KINDRA DELIVERABLE D3.1

DRAFT SYNTHESIS OF COUNTRY REPORTS

Summary:

The present document summarizes the draft synthesis of data, which are included in the Country reports and the EIGR (European Inventory of Groundwater Research). The Country reports and most of the EIGR records are provided by the experts from the EFG's national member associations (Linked Third Parties). The experts gathered the information from diverse sources and used the terminology and the guidelines, created in WP1. This deliverable contains a qualitative and quantitative assessment of the resources uploaded to EIGR using the developed HRC-SYS classification system and the barriers & gaps identified in the Country reports. The analytical tools for the data assessment (EIGR tools and VOS viewer) are also introduced in this deliverable. These tools will be used for more in depth analyses of groundwater research in following reports and papers e.g. when comparing EIGR data from the commercial research databases, Scopus and Web of Science.

The metadata inserted into the EIGR until the end of February 2017 have been considered in the statistics.

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Table of Contents

1   INTRODUCTION

Within the framework of the WP2, the European Inventory of Groundwater Research (EIGR) has been developed to collect the Europe-wide hydrogeology related applied and scientific knowledge on international, national and regional levels. The EIGR makes the information available with open access for researchers and the public. The metadata insertion to the EIGR has been implemented by the European Federation of Geologists Linked Third Parties (LTP, 20 National Associations/Geological Societies) participating in the project. The Associations provided "Country reports" related to the qualitative status of the inserted EIGR metadata. The experts gathered the information from diverse sources and used the concept, terminology and the guidelines, created in WP1.

This deliverable follows the preliminary D2.3 (Country reports) & D2.4 (Datasheets), and contains the overview of Country reports and EIGR metadata. The qualitative/quantitative assessment of available information focused on the HRC-SYS, as well as barriers and gaps summarized in the Country reports. In this document the developed analytical tools of EIGR and an external tool-VOSviewer- are also presented.

The metadata inserted into the EIGR until the end of February 2017 have been considered in the statistics.

2   OVERVIEW OF COUNTRY REPORTS

The EFG Linked Third Parties (LTPs) representing 20 European countries have provided Country reports or will report in 2017.

The Country reports include 6 questions, including information about the overview of the uploaded metadata, time consumed for uploading to EIGR, the main source of information used during the data collection, classification of their information based on the "Research and knowledge classes", classification of their entries into 7 categories (database, maps, books, etc.), barriers to find data and gaps in finding the information. The detailed description of the Country reports is in D2.3 (Country reports). The template of Country reports can be found in **Annex 1**.

The EIGR metadata were inserted by the LPTs and the KINDRA consortium partners. Until 28/02/2017, from the 2265 records 1999 EIGR metadata were uploaded by the LPTs, but the number of metadata is constantly increasing. The EFG expected 50-100 entries by each LPT. **Table 1** list the total number of uploaded metadata by the LTPs.

18 LPTs have provided the Country reports and inserted the expected number of metadata records. Due to the lack of human resources Ireland, Switzerland and UK have started their KINDRA tasks later, didn't provide Country reports and were not able to upload the expected minimum 50 entries until now, but they have decided in agreement with EFG, to execute their tasks during 2017.

Of the 1999 records, 1727 entries were classified into the HRC-SYS main categories (Operational Actions, Research Topics, Societal Challenges), 271 metadata are inadequate for further statistical analyses in their current state.

Table 1. Summary of the Inventory data collection and the total number of entries by EFG LTPs until the 28/02/2017

Country	Number of inserted metadata	Metadata with HRC-SYS categories
1. Belgium/Luxembourg	53	53
2. Croatia	51	3
3. Czech Republic	796	647
4. Denmark	51	50
5. Finland	155	151
6. France	119	117
7. Germany	61	56
8. Greece	50	50
9. Hungary	53	47
10. Ireland	10	3
11. Italy	102	102
12. Netherlands	54	21
13. Poland	50	50
14. Portugal	57	52
15. Serbia	143	134
16. Slovenia	62	59
17. Spain	51	51
18. Switzerland	18	18
19. Ukraine	51	51
20. UK	12	12
Total:	**1999**	**1727**

2.1 INFORMATION SOURCES

The LTPs used different sources on regional, national and international level to collect the relevant information for their EIGR entries. The LTPs were asked to classify their sources of information to the following groups.
- Institutions dealing with groundwater research/survey ,
- Groundwater monitoring, availability of data ,
- Journals/archives focused on hydrogeology,

The most important sources were the national databases, reports and journals, responsible governmental bodies, universities and national geological surveys. **Table 2** summarizes the most important sources of information per country as reported by the LTPs.

Table 2. Summary of the most important sources of information per country

Country	Source of information		
	Institutions dealing with groundwater research/survey	**Groundwater monitoring, availability of data**	**Journals/archives focused on hydrogeology**
Belgium/ Luxembourg	- DOV-Vlaanderen - Smart Geotherm - VITO - VITAQUA - University of Liege - University of Namur - University of Mons - ISSEP - SPAQUE - OVAM	- Hydrogeological