-	-	-	-
Poland	Not set	-	-	Approx. 1300 (groundwater monitoring network) and some special groundwater's intakes-	Yes, sampling every 1-3 years (groundwater monitoring network)-	Whole country -	No	
Portugal	No value	Not monitored	Yes	-	-	-	-	No treshold value defined in portuguese legislation
Romania	Not set	Yes, in some therapeutic mineral water.	Yes	None	No	Only in areas with concession licenses for natural mineral water and in areas with monitoring wells for drinking water	No	Elevated concentration in some therapeutic mineral water (concentration in iodine higher than 1 mgl^{-1} for iodine water)
Serbia	Not set	Mineral water of Pannonian basin	Sediments of Pannonian basin	-	-	-	-	-
Slovenia	Not set	Yes, some mineral and thermomineral waters	Yes	Approx. 30 sites with 50 wells	Thermal waters are tested in year 1, year 3 and then every 6th year (mostly years 2016-2018-2024), mineral waters can be different frequency	Specific, mineral and thermal waters with concessions and some natural springs all over slovenia	No	Elevated in some mineral and thermal waters in ne slovenia
Spain	Not set	Yes	Yes	12	Yes. Sampling frequency varies depending on the region	They cover the whole country, althougt there are significative differences in the number of observations between regions	No	-
Spain (Catalonia)	Not set	-	Yes	A little	No, unsystematic.	No	No	-
Sweden	-	-	-	0	-	No	No	-
Ukraine	50	Should be examined properly	Yes, if is determined	A lot of wells, the number can be determined by database sampling if necessary	Yes, at least for the period 2010-2018	Yes	No	TV is determined only for bottled water

3.3.11 Iron

Table 24: Iron in groundwater – Overview of data availability in participating countries/regions.

iron	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?

yes	8	12	11
some	3	2	3
not sure	0	0	1
no	4	2	2
no information provided	7	6	5

Table 25: Iron in groundwater – Data availability in participating countries/regions.

Iron in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Austria	Not set (drinking water); 0,05 (indicator parameter)	Yes	Yes	2.844	Yes, h20-fachdatenbank (third party), up to 4 measurements/year	Whole country	Yes	-
Belgium	-	-	-	-	-	-	-	-
Bosnia and Herzegovina	Not set (Natural mineral water), 0,2 (drinking water)	Not investigated	Yes	5-10 wells	No, There are individual studies data,is no systematic testing	No, the entity Federation of Bosnia and Herzegovina	No	To appear in a large number of mineral and thermomineral waters
Czech Rep	0,2	-	Partly yes	Thousands of samples (archive data)	The data falls under the management of another organization, it would probably be possible to get it	Whole country	Yes	-
Denmark	0,2	Yes	Yes	6.938	Yes, approx every 2-3 years	Whole country	No	-
France	0,05 (guide value) 0,2 (maximum acceptable concentration)	Yes, not taken into account, because of complex redox phenomena	Plenty of information available on the ades and infoterre websites	Plenty of information available on the ades and infoterre websites	Plenty of information available on the ades and infoterre websites	Plenty of information available on the ades and infoterre websites	Plenty of information available on the ades and infoterre websites	Plenty of information available on the ades and infoterre websites
Hungary	Not set (Natural mineral water) 0,2 (drinking water, but only indicator value and not treshold limit value)	Not investigated.	Not applicable.	Few hundreds.	Not for the last 5 years. If neede, probably it can be accessed through third party. Mostly yearly sampling; for termal waters can be up to 1/6 years.	-	No	-
Iceland	0,2	No	In some cases	unknown	Yes. Varies	No. Distributed sampling points	No	-
Ireland	0,2 (indicator parameter)	Yes (75% < threshold)	No	300	Yes, 3 times per year	Whole country	Yes	-
Italy	-	-	-	-	-	-	-	This topics are not in the assignments of the Geological Survey of Italy of ISPRA
Latvia	0,2 (drinking water)	Yes	Yes	Not checked	Yes, not checked	Not checked	No	-
Lithuania	-	-	-	-	-	-	-	-
Malta	-	-	-	-	-	-	-	-
Poland	0,2 (drinking water)	Yes	Yes	Approx. 1300 (groundwater monitoring network) and some special groundwater's intakes	Yes, sampling every 1-3 years (groundwater monitoring network)	Whole country	No	--
Portugal	0,2	In the north of Portugal was	Yes	21 points, but only one	The Portuguese Environment	Yes. The groundwater	No	In the case of natural spring water

Iron in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
		detected some points above the threshold value.		sampling (field inventory of LNEG) and groundwater monitoring network data	Agency is responsible for the groundwater quality monitoring network. LNEG does not currently have access to this data. However LNEG will try to obtain this data and their authorization to make them available to the project partners.	quality monitoring network cover the whole country		(as well as water for human consumption) the levels of physical-chemical parameters are established by the Decree-Law no.152/2017. For the natural mineral water this element is not subject to maximum admissible values Decree-law no. 72/2004.
Romania	0,2 (drinking water).	Yes, in some therapeutic mineral water and thermal water.	Yes.	None.	No.	Only in areas with concession licenses for natural mineral water and in areas with monitoring wells for drinking water.	No.	Elevated concentration in some mineral water and therapeutic mineral water (concentration higher than 10 mg/l in therapeutic mineral water). Drinking water is treated before to be used.
Serbia	0.2	-	-	-	-	-	-	-
Slovenia	Not set (Natural mineral water) 0,2 (drinking water)	Yes, some mineral and thermomineral waters	Yes	Approx. 30 sites with 50 wells	Thermal waters are tested in year 1, year 3 and then every 6th year (mostly years 2016-2018-2024), mineral waters can be different frequency	Specific, mineral and thermal waters with concessions and some natural springs all over Slovenia	No	Is of geogenic origin in NE Slovenia
Spain	0,2 drinking water and spring water. Not set for natural mineral water	Yes	Yes	3.805	Yes. Sampling frequency varies depending on the region	They cover the whole country, althougt there are significative differences in the number of observations between regions	No	-
Spain (Catalonia)	0,2 (RD 140/2003 drinking waters) 0,2 (RD 1798/2010 Natural mineral water)	Anomalies detected, in specific areas with Miocene volcanism associated with regional faults, and in Igneous and metamorphic-rock aquifers or related to old mining activity.	Yes	In general, approximately 350 points with regular frequency, and other points not regularly sampled. Mostly yearly sampling.	Yes in some of them. At the East basins of Catalonia, the network has 350 points yearly sampling. At the West of Catalonia (Ebro basin) there is information but not regularly sampled	No. Primarily the most productive or priority aquifer in terms of vulnerability	No	-
Sweden	-	-	-	40.000	Yes; see comment	Yes, but few analyses from northern Sweden	No	-
Ukraine	1,0	Should be examined properly	Yes, if is determined	A lot of wells, the number can be determined by database	Yes, at least for the period 2010-2018	Yes	No	-

Iron in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
				sampling if necessary				

3.3.12 Lead

Table 26: Lead in groundwater – Overview of data availability in participating countries/regions.

Lead	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?
yes	8	9	12
some	2	3	2
not sure	0	0	1
no	7	3	3
no information provided	5	7	4

Table 27: Lead in groundwater – Data availability in participating countries/regions.

Lead in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Austria	0,01 (drinking water); not set (indicator parameter)	Yes	Yes	2.837	Yes, h20-fachdatenbank (third party), up to 4 measurements/year	Whole country	Yes	-
Belgium	0,01	Very exceptional, no specific region	-	4.000	Yes, sampling frequency once or twice per year (depending on monitoring network)	Yes	Not yet	Exceedings probably due to anthropogenic activities
Bosnia and Herzegovina	0,01 (drinking water and Natural mineral water)	Not investigated	Little	Little	No, There are individual studies data,is no systematic testing	No, the entity Federation of Bosnia and Herzegovina	No	No
Czech Rep	0,01	-	Partly yes	Thousands of samples (archive data)	The data falls under the management of another organization, it would probably be possible to get it	Whole country	Yes	-
Denmark	0,005	Yes	Yes	809	Yes, every 2-3 years	Whole country	No	-

Lead in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
France	0,05 (maximum acceptable concentration) 0,01 (parametric value - Corrigendum to Official Journal of the European Union of L111 of 20 April 2001)	Yes	Plenty of information available on the ADES and infoterre websites	Plenty of information available on the ADES and infoterre websites	Plenty of information available on the ADES and infoterre websites	Plenty of information available on the ADES and infoterre websites	Yes, maps of high natural background risk zones in traces elements	BRGM public report: Sectors identified during the national study - Delimitation of high natural background risk zones in traces elements
Hungary	0,01 (Natural mineral water) 0,01 (drinking water)	No.	Not applicable.	Few hundreds, (varies approximately between 200 and 600 per year).	Not for the last 5 years. If neede, probably it can be accessed through third party. Mostly yearly sampling; for termal waters can be up to 1/6 years.	-	Maps not, but values on groundrinking waterater body levels yes.	-
Iceland	0,01	No	In some cases	?	Yes. Varies	No. Distributed sampling points	No	-
Ireland	0,01	Yes (98% < threshold)	No	300	Yes, 3 times per year	Whole country	Yes	-
Italy	-	-	-	-	-	-	-	This topics are not in the assignments of the Geological Survey of Italy of ISPRA
Latvia	0,01 (drinking water)	Not checked	No	Not checked	Yes, not checked	Not checked	No	-
Lithuania	No information	No information	No information	No information	No information	No information	No information	No information
Malta	0,01	No	-	-	-	-	-	-
Poland	0,01 (drinking water and natural mineral water)	Yes	Yes	Approx. 1300 (groundwater monitoring network) and some special groundwater's intakes	Yes, sampling every 1-3 years (groundwater monitoring network)	Whole country	No	-
Portugal	0,01	In the north of Portugal was detected in vicinity of abandoned gold mine	Yes/abandoned gold mine	6 point, but only one sampling (LNEG field inventory) and groundwater monitoring network data	The Portuguese Environment Agency is responsible for the groundwater quality monitoring network. LNEG does not currently have access to this data. However LNEG will try to obtain this data and their authorization to make them available to the project partners.	Yes. The groundwater quality monitoring network cover the whole country	No	In the case of natural spring water (as well as water for human consumption) the levels of physical-chemical parameters are established by the Decree-Law no.152/2017. For the natural mineral water this element is subject to maximum admissible values (5mg/L)Decree-law no. 72/2004.
Romania	0,01	No information	-	None.	No.	Only in areas with concession licenses for	No.	-

Lead in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
						natural mineral water and in areas with monitoring wells for drinking water.		
Serbia	0,01	-	-	-	-	-	-	-
Slovenia	0,01 (drinking water and Natural mineral water)	Not investigated	Yes	Little	No, unsystematic, only for research purposes	Specific, mineral and thermal waters with concessions and some natural springs all over Slovenia	No	Not investigated
Spain	0,01 (drinking water, Natural mineral water and spring water	Yes	Yes	1.496	Yes. Sampling frequency varies depending on the region	They cover the whole country, althougt there are significative differences in the number of observations between regions	No	-
Spain (Catalonia)	0,01 (RD 140/2003 drinking waters) 0,01 (RD 1798/2010 Natural mineral water)	Yes in some areas, with geogenetic origin where exists mineralization of sulphurs, also in areas where existed old mine activities, and in areas with hydro-geothermal manifestations.	Yes	In general, approximately 350 points with regular frequency, and other points not regularly sampled. Mostly yearly sampling.	Yes in some of them. At the East basins of Catalonia, the network has 350 points yearly sampling. At the West of Catalonia (Ebro basin) there is information but not regularly sampled	No. Primarily the most productive or priority aquifer in terms of vulnerability	No	-
Sweden	0,01	-	-	20.000	Yes; see comment	Yes, but few analyses from northern Sweden	No	-
Ukraine	0,01	Should be examined properly	Yes, if is determined	A lot of wells, the number can be determined by database sampling if necessary	Yes, at least for the period 2010-2018	Yes	No	-

3.3.13 Lithium

Table 28: Lithium in groundwater – Overview of data availability in participating countries/regions.

Lithium	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in	Do you have access to concentrations in groundwater observation

		groundwater by a simple geological classification of the aquifer?	wells/springs in your country for at least 5 recent years and what is the sampling frequency?
yes	3	5	5
some	0	3	2
not sure	0	0	1
no	10	4	5
no information	9	10	9

Table 29: Lithium in groundwater – Data availability in participating countries/regions.

Lithium in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Austria	Not set	Not set	Yes	2.837	Yes, h20-fachdatenbank (third party), up to 4 measurements/year	Specific areas	No	-
Belgium	-	-	-	-	-	-	-	-
Bosnia and Herzegovina	Not set	Not investigated	Yes	Little	No, there are individual studies data,is no systematic testing	No, the entity federation of bosnia and herzegovina	No	No
Czech Rep	Not set	-	Partly yes	Thousands of samples (archive data)	The data falls under the management of another organization, it would probably be possible to get it	Whole country	Yes	-
Denmark	Not set	Not known, but unlikely (Li was measured in approx. 200 drinking water samples and concentrations were max. Around 30µg/l	-	0	No	-	Yes, but based on drinking water measurements	There has been two sampling campaigns of drinking water li in denmark (2013 and 2016). Li is assumed to originate only from natural background and maps with li levels in drinking water (i.e. Groundrinking waterater) have been published
France	-	-	-	-	-	-	-	-
Hungary	Not set (Natural mineral water) Not set (drinking water)	No reference value.	Theoretically yes.	Sparse.	Not for the last 5 years. Mostly yearly sampling; for termal waters can be up to 1/6 years.	-	No.	-
Iceland	-	No	In some cases	?	Yes. Varies	No. Distributed sampling points	No	-
Ireland	Not set	-	-	None / limited records	No	None / limited records	No	-
Italy	-	-	-	-	-	-	-	This topics are not in the assignments of the Geological Survey of Italy of ISPRA
Latvia	Not set	Not checked	No	Not checked	Yes, not checked	Not checked	No	-
Lithuania	-	-	-	-	-	-	-	-
Malta	-	-	-	-	-	-	-	-
Poland	Not set	-	-	Approx. 1300 (groundwater monitoring	Yes, sampling every 1-3 years (groundwater	Whole country -	No	-

				network) and some special groundwater's intakes-	monitoring network)-			
Portugal	No value	Not monitored	Yes	-	-	-	-	No treshold value defined in portuguese legislation
Romania	Not set	Yes, in some therapeutic mineral water.	Yes	None	No	Only in areas with concession licenses for natural mineral water and in areas with monitoring wells for drinking water	No	Elevated concentration in some therapeutic mineral water and thermal water(concentration higher than 3 mgl^{-1} in therapeutic mineral water)
Serbia	-	-	-	-	-	-	-	-
Slovenia	Not set	Yes, some mineral and thermomineral waters	Yes	Approx. 30 sites with 50 wells	Thermal waters are tested in year 1, year 3 and then every 6th year (mostly years 2016-2018-2024), mineral waters can be different frequency	Specific, mineral and thermal waters with concessions and some natural springs all over slovenia	No	Elevated in some mineral and thermal waters in ne slovenia
Spain	Not set	Yes	Yes	1.716	Yes. Sampling frequency varies depending on the region	They cover the whole country, althougt there are significative differences in the number of observations between regions	No	-
Spain (Catalonia)	Not set	Anomalies detected in some areas, with metamorphic and granitic massifs, in areas with hydro-geothermal manifestations.	Yes	A little	No, unsystematic.	No	No	-
Sweden	-	-	-	500	-	No	No	-
Ukraine	0,03	Should be examined properly	Yes, if is determined	A lot of wells, the number can be determined by database sampling if necessary	Yes, at least for the period 2010-2018	Yes	No	-

3.3.14 Manganese

Table 30: Manganese in groundwater – Overview of data availability in participating countries/regions.

Manganese	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?
yes	8	10	10
some	2	2	2
not sure	0	0	1
no	4	3	3

no information provided	8	7	6

Table 31: Manganese in groundwater – Data availability in participating countries/regions.

Manganese in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Austria	Not set (drinking water) 0,05 (indicator parameter)	Yes	Yes	2.837	Yes, h20-fachdatenbank (third party), up to 4 measurements/year	Whole country	Yes	-
Belgium	-	-	-	-	-	-	-	-
Bosnia and Herzegovina	0,5 (Natural mineral waters) 0,05 (drinking water)	Not investigated	Yes	-	No, There are individual studies data,is no systematic testing	No, the entity Federation of Bosnia and Herzegovina	No	To appear in a large number of mineral waters
Czech Rep	0,05	-	Partly yes	Thousands of samples (archive data)	The data falls under the management of another organization, it would probably be possible to get it	Whole country	Yes	-
Denmark	0,05	Yes	Yes	6.936	Yes, every 2-3 years	Whole country	No	-
France	0,02 (Guide value) 0,05 (maximum acceptable concentration)	Yes, not taken into account, because of complex redox phenomena	-	-	-	-	-	-
Hungary	0,5 (Natural mineral water); 0,5 (drinking water)	Not investigated.	Not applicable.	Few hundreds.	Not for the last 5 years. If neede, probably it can be accessed through third party. Mostly yearly sampling; for termal waters can be up to 1/6 years.	-	No.	-
Iceland	-	No	In some cases	?	Yes. Varies	No. Distributed sampling points	No	-
Ireland	0,05 (indicator parameter)	Yes (65%< threshold)	No	300	Yes, 3 times per year	Whole country	Yes	-
Italy	-	-	-	-	-	-	-	This topics are not in the assignments of the Geological Survey of Italy of ISPRA
Latvia	0,05 (drinking water)	Not checked	No	Not checked	Yes, not checked	Not checked	No	-
Lithuania	No information	No information	No information	No information	No information	No information	No information	No information
Malta	-	-	-	-	-	-	-	-
Poland	0,05 (drinking water and natural mineral water)	Yes	Yes	Approx. 1300 (groundwater monitoring network) plus some special groundwater's intakes	Yes, sampling every 1-3 years (groundwater monitoring network)	Whole country	No	--
Portugal	0,05	In the north of Portugal was detected some points above the threshold value.	Yes	49 points, but only one sampling (field inventory of LNEG) and gorundwatermonitoring network data	The Portuguese Environment Agency is responsible for the groundwater quality monitoring network. LNEG does not currently have access to this data. However LNEG will try to obtain this data and their	Yes. The groundwater quality monitoring network cover the whole country	No	In the case of natural spring water (as well as water for human consumption) the levels of physical-chemical parameters are established

Manganese in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
					authorization to make them available to the project partners.			by the Decree-Law no.152/2017. For the natural mineral water this element is subject to maximum admissible values Decree-law no. 72/2004.
Romania	0,5 (Natural mineral water) 0,05 (drinking water).	Yes, in some therapeutic mineral water.	Yes.	None.	No.	Only in areas with concession licenses for natural mineral water and in areas with monitoring wells for drinking water.	No.	Elevated concentration in some mineral water . Water is treated befor to be use.
Serbia	0,05	-	-	-	-	-	-	-
Slovenia	0,50 (Natural mineral waters) 0,05 (drinking water)	Yes, some mineral and thermomineral waters	Yes	Approx. 30 sites with 50 wells	Thermal waters are tested in year 1, year 3 and then every 6th year (mostly years 2016-2018-2024), mineral waters can be different frequency	Specific, mineral and thermal waters with concessions and some natural springs all over Slovenia	No	Is of geogenic origin in NE Slovenia
Spain	0,05 (drinking water) spring water. 0,5 (Natural mineral water)	Yes	Yes	2.999	Yes. Sampling frequency varies depending on the region	They cover the whole country, althougt there are significative differences in the number of observations between regions	No	-
Spain (Catalonia)	0,05 mg/l (RD 140/2003 drinking water) 0,5 – 0,05 mg/l (RD 1798/2010 Natural mineral water)	Anomalies detected in some areas, with hydro-geothermal manifestations.	Yes	In general, approximately 350 points with regular frequency, and other points not regularly sampled. Mostly yearly sampling.	Yes in some of them. At the East basins of Catalonia, the network has 350 points yearly sampling. At the West of Catalonia (Ebro basin) there is information but not regularly sampled	No. Primarily the most productive or priority aquifer in terms of vulnerability	No	-
Sweden	-	-	-	40.000	Yes; see comment	Yes, but few analyses from northern Sweden	No	-
Ukraine	0,5	Should be examined properly	Yes, if is determined	A lot of wells, the number can be determined by database sampling if necessary	Yes, at least for the period 2010-2018	Yes	No	-

3.3.15 Mercury

Table 32: Mercury in groundwater – Overview of data availability in participating countries/regions.

Mercury	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?
yes	3	7	10
some	0	3	1
not sure	0	0	2
no	7	3	3
no information provided	12	9	6

Table 33: Mercury in groundwater – Data availability in participating countries/regions.

Mercury in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Austria	0,001 (drinking water) not set (indicator parameter)	Yes	Yes	2.837	Yes, h20-fachdatenbank (third party), up to 4 measurements/year	Whole country	Yes	-
Belgium	-	-	-	-	-	-	-	-
Bosnia and Herzegovina	0,001 (drinking water and Natural mineral water)	Not investigated	Little	Little	No, There are individual studies data,is no systematic testing	No, the entity Federation of Bosnia and Herzegovina	No	Not investigated
Czech Rep	0,001	-	Partly yes	Thousands of samples (archive data)	The data falls under the management of another organization, it would probably be possible to get it	Whole country	Yes	-
Denmark	0,001	Yes	Yes	92	Yes, approx. Every 4-5 years	Very sparse data	No	-
France	0,001 (maximum acceptable concentration)	-	-	-	-	-	-	-
Hungary	0,001 (Natural mineral water); 0,001 (drinking water)	No.	Not applicable.	Few hundreds, (varies approximately between 200 and 600 per year).	Not for the last 5 years. If neede, probably it can be accessed through third party. Mostly yearly sampling; for termal waters can be up to 1/6 years.	-	Maps not, but values on groundwater body levels yes.	-
Iceland	0,001	No	In some cases	Unknown	Yes, varies	No. Distributed sampling points	No	-
Ireland	0,001	No (99.9% < threshold)	N/A	300	Yes, 3 times per year	Whole country	Yes	-
Italy	-	-	-	-	-	-	-	This topics are not in the assignments of the Geological Survey of Italy of ISPRA
Latvia	0,001 (drinking water)	Not checked	No	Not checked	Yes, not checked	Not checked	No	-
Lithuania	No information	No information	No information	No information	No information	No information	No information	No information
Malta	-	-	-	-	-	-	-	-
Poland	0,001 (drinking water and natural mineral	No	-	Approx. 1300 (groundwater	Yes, sampling every 1-3 years (groundwater	Whole country	No	--

Mercury in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
	water)			monitoring network)	monitoring network)			
Portugal	0,001	-	Yes	The groundwater quality monitoring network consists of about 700 points and its distribution in the country is not uniform. The frequency of sampling is by-annual. The parameters monitored are not the same at all points.	The Portuguese Environment Agency is responsible for the groundwater quality monitoring network. LNEG does not currently have access to this data. However LNEG will try to obtain this data and their authorization to make them available to the project partners.	Yes. The groundwater quality monitoring network cover the whole country	No	In the case of natural spring water (as well as water for human consumption) the levels of physical-chemical parameters are established by the Decree-Law no.152/2017. For the natural mineral water this element is subject to maximum admissible values Decree-law no. 72/2004.
Romania	0,001	No information.	-	None.	No.	Only in areas with concession licenses for natural mineral water and in areas with monitoring wells for drinking water.	No.	-
Serbia	0,001	-	-	-	-	-	-	-
Slovenia	0,001 (drinking water and Natural mineral water)	Not investigated	Yes	Little	No, unsystematic, only for research purposes	Specific, mineral and thermal waters with concessions and some natural springs all over Slovenia	No	Not investigated
Spain	0,001(drinking water, Natural mineral water and spring water)	Yes	Yes	1.195	Yes. Sampling frequency varies depending on the region	They cover the whole country, althougt there are significative differences in the number of observations between regions	No	-
Spain (Catalonia)	0,001 (RD 140/2003 drinking waters) 0,001 (RD 1798/2010 Natural mineral water)	-	Yes	In general, approximately 350 points with regular frequency, and other points not regularly sampled. Mostly yearly sampling.	Yes in some of them. At the East basins of Catalonia, the network has 350 points yearly sampling. At the West of Catalonia (Ebro basin) there is information but not regularly sampled	No. Primarily the most productive or priority aquifer in terms of vulnerability	No	-
Sweden	0,001	-	-	500	Yes; see comment	No	No	-
Ukraine	0,0005	Should be examined properly	Yes, if is determined	A lot of wells, the number can be determined by database sampling if necessary	Yes, at least for the period 2010-2018	Yes	No	-

3.3.16 Nickel

Table 34: Nickel in groundwater – Overview of data availability in participating countries/regions.

Nickel	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?
yes	4	11	12
some	2	2	1
not sure	0	0	2
no	8	3	3
no information provided	8	6	4

Table 35: Nickel in groundwater – Data availability in participating countries/regions.

Nickel in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Austria	0,02 (drinking water); not set (indicator parameter)	some	Yes	2.837	Yes, h20-fachdatenbank (third party), up to 4 measurements/year	Whole country	Yes	-
Belgium	0,020 - 0,097	Yes, for example Campine region and East-Flanders	Sandy aquifers with acid water	4.000	Yes, sampling frequency once or twice per year (depending on monitoring network)	Yes	Not yet	-
Bosnia and Herzegovina	0,020 (drinking water and Natural mineral water)	Not investigated	Yes	1-2 wells	No, There are individual studies data,is no systematic testing	No, the entity Federation of Bosnia and Herzegovina	No	To appear in a little number of mineral waters
Czech Rep	0,02	-	Partly yes	Thousands of samples (archive data)	The data falls under the management of another organization, it would probably be possible to get it	Whole country	Yes	-
Denmark	0,02	Yes	Yes	6.636	Yes, approx. Every 3 years	Whole country	No	-
France	0,05 (maximum acceptable concentration) 0,02 (parametric value - Corrigendum to Official Journal of the European Union of L111 of 20 April 2001)	Yes	Plenty of information available on the ADES and infoterre websites	Plenty of information available on the ADES and infoterre websites	Plenty of information available on the ADES and infoterre websites	Plenty of information available on the ADES and infoterre websites	Yes, maps of high natural background risk zones in traces elements	BRGM public report: Sectors identified during the national study - Delimitation of high natural background risk zones in traces elements
Hungary	0.02 (Natural mineral water) 0,02 (drinking water)	Not investigated.	Not applicable.	Sparse.	Not for the last 5 years. Mostly yearly sampling; for termal waters can be up to 1/6 years.	-	No.	-

Nickel in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Iceland	0,02	No	In some cases	?	Yes. Varies	No. Distributed sampling points	No	-
Ireland	0,02	No (99%<threshold)	N/A	300	Yes, 3 times per year	Whole country	Yes	-
Italy	-	-	-	-	-	-	-	This topics are not in the assignments of the Geological Survey of Italy of ISPRA
Latvia	0,02 (drinking water)	Not checked	No	Not checked	Yes, not checked	Not checked	No	-
Lithuania	No information	No information	No information	No information	No information	No information	No information	No information
Malta	-	-	-	-	-	-	-	-
Poland	0,02 (drinking water and natural mineral water)	Yes, rare	Yes	Approx. 1300 (groundwater monitoring network) and some special groundwater's intakes	Yes, sampling every 1-3 years (groundwater monitoring network)	Whole country	No	
Portugal	0,02	-	Yes	The groundwater quality monitoring network consists of about 700 points and its distribution in the country is not uniform. The frequency of sampling is by-annual. The parameters monitored are not the same at all points.	The Portuguese Environment Agency is responsible for the groundwater quality monitoring network. LNEG does not currently have access to this data. However LNEG will try to obtain this data and their authorization to make them available to the project partners.	Yes. The groundwater quality monitoring network cover the whole country	No	In the case of natural spring water (as well as water for human consumption) the levels of physical-chemical parameters are established by the Decree-Law no.152/2017. For the natural mineral water this element is subject to maximum admissible values Decree-law no. 72/2004.
Romania	0,02	No information.	-	None.	No.	Only in areas with concession licenses for natural mineral water and in areas with monitoring wells for drinking water.	No.	-
Serbia	0,02	-	-	-	-	-	-	-
Slovenia	0,02 (drinking water and Natural mineral water)	Not investigated	Yes	Little	No, unsystematic, only for research purposes	Specific, mineral and thermal waters with concessions and some natural springs all over Slovenia	No	Not investigated
Spain	0,02 (drinking water, Natural mineral water and spring water)	Yes	Yes	493	Yes. Sampling frequency varies depending on the region	They cover the whole country, althougt there are significative differences in the number of observations between regions	No	-

Nickel in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Spain (Catalonia)	0,02 (RD 140/2003 drinking waters) 0,02 (RD 1798/2010 Natural mineral water)	-	Yes	In general, approximately 350 points with regular frequency, and other points not regularly sampled. Mostly yearly sampling.	Yes in some of them. At the East basins of Catalonia, the network has 350 points yearly sampling. At the West of Catalonia (Ebro basin) there is information but not regularly sampled	No. Primarily the most productive or priority aquifer in terms of vulnerability	No	-
Sweden	0,02	-	-	15.000	Yes; see comment	Yes, but few analyses from northern Sweden	No	-
Ukraine	0,02	Should be examined properly	Yes, if is determined	A lot of wells, the number can be determined by database sampling if necessary	Yes, at least for the period 2010-2018	Yes	No	-

3.3.17 Selenium

Table 36: Selenium in groundwater – Overview of data availability in participating countries/regions.

Selenium	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?
yes	3	9	10
some	4	4	1
not sure	0	0	2
no	8	2	4
no information provided	7	7	5

Table 37: Selenium in groundwater – Data availability in participating countries/regions.

Selenium in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Austria	0,01 (drinking water) not set (indicator parameter)	Limited records	Yes, for some areas	2.844	Yes, h20-fachdatenbank (third party), up to 4 measurements/year	Whole country	No	-
Belgium	-	-	-	-	-	-	-	-
Bosnia and Herzegovina	0,01 (drinking water and Natural mineral water)	Not investigated	Little	Little	No, There are individual studies data,is no systematic testing	No, the entity Federation of Bosnia	No	No

Selenium in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
						and Herzegovina		
Czech Rep	0,01	-	Partly yes	Thousands of samples (archive data)	The data falls under the management of another organization, it would probably be possible to get it	Whole country	Yes	-
Denmark	0,01	No	Yes	39	Yes, approx every 5 years	Very sparse data	No	-
France	0,01 (maximum acceptable concentration) 0,01 (parametric value - Corrigendum to Official Journal of the European Union of L111 of 20 April 2001)	Yes	Plenty of information available on the ADES and infoterre websites	Plenty of information available on the ADES and infoterre websites	Plenty of information available on the ADES and infoterre websites	Plenty of information available on the ADES and infoterre websites	Yes, maps of high natural background risk zones in traces elements	BRGM public report: Sectors identified during the national study - Delimitation of high natural background risk zones in traces elements
Hungary	0,01 (Natural mineral water); 0,01 (drinking water)	Not investigated.	Not applicable.	Sparse.	Not for the last 5 years. Mostly yearly sampling; for termal waters can be up to 1/6 years.	-	No.	-
Iceland	0,01	No	In some cases	?	Yes. Varies	No. Distributed sampling points	No	-
Ireland	0,01	None / limited records	None / limited records	None / limited records	No	None / limited records	No	-
Italy	-	-	-	-	-	-	-	This topics are not in the assignments of the Geological Survey of Italy of ISPRA
Latvia	0,01 (drinking water)	Not checked	No	Not checked	Yes, not checked	Not checked	No	-
Lithuania	No information	No information	No information	No information	No information	No information	No information	No information
Malta	-	-	-	-	-	-	-	-
Poland	0,01 (drinking water and natural mineral water	Yes	Yes	Approx. 1300 (groundwater monitoring network) and some special groundwater's intakes	Yes, sampling every 1-3 years (groundwater monitoring network)	Whole country	No	-
Portugal	0,01	In the north of Portugal was detected in vicinity of abandoned gold mine	Yes/abandoned gold mine	4 point, but only one sampling (LNEG field inventory) and gorundwatermonitoring network data	The Portuguese Environment Agency is responsible for the groundwater quality monitoring network. LNEG does not currently have access to this data. However LNEG will try to obtain this data and their authorization to make them available to the project partners.	Yes. The groundwater quality monitoring network cover the whole country	No	In the case of natural spring water (as well as water for human consumption) the levels of physical-chemical parameters are established by the Decree-Law no.152/2017. For the natural mineral

Selenium in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
								water this element is subject to maximum admissible values Decree-law no. 72/2004.
Romania	0,01	No information.	-	None.	No.	Only in areas with concession licenses for natural mineral water and in areas with monitoring wells for drinking water.	No.	-
Serbia	0,01	-	-	-	-	-	-	-
Slovenia	0,010 (drinking water and Natural mineral water)	Not investigated	Yes	Little	No, unsystematic, only for research purposes	Specific, mineral and thermal waters with concessions and some natural springs all over Slovenia	No	Not investigated
Spain	0,01 (drinking water, Natural mineral water and spring water)	Yes	Yes	955	Yes. Sampling frequency varies depending on the region	They cover the whole country, although there are significative differences in the number of observations between regions	No	-
Spain (Catalonia)	0,01 (RD 140/2003 drinking waters) 0,01 (RD 1798/2010 Natural mineral water)	Anomalies detected in some areas, with hydro-geothermal manifestations.	Yes	In general, approximately 350 points with regular frequency, and other points not regularly sampled. Mostly yearly sampling.	Yes in some of them. At the East basins of Catalonia, the network has 350 points yearly sampling. At the West of Catalonia (Ebro basin) there is information but not regularly sampled	No. Primarily the most productive or priority aquifer in terms of vulnerability	No	-
Sweden	0,01	-	-	15.000	-	Yes, but few analyses from northern Sweden	No	-
Ukraine	0,01	Should be examined properly	Yes, if is determined	A lot of wells, the number can be determined by database sampling if necessary	Yes, at least for the period 2010-2018	Yes	No	-

3.3.18 Strontium

Table 38: Strontium in groundwater – Overview of data availability in participating countries/regions.

Strontium	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?
yes	0	7	7
some	0	2	1
not sure	0	0	1
no	13	3	4
no information provided	9	10	9

Table 39: Strontium in groundwater – Data availability in participating countries/regions.

Strontium in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Austria	Not set	Not set	Yes	2.844	Yes, h20-fachdatenbank (third party), up to 4 measurements/year	Whole country	No	-
Belgium	-	-	-	-	-	-	-	-
Bosnia and Herzegovina	Not set	Not investigated	Yes	Little	No, there are individual studies data,is no systematic testing	No, the entity federation of bosnia and herzegovina	No	No
Czech Rep	Not set	-	Partly yes	Thousands of samples (archive data)	The data falls under the management of another organization, it would probably be possible to get it	Whole country	Yes	-
Denmark	Not set	-	Yes	1.143	Yes, approx. Every 3 years	Whole country	No	-
France	Not set	-	-	-	-	-	-	-
Hungary	Not set (Natural mineral water); Not set (drinking water)	No reference value.	Not applicable.	Sparse.	Not for the last 5 years. Mostly yearly sampling; for termal waters can be up to 1/6 years.	-	No.	-
Iceland	Not set	No	In some cases	?	Yes. Varies	No. Distributed sampling points	No	-
Ireland	Not set	-	-	300	Yes, 3 times per year	Whole country	Yes	-
Italy	-	-	-	-	-	-	-	This topics are not in the assignments of the Geological Survey of Italy of ISPRA
Latvia	Not set	Not checked	No	Not checked	Yes, not checked	Not checked	No	-
Lithuania	-	-	-	-	-	-	-	-
Malta	-	-	-	-	-	-	-	-
Poland	Not set	--	--	Approx. 1300 (groundwater monitoring network) and some special groundwater's intakes-	Yes, sampling every 1-3 years (groundwater monitoring network)-	Whole country -	No	--
Portugal	Not set	Not monitored	-	-	-	-	-	No treshold value defined in portuguese legislation

Strontium in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Romania	Not set.	No information.	-	None	No.	Only in areas with concession licenses for natural mineral water and in areas with monitoring wells for drinking water.	No.	-
Serbia	-	-	-	-	-	-	-	-
Slovenia	Not set	Yes, some mineral and thermomineral waters	Yes	Approx. 30 sites with 50 wells	Thermal waters are tested in year 1, year 3 and then every 6th year (mostly years 2016-2018-2024), mineral waters can be different frequency	Specific, mineral and thermal waters with concessions and some natural springs all over slovenia	No	Elevated in some mineral and thermal waters in ne slovenia
Spain	Not set	Yes	Yes	7	Yes. Sampling frequency varies depending on the region	They cover the whole country, althougt there are significative differences in the number of observations between regions	No	-
Spain (Catalonia)	Not set	-	Yes	A little	No, unsystematic.	No	No	-
Sweden	-	-	-	200	-	No	No	-
Ukraine	≤7,0	Should be examined properly	Yes, if is determined	A lot of wells, the number can be determined by database sampling if necessary	Yes, at least for the period 2010-2018	Yes	No	-

3.3.19 Uranium

Table 40: Strontium in groundwater – Overview of data availability in participating countries/regions.

Uraninum	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?
yes	4	7	7
some	1	2	1
not sure	0	0	1
no	10	4	5
no information provided	7	9	8

Table 41: Uranium in groundwater – Data availability in participating countries/regions.

Uranium in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Austria	0,015 (drinking water); not set (indicator parameter	Yes	Yes	2.844	Yes, h20-fachdatenbank (third party), up to 4 measurements/year	Whole country	Yes	-
Belgium	-	-	-	-	-	-	-	-
Bosnia and Herzegovina	Not set	Not investigated	Yes	Little	No, there are individual studies data, no systematic testing	No, the entity federation of bosnia and herzegovina	No	No
Czech Rep	0,015	Yes	Partly yes	Thousands of samples (archive data)	The data falls under the management of another organization, it would probably be possible to get it	Whole country	Yes	-
Denmark	Not set	-	No	0	No	-	No	-
France	-	-	-	-	-	-	-	-
Hungary	Not set (Natural mineral water) Not set (drinking water)	No reference value	Not applicable.	Sparse	Not for the last 5 years. Mostly yearly sampling; for termal waters can be up to 1/6 years.	-	No	-
Iceland	-	No	In some cases	Unknown	Yes. Varies	No. Distributed sampling points	No	-
Ireland	Not set	-	-	300	Yes, 3 times per year	Whole country	Yes	-
Italy	-	-	-	-	-	-	-	This topics are not in the assignments of the Geological Survey of Italy of ISPRA
Latvia	No	Not checked	No	Not checked	Yes, not checked	Not checked	No	-
Lithuania	-	-	-	-	-	-	-	-
Malta	-	-	-	-	-	-	-	-
Poland	Not set	-	-	Approx. 1300 (groundwater monitoring network)	Yes, sampling every 1-3 years (groundwater monitoring network)	Whole country	No	--
Portugal	No value	Not monitored	-	-	-	-	-	No treshold value defined in portuguese legislation
Romania	Not set.	No information.	-	None.	No.	Only in areas with concession licenses for natural mineral water and in areas with monitoring wells for drinking water.	No.	-
Serbia	-	-	-	-	-	-	-	-
Slovenia	Not set	Not investigated	Yes	Very little	No, unsystematic, only for research purposes	Specific, mineral and thermal waters with concessions and some natural springs all over slovenia	No	Not investigated
Spain	Not set	Yes	Yes	57	Yes. Sampling frequency varies depending on the region	They cover the whole country, althougt there are significative differences in	No	-

						the number of observations between regions		
Spain (Catalonia)	Not set	Anomalies detected in some areas, of granitic massifs in catalonia and in natural mineral waters .	Yes	A little	No, unsystematic.	No	No	-
Sweden	-	-	-	25.000	-	Yes, but few analyses from northern Sweden	No	-
Ukraine	-	Should be examined properly	Yes, if is determined	A lot of wells, the number can be determined by database sampling if necessary	Yes, at least for the period 2010-2018	Yes	No	-

3.3.20 Vanadium

Table 42: Vanadium in groundwater – Overview of data availability in participating countries/regions.

Vanadium	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?
yes	2	7	6
some	0	3	1
not sure	0	0	2
no	10	4	6
no information provided	10	8	7

Table 43: Vanadium in groundwater – Data availability in participating countries/regions.

Vanadium in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Austria	Not set (drinking water) not set (indicator parameter)	Not set	Yes	2.844	Yes, h20-fachdatenbank (third party), up to 4 measurements/year	Whole country	No	-
Belgium	Not set	-	-	-	-	-	-	-
Bosnia and Herzegovina	Not set	Not investigated	Very little	Very little	No, there are individual studies data,is no systematic testing	No, the entity federation of bosnia and herzegovina	No	No
Czech Rep	Not set	-	Partly yes	Thousands of samples (archive data)	The data falls under the management of another organization, it would probably be possible to get it	Whole country	Yes	-

Denmark	Not set	-	No	0	No	-	No	-
France	-	-	-	-	-	-	-	-
Hungary	Not set (Natural mineral water); Not set (drinking water)	No reference value.	Not applicable.	Sparse.	Not for the last 5 years. Mostly yearly sampling; for termal waters can be up to 1/6 years.	-	No.	-
Iceland	Not set	No	In some cases	?	Yes. Varies	No. Distributed sampling points	No	-
Ireland	Not set	N/a	N/a	None / limited records	No	None / limited records	No	-
Italy	-	-	-	-	-	-	-	This topics are not in the assignments of the Geological Survey of Italy of ISPRA
Latvia	No	Not checked	No	Not checked	Yes, not checked	Not checked	No	-
Lithuania	No information	No information	No information	No information	No information	No information	No information	No information
Malta	-	-	-	-	-	-	-	-
Poland	Not set	-		Approx. 1300 (groundwater monitoring network) and some special groundwater's intakes	Yes, sampling every 1-3 years (groundwater monitoring network)	Whole country	No	-
Portugal	Not set	-	Yes	The groundwater quality monitoring network consists of about 700 points and its distribution in the country is not uniform. The frequency of sampling is by-annual. The parameters monitored are not the same at all points.	The portuguese environment agency is responsible for the groundwater quality monitoring network. Lneg does not currently have access to this data. However lneg will try to obtain this data and their authorization to make them available to the project partners.	Yes. The groundwater quality monitoring network cover the whole country	No	No treshold value defined in portuguese legislation
Romania	Not set.	No information.	-	None.	No.	Only in areas with concession licenses for natural mineral water and in areas with monitoring wells for drinking water.	No.	-
Serbia	-	-	-	-	-	-	-	-
Slovenia	Not set	Not investigated	Yes	Very little	No, unsystematic, only for research purposes	Specific, mineral and thermal waters with concessions and some natural springs all over slovenia	No	Not investigated
Spain	Not set	Yes	Yes	63	Yes. Sampling frequency varies depending on the region	They cover the whole country, althougt there are significative differences in the number of observations between regions	No	-
Spain (Catalonia)	Not set	-	Yes	A little	No, unsystematic.	No	No	-
Sweden	-	-	-	500	Yes; see comment	No	No	-
Ukraine	0,1	Should be examined properly	Yes, if is determined	A lot of wells, the number can be determined by database sampling if necessary	Yes, at least for the period 2010-2018	Yes	No	-

3.3.21 Zinc

Table 44: Zinc in groundwater – Overview of data availability in participating countries/regions.

Zinc	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?	Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?
yes	5	9	11
some	0	4	1
not sure	0	0	2
no	9	3	4
no information provided	8	6	4

Table 45: Zinc in groundwater – Data availability in participating countries/regions.

Zinc in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
Austria	Not set	Not set	Possible	2.844	Yes, h20-fachdatenbank (third party), up to 4 measurements/year	Whole country	Yes	-
Belgium	0,260 - 0,410	Yes, Campine region	Sandy aquifers with acid water	4.000	Yes, sampling frequency once or twice per year (depending on monitoring network)	Yes	Not yet	In higher concentrations due to historical industrial pollution
Bosnia and Herzegovina	Not set	Not investigated	Little	Little	No, there are individual studies data,is no systematic testing	No, the entity federation of bosnia and herzegovina	No	No
Czech Rep	Not set	-	Partly yes	Thousands of samples (archive data)	The data falls under the management of another organization, it would probably be possible to get it	Whole country	Yes	-
Denmark	3	No	Yes	802	Yes, approx. Every 2-3 years	Whole country	No	-
France	0,1 / 5 (guide values)	Yes	Plenty of information available on the ades and infoterre websites	Plenty of information available on the ades and infoterre websites	Plenty of information available on the ades and infoterre websites	Plenty of information available on the ades and infoterre websites	Yes, maps of high natural background risk zones in traces elements	Brgm public report: sectors identified during the national study - delimitation of high natural background risk zones in traces elements
Hungary	Not set (Natural mineral water); drinking water (Not set)	No reference value.	Not applicable.	Few hundreds.	Not for the last 5 years. Mostly yearly sampling; for termal waters can be up to 1/6 years.	-	No.	-
Iceland	Not set	No	In some cases	Unknown	Yes. Varies	No. Distributed sampling points	No	-
Ireland	Not set	-	-	300	Yes, 3 times per year	Whole country	Yes	-
Italy	-	-	-	-	-	-	-	This topics are not in the assignments of the Geological

Zinc in groundwater	What is the threshold value in your country (mg L^{-1})?	Are there regions in your country where concentrations exceed the threshold value?	Can you characterize the geology of the regions with elevated concentrations in groundrinking waterater by a simple geological classification of the aquifer?	For how many observation wells/springs do you have data?	Do you have access to concentrations in groundrinking waterater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?	Do the observations cover the whole country or specific areas only? If only specific areas: which ones?	Are there existing maps of natural background values?	Comments to the specific element.
								Survey of Italy of ISPRA
Latvia	Not set	Not checked	No	Not checked	Yes, not checked	Not checked	No	-
Lithuania	-	-	-	-	-	-	-	-
Malta	-	-	-	-	-	-	-	-
Poland	Not set	-	-	Approx. 1300 (groundwater monitoring network) and some special groundwater's intakes	Yes, sampling every 1-3 years (groundwater monitoring network)	Whole country	No	--
Portugal	No value	-	Yes	The groundwater quality monitoring network consists of about 700 points and its distribution in the country is not uniform. The frequency of sampling is by-annual. The parameters monitored are not the same at all points.	The portuguese environment agency is responsible for the groundwater quality monitoring network. Lneg does not currently have access to this data. However lneg will try to obtain this data and their authorization to make them available to the project partners.	Yes. The groundwater quality monitoring network cover the whole country	No	No treshold value defined in portuguese legislation
Romania	5	No information.	-	None.	No.	Only in areas with concession licenses for natural mineral water and in areas with monitoring wells for drinking water.	No.	-
Serbia	-	-	-	-	-	-	-	-
Slovenia	Not set	Not investigated	Yes	Little	No, unsystematic, only for research purposes	Specific, mineral and thermal waters with concessions and some natural springs all over slovenia	No	Not investigated
Spain	Not set	Yes	Yes	4.537	Yes. Sampling frequency varies depending on the region	They cover the whole country, althougt there are significative differences in the number of observations between regions	No	-
Spain (Catalonia)	Not set	-	Yes	A little	No, unsystematic.	No	No	-
Sweden	Not set	-	-	500	Yes; see comment	Yes, but few analyses from northern Sweden	No	-
Ukraine	1,0	Should be examined properly	Yes, if is determined	A lot of wells, the number can be determined by database sampling if necessary	Yes, at least for the period 2010-2018	Yes	No	-

4 DATABASE FOR NATURAL MINERAL WATERS AND THERMAL WATERS

The aim is to create a harmonized overview about existing natural mineral water and thermal water sources within participating countries/regions. The final product will be a WMS service for the European Geological Data Infrastructure (EGDI) (see HOVER WP3 Task 3.5).

Data collection:

- **Natural mineral waters:** The Directive 2009/54/EC regulates the marketing and exploitation of natural mineral waters in Europe. Therefore, the focus must be given to listed recognized natural mineral waters. The majority of participating countries/regions in HOVER WP3 is found in the list of natural mineral waters recognised by EU member states (see chapter 3.1.1). Sources in non-listed countries that have national definitions for natural mineral waters can be only considered, if the criteria for recognition are very similar.
- **Thermal water:** The focus will be given to in-use thermal water sources for balneology, heating and/or electricity production. Due to the inconsistency of national definitions for thermal waters, we propose to differentiate between outlet water temperature classes (<15; 15-20; 20-30; 30-40; 40-50; 50-60; 60-70; 70-80; 80-90; 90-100; >100°C). The temperature classes <15 °C and 15-20 °C are included to consider thermal waters with lower outlet temperatures recognized on national levels (e.g. Spain and Bosnia and Herzegovina; see chapter 3.2.2).

4.1 Database structure

The database structure (see Table 46) was developed based upon the results of the conducted specific questionnaire. Participating surveys were able to provide feedback to a previous draft version.
Instead of providing exact coordinates, locations of sources will be allocated to country specific EEA reference grid cells based on 1 km^2 (see https://www.eea.europa.eu/data-and-maps/data/eea-reference-grids-2). Centroids can be later calculated for the WMS and a reference scale can be chosen. To guarantee harmonization for collected data, predefined contents for fields are essential. Therefore, such predefined selection lists for specific fields are found in Table 47. Furthermore, INSPIRE code lists (see http://inspire.ec.europa.eu/codelist) and Geoscience Vocabularies for Linked Data (see http://resource.geosciml.org/) will be used to describe used aquifers. The hydrochemistry of sources will be described by a single representative hydrochemical analysis.
Results from the specific questionnaire have shown, that most participating survey do have access to a large set of relevant data that can be also shared. However, if data for specific fields can't be provided, we suggest to use the following abbreviations. In any case, it is important to avoid blank fields that may lead to misinterpretation:

- **nA:** no data available
- **nS:** data can't be shared

Table 46: Database structure for Natural mineral water and Thermal water Data collection.

	Field	unit	type	explanation
Name				
N1	name of source		text	Please provide the name of source from the list of recognized natural mineral waters, otherwise a name for the thermal water source
N2	official name of natural mineral water		text	Please provide the trade description from the list of recognized natural mineral waters; not relevant for thermal waters
N3	country		text	
General information				
G1	classification		choose from list	
G2	location		choose country specific grid cell ID	download country specific grids from https://www.eea.europa.eu/data-and-maps/data/eea-reference-grids-2
G3	type of water source		choose from list	
G4	intended use 1		choose from list	
G5	intended use 2		choose from list	
G6	intended use 3		choose from list	
G7	yield class	l/s	choose from list	extraction allowed by law regulation
Aquifer				
B1	If borehole: true vertical depth	m	number	below terrain
B2	If borehole: screen or open hole: FROM (true vertical depth)	m	number	below terrain
B3	If borehole: screen or open hole: TO (true vertical depth)	m	number	below terrain
B4	Aquifer media type		choose ID from INSPIRE code list	http://inspire.ec.europa.eu/codelist/AquiferMediaTypeValue
B5	Aquifer type		choose ID from INSPIRE code list	http://inspire.ec.europa.eu/codelist/AquiferTypeValue
B6	Lithology of the aquifer 1		choose ID from INSPIRE code list	http://inspire.ec.europa.eu/codelist/LithologyValue
B7	Proportion, lithology of the aquifer 1		choose from CGI Geoscience codelist	http://resource.geosciml.org/classifier/cgi/proportionterm
B8	Lithology of the aquifer 2		choose ID from INSPIRE code list	http://inspire.ec.europa.eu/codelist/LithologyValue

	Field	unit	type	explanation
B9	Proportion, lithology of the aquifer 2		choose from CGI Geoscience codelist	http://resource.geosciml.org/classifier/cgi/proportionterm
B10	Lithology of the aquifer 3		choose ID from INSPIRE code list	http://inspire.ec.europa.eu/codelist/LithologyValue
B11	Proportion, lithology of the aquifer 3		choose from CGI Geoscience codelist	http://resource.geosciml.org/classifier/cgi/proportionterm
B12	Aquifer, younger age		choose ID from INSPIRE code list	http://inspire.ec.europa.eu/codelist/GeochronologicEraValue/
B13	Aquifer, older age		choose ID from INSPIRE code list	http://inspire.ec.europa.eu/codelist/GeochronologicEraValue/
Groundwater age				
A1	groundwater age		choose from list	
Hydrochemistry				
H1	Temperature class	°C	choose from list	water temperature at the outlet
H2	Total dissolved solid class	g/l	choose from list	
H3	Specific conductivity	µS/cm; 25°C	number/text	representative hydrochemical analysis
H4	pH		number/text	representative hydrochemical analysis
H5	Redox potential (Eh)	mV	number/text	representative hydrochemical analysis
H6	Oxygen (O2)	mg/l	number/text	representative hydrochemical analysis
H7	Sodium (Na)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H8	Potassium (K)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H9	Calcium (Ca)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H10	Magnesium (Mg)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H11	Strontium (Sr)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H12	Barium (Ba)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H13	Iron (Fe total)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H14	Manganese (Mn total)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H15	Ammonium (NH_4)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H16	Bicarbonate (HCO_3)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H17	Carbonat (CO_3)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H18	Fluoride (F)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H19	Chloride (Cl)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL

	Field	unit	type	explanation
H20	Bromide (Br)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H21	Iodide (I)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H22	Sulfate (SO_4)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H23	Nitrate (NO_3)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H24	Hydrogen Sulfide (HS)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H25	Aluminium (Al)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H26	Antimony (Sb)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H27	Arsenic (As)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H28	Beryllium (Be)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H29	Lead (Pb)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H30	Cadmium (Cd)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H31	Cesium (Cs)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H32	Chrome (Cr)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H33	Cobalt (Co)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H34	Copper (Cu)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H35	Lithium (Li)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H36	Molybdenum (Mo)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H37	Nickel (Ni)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H38	Mercury (Hg)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H39	Rubidium (Rb)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H40	Selenium (Se)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H41	Uranium (U)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H42	Vanadium (V)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H43	Zinc (Zn)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H44	Tin (Sn)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H45	m-Silic acid (H_2SiO_3)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H46	o-Boric acid (H_3BO_3)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H47	gas phase dominance	dominance	choose from list	
Comments				
C1	free comment		text	

Table 47: Predefined selection lists for specific fields.

	G1	G3	G4 to G6	G7	A1	H1	H2	H43
Field	**classification**	**type of water source**	**intended use**	**yield class (l/s)**	**groundwater age (years)**	**temperature class**	**total dissolved solid class (g)**	**gas phase dominance**
1	thermal water source	single well	bottled natural mineral water	<5	younger than 60	<15	<1	Methane (CH_4)
2	natural mineral water (Directive 2009/54/EC)	well field	natural mineral water publicly available	5-25	older than 60	15-20	1-14,5	Carbon dioxide (CO_2)
3	Natural mineral water (national law recognition)	single artesian well	thermal water for balneology	>25	older than 10.000	20-30	>14,5	Nitrogen (N_2) including noble gases
4		artesian well field	thermal water for heating		older than 11.500.000	30-40		
5		single captured spring	thermal water for electricity production			40-50		
6		captured spring group				50-60		
7		single gallery				60-70		
8		gallery group				70-80		
9						80-90		
10						90-100		
11						>100		

4.2 Data collection

Data was received from 14 countries (Austria, Bosnia and Herzegovina, Denmark, France, Hungary, Iceland, Italy, Lithuania, Poland, Portugal, Romania, Serbia, Slovenia and Spain including Catalonia (see Table 48). Data isn't available or can't be shared in Belgium, Ireland, Malta, Sweden and Ukraine. No responses were received from Czech Republic, Latvia and Ukraine.

Table 48: Overview of data collection: Existing sources in participation countries/regions.

Sources in countries	Classification		
	Natural mineral water (Directive 2009/54/EC)	Natural mineral water (national law recognition)	Thermal water
Austria	40		62
Bosnia and Herzegovina		10	28
Denmark	14		
France	33	240	

Hungary		91	1447
Iceland			3
Italy			241
Lithuania	21	19	
Poland	117	132	53
Portugal	17	61	121
Romania	0	85	15
Serbia	15	4	41
Slovenia	9		33
Spain	164	21	89
Total	*430*	*423*	*550*

5 NATURAL MINERAL AND THERMAL WATERS - PARTICIPATING COUNTRY PROFILES

5.1 Austria

Author: Daniel Elster

5.1.1 Relevant national definitions in Austria

Natural mineral water is defined in the mineral water and spring water regulation: Mineralwässer nach der Mineral- und Quellwasserverordnung, BGBl. II, Nr. 309/1999 (https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20000003). Further considered has to be:

- Wasserrechtsgesetz 1959 – WRG 1959, BGBl. Nr. 215/1959 idgF. (https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=10010290)
- Trinkwasserverordnung – TWV, BGBl. II Nr. 304/2001 idgF. (https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20001483)
- Gesundheits- und Ernährungssicherheitsgesetz – GESG, BGBl. I Nr. 63/2002 idgF. (https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20001896)
- Lebensmittelsicherheits- und Verbraucherschutzgesetz – LMSVG, BGBl. I Nr. 13/2006 idgF. (https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20004546)
- Lebensmittelkennzeichnungsverordnung 1993 – LMKV, BGBl. Nr. 72/1993 idgF. (https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=10010723&FassungVom=2005-04-26)

Threshold values specific for natural mineral waters ar listed in Table 49.

Thermal water is defined in the following laws for each state in Austria except Vorarlberg. Groundwaters with a temperature of 20 °C or higher at the outlet are considered as thermal water.

- Burgenländisches Heilvorkommen- und Kurortegesetz - Bgld. HeiKuG, LGBl. Nr. 15/1963, zuletzt geändert durch LGBl. Nr. 79/2013 (https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=LrBgld&Gesetzesnummer=10000048)
- Kärntner Heilvorkommen- und Kurortegesetz, K-HKG, LGBl. Nr. 157/1962, zuletzt geändert durch LGBl. Nr. 85/2013 (https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=LrK&Gesetzesnummer=10000024)
- NÖ Heilvorkommen- und Kurortegesetz 1978, LGBl. Nr. 272/1978, zuletzt geändert durch LGBl. Nr. 219/2001 (https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=LrNO&Gesetzesnummer=20000627)

- Oö. Heilvorkommen- und Kurortegesetz - Oö. HKG; LGBl. Nr. 47/1961, zuletzt geändert durch LGBl. Nr. 90/2013 (https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=LrOO&Gesetzesnummer=10000048)
- Salzburger Heilvorkommen- und Kurortegesetz 1997 - HKG 1997, LGBl. Nr. 101/1997, zuletzt geändert durch LGBl Nr. 106/2013 (https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=LrSbg&Gesetzesnummer=10001039)
- Steiermärkisches Heilvorkommen- und Kurortegesetz, LGBl. Nr. 161/1962, zuletzt geändert durch LGBl. 87/2013 (https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=LrStmk&Gesetzesnummer=20000421)
- Tiroler Heilvorkommen- und Kurortegesetz 2004, LGBl. Nr. 24/2004, zuletzt geändert durch LGBl. Nr. 130/2013 (https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=LrT&Gesetzesnummer=20000191)
- Wiener Heilvorkommen- und Kuranstaltengesetz - WHKG, LGBl. Nr. 29/2013 (https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=LrW&Gesetzesnummer=20000303)

Table 49: Threshold values specific for natural mineral waters in Austria.

Parameter	Threshold values (mg/l) Mineralwasser- und Quellwasserverordnung, BGBl. II, Nr. 309/1999 idgF.	Threshold values (mg/l) Österreichisches Lebensmittelbuch (ÖLMB), Kapitel B 17 „Abgefüllte Wässer“ (BMGF-75210/0005-II/B/13/2016))
Antimony	0,0050	0,0050
Arsenic	0,010 (insgesamt)	0,010 (insgesamt)
Barium	1,0	1
Lead	0,010	0,010
Boron		5,0
Cadmium	0,003	0,003
Chromium	0,050	0,050
Cyanid	0,070	0,070
Fluorine	5,0	5,0
Copper	1,0	1,0
Manganese	0,50	0,50
Nickel	0,020	0,020
Nitrate	50 (for natural mineral waters sourced in Austia exists a threshold of 25)	25
Nitrite	0,1	0,1
Oxidized organic compounds		3,0
Mercury	0,0010	0,0010
H2S	0,05	
Selen	0,010	0,010
Uranium		0,015
Zinc		5,0
Surface active substances that react with $C_{16}H_{18}ClN_3S$ (TBS)		0,2
Pesticides (sum)	0,0001	
radioactivity		See Codexkapitels B 1 „Trinkwasser“

Parameter	Threshold values (mg/l) Mineralwasser- und Quellwasserverordnung, BGBl. II, Nr. 309/1999 idgF.	Threshold values (mg/l) Österreichisches Lebensmittelbuch (ÖLMB), Kapitel B 17 „Abgefüllte Wässer“ (BMGF-75210/0005-II/B/13/2016))
Polycyclic aromatic hydrocarbons		0,0001 (Sum of concentrations of contents: ; bei Benzo-(b)-fluoranthen Benzo-(k)-fluoranthen Benzo-(ghi)-perylen Inden-(1,2,3-cd)-pyren)

5.1.2 Overview of natural mineral and thermal water resources in Austria

There are 40 natural mineral waters recognized in Austria which are located in different geological settings. Consequently, this leads to variable hydrochemical compositions. Each source is described in the publication of ELSTER et al. (2018) in detail (see Figure 6).

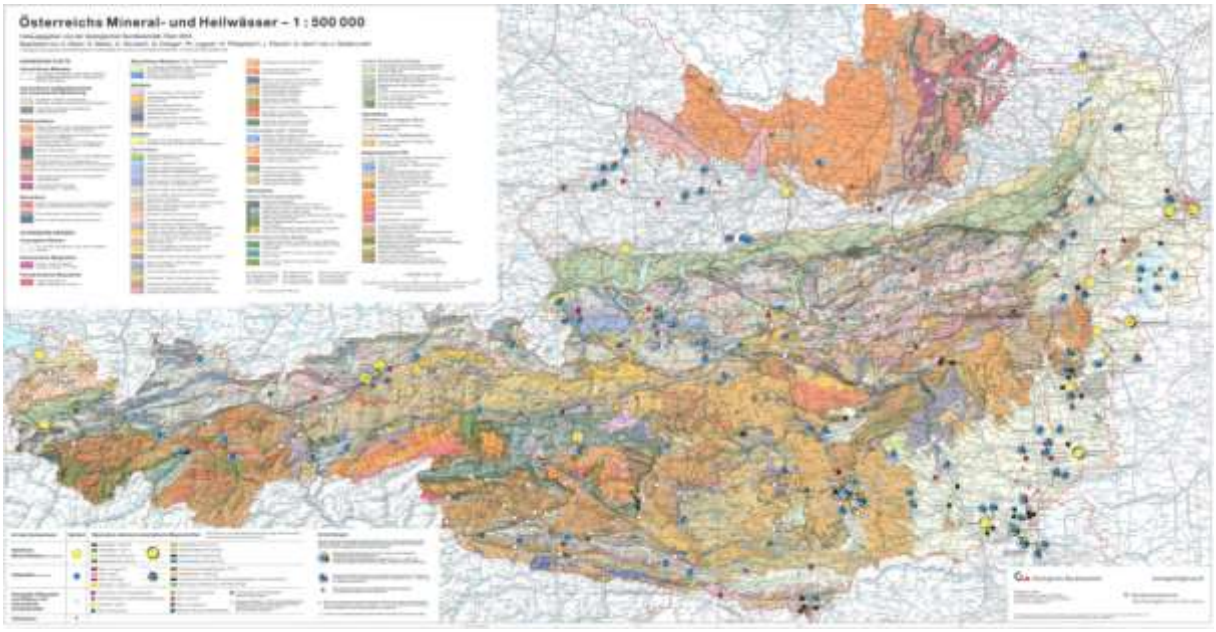

Figure 6: Natural mineral waters and therapeutic waters in Austria (ELSTER et al. 2018)

There are approximately 77 thermal water sources (spring groups and well fields summarized) known in Austria. Not all are used and a selection has been included in the proposed database. Most important sources are found in the Vienna Basin, the Styrian Basin and the Upper Austrian Molasse. Those areas bear the highest geothermal potential. Geothermal district heating plants do currently exist in Upper Austria (Molasse Zone; Upper Jurassic carbonates) and Styria (Styrian Basin; mainly Paleozoic carbonates), but recent attempts have been focusing on the Vienna Basin. Some of the plants also produce electricity (ORC), but only on a very limited level. The majority of thermal sources are used for balneology like spas and often have an old history, approximately 17 sources have been used already in the 19th century. Figure 7 provides an

overview of the known thermal water sources including drilling attempts for thermal waters that have failed.

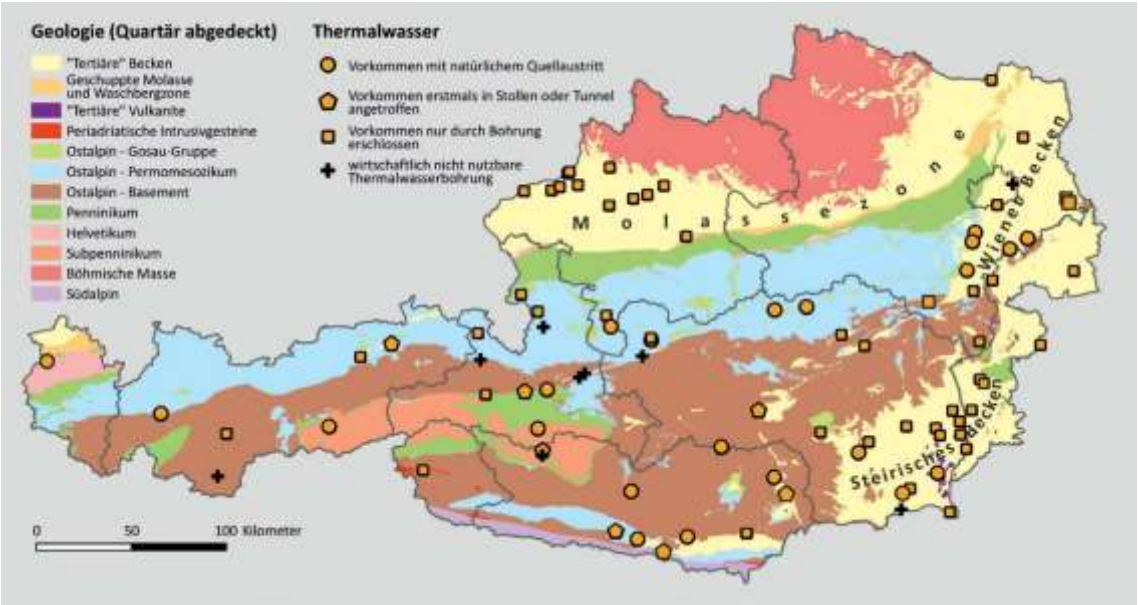

Figure 7: Overview on thermal water resources in Austria (ELSTER et al. 2016)

References

ELSTER, D., FISCHER, L., HANN, S., GOLDBRUNNER, J., SCHUBERT, G., BERKA, R., HOBIGER, G., LEGERER, P. & PHILIPPITSCH, R. (2018): Österreichs Mineral- und Heilwässer. – 448 S., Geologische Bundesanstalt, Wien.

ELSTER, D., GOLDBRUNNER, J., WESSELY, G., NIEDERBACHER, P., SCHUBERT, G., BERKA, R., PHILIPPITSCH, R. & HÖRHAN, T. (2016): Erläuterungen zur geologischen Themenkarte Thermalwässer in Österreich 1:500.000. – 296 S., Wien (Geologische Bundesanstalt).

5.2 Bosnia and Herzegovina

Author: Ferid Skopljak

5.2.1 Relevant national definitions in Bosnia and Herzegovina

Natural mineral waters are groundwaters whose total mineralization is > 1 g/l, as well as mineralization water < 1 g/l; which have an increased content of gases (H_2S > 5 mg/l, CO_2 > 500 mg/l, and others) or individual chemical elements (Fe > 10 mg/l, As > 1.0 mg/l, Br > 25 mg/l , J > 5.0 mg/l, F > 5.0 mg/l, H_2SiO_3 > 50 mg/l, and others) and significantly increased radionuclide content (Rn > 133 Bq/l, Ra > 0.185 Bq/l) and other chemical elements. The temperature of mineral waters is less than the mean annual air temperature of the area in which these waters appear.

Thermal waters are groundwater having a total mineralization < 1 g/l and a temperature greater than the mean annual air temperature of the area in which these waters appear.

Thermomineral waters are mineral waters whose temperature is higher than the mean annual air temperature of the site in which they occur.

Mineral, thermal and thermomineral waters in the Federation of Bosnia and Herzegovina are defined in the following regulatory frameworks and laws:

- The law on Waters ("Official Gazette of the Federation BiH" No. 70/06)
- The law on Geological Surveys ("Official Gazette of FBiH", No. 9/10)
- The law on Bottled Water in Bosnia and Herzegovina (No.45 / 04)
- The law on Concessions on Water and Public Property ("Official Gazette of the Federation BiH", No. 8/00.)
- Rulebook on natural mineral and natural spring waters (Official Gazette of BiH No. 26/10)
- Rulebook on the categorization, classification, calculation of groundwater reserves and keeping records on them ("Official Gazette of the FBiH", No. 47/11)
- Rulebook on conditions for determining sanitary protection zones and protective measures for water sources used or planned to be used for drinking ("Official Gazette of the Federation BiH", No. 51/02)
- Rulebook on minimum technical, technological and personnel requirements for the production of refreshing soft drinks, fruit juices and syrups and bottled waters (Official Gazette of the Federation BiH, no. 81/06)
- Rulebook on table water ("Official Gazette of BiH" No. 40/10.)
- Rulebook on the health health safety of drinking water (Official Gazette of BiH No. 40/10)
- Rulebook on the manner of keeping records and creating Cadastre of deposits of mineral raw materials, geological phenomena and approved investigative areas (Official Gazette of the Federation of BiH, no.38 / 11)

5.2.2 Overview of natural mineral and thermal water Resources in Bosnia and Herzegovina

There are about 450 localites of mineral, thermal and thermomineral waters in the Federation Bosnia and Herzegovina which are registered.
There are more types of waters with regard to their physical and chemical composition: Mineral waters (salted, mineral waters with CO_2 and waters with combined chemical composition). Thermal waters constitute only one category, until Thermomineral waters can be with CO_2, salted with H_2S and combined chemical composition.

The present use of mineral, thermal and thermomineral waters in the Federation Bosnia and Herzegovina is the following:

- salt mineral waters near Tuzla are used in chemical industry
- mineral waters with CO2 bottle in Kiseljak, Tešanj, Tuzla and Sarajevo
- exploitation of CO2 gas deduct in Klokoti near Sarajevo and Gračanica
- thermal waters are used in spa capacity in Fojnica, Olovo, also swimming pool in Breza and Mala Kladuša
- thermomineral waters are used in spa capacity: Gradačac, Tuzla and Ilidža Sarajevo
- using of thermomineral waters for heating deducted in Domaljevac and Sarajevo

Useful value mineral, thermal and thermomineral waters Federation Bosnia and Herzegovina are proved but they are very insufficient expored and made use of.

5.3 Denmark

Author: Denitza Voutchkova

5.3.1 Relevant national definitions in Denmark

For Natural mineral water, the source/spring has to be approved by the Danish Veterinary and Food Administration under the Ministry of Environment and Food of Denmark. The official list of approved "natural mineral waters" (https://www.foedevarestyrelsen.dk/Leksikon/Sider/Naturligt-mineralvand-godkendt-i-Danmark.aspx, last updated on 27 feb 2019) contains the same brands as "List of natural mineral waters recognised by member states" (last update: 8 Feb 2019) with the addition of Balders Kilde.

Legislation on Natural mineral waters applied in Denmark:

- Directive 2009/54/EC of the European Parliament and of the Council of 18 June 2009 on the exploitation and marketing of natural mineral waters
- Commission Regulation (EU) No 115/2010 of 9 February 2010 laying down the conditions for use of activated alumina for the removal of fluoride from natural mineral waters and spring waters
- BEK nr 38 of 12/01/2016 Bekendtgørelse om naturligt mineralvand, kildevand og emballeret drikkevand (https://www.retsinformation.dk/Forms/R0710.aspx?id=176930)
- VEJ nr 9105 of 10/04/2008 Vejledning om mærkning af naturligt mineralvand, kildevand og emballeret drikkevand (https://www.retsinformation.dk/Forms/R0710.aspx?id=116414)

5.3.2 Overview of natural mineral and thermal water resources in Denmark

In general, the waters are with low mineralization (TDS < 1g), there are no thermal waters (all waters <15 °C), and only few of the sources are artesian (springs). To the best of our knowledge, there is no public access to the sources. The natural mineral waters are mostly from sandy (Quaternary, Miocene) or limestone/chalk (Danian, Maastrichtian) aquifers. There is only one exception: Boring 7, located on Bornholm, where the well is in Cambrian Sandstone.

5.4 France

Author: Eline Malcuit

5.4.1 Relevant national definitions in France

Natural mineral water comes from exclusively groundwater ressources, either from springs, wells or boreholes. According to the regulations, it is used for bottling and/or thermalism. Pure, geologically protected and with a perfectly stable mineral composition, it is not subject to any chemical treatment or disinfection before bottling or thermal use. These waters belong to aquifers with high inertia, generally deep, carbogaseous waters in some cases. These aquifers are well protected from surface contamination by their geological cover and, if necessary, also

by dedicated protection policies. They are generally located in regions that are not subject to much anthropic pressure (intensive agriculture, industry, urbanisation, etc.).
Natural mineral water is defined by regulation in France by transposition into the Public Health Code and in the regulations (1), European regulations (2) (EFBW, 2017).

1. Décret n°2007-49 du 11 janvier 2007 relatif à la sécurité sanitaire des eaux destinées à la consommation humaine.
2. European Federation of Bottled Water (EFBW, 2017), available on: http://www.efbw.org/

The decree of 2007 is supplemented by 5 orders of 2007, 2010 and 2013 (3) relating to the constitution of the application files for public interest declaration, assignment of a protection perimeter, the constitution of the authorisation application file, water quality criteria, analyses of sanitary control and water monitoring, etc.

3. Chambre Syndicale des Eaux Minérales (CSEM), 2014. *Eau Minérale Naturelle*. Available on: https://eaumineralenaturelle.fr/

In this context, Article R. 1322-2 of the Public Health Code transposes the European Community definition of natural mineral water as follows: “Natural mineral water means microbiologically wholesome water, originating in an underground water table or deposit and emerging from a spring tapped at one or more natural or bore exits. It demonstrates, within known natural fluctuations, stability of its essential characteristics, including its composition and temperature at the outlet, which is unaffected by the flow rate of the water withdrawn. Natural mineral water can be clearly distinguished from ordinary drinking water: (i) by its nature, which is characterised by its mineral content, trace elements or other constituents, (ii) by its original purity; both characteristics having been preserved intact because of the underground origin of such water, which has been protected from all risks of pollution.”
Threshold values specific for natural mineral waters are listed in Table 491.

Table 50: Threshold values specific for natural mineral waters in France (extract from VIGOUROUX, 2005).

Parameter	Antimony	Arsenic	Barium	Boron	Cadmium	Chrome	Copper	Cyanide
Threshold value	5 µg/L	10 µg/l	1 mg/L	-	3 µg/L	50 µg/L	1 mg/L	70 µg/L
Parameter	Fluoride	Lead (	Manganese	Mercury	Nickel	Nitrate	Nitrite	Selenium
Threshold value	5 mg/L	10 µg/L	0,5 mg/L	1 µg/L	20 µg/L	50 mg/L	0,1 mg/L	10 µg/L

A thermal establishment is an establishment which uses on site or by direct adduction, for the internal or external treatment of the curists, water from one or more regularly authorized mineral sources and/or sludges and/or gases (article R 1322-52 of the Public Health Code).

5.4.2 Overview of natural mineral and thermal water resources in France

There are 89 recognized natural mineral waters in France and that appear on the official European list [5], which 86 on French metropolitan territory and Corsica (Figure 8). French natural mineral waters come from aquifers in different geological, hydrogeological and lithological contexts (volcanic, granitic, metamorphic, sedimentary) that correspond to variable stratigraphic ages, from the Permian-Triassic to the Cenozoic ; that is why we can see a great

variability in their geochemical composition. As several waters can be bottled on the same site, there are about 60 production sites.

Figure 8: Location and name of the natural mineral waters in French metropolitan territory and Corsica (modified from CSEM, 2014).

There are more than one hundred thermal establishments in France, mostly located in the South-West and South-East regions (Nouvelle Aquitaine, Occitanie, Provence-Alpes-Côte-d'Azur, Auvergne-Rhône-Alpes, Bourgogne-France-Comté, Grand-Est). The majority of thermal waters are used for balneology and often have an old history (LACHASSAGNE, 2019). Figure 9 provides an averview on thermal establishments in France.

Figure 9: Overview on thermal establishments in France (modified from https://www.officiel-thermalisme.com/la-carte-des-stations-thermales/)

Within the framework of the HOVER project, specifically from task 3.1 of WP3, the French data were extracted from the French national databases (BSS and ADES).
Geological and hydrogeological information is accessible via the infoterre website, which corresponds to the French national subsoils databank named « La Banque du sous-sol (BSS) » (http://infoterre.brgm.fr/rechercher/search.htm) and the quality data is available on the ADES website, which corresponds to the French National database for quantitative and qualitative data on groundwater resources (https://ades.eaufrance.fr/).

French natural mineral waters are not the subject of a specific monitoring network, with the banked data in the ADES database, this is why we find very little data in the ADES database. Therefore a selection had to be made for the proposed database (Figure 10).

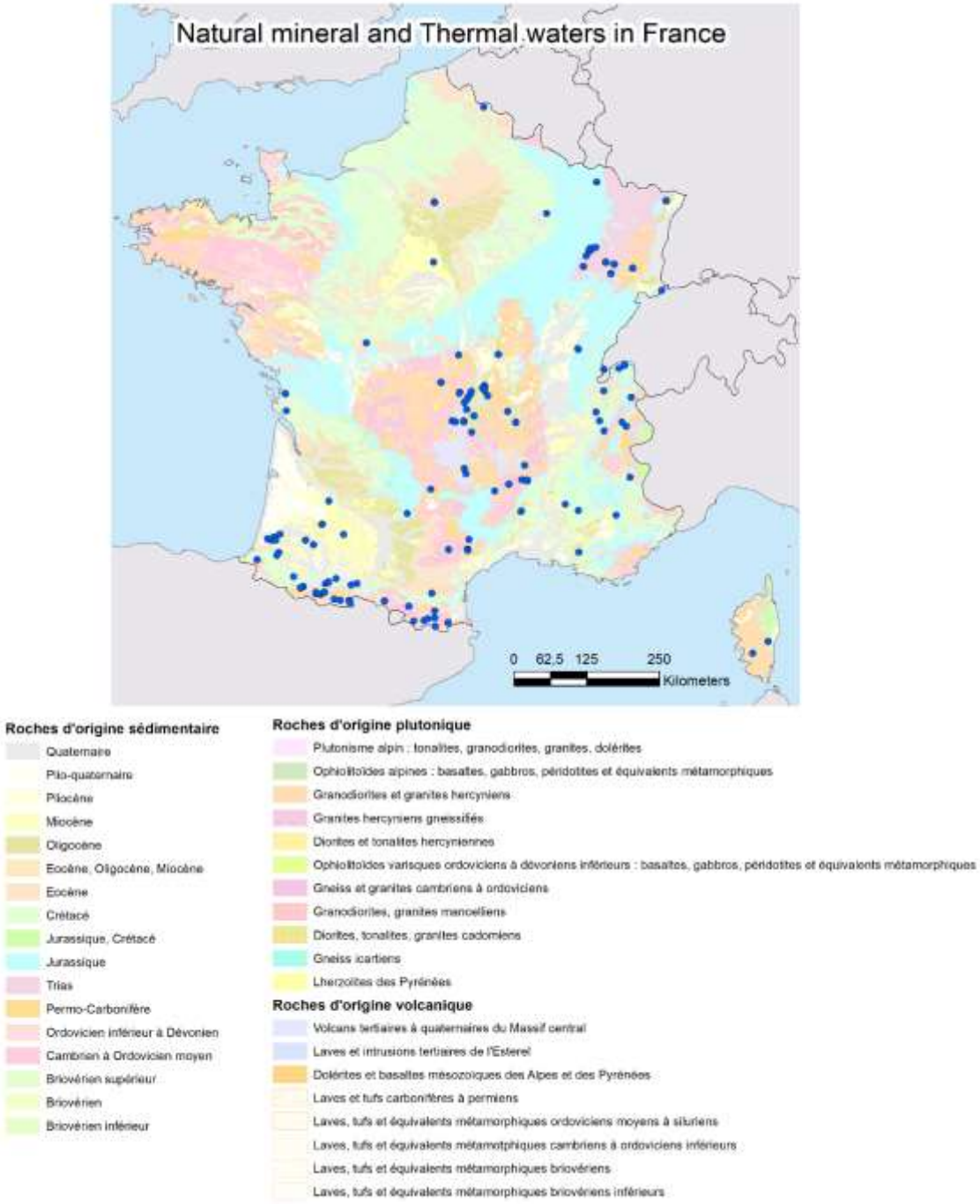

Figure 10: Overview of natural mineral and thermal water points (for which the data was communicated within the framework of the HOVER project) on a simplified geological map background.

References:
L'officiel du thermalisme en France, avalable on : https://www.officiel-thermalisme.com/la-carte-des-stations-thermales/
Liste des eaux minérales naturelles reconnues par les états membres (2013/C 95/03). http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2013:095:0038:0108:FR:PDF Last update : 18/09/15.
Terroirs et thermalisme de France, sous la direction de C. Pomerol et J. Ricour, Collection Terroir de France, BRGM Editions, Orléans, 1992.

LACHASSAGNE P. (2019): Les eaux minérales naturelles. Encyclopédie de l'environnement. Available on: https://www.encyclopedie-environnement.org/eau/eaux-minerales-naturelles/
VIGOUROUX P. (1999): Atlas des périmètres de protection des sources d'eau minérale en France. Rapport BRGM/RR-40466-FR, 270 p. Available on: http://infoterre.brgm.fr/rapports//RR-40466-FR.pdf
VIGOUROUX P., (2005): Guide qualité pour la ressource en eau minérale et thermale. BRGM Éditions, Collection scientifique et technique. ISBN 2-7159-0959-4.
VIGOUROUX P., (2005): Les eaux minérales et les eaux de sources de France, carte à 1/1 000 000. BRGM Editions, Orléans.

5.5 Hungary

Author: Teodóra Szőcs

5.5.1 Relevant national definitions in Hungary

Mineral water according to Hungarian law LVII from 1995 on water management is defined as water which originates from a natural aquifer, which has a typically different mineral composition compared to those used as a source for regular human drinking water, and its water composition meets the (biological and chemical) criteria defined in the relevant legislation.

Medicinal water is that mineral water which has proven medicinal properties and it is licenced for medical purposes following the relevant legislation.

Thermal water according to Hungarian law LVII from 1995 on water management is defined as water having as source an aquifer, which has a 30 °C or higher outflow water temperature at surface.

The 65/2004 (IV. 27.) FVM-ESzCsM-GKM common ministerial decree (with its update according to the 59/2006 (VIII. 14.) FVM-EüM-SZMM common ministerial decree) defines the requirements of bottled natural mineral water, spring water, drinking water, and enriched, flavoured, or enriched and flavoured bottled water. This decree is the law adopting and implementing the 80/777/EEC, 96/70/EC és 2003/40/EC EU laws. This decree does not regulate those non-bottled natural mineral waters which are used at their abstraction location or are used for medicinal purposes in balneological, health recuperation institutes. Those waters which are recognised as medicinal waters, including recognised medicinal mineral waters, are regulated by the 74/1999 (XII. 25.) EüM ministerial decree on natural medical factors.

Natural mineral water is defined in Hungary as water recognised for human consumption in its natural, original form, which

- has a protected aquifer as source and is tapped by one or more natural or man-made springs or wells
- it is unpolluted at source
- it contains minerals and trace elements and other constituents which have beneficial health properties and it is clearly different from drinking water
- its composition and temperature are near constant, or it is within the natural fluctuation range
- the concentration of the following elements and components is less than Antimony 0.005, Arsenic 0.01, Barium 1.0, Cadmium 0.003, Chromium 0.05, Copper 1.0, Cyanide 0.07, Fluoride 5.0, Lead 0.010, Manganese 0.5, Mercury 0.001, Nickel 0.02, Nitrate 50, Nitrite 0.1, Selenium 0.01
- its microbiological properties comply with the requirements of this decree

5.5.2 Overview of natural mineral and thermal water resources in Hungary

Hungary is rich in both cold and thermal groundwater. Although the drinking water supply is based for about 95% on groundwater, the consumption of bottled mineral water has increased considerably over the last 2-3 decades. This is reflected by the large number and variety of recognised mineral waters. According to the list of natural mineral waters recognised by the EU member states updated on the 3rd of May 2018, 231 Hungarian natural mineral waters are named, of which 224 could be identified with their source within the framework of HOVER WP3. If we consider that 123 natural mineral waters were recognised in 2014, this shows an increase of more than 80% in their number. While the average annual consumption in Hungary was around 3 l/person in the ’80s and early the ’90s, this has reached about 126 l/person/year by 2015. Consumption seems to have stabilised around this value. While in the past carbonated mineral water was mainly being consumed, this has gradually changed and still water took over in 2016, with a consumption of 54% still water in 2018. Although spring water, table water and other flavoured waters are available for consumers, the market share of mineral waters is about 98-99% considering all bottled waters.

About 65% of recognised natural mineral waters are sourced from Quaternary – Pliocene porous sediments, and with a few exceptions the rest is from the Mesozoic – Eocene carbonate aquifers. In total more than 70% of these waters originate from porous sediment sequences, and about 25% from karstic and fractured limestones and dolomites. Of this latter type, some 10% is made up of carbonate rich mud. The bottled mineral waters are dominantly Ca-Mg-HCO_3 type, which originate either from karstic aquifers or from the upper parts of the sediment sequences of the porous basin, characteristic for the recharge areas of the intermediate and regional flow systems. In some cases, mineral waters from the Mesozoic and Miocene aquifers can contain up to 20-25% sulphate content as anion. $NaHCO_3$ type mineral waters are also bottled, but account for a smaller volume. Their source is typically in discharge areas of the Great Hungarian Plain, or where the sodium becomes the dominant cation due to ion exchange along the flow paths, which is characteristic to the Upper-Pannonian (Upper Miocene) sediment sequence. In some cases, the iodine and fluoride concentration can also be high.

Due to its geological setting the geothermal potential is very good in Hungary. The average heat flow is about 90-100 mW/m^2, with a 45-50°C/km temperature gradient in most parts of the country resulting in an average temperature of 35-40°C at about 500 m below surface. This increases to 100-110°C at 2000 m depth, but in certain regions can reach even 120-130 °C (DÖVÉNYI P.–HORVÁTH F. 1988). Thermal waters with a 30°C surface outflow temperature can

be found in about 70% of Hungary, having their source in porous intergranular sediment sequences (sand, sandstone) or in limestones and dolomites.
Thermal water has been widely used for balneological purposes since centuries, but agricultural use is also widespread, and its use for district heating is gradually increasing.
The outflow temperature of thermal waters used for balneology typically ranges between 30 to 50°C and is characteristic both for the deeper layers of the Upper Pannonian sediment sequence and for the limestone – dolomite thermal aquifers. However, wells with 75–95°C outflow temperatures are also exploited, one at Zalaegerszeg being the hottest, for example (95°C). This well produces from the Upper Cretaceous limestone basement. The estimated installed capacity for 2017 of those wells which are used for balneology is about 249.5 MWth with an annual use of about 745.5 GWhth/yr.
The major sector for direct heat utilization is agriculture, mainly heating of greenhouses and plastic tents, but also includes other energy applications such as heating for animal husbandry. This is estimated to represent an installed capacity of about 358 MWth and about 803 GWhth/yr production.
District heating based on thermal water is available in 23 towns (reference year 2017), with an installed capacity of about 223.36 MWth and 635.66 GWhth/yr production.
There is one geothermal power plant in Hungary located in Tura, in an uplifted Triassic carbonate reservoir in the depth range of 1700-2200 m. The well produces 125 °C, 6000 l/min hot water from a depth of about 1500 m. The project aimed to achieve a 3.0 MWe capacity, however its actual gross electricity production is 2.3 MWe.
While thermal waters used for agricultural purposes are mainly NaHCO3 type and captured in the Upper Pannonian sediments, the water composition for balneology and spas vary over a wide range, with a dominance of the NaHCO3 type, but about a quarter of them having $NaHCO_3Cl$ type. Their health benefits also depend on other parameters, like sulphur, iodine, bromide and radon content, for example.
One unusual Hungarian application is the use of thermal waters for drinking water purposes in areas where there isn't enough good quality fresh water. These thermal waters are typically more than 90% $NaHCO_3$, $CaMgNaHCO_3$ type, with their outflow temperatures varying between 30–35°C.
Brief overview: Hungarian national definitions of natural mineral water and thermal water
Mineral water according to Hungarian law LVII from 1995 on water management is defined as water which originates from a natural aquifer, which has a typically different mineral composition compared to those used as a source for regular human drinking water, and its water composition meets the (biological and chemical) criteria defined in the relevant legislation.
Medicinal water is that mineral water which has proven medicinal properties and it is licenced for medical purposes following the relevant legislation.
Thermal water according to Hungarian law LVII from 1995 on water management is defined as water having as source an aquifer, which has a 30°C or higher outflow water temperature at surface.
The 65/2004 (IV. 27.) FVM-ESzCsM-GKM common ministerial decree (with its update according to the 59/2006 (VIII. 14.) FVM-EüM-SZMM common ministerial decree) defines the requirements of bottled natural mineral water, spring water, drinking water, and enriched, flavoured, or enriched and flavoured bottled water. This decree is the law adopting and implementing the 80/777/EEC, 96/70/EC és 2003/40/EC EU laws. This decree does not regulate those non-bottled natural mineral waters which are used at their abstraction location or are

used for medicinal purposes in balneological, health recuperation institutes. Those waters which are recognised as medicinal waters, including recognised medicinal mineral waters, are regulated by the 74/1999 (XII. 25.) EüM ministerial decree on natural medical factors.
Natural mineral water is defined in Hungary as water recognised for human consumption in its natural, original form, which

- has a protected aquifer as source and is tapped by one or more natural or man-made springs or wells
- it is unpolluted at source
- it contains minerals and trace elements and other constituents which have beneficial health properties and it is clearly different from drinking water
- its composition and temperature are near constant, or it is within the natural fluctuation range
- the concentration of the following elements and components is less than Antimony 0.005, Arsenic 0.01, Barium 1.0, Cadmium 0.003, Chromium 0.05, Copper 1.0, Cyanide 0.07, Fluoride 5.0, Lead 0.010, Manganese 0.5, Mercury 0.001, Nickel 0.02, Nitrate 50, Nitrite 0.1, Selenium 0.01
- its microbiological properties comply with the requirements of this decree

5.6 Iceland

See only data contribution.

5.7 Italy

Authors: Lucio Martarelli, Barbara Dessi

5.7.1 Relevant national definitions in Italy

Mineral water is not defined within a specific Act. In any case, the Italian Legislative Decree N.176 of 8 October 2011, which adopts the EU Directive 2009/54/EC and deals with natural mineral water, reports (Article 12.2) the following classification of natural mineral waters according to their mineralization values expressed as fixed residue in: 1) oligomineral waters (fixed residue between 50 and 500 mg/l); 2) medium mineral waters (between 500 and 1500 mg/l); 3) waters rich in mineral salts (above 1500 mg/l).

Thermal water is mentioned in the Italian Governmental Law N.323 of 24 October 2000 but this act deals only with the exploitation permits and not with technical-scientific issues.
Thermomineral water is not defined within a specific Act.

Natural mineral water is defined in the Italian Legislative Decree N.176 of 8 October 2011, which adopts the EU Directive 2009/54/EC. Article 2.1 defines it as water which originated from a groundwater body, crops out at one or more natural of artificial springs and has peculiar purity conditions and health relevant properties. Article 2.2 defines that it must have properties which clearly distinguish it from drinking water, due to conservation of its original purity, content of dissolved solids, trace elements or other components and may have certain nutritional and physiological effects.
Article 12.2 distinguishes natural mineral waters, based on the values of fixed residue, in:

1- oligomineral waters (fixed residue between 50 and 500 mg/l);

2- medium mineral waters (between 500 and 1500 mg/l);
3- waters rich in mineral salts (above 1500 mg/l).

The same article provides the following classification based on the predominant and qualifying chemical elements:

1- bicarbonate waters
2- sulfuric acid waters
3- chlorinated waters
4- calcium waters
5- magnesium water
6- fluorinated waters
7- ferruginous waters
8- sodium waters
9- hyposodic waters

5.7.2 Overview of natural mineral and thermal water resources in Italy

A great variety of geological, morphological and climatic environments characterizes the Italian territory transmitting to groundwater unique and special properties. Concerning groundwater resources, alluvial and coastal plains, calcareous rocks and volcanic rocks usually host quite large amounts of groundwater. Instead, magmatic and metamorphic rocks and the large areas with mainly terrigenous sediments display only minor amounts of groundwater. The presence of active volcanoes witnesses uplift processes of hot vapor and gas from deep levels along fractures and faults. These vapor and gas interact with both host rocks and groundwater and lead to cropping out of thermal-mineral sources.

As concerns the hydrogeological settings of the terrains which those sources emerge in, the hydrogeological complexes having a high infiltration rank (e.g. carbonate rocks, calcareous-dolomitic successions) may act as groundwater recharge areas and/or fissured medium for hydrothermal ascending fluids in favorable structural settings. The low permeability complexes (e.g., clayey-marly terrains, terrigenous successions) may serve as a cover for buried geothermal reservoirs. Furthermore, the metamorphic and plutonic rock complexes represent the crystalline basement from which hydrothermal fluids may potentially originate. Finally, the volcanic complexes, mostly aligned along the Tyrrhenian margin, host the most of thermal-mineral sources originated by hydrothermal fluids related to magma ascent processes.

From the point of view of use, Italy is the country in Europe where more bottled water is consumed, reflecting the large number and variety of available resource and awareness of the benefits. Other than drinking purpose, it is relevant a widespread and extensive use of waters at different temperatures (e.g. hydropinotherapy, breathing, bathing, mud-bathing). The presence of substances such as sulphur, iodine, chlorine, bromide, arsenic, lithium, calcium, gas and radioactive elements may give water therapeutic virtues. When water yield and temperature are high, thermal-mineral waters may be also used for building heating and electric power production.

In a scenario considering the main Italian thermal-mineral sources having water temperature higher than 20°C, it is possible to evidence that they are drawn by 72% from springs and 28% from wells. The distribution of these sources throughout the Italian territory is not homogeneous, since six regions out of twenty (Tuscany, 25% of total sources; Latium, 16%; Campania, 13%; Sicily, 12%; Sardinia, 9%; Veneto, 8%) cover in total the 83% of the exploited thermal-mineral water resource. In these regions, mostly aligned along the Tyrrhenian-

Apenninic margin and in the Italian islands, the most relevant active or quiescent magmatic bodies occur.
As regards water temperature, about 70% of thermal-mineral sources have values between 20-40°C, about 20% exhibit between 40-60°C and about 10% display temperature >60°C. Concerning total dissolved solids (TDS), about 25% of sources have TDS<1000 ppm, about 40% have TDS between 1000-3000 ppm, about 20% between 3000-5000 ppm and the remaining 15% display TDS >5000 ppm. Considering source yields (reliable information is not always available), about 30% of sources have yields <1 l/s, about 35% have 1-5 l/s, about 15% exhibit 5-25 l/s, about 10% are between 25-100 l/s and the remaining 10% show yields >100 l/s.

5.8 Lithuania

Author: Jurga Arustienė

5.8.1 Overview of natural mineral and thermal water resources in Lithuania

Natural mineral water and Thermal water resources
Natural mineral water (TDS 1-35 g/l) resources are found in aquifers of slower or slow water exchange zones and in anomaly zones of deep-water discharge. Lithuania is situated in the central part of Baltic artesian basin, the most of pre-Quaternary aquifers have inclination from north -north east to south west, so mineralisation of groundwater increases naturally with depth. There are 11 major aquifer and aquifer complexes, starting from Jurassic to crystal foundation, where mineral water of different mineralization and composition is found. The local hydrochemical anomalies are found in areas where deep saline water is discharging to fresh active water exchange zone through tectonically deformed zones (fault lines and paleo valley). Such type of hydroinjection mineral water is mostly found in valley of river Nemunas. There salty water from lower triassic aquifer ascends through tectonic faults zone to upper aquifers. Mineral water domes have quite clear boundaries, mineralisation decreases sharply from centre to edges in plane. Such mineral water sources are sensitive to groundwater abstraction.

Based on the data from the Register of Underground there are 41 wellfields (source) of mineral water in Lithuania, 24 of them currently exploited. The wellfield (source) is considered as mineral water, when it is officially recognised as natural mineral water or contains groundwater with a TDS higher than 1 mg/l and resources are investigated and accepted based on local legal requirements.
Natural mineral waters with low content of dissolved solids < 1 g/l, mostly contain bicarbonates, are currently extracted and used for bottling.
Natural mineral water with concentration of dissolved solids from 1 to 10 g/l contain sulphates, chlorides, calcium and sodium. Such type of mineral water is mostly used for drinking as natural mineral water in sanatoriums and SPA and bottled.
Mineral water with TDS higher than 15 g/l contain chlorides and sodium, often bromides. Such mineral water is used for balneology.

Geothermal resources
The underground temperatures increase from north east to south west and with depth. The geothermal anomaly can be traced from middle Lithuania. The highest temperatures 80-85 °C are found in the western part of Lithuania at the depth of 2.000 m. At the depth of 1.500 m,

highest temperatures ranges from 50 to 75 °C, at the depth of 1.000 m – from 30 to 55 °C and in the depth of 500 m – from 20 to 35 °C. Geothermal energy, extracted from 40 °C warm groundwater, was used for heating only in a power plant situated near Klaipėda.

5.9 Poland

Author: Agnieszka Felter

5.9.1 Relevant national definitions in Poland

Thermal water is groundwater which temperature at the outflow from the intake is not lower than 20°C. The above definition of thermal water comes from Act of 9 June 2011 Geological and Mining Law (Jour. of Law 2018 item 1563) http://prawo.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20180001563.

Mineral water is groundwater with the total dissolved solids (TDS) rate of not less than 1 g/L. This kind of groundwater not been defined in any law act but the term is commonly used in hydrogeological literature. Lots of documented occurrences of mineral water have been classified as **therapeutic water**.

Therapeutic water is groundwater which is not contaminated in chemical and microbiological terms, is characterized by natural variability of physical and chemical properties, and contents:

- TDS – not less than 1000 mg/L, or
- Ferrous ion – not less than 10 mg/L, or
- Fluoride ion – not less than 2 mg/L, or
- Iodine ion – not less than 1 mg/L, or
- Divalent sulfur – not less than 1 mg/L, or
- Metasilic acid – not less than 70 mg/L, or
- Radon – not less than 74 Bq/L, or
- Carbon dioxide – not less than 250 mg/L

The above definition of therapeutic water comes from Act of 9 June 2011 Geological and Mining Law (Jour. of Law 2018 item 1563) http://prawo.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20180001563.

Natural mineral water is groundwater which differs from water used for human consumption in its original chemical and microbiological purity, its characteristic stable mineral composition and, in certain cases, its properties cold have beneficial effects on human health. The above definition of thermal water comes from Act of 25 August 2006 on Food and Nutrition Safety (Jour. of Law 2006 No 171 item 1563) http://prawo.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20061711225. The requirements concerning the composition and physical properties of natural mineral water are set out in the Regulation of 31 March 2011 on Natural Mineral Water, Spring Water and Table Water (Jour. of Law 2011 No 85 item 466) http://prawo.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20110850466. Over 30% of natural mineral water bottled in Poland and listed in the Commission List are **therapeutic waters**.

5.9.2 Overview of natural mineral and thermal water resources in Poland

The occurrences of **thermal and therapeutic water** are documented in over 130 locations (groups of wells and springs) in almost all regions of Poland. The total number of thermal and therapeutic waters intakes is about 400, the resources of exploitation wells and springs (the admissible volume of extracted waters) reach 6 000 m^3/h and the actual annual extraction is almost 13 000 000 m^3 (2017). Detailed information on thermal and therapeutic water of Poland can be found in the publication of FELTER at al. (2019) (see Figure 11).

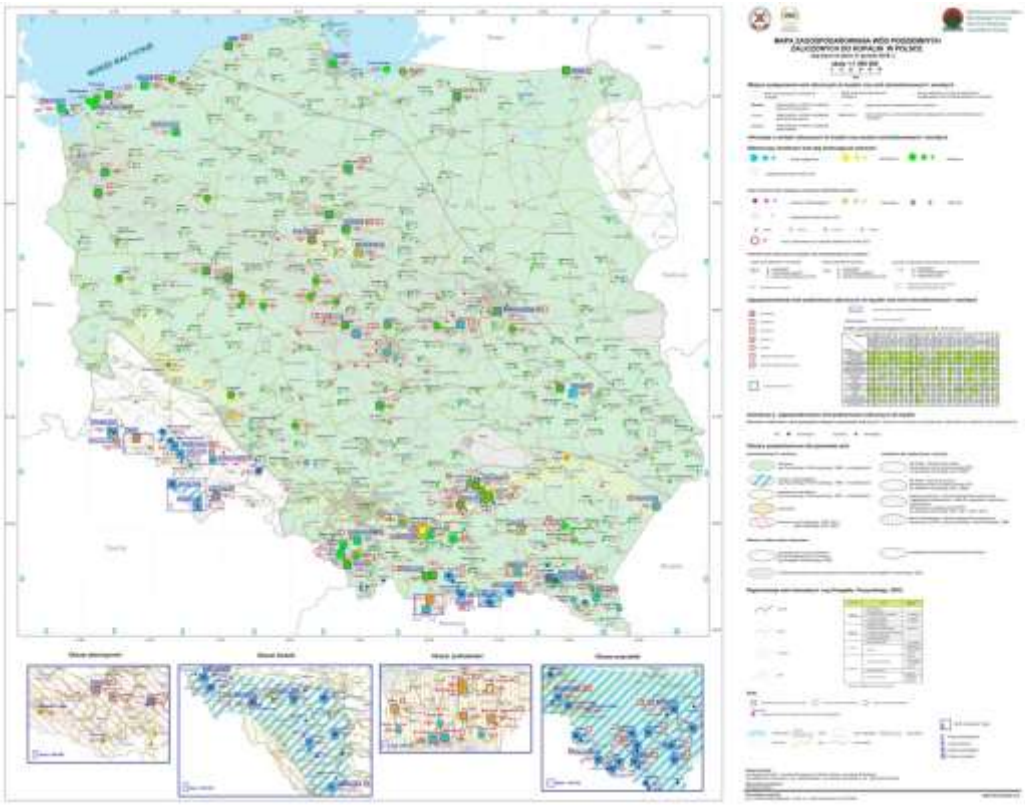

Figure 11: Thermal and therapeutic water in Poland (FELTER et al. 2019).

In Poland, there are three geothermal provinces with beneficial geothermal conditions. As the most prospective reservoirs of **thermal waters** are regarded (1) the lower Cretaceous and Jurassic porous-fractured aquifers forming the cover of the Western European crystalline shield, (2) the Paleogene-Mesozoic porous-fractured aquifer of the Podhale Basin (the Inter Carpathians) and (3) the Old Paleozoic fractured aquifers of the Sudetes. The depth of exploited geothermal aquifers is up to 3,5 km. The TDS of thermal waters ranges from 0,4 to 150 g/L, their temperature at the outflow reaches even 92°C, and the maximum discharge of the well is up to 550 m^3/h. Thermal waters are documented in 29 locations in Poland and are used for heat production (6 geothermal heating plants), recreational purposes (17 geothermal recreation centers), fish farming (1 farm). Moreover, in 28 locations, there were found the therapeutic waters with a temperature not less than 20°C at the outflow from the intake (i.e. therapeutic thermal waters), which are used for balneological treatments. The resources of thermal waters

exploitation wells and springs are over 4 000 m^3/h (plus over 1 000 m^3/h of therapeutic thermal waters) and their annual extraction reaches almost 11 000 000 m^3 (plus 790 000 m^3 of therapeutic thermal waters) (2018).

The **therapeutic water** occurrences are documented in over 100 localities (28 of it are therapeutic thermal waters). The TDS of therapeutic waters differs from 0,2 to over 100 g/L. The most common are chloride waters with iodine content and high TDS value, which occur in various age rock at the depth from several dozen to several thousand meters and are used for balneotherapeutic treatments. The total resources of therapeutic waters exploitation wells and springs are nearly 2 000 m^3/h and their annual extraction reaches almost 2 000 000 m^3 (2018).

The most valuable types of therapeutic water, in many cases also recognized as the **natural mineral water**, are found in the southern part of Poland. These are usually bicarbonate waters with carbon dioxide content with the TDS values not exceeding in general a few g/L, which are documented in fractured-porous Paleogene and Cretaceous sediments in the Carpathians and fractured old Paleozoic rock in the Sudetes. This kind of waters is used in the bottling industry and represents over 30% of the volume of natural mineral water in Poland. The remaining groundwater is used in the bottling industry as natural mineral water is characterized by the TDS not exceeding 0,8 g/L and occurs in various geological formations all over the country.

The selection of thermal and natural mineral water intakes has been included in the table below and the data base.

References

FELTER A., SKRZYPCZYK L., SOCHA M., SOKOŁOWSKI J., SOSNOWSKA M., STOŻEK J., GRYSZKIEWICZ I., WRZOSEK A. (2019): Mapa zagospodarowania wód p[odziemnych zaliczonych do kopalin w Polsce wg stanu na 31.12.2018 r. Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy, Warszawa. ISBN 978-83-66305-45-8.
https://mineralne.pgi.gov.pl/component/content/article.html?layout=edit&id=2592

5.10 Portugal

Authors: Ana Pereira, José Sampaio

5.10.1 Relevant national definitions in Portugal

The Portuguese legislation considers natural mineral waters, mineral-industrial waters and geothermal resources as "Geological Resources" and establishes a legal regime applicable to each type of resource. The legal framework for natural mineral waters applies to both bottled waters and thermal establishments.

The legal framework and complementary specific legislation include:

- Decree-Law No. 85/90, of 16 March 1990 – Establishes the industrial mineral waters regulation. https://dre.pt/application/conteudo/333158

- Decree-Law No. 86/90, of 16 March 1990 – Establishes the natural mineral waters regulation. https://dre.pt/pesquisa/-/search/333159/details/maximized
- Decree-Law No. 87/90, of 16 March 1990 – Establishes the geothermal resources regulation.
  https://dre.pt/application/conteudo/333155
- Decree-Law No. 156/98, of 6 June 1998 – Approves the definition and characterization of natural mineral waters and spring waters and establishment of rules for their exploitation, conditioning and commercialization.
  https://dre.pt/application/dir/pdf1sdip/1998/06/131A00/25932599.PDF
- Ministerial Order No. 1220/2000, of 29 December 2000 – Defines the conditions which natural mineral waters and spring waters must comply in order to be considered bacteriologically proper.
  https://dre.pt/application/dir/pdf1sdip/2000/12/299B00/74867487.pdf
- Decree-Law No. 268/2002, of 27 November 2002 – Repeal of the legal regime contained in the nº 4, article 7, of Decree-Law nº 156/98, of 6 June 1998, with regard to the conditioning of natural mineral waters and spring waters.
  https://dre.pt/application/dir/pdf1sdip/2002/11/274A00/74407441.pdf
- Decree-Law No. 72/2004, of 25 March 2004 – Transpose into Portuguese Law the Commission Directive 2003/40/EC, of 16 May 2003, establishing the list, concentration limits and labelling requirements for the constituents of natural mineral waters and the conditions for using ozone-enriched air for the treatment of natural mineral waters and spring waters.
  https://dre.pt/pesquisa/-/search/211034/details/maximized
- Decree-Law No. 142/2004, of 11 June 2004 – Regulates the licensing, organization, operation and inspection of thermal establishments.
  https://dre.pt/application/conteudo/286109
- Decision No. 4859/2015, of 11 May 2015 – Defines the concepts of "summarized physical-chemical analyzes" and "complete physical-chemical analyzes", provided for in Decree-Law nº 86/90 of 16 March 1990. https://dre.pt/application/file/67184523
- Law No. 54/2015, of 22 June 2015 – Establishes the basis of the legal regime for the disclosure and enhancement of the existing geological resources in national territory, including those located in the national maritime space.
  https://dre.pt/application/conteudo/67552498

In these legal context, the following definitions should be mentioned:

- **Mineral-industrial water** – underground circulation waters that allow the economic extraction of substances contained therein.
- **Natural mineral water** – water bacteriologically safe, of deep circulation, with physic-chemical properties that are stable within the annual variation range, and from which therapeutic qualities may result, or it may simply have favorable effects on human health.
- **Geothermal resources** – fluids and geological formations of the subsoil, whose temperature is likely to be used economically.
- **Thermal Establishments ("Termas") –** the places where one or more natural mineral waters emerge suitable for the practice of thermalism.

- **Thermalism** – the use of natural mineral water and other complementary means for health prevention, therapy, rehabilitation or well-being;
- **Thermal Tourisme Facilities ("Estância Termal")** – means the duly ordered geographic area in which one or more emergencies of natural mineral water are explored, as well as the environmental conditions and infrastructures necessary for the installation of tourist undertakings and the satisfaction of needs for culture, recreation, active leisure, physical and mental recovery ensured by adequate entertainment services.

The qualification and authorization to the natural mineral water exploitation is a demanding process and it takes place within the scope of the specific competences of the government authorities Directorate General of Energy and Geology (DGEG) and the Directorate General of Health (DGS). These authorities are also competent to inspect and close the activity in case of non-compliance.

Special care is thus taken in the natural mineral water quality monitoring and preservation. This is based in an exploration plan, a technical and scientific based document that defines the natural mineral water exploitation and use. Periodic physical and chemical analyses are also carried out by the exploitation companies, regularly reporting to the government authorities. To support hydromineral resources management, DGEG implemented a Remote Monitoring System – HIDROMONITOR to store air temperature, water temperature, flow, pH, conductivity, static level, dynamic level and accumulated volume of captured water data.

Based on hydrogeological studies and criteria, within the scope of protection and preservation measures related with hydromineral aquifer recharge area, the legal regime requires the delimitation of protection zones (outer, intermediate and inner zones) for the natural mineral water source. For each of the zones, restrictions and constraints to human activity are established, which increase from the outer to the inner zone.

In December 2019, DGEG presented a study on the Natural Microbism of Natural Mineral Waters (HIDROGENOMA Project, financed by EC, Portugal 2020 – POSEUR Programme) providing on their website technical information on geochemistry, geology, hydrogeology and microbiology related to natural mineral waters.
https://hidrogenoma.javali.pt/pagina/o-projeto-hidrogenoma

NOTE: *The data regarding the natural mineral water concessions is confidential. According to the Portuguese legislation, only information in the public domain can be provided.*

5.9.1 Overview of natural mineral and thermal water resources in Portugal

Portugal has a considerable geological diversity and complexity. It's lithological, stratigraphic and tectonic-structural framework, comprising stratigraphic ages between Proterozoic and Cenozoic, allows the presence of several aquifers in sedimentary and crystalline medium and, at the same time, the presence of several hydromineral and geothermal occurrences.

On mainland territory, there are about 200 legal water sources (springs and boreholes) distributed by 77 official concessions for natural mineral waters recognized by Portuguese Law, that includes 21 bottled waters according to the Directive 2009/54/EC (some concessions produce more than one brand of bottled water). There are also more than 120 water springs

identified as a potential hydromineral resources, either abandoned or publicly available (see figure 12).

Most of the natural mineral waters occur in the north and central regions of the country, in the Iberian Massif, emerging predominantly from granitic rocks, related with very deep fractured reservoirs and associated to major regional active faults (with overall NNE-SSW direction). In this context, the following water types stand out:

- Sulphur waters – The most abundant type, characterized by the presence of reduced forms of the sulphur ion, high contents of silica and fluorine ions. Normally the pH values vary from 7.5 to 9.5, the water temperatures range from 20 to 69 °C and the total mineralization can reach 700 mg/L. These waters are used for thermalism.
- Natural CO2 water – Occurs in northern Portugal, only. The CO2 levels range between 500 and 2600 mg/L, the total mineralization goes up to 5700 mg/L, the pH values vary from 5.9 to 6.9 and water temperatures are typically below 20 °C; but in Caldas de Chaves they reach 77 °C. The majority of these waters is used for bottling, but in some cases are also used for thermalism and only in Chaves they are used for geothermal purpose.

In Iberian Massif (Central Iberian Zone) still deserving reference are the water type associates with quartzitic and granitic rocks:

- Silicate waters – The SiO2 content represents more than 30% of total mineralization. The hydrochemical facies are sodium chloride and sodium bicarbonate, for waters emerging from quartzitic and granitic rocks, respectively. In generally, they are very low mineralized and acid waters (4.7 < pH < 6.3; geometric mean = 5.6), with temperatures up to 29 °C. These waters are used for both bottling and thermalism.

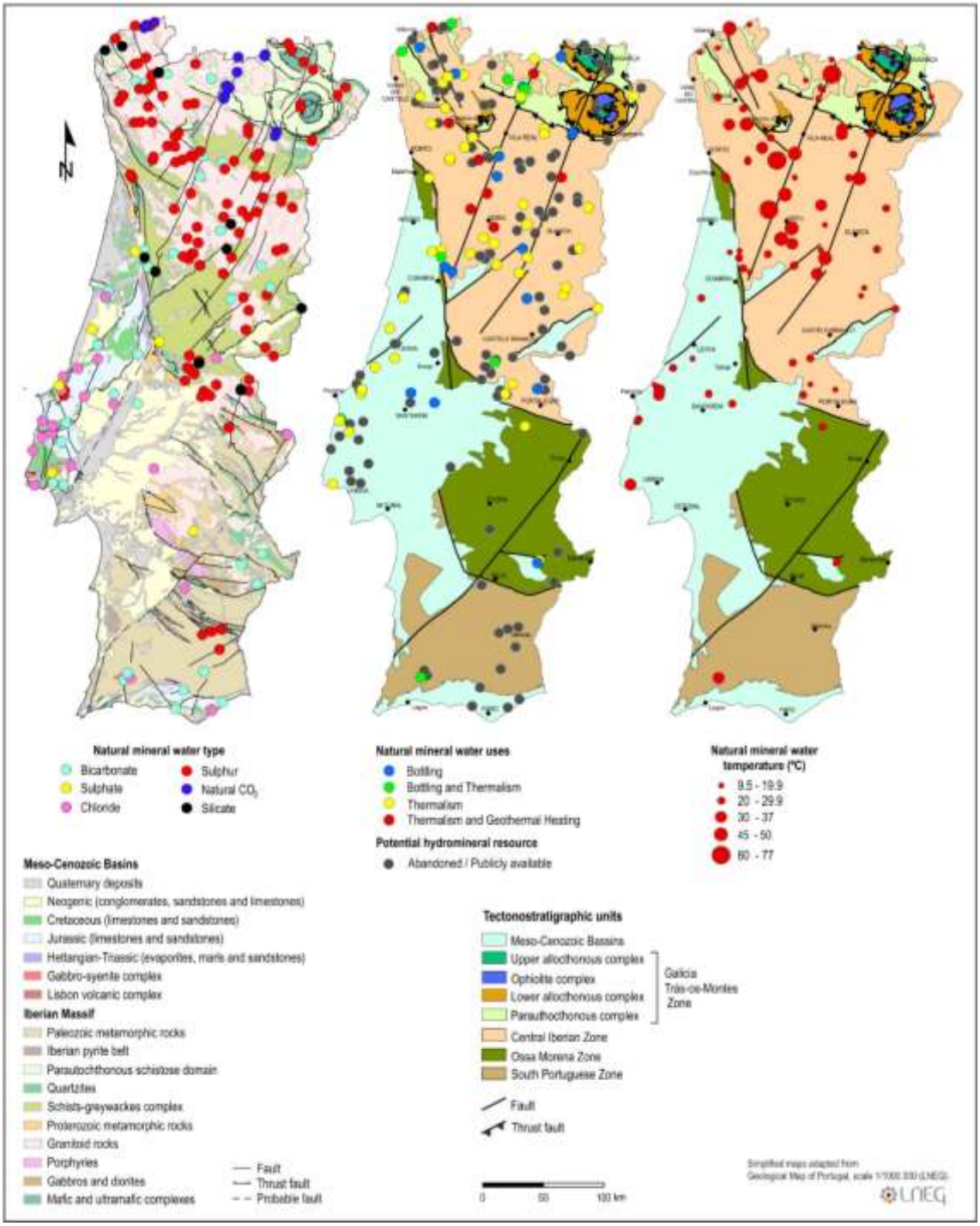

Figure 12: Overview distribution of type, uses and temperature of natural mineral waters in mainland Portugal.

In the Western and Southern Meso-Cenozoic sedimentary basins where sandstones and limestones are abundant lithologies, the natural mineral waters have the highest flows. The typical hydrochemical facies are sodium-chloride-bicarbonate and calcium-sulphate. The pH

values are close to 7, the water temperatures ranging between 19 and 37 °C and the total mineralization vary from 180 to 6600 mg/L; but in Batalha (Salgada da Batalha borehole) reach 32500 mg/L. These waters are usually related with active fault systems and their ionic composition is strongly influenced by the salt diapir structures or evaporites (halite and gypsum) levels in Lower Jurassic formations. These waters are used for thermalism and bottling.

In Portugal, groundwaters with a temperature of 20 °C or higher at the outlet are considered as resources with potential geothermal use. In mainland territory the natural mineral water temperature varies between 9.5 and 77 °C and therefore natural mineral waters can simultaneously constitute geothermal resources. According Portuguese HOVER WP3 database there are 61 occurrences with temperature above 20 °C. Currently there are 8 concessions in which water is used for both thermalism and geothermal heating (see Figure 12).

References

ALMEIDA, F., MOURA, J. (1970): Carta das nascentes minerais de Portugal, escala 1:1000 000. Direcção Geral de Minas e Serviços Geológicos, Serviços Geológicos de Portugal, Lisboa.

BRITO, F. (2011): Modelação do Escoamento Subterrâneo do Sector do Ribeiro Frio dos Sistema aquíferoda Água Fonte da Fraga. Dissertação de Mestrado, UBI, Covilã. 145p.

CALADO, C. (1992): Carta de Nascentes Minerais, escala 1:1.000.000, Atlas do Ambiente. Direcção-Geral de Recursos Naturais, Ministério do Ambiente e Recursos Naturais. Lisboa.

CAVALEIRO, V., PIRES, J., CARVALHO, A. (2017): Contribuição para o conhecimento do modelo hidrogeológico conceptual das águas subterrâneas das Caldas de São Paulo. Atas do 11º Seminário sobre Águas Subterrâneas, Porto. 95-98.

DIAZ, R., RAMALHO, E. (2015): Características geoquímicas das antigas nascentes termominerais de Alfama (Lisboa, Portugal): estudo preliminar do seu potencial geotérmico e hidromineral. Comunicações Geológicas 102, Especial I, 129-132 ISSN: 0873-948X; e-ISSN: 1647-581.

DGGM (1992): Termas e Águas Engarrafadas em Portugal. Catálogo.Direção-Geral de Geologia e Minas. Lisboa.

FERREIRA, L., CARVALHO, P., PAIS, L. (2019): Hydrogeochemical studies of a groundwater with a view to its classification as mineral water for a new medical spa in Portugal. IOP Conf. Ser.: Earth Environ. Sci. 221 012030; IOP Publishing; 10p.

FERREIRA, P., GOMES, L., OLIVEIRA, A., MOURA, R., LOURENÇO, J. (2020): Estudos hidrogeológicos para avaliar a disponibilidade de um recurso hídrico subterrâneo quente nas Termas Da Areola (40-54) Atena Ed. ISBN: 978-85-7247-910-3 DOI 10.22533/at.ed.1032013014

FREITAS, H. (2015): Investigações hidrogeológicas da sondagem CC3 do aquífero termomineral de Chaves: implicações para o modelo conceptual. Dissertação de Mestrado, ISEP, Departamento de Engenharia Geotécnica, Porto. 197p + Anexos.

GOMES, L., GUEDES, J., COSTA, T., FERREIRA, P., TROTA, A. (2014): Geothermal potential of Portuguese granitic rock masses: lessons learned from deep boreholes Environ Earth Sci 73(6) DOI - 10.1007/s12665-014-3605-y.

LOURENÇO, C., CRUZ, J. (2010): Catálogo de Recursos Geotérmicos em Portugal Continental. http://geoportal.lneg.pt/index.php?option=com_content&id=59&lg=pt
LOURENÇO, C., RIBEIRO, L.; CRUZ, J. (2010): Classification of natural mineral and spring bottled waters of Portugal using Principal Component Analysis. Journal of Geochemical Exploration, 107(3), 362–372.

MARQUES, J., CARREIRA, P., AIRES-BARROS, L., SANTOS, F., ANTUNES DA SILVA, M., REPRESAS, P. (2019): Assessment of Chaves Low-Temperature CO2-Rich Geothermal System (N-Portugal) Using an Interdisciplinary Geosciences Approach Hindawi Geofluids Volume 2019, Article ID 1379093, 24 pages https://doi.org/10.1155/2019/1379093

MARQUES, J. (2008): Origins of High pH Mineral Waters from Ultramafic Rocks, Central Portugal./Applied Geochemistry 23 (2008) 3278–3289/Etiope_et_al_2013 Methane in serpentinized ultramafic rocks in mainland Portugal _Marine_Petrol_Geol 75 (2013), 12-16.

MARQUES, J., ESPINHA MARQUES, J., CARREIRA, P., AIRES-BARROS, L., CARVALHO, J.; BORGES, F. (2004): New approach on the hydrogeochemical signatures of Caldas do Moledo thermomineral system (N Portugal): implications for the hydrogeologic conceptual model elaboration. Caderno Lab. Xeolóxico de Laxe Coruña. 2004. Vol. 29, pp. 119-146.

REBELO, M., SILVA, E.,ROCHA, F. (2014): Characterization of Portuguese thermo-mineral waters to be applied in peloids maturation. Environ Earth Sci DOI 10.1007/s12665-014-3670-2.

SILVA, V., AZEVEDO, J., CASTILHO, A., GOMES, L. (2019): Hidrogeologia dos Domínios Envolventes das Termas da Touca, Alpedrinha, Fundão. Atas do 12º Congresso Água., Coimbra 40-43 ISBN: 978-989-8509-22-2.

5.11 Romania

Author: Alina Mercan

5.11.1 Relevant national definitions in Romania

According to Annex no. 1 from Government Decision 1020/2005, **the natural mineral water** is a pure microbiological water, originating in an underground aquifer, protected from any possible risk of pollution. It is exploited by one or more natural emergents or wells and it is characterized by a stable composition, temperature and other characteristics within the limits of natural fluctuation and in terms of source flow variations. Natural mineral water is clearly distinguished from ordinary drinking water by its nature (characterized by its specific content in dissolved mineral salts, trace elements or other constituents) and by its original purity. Both characteristics (nature and original purity) being maintained intact due to the underground origin and high degree of protection and confer favourable properties to human health.

5.11.2 Overview of natural mineral and thermal water resources in Romania

According to Government Decision 1154/2004, art.44, the therapeutic mineral water, is a water that comes from a natural source, lake, spring or wells and meets at least one of the following conditions: content of dissolved mineral salts over is above 1 g/l; the presence of chemical

elements with known pharmacological action, in the minimum necessary proportions; content of dissolved gas with biological effects, in established concentration 1000 mg CO_2, of 1 mg/l H_2S; temperature above 20°C, independent of the mineral content, which gives them the characteristic of thermal water; the existence of a scientifically recognized therapeutic action, a situation which gives these therapeutic mineral water the status of drug, being prohibited any modification of processing by addition or extraction of substances other than CO_2.
According to Government Decision 1154/2004, art.44, the therapeutic mineral water, is a water that comes from a natural source, lake, spring or wells and meets at least one of the following conditions:

- the content of dissolved mineral salts over is above 1 g/l;
- the presence of chemical elements with known pharmacological action, in the minimum necessary proportions;
- content of dissolved gases with biological effects, in established concentration of 1000 mg for CO_2, and 1 mg/l for H_2S;
- temperature above 20°C, independent of the mineral content, which gives them the characteristic of thermal water;
- the existence of a scientifically recognized therapeutic action, a situation which gives these therapeutic mineral waters the status of drug, being prohibited any modification of processing by addition or extraction of substances other than CO_2.

Thermal water, according to Government Decision 1154/2004, art. 44, point 1, letter d is a water that comes from a natural source, lake, spring or wells, which has at source a temperature of over 200C, independent of mineral content.
Thermomineral water, according to Government Decision 1154/2004, is a thermal water that comes from a natural source, lake, spring or well dependent of mineral content.

According to FERU (2004): As a result of its complex geological structure, Romania has a large variety of mineral water types, amounting to 2,000 springs over the entire territory. Among them, an outstanding position is occupied by the naturally carbonated mineral waters, the origin of which is associated to the post-volcanic phenomena of the Neogene volcanic domain of the Carpathian Mountains, that displays the most extended surrounding of volcanic gas outflows in the entire Europe. In terms of their geologic setting, most of the mineral water accumulations occur in carbonate rocks that include limestones, calcarenites, conglomerates (about 45%), next in pyroclastics and andesites (about 25%), in detritic deposits consisting of sand and gravel (about 25%), and to a limited extend in sandstones and crystalline schists. The main intakes of natural mineral water in Romania are located in mountains and in intra-mountains depressions areas, and they are related to the domain where Neogene post-volcanic activity has occurred.

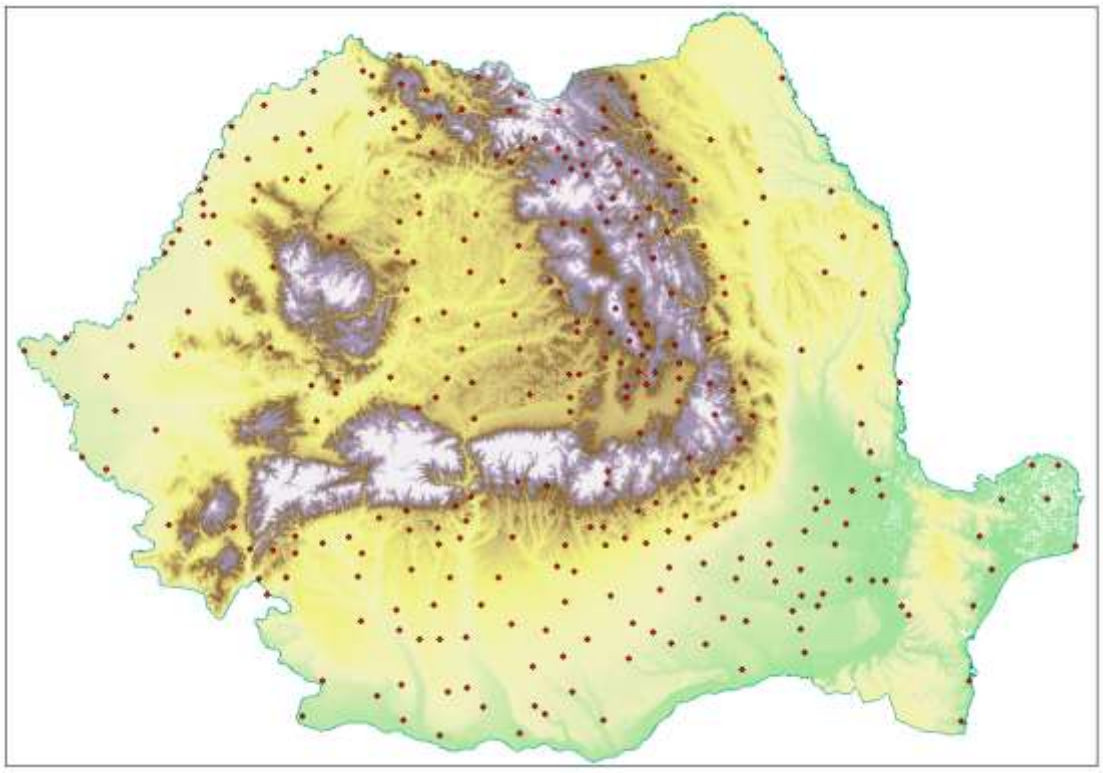

Figure 13: Overview of main mineral and thermal waters locations (BANDRABUR et al., 1985).

One of the numerous classification systems of mineral waters is based on the following criteria:
– the total mineralisation;
– the CO_2 content and origin;
– the ionic composition.

By taking into account the dry residue, according to the EC Directive 80/777, mineral natural waters are separated into:
– very low mineral content—dry residue at 180°C below 50 mg/l;
– low mineral content (oligomineral) — dry residue at 180°C ranging between 50–500 mg/l;
– rich in mineral salts — dry residue at 180°C above 1.500 mg/l.
The main weight among bottled mineral waters in Romania is detained by waters of average mineral content (61%), followed by low mineral content waters (29%) and by high mineral content waters (10%), according to FERU (2004).

As a function of the CO_2 content of the water sampled in natural state, at the source, the mineral waters are separated into: carbonated mineral waters (CO2>250 mg/l) and still mineral waters (CO2<250 mg/l). Carbonated mineral water consumption in Romania is subject to a strong tradition. The main weight on the market is detained by the naturally carbonated natural mineral water (66%), followed by CO2 impregnated mineral water, derived from water that at the outlet is non-carbonated (28%).

In terms of the major ion contents of the mineral water, the mineral waters are distinguished based on one or two anions and one or two cations having ionic percentages in excess 20% of the milliequivalents content, indicated in a decreasing order. The main bottled mineral water type is the calcium and sodium bicarbonate waters. Also, most sodium sulphate and sodium chloride waters bottled as natural mineral waters have low mineralisation.

References

FERU, A., (2004): Bottled natural mineral waters in Romania. In: Environmental Geology 46:670–674, Springer Verlag – Heidelberg.
FERU, A. (2012): Ghidul apelor minerale In: Patronatului APEMIN, București.
PRICĂJAN, A. (1972) - Apele minerale și termale din România, Ed. Tehnică, București

5.12 Serbia

Author: Tanja Petrović Pantić

5.12.1 Relevant national definitions in Serbia

There are no precise terms from national laws or rulebooks; however, we are guided by the following definition:
Mineral water is groundwater with higher content of dissolved minerals (> 1 g/l) or higher content of certain specific components (CO_2, H_2S, Rn, Fe, Br, J etc.).
Natural mineral water (Rulebook on quality and other requirements for natural mineral water, Spring Water and Bottled Drinking Water (Official Gazette of Serbia and Montenegro, volume 53/05) is water for human use in own natural state. It can be bottled, just if it is regular chemical and microbiological, if its quality is stable and formed in natural conditions.
Thermal water is groundwater which temperature is higher than the average annual temperature of a given place. To be considered as a thermal groundwater, it should meet certain requirements: to have a stable regime and to be heated from the temperature of the Earth's crust, not from the Sun's heat, which means that its temperature should be a consequence of geothermal processes in the Earth's crust. Nevertheless, we usually consider the outlet water temperature > 20°C.
In the last years, we avoid the term thermomineral water. It is considered that thermomineral water is groundwater with temperature above 20°C and content of dissolved minerals more than 1 g/l or higher content of certain specific components (CO_2, H_2S, Rn, Fe, Br, J etc.).
According to Regulation on Quality and Other Requirements for Natural Mineral Water, Spring Water and Table Water (Official Gazette of SCG No. 53/2005) natural mineral water, natural spring water and table water are groundwater, which occur from a well/borehole or spring.

5.12.2 Overview of natural mineral and thermal water resources in Serbia

Thermal water

Currently, groundwater with temperature more than 20°C is registered on 145 locations (Petrović Pantić et al, 2019). The highest temperatures are registered in south Serbia, from Vranjska Banja (111°C) to north-east direction- Tulare- Sijarinska Banja (78°C) - Lukovska Banja (68°C)- Jošanička Banja (78°C), furthermore in north province of Serbia-Vojvodina (Vrbica, 82°C; Kanjiža, 72°C), especially on the north-east border and Mačva (Bogatić, 79°C). Geothermal resources are mostly used for bathing and swiming, then for space heating and greenhouses.

The north part of Serbia belongs to Pannonian basin. There is predominant intergranular aquifer, with Quaternary and Neogene sediments. At greater depts, thermal waters are captured from different aquifers: sand, sandy-clay deposits, sandstone, limestone, dolomite, sandstone, conglomerate and breccia.
On the east part of Serbia is geotectonic unit – Dinarides. Thermal water is formed in: Neogene sediments with productive aquifer in Triassic limestone under them; peridotite massif and ophiolitic mélange with aquifer in Triassic limestone; granitoid and volcanic rocks (MARTINOVIĆ & MILIVOJEVIĆ, 2010)
In central Serbia, there is geotectonic unit Serbo-Macedonian Massif, or according to hydrogeological reonization: Serbian Crystalline Core. Fractured aquifer is presented in different magmatic rocks (granite, andesite), Proterozoic metamorphic rocks (crystalline schist), and solid sediment rocks (sandstone, marls, conglomerates, breccia). The highest temperatures and significant amount of groundwater is captured from these rocks, as a consequence of heavily fractures due of heating and cooling.
In the east part of Serbia is geotectonic unit Carpatho-Balkanides. The karst aquifer is presented with limestone and dolomite. The characteristic of karst springs vary of yield and temperature, like spring in Niška Banja with yield from 35 to 5000 l/s and temperature from 13 to 39°C.

Mineral water

A numerous thermal water are also mineral water - thermomineral water. Almost all thermal water from magmatic and metamorphic rocks are usually with higher content of dissolved minerals (> 1 g/l) or higher content of certain specific components (CO_2, H_2S, Rn, Fe, Br, I etc).
Karst water do not have high content of TDS, approximately about 0,5 g/l. But some of them are classified like mineral (thermomineral) because they have high content of Rn (Sokobanja, Niška Banja).
In practice, we use term mineral water for mineralized waters containing more than 1 g/l of total dissolved solids, or enriched with free gases, e.g. CO2, H2S,.. or some other component, e.g. iron.
Mineral, cold water with CO_2 are formed within metamorphic rocks. The most popular carbonated bottled waters (TDS> 1 g/l) are Knjaz Miloš, Vrnjci, Heba, Bivoda, Karađorđe, Minaqua.
Minaqua is a representative water from Pannonian basin. Presence of higher content of Na, Cl and I is consequences of draining of ex Pannonian sea (PETROVIĆ et al., 2012), as well as the spring Slanjača https://geoera.eu/blog/geomanifestations-in-north-serbia-vojvodina/).
In the Serbia, there is more mineral water, with presence of some elements, available for drinking or for healing.

References

MARTINOVIĆ, M. AND MILIVOJEVIĆ, M. (2010): Serbia Country Update, Proceeding World Geothermal Congress 2010, Bali Indonesia, 25-29 April
PETROVIĆ T., ZLOKOLICA MNADIĆ M., VELJKOVIĆ N., PAPIĆ, P., POZNANOVIĆ, M., STOJKOVIĆ, J., MAGAZINOVIĆ, S. MACRO and microelements in bottled and tap water from Serbia, Hemijska industrija 66 (1) 107-122
PETROVIĆ PANTIĆ, T., TOMIĆ, M., ATANASKOVIĆ SAMOLOV, K. (2019): Geothermal resources of Serbia 4th IAH CEG Conference, Donji Milanovac, Serbia, 18-20 June
https://geoera.eu/blog/geomanifestations-in-north-serbia-vojvodina/

5.13 Slovenia

Author: Nina Rman

5.13.1 Relevant national definitions in Slovenia

Mineral water is defined in the Waters Act (Official Gazzette of Rep. Of Slovenia No. 67/02, 2/04 – ZZdrI-A, 41/04 – ZVO-1, 57/08, 57/12, 100/13, 40/14, 56/15). Row 5. of the article 7 defines the mineral water as a groundwater which fulfills the written criteria, and orignates from a well, a spring or a capture. The issue is that the criteria are NOT listed anywhere.

Thermal water is defined in the Waters Act (Official Gazzette of Rep. Of Slovenia No. 67/02, 2/04 – ZZdrI-A, 41/04 – ZVO-1, 57/08, 57/12, 100/13, 40/14, 56/15). Row 6. of the article 7 defines it as a gounrdwater from a well, spring or a capture which is heated in geothermal processes in Earth's crust and has the temperature at the spring or wellhead at least of 20 °C.

Thermomineral water is defined in the Waters Act (Official Gazzette of Rep. Of Slovenia No. 67/02, 2/04 – ZZdrI-A, 41/04 – ZVO-1, 57/08, 57/12, 100/13, 40/14, 56/15). Row 7. of the article 7 defines it as the thermal water with properties of mineral water.

Natural mineral water is defined in the Rules on natural mineral water, spring water and table water (Official Gazzette of Rep. Of Slovenia No. 50/04, 75/05 in 45/08 – ZKme-1). Article 4 defines it as water which beside microbiological requirements from the 5th article also: has a source in a subsurface water source (is grounwater), protected from any possibility of contamination, and springs or is pumped at a spring from one or more natural outflows or wells; has properties which clearly distinguish it from drinking water and may be connected to content of dissolved solids, trace elements or other ingredients, and may have certain nutritional and physiological effects; has the same purity as at the source… and the deviation from the mean annual measured values for the main constituents specific to the individual natural mineral water, may not exceed ± 20%.

Natural healing remedy can be also groundwater, usually that is a mineral, radioactive or termal water, which is used for bathing or drinking. It is managed by the Natural Healing Remedies and Natural Spa Act = Zakono naravnih zdravilnih sredstvih in o naravnih zdraviliščih (Official Gazzette of the Soc. Rep. of Slovenia No. 36/64 and 11/65) which defines that its quality should be tested at least every five years, and also allows for water protection areas to be declared.

5.13.2 Overview of natural mineral and thermal water resources in Slovenia

There are nine brands of natural mineral waters recognized in Slovenia. The historical ones in Radenci and Rogaška Slatina produce high mineralized water with lots of free mantle CO_2. Radenska® has a Na-Ca-Mg-HCO_3 water type and outflows from Miocene siliciclastic sediments near the Raba Fault Zone. Donat Mg® water of Mg-Na-HCO_3-SO_4 type outflows from Oligocene andesite and tuf along the Donat Fault Zone. Newer brands produce mostly low mineralized Ca-Mg-HCO_3 waters from the dolomite.

Thermal water with temperature of above 20 °C has been identified in 51 places in Slovenia and in 18 of theses cases water is thermomineral, e.g. containing above 1,000 mg/l of total dissolved solids or 250 mg/l of free CO_2. Three types of geothermal reservoirs store thermal water:

a) In low temperature geothermal systems with warm springs and fracture porosity thermal springs emerge at the intersection of fault zones at eight sites. Aquifers consist mostly of carbonate rocks, which results in low mineralization of thermal water. The general water type is Ca-(Mg)-HCO_3, but sulphate ions may predominate locally due to gypsum or anhydrite dissolution. The occurrence of this system is indicated by thermal springs, which were first captured with wells and afterwards with boreholes moving away from the springs. The characteristic temperature of thermal water at the surface is 20-50 °C. Similar fracture systems are common at the margins of Tertiary sedimentary basins at the boundary between carbonate and clastic rocks. The latter have low permeability and low thermal conductivity. Thermal water of this type springs at 16 sites with water temperature up to 48 °C.

b) Low temperature geothermal systems with aquifers in sedimentary basins and of intergranular porosity are located in Neogene clastic sediments and sedimentary rocks in north-eastern Slovenia. They were discovered during oil and gas drilling research between the 1950's and 1970's. The water-bearing Pliocene sand and sandy gravel deepen to the east and store Pleistocene rainwater. These aquifers have temperature and mineralization zones as their values increase with depth. The predominant water type is Na-HCO_3. Mineralization changes from around 1 g/l at the shallow parts to a few g/l in deeper ones. As an exception, thermomineral water in Radenci consists of up to 11 g/l of TDS due to a high mantle CO_2 content. Produced water temperatures at 13 sites reach up to 75 °C.

c) Low temperature geothermal systems with aquifers in the basement of sedimentary basins and with fracture porosity are identified throughout Slovenia. In the east, two types of thermomineral waters are stored in metamorphic and sedimentary Paleozoic and Mesozoic rocks beneath sediments of the Mura-Zala basin. The northern and shallower Radgona-Vaš sub-basin withholds thermal water of up to 10 g/l TDS and the Na-HCO_3 type, but spatially limited dolomitic rocks in the deeper and southern lying Haloze-Ljutomer sub-basin bear a brine of the Na-Cl type. This is the warmest thermomineral water in Slovenia which contains up to 27 g/l of TDS and considerable quantities of CO_2. This is not the case in other places where basement aquifers are formed in different Mesozoic and Cenozoic carbonate rocks lying beneath low permeable and heat insulating rocks. Here, thermal water stored in carbonates of the Littoral, Krško-Brežice basin, Sava Folds and Šaleška valley is mostly of the Ca-Mg-HCO_3 type, has low mineralization and almost no CO_2. At submarine springs in Izola the marine water mixes with meteoric and the water type is Na-Ca-Mg-Cl-HCO_3-SO_4. Such waters with temperatures up to 90 °C are identified at 14 sites. Besides the already presented locations, there are at least eight subthermal (16-20 °C) springs, mostly in carbonate rocks.

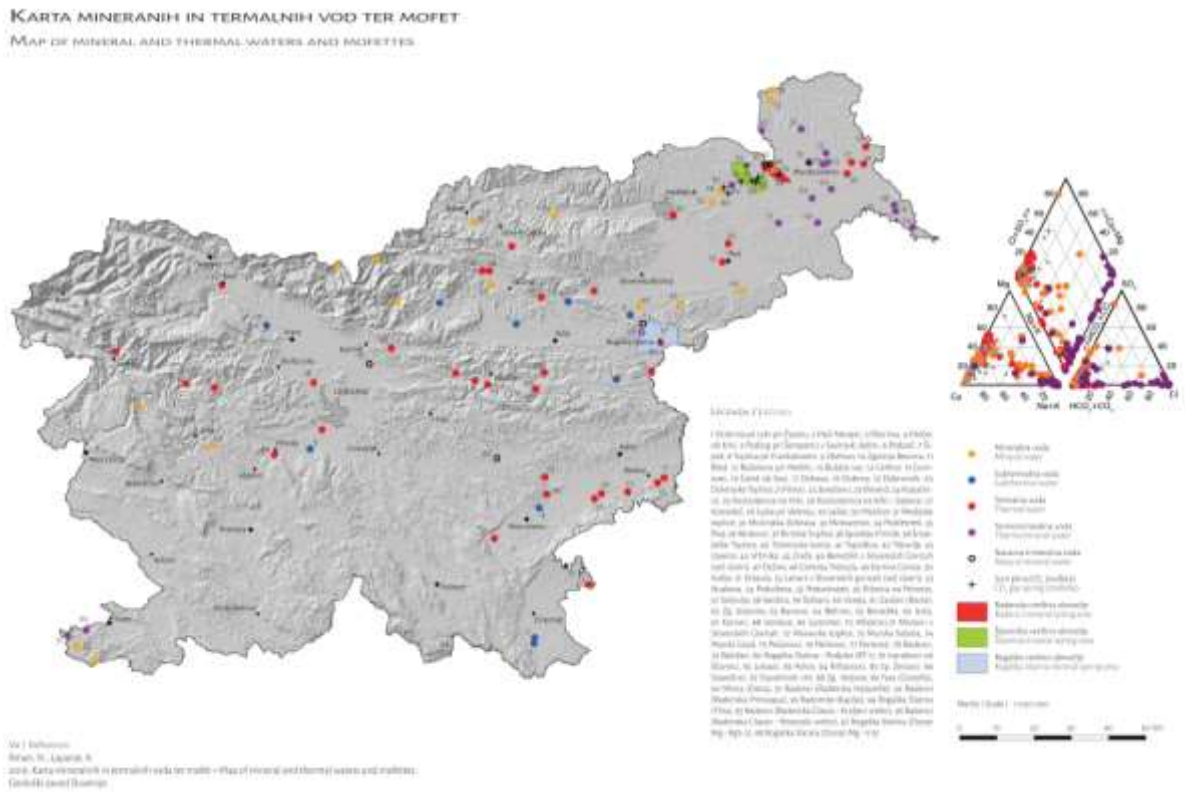

Figure 14: Overview of mineral and thermal waters in Slovenia.

References

LAPANJE, A., RMAN N. 2009: Termalna in termomineralna voda = Thermal and thermomineral water. In: Pleničar, M. et al. (eds.): Geologija Slovenije = The geology of Slovenia. Ljubljana: Geološki zavod Slovenije. 553-560.

RMAN N., LAPANJE, A., MEZGA, K. 2016: Mineralne in termalne vode ter mofete = Mineral waters, thermal waters and mofettes. In: Novak, M., Rman, N. (eds.): Geološki atlas Slovenije = Geological atlas of Slovenia. Ljubljana: Geološki zavod Slovenije. 44-45.

LAPANJE, A. (2006): Origin and chemical composition of thermal and thermomineral waters in Slovenia = Izvor in kemijska sestava termalnih in termomineralnih vod v Sloveniji. Geologija 49/2, 347-370.

5.14 Spain (Catalonia included)

Authors: Georgina Arnó, Elena Giménez Forcada

5.14.1 Relevant national definitions in Spain

Natural Mineral and **Thermal waters** in Spain are regulated by the following legislation:

- Law of Mines 22/1973, 21 of July (BOE number 189, de 24-07-1973) https://www.boe.es/buscar/doc.php?id=BOE-A-1973-1018
- Royal Law 2857/1978, 25 of August (BOE number 295, de 11-12-1978) https://www.boe.es/buscar/doc.php?id=BOE-A-1978-29905

According to the Article 23.1 and 23.2 of the 22/173 Law of Mines and the Article 38.1 of the 2857/1978 Royal Law, Mineral and Thermal waters are defined as a Natural Resource and are classified into:

1- **Mineral Waters**
- Mineral-medicinal Waters are those that naturally or artificially reach the topographic surface with certain characteristics and curative qualities that would permit be declared of public utility.
- Mineral and Industrial Waters are those that allow the sustainable exploitation and utilisation of the substances they contain.

2- Mineral Water is considered as **Thermal water** when the outlet water temperature is 4ºC (Celsius degrees) greater than the mean annual air temperature in the same location where the water source is located.

Furthermore, **Natural mineral waters** are also regulated by the Royal Law 1798/2010 regarding the exploitation and commercialization of bottled drinking Natural mineral waters and spring waters. From the interpretation of this legislation, it can be understood that depending on the use or destination, Mineral-medicinal waters could be classified into:

- **Natural mineral waters:** Those are microbiologically-free and with a constant chemical composition over time regardless of the water flow. They have a specific mineral and trace elements composition and are characterized for its original purity.
- **Spring waters:** Those are microbiologically-free but no constant chemical composition over time is required.

5.14.2 Overview of natural mineral and thermal water resources in Spain

Spain has more than 160 **natural mineral waters** recognized by the European Commission in compliance of the Directive 2009/54/EC. Numerous Thermal water sources are also found in characteristic hydrogeological settings due to geothermal anomalies.

Natural mineral and **thermal water exploitation** are regulated in Spanish legislation (Articles 24 and 25 of the 22/173 Law of Mines) and can be summarized, in terms of use and protection of this natural resource, in two main points:

First, a *National official recognition* of Natural Mineral and/or thermal water by resolution of the Ministry of Industry of the Spanish Government is mandatory to obtain the exploitation authorisation.
An extensive hydrogeological study has to be carried out. It includes a geological and hydrogeological characterization of the study area, a conceptual hydrogeological model, a description and hydraulic characterization of the water source, representative pumping tests and a detailed hydrochemical characterization of water. Regarding hydrochemical analyses, they have to be done during twelve consecutive months. For **natural mineral waters** it has to be ensuring that water chemical composition is stable and results are in compliance with legal

regulations of bottled drinking natural mineral waters (Royal Law 1798/2010 and DE 2009/54). Analyses of the first and the last month have to include measurements of temperature, pH, electric conductivity, alkalinity, main anions and cations, nitrates, nitrites, microbiological and metal compounds, hydrocarbons, pesticides, trihalomethanes, radioactive compounds and isotopes. The other ten analyses are simplified and include measurements of temperature, pH, electric conductivity, alkalinity, main anions and cations, nitrates, nitrites, and microbiological and metal compounds. No quantitative specifications are established.

If Natural mineral water is going to be used also for medical purposes a pharmacologic, physiologic and clinical study has to be also reported specifying the water health qualities and the potential application for balneotherapy. Often a list of non-recommended uses is included as well.

For t**hermal waters**, the outlet water temperature has to be measured during twelve consecutive months, and the obtained data have to be compared with the air temperature at the nearest official meteorological station. If the outlet water temperature is always 4ºC above the mean annual air temperature at the meteorological station of reference, then it can be recognized as thermal water.
Once the *national official recognition* has been obtained, additional information has to be reported to obtain the authorization for its exploitation. A general exploitation project has to include the description of facilities, the exploitation flow rates and an economic feasibility plan. Finally, a delimitation of protection area has to be proposed for the declared Mineral Water.
At the end, the recognition of Mineral Water and the delimitation of protection area are officially published in the BOE (Official Gazette of the Spanish Government).

A list of Natural mineral waters and/or Thermal waters officially recognized in Spain has been included (see database), although no complete hydrochemical data of Natural Mineral and/or Thermal waters has been provided because of data privacy restrictions.

6 PERSPECTIVES AND PROPOSED WORKFLOW

- This technical report comprises an inventory of available data needed to describe anomalies of natural origin of dissolved elements in groundwater. Involved surveys made investigations on the availability of own data including natural mineral waters, thermal waters, hydrochemical data for observation wells/springs including a large set of trace elements and geological backgrounds.
  see chapter 3
- Furthermore, a harmonized terminology for characterizing natural mineral water and thermal water was proposed and a database structure for data collection was developed.
  see chapter 4
- Data collection for natural mineral waters and thermal has started and preliminary data collection is available in this deliverable.
  see chapters 4.2, 5 and ***Erreur ! Source du renvoi introuvable.***
  see attachment A2 – Database with preliminary data on natural mineral waters and thermal waters

Natural mineral water and thermal water

The next step will be to continue with data collection for natural mineral waters and thermal waters by using the developed database structure. Experience from preliminary data collection has shown, that an iterative process of co-reviewing delivered data is needed to meet the goal of producing a harmonized dataset with a high-quality standard for a pan-European level product. Producing a web map service will be an aim of upcoming Task 3-5. However, we highly suggest to involve the GeoERA Information Platform earlier during data collection to receive important inputs on developing the planned WMS data model (Deliverable 3.5a).

Pan-European information layers of indicators of chemical anomalies of natural origin

D3.1 provides an important background information for the compilation of analyses of possible use at a pan-European scale. The overall aim will be the development of European exposure maps of selected elements and indicators. See Task 3.3 for indicators and Task 3.4 for compilations of analyses and indicators. Experiences from Task 3.1 und also Task 3.2 have shown that data collection is challenging in some cases and we are looking forward to receive support from participating surveys.

7 APPENDIX

7.1 Specific Questionnaire for WP3

Table 51: Template of the specific questionnaire.

WP3 specific questionnaire	
question code	**question**
GENERAL QUESTIONS	
Q_WP3_1	Organisation
Q_WP3_2	Name
Q_WP3_3	E-Mail
Q_WP3_4	Do you have special investigation areas (pilot areas) in your country with high observation density of ground water quality? If yes, which ones?
Q_WP3_5	Does the EU Directive 2009/54/EC ("natural mineral waters") apply to your country?
Q_WP3_6	If no, which law regulates "natural mineral waters" in your country?
Q_WP3_7	If no, what are the requirements to define a "natural mineral water" in your country?
Q_WP3_8	If yes, is there a national law in your country which regulates "natural mineral waters"?
Q_WP3_9	If yes, name of the national law which regulates "natural mineral waters"
Q_WP3_10	Do you have access to locations (coordinates) of used "natural mineral water" occurrences in your country?[1]
Q_WP3_11	Is it possible to publish coordinates on a large map scale (=no exact location)?[1]
Q_WP3_12	Do you have access to hydrochemical analyses and temperatures of used "natural mineral waters" occurrences in your country?
Q_WP3_13	Is it possible to publish those analyses in an overview map (no values, but classes; large map scale)?
Q_WP3_14	Can you characterize the geology of the aquifer of the used "natural mineral waters" occurrences in your country by a simply geological classification?
Q_WP3_15	Which law regulates the definition of "thermal water" in your country?[1]
Q_WP3_16	What is the minimum temperature (°C) to define a "thermal water" in your country?
Q_WP3_17	Do you have access to the coordinates of locations of „thermal waters" occurrences in your country?[1]
Q_WP3_18	Is it possible to publish locations on a large map scale map (no exact location)?
Q_WP3_19	Do you have access to hydrochemical analyses and temperatures of used "thermal water" occurrences in your country?[1]
Q_WP3_20	Can you deliver the true vertical drilling depth (minimum, maximum) of the "thermal water" occurrences in your country?
Q_WP3_21	Is it possible to publish those analyses in an overview map (no values, but classes; large map scale)?
Q_WP3_22	Can you characterize the geology of the aquifer of the "thermal water" occurrences in your country by a simply geological classification?
FIELD DATA & MAIN IONS	
Q_WP3_23	Location (Projected Coordinate System: ETRS_1989_LAEA; Projection: Lambert_Azimuthal_Equal_Area)
Q_WP3_24	Elevation of terrain (m a.s.l.; EVRF2007)
Q_WP3_25	Total depth of well (m below terrain)
Q_WP3_26	Depth to water table (m below terrain)
Q_WP3_27	Well screen from-to (m below terrain)
Q_WP3_28	Discharge (L s-1) during hydrochemical sampling
Q_WP3_29	Type of hydrochemical sampling (e.g. from pumping)
	Can you provide the following data for observation wells and springs in your country?
Q_WP3_30	Groundwater temperature (°C)
Q_WP3_31	EC (µS/cm, 25 °C)
Q_WP3_32	eH (mV)
Q_WP3_33	O2 (mg L-1)
Q_WP3_34	Ca (mg L-1)
Q_WP3_35	K (mg L-1)
Q_WP3_36	Na (mg L-1)
Q_WP3_37	NH4 (mg L-1)
Q_WP3_38	Cl (mg L-1)
Q_WP3_39	HCO3 (mg L-1)
Q_WP3_40	SO4 (mg L-1)
Q_WP3_41	NO3 (mg L-1)
Q_WP3_42	NO2 (mg L-1)
TRACE ELEMENTS	

The following questions were asked for each element. **The list of elements comprised: Al, Sb, As, Ba, B, Br, Cd, Cr, Cu, F, I, Fe, Pb, Li, Mn, Hg, Ni, Se, Sr, U, V, Zn,** Question codes Q_WP3_43 to Q_WP3_218
What is the threshold value in your country (mg L^{-1})?
Are there regions in your country where concentrations exceed the threshold value?
Can you characterize the geology of the regions with elevated concentrations in groundwater by a simple geological classification of the aquifer?
For how many observation wells/springs do you have data?
Do you have access to concentrations in groundwater observation wells/springs in your country for at least 5 recent years and what is the sampling frequency?
Do the observations cover the whole country or specific areas only? If only specific areas: which ones?
Are there existing maps of natural background values?
Comments to the specific element.

7.2 Data collection table for Task 3-1

Table 52: Template of the data collection table.

	Field	unit	type	explanation
Name				
N1	name of source		text	Please provide the name of source from the list of recognized natural mineral waters, otherwise a name for the thermal water source
N2	official name of natural mineral water		text	Please provide the trade description from the list of recognized natural mineral waters; not relevant for thermal waters
N3	country		text	
General information				
G1	classification		choose from list	
G2	location		choose country specific grid cell ID	download country specific grids from https://www.eea.europa.eu/data-and-maps/data/eea-reference-grids-2
G3	type of water source		choose from list	
G4	intended use 1		choose from list	
G5	intended use 2		choose from list	
G6	intended use 3		choose from list	
G7	yield class	l/s	choose from list	extraction allowed by water law
Aquifer				
B1	If borehole: true vertical depth	m	number	below terrain
B2	If borehole: screen or open hole: FROM (true vertical depth)	m	number	below terrain
B3	If borehole: screen or open hole: TO (true vertical depth)	m	number	below terrain
B4	Aquifer media type		choose ID from INSPIRE code list	http://inspire.ec.europa.eu/codelist/AquiferMediaTypeValue

B5	Aquifer type		choose ID from INSPIRE code list	http://inspire.ec.europa.eu/codelist/AquiferTypeValue
B6	Lithology of the aquifer 1		choose ID from INSPIRE code list	http://inspire.ec.europa.eu/codelist/LithologyValue
B7	Proportion, lithology of the aquifer 1		choose from CGI Geoscience codelist	http://resource.geosciml.org/classifier/cgi/proportionterm
B8	Lithology of the aquifer 2		choose ID from INSPIRE code list	http://inspire.ec.europa.eu/codelist/LithologyValue
B9	Proportion, lithology of the aquifer 2		choose from CGI Geoscience codelist	http://resource.geosciml.org/classifier/cgi/proportionterm
B10	Lithology of the aquifer 3		choose ID from INSPIRE code list	http://inspire.ec.europa.eu/codelist/LithologyValue
B11	Proportion, lithology of the aquifer 3		choose from CGI Geoscience codelist	http://resource.geosciml.org/classifier/cgi/proportionterm
B12	Aquifer, younger age		choose ID from INSPIRE code list	http://inspire.ec.europa.eu/codelist/GeochronologicEraValue/
B13	Aquifer, older age		choose ID from INSPIRE code list	http://inspire.ec.europa.eu/codelist/GeochronologicEraValue/
Groundwater age information				
A1	groundwater age		choose from list	
Hydrochemistry				**please provide a representative hydrochemical analysis of the raw water not the finishes product**
H1	Temperature class	°C	choose from list	water temperature at the outlet
H2	Total dissolved solid class	g/l	choose from list	
H3	Specific conductivity	µS/cm; 25°C	number/text	representative hydrochemical analysis
H4	pH		number/text	representative hydrochemical analysis
H5	Redox potential (Eh)	mV	number/text	representative hydrochemical analysis
H6	Oxygen (O2)	mg/l	number/text	representative hydrochemical analysis
H7	Sodium (Na)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H8	Potassium (K)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H9	Calcium (Ca)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H10	Magnesium (Mg)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL

H11	Strontium (Sr)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H12	Barium (Ba)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H13	Iron (Fe total)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H14	Manganese (Mn total)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H15	Ammonium (NH_4)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H16	Bicarbonate (HCO_3)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H17	Carbonat (CO_3)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H18	Fluoride (F)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H19	Chloride (Cl)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H20	Bromide (Br)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H21	Iodide (I)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H22	Sulfate (SO_4)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H23	Nitrate (NO_3)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H24	Hydrogen Sulfide (HS)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H25	Aluminium (Al)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H26	Antimony (Sb)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H27	Arsenic (As)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H28	Beryllium (Be)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H29	Lead (Pb)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H30	Cadmium (Cd)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H31	Cesium (Cs)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H32	Chrome (Cr)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H33	Cobalt (Co)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H34	Copper (Cu)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H35	Lithium (Li)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H36	Molybdenum (Mo)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H37	Nickel (Ni)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H38	Mercury (Hg)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H39	Rubidium (Rb)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H40	Selenium (Se)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H41	Uranium (U)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL

H42	Vanadium (V)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H43	Zinc (Zn)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H44	Tin (Sn)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H45	m-Silic acid (H_2SiO_3)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H46	o-Boric acid (H_3BO_3)	mg/l	number/text	representative hydrochemical analysis, if under detection limit provide < + number e.g. <0,2; if not available <DL
H47	gas phase dominance	dominance	choose from list	
Comments				
C1	free comment		text	

Table 53: Selection lists of the data collection table.

G1	G3	G4 to G6	G7	A1	H1	H2	H43
classification	**type of water source**	**intended use**	**yield class (l/s)**	**groundwater age (years)**	**temperature class**	**total dissolved solid class (g)**	**gas phase dominance**
thermal water source	single well	bottled natural mineral water	<5	younger than 60	<15	<1	Methane (CH_4)
natural mineral water (Directive 2009/54/EC)	well field	natural mineral water publicly available	5-25	older than 60	15-20	1-14,5	Carbon dioxide (CO_2)
Natural mineral water (national law recognition)	single artesian well	thermal water for balneology	>25	older than 10.000	20-30	>14,5	Nitrogen (N_2) including noble gases
	artesian well field	thermal water for heating		older than 11.500.000	30-40		
	single captured spring	thermal water for electricity production			40-50		
	captured spring group				50-60		
	single gallery				60-70		
	gallery group				70-80		
					80-90		
					90-100		
					>100		

7.3 Remarks on data collection

7.3.1 Denmark

Most of the data provided in the Questionnaire (WP 3.1) is from the national database on groundwater and drinking water (JUPITER), hosted by GEUS. We also contacted all brand-owners by e-mail to request official information on "representative" geochemical analysis and approved daily yield. Next to questions on the chemistry, we also asked the brand owners, if we could use the information available in JUPITER. Unfortunately, we received responses for only five brands (Aqua d'Or, Denice, Boring 7, Iskilde, and Balders kilde) out of 14.
Representative geochemical analysis is a problematic definition in the context of this questionnaire. The documentation for approval of natural mineral waters must include information on water chemistry, but those documents are not publically accessible and are not available within GEUS. The bottle labels contain the necessary information as per Danish and EU regulations; however, the regular quality check at the boreholes/sources may vary around these values.

Notes on specific Questionnaire sections
G2: For well fields, when the wells are in different 1km grid-cells, we provide all relevant grid-cell codes:

- Egekilde: five wells are listed as industrial/process water and they fall in 3 grid-cells: 2 in 1kmE4454N3576, 2 in 1kmE4453N3576, and one in 1kmE4453N3575; the locations of the wells is different from the location of the waterworks (official address, associated with the brand)
- Kildevæld: the official address is also the location of the waterworks (brewery), but the well field is located in two 1km grid-cells: 1kmE4302N3796, 1kmE4303N3796

G7: yield class is not provided in the JUPITER database; there is however information on approved annual extraction volumes for each well/well field and waterworks/plant. The data comes from the brand-owners' responses.

Aquifer (from B1 to B13): the information on borehole and filter depths, as well as lithology and aquifer age is from the JUPITER database. If the source is a single well, the identification number of the well is provided in C1 (Comments section), where DGU is the ID number used in JUPITER. When there were multiple wells (well field), the lithology and age of the aquifer were determined after checking all relevant borehole reports.

A1 (Groundwater age): only the information provided from the brand owners is used; no groundwater age available in Jupiter. Balders kilde is 3397 years old, based on Radio Noble Gas Dating (2012), conducted by Physics Institute, University of Bern. Iskilden is younger than 60 years, while Aqua d'Or and Denice are older than 60 years, but no details on dating methods were provided by the brand owners of these 3 brands.

Hydrogeochemistry (H1: H47): priority has been given to the responses from the brand owners (when available). If hydrogeochemical analysis were available in JUPITER for specific well/borehole, the latest most complete sample was used (sample with most of the requested elements). In that case, the sample ID and the date of sampling are provided as C2 and C3 comments. For the well fields, the sample(s) that we chose are for "exit waterworks", and not

from a specific borehole. For Denice and Aqua d'Or, we supplemented with data published on the brand label.
Comments section
C1: identification number in JUPITER; all boreholes have an ID number (DGU); for multiple wells, or when the spring is not associated with a borehole number, the "Anlægsid" (plant ID) is also provided; The geological and geochemical data can be accessed freely through the "DGU" and "Anlægsid" numbers
C2: sample ID; the most recent and most complete sample has been used for the chemical composition when information was not provided by the brand-owners.
C3: sampling date (corresponds to the sample ID); C2 and C3 help identifying the specific analysis in the JUPITER database.
C4: feedback provided from the trademark owner (logical field): yes/no; if yes, the chemical analysis are the ones provided by the brand-owners

8 ATTACHMENTS

- **A2 – Datast on natural mineral waters and thermal waters**
  Files: HOVER_WP3_TASK3-1_XLS.xls, HOVER_WP3_TASK3-1_DB.mlb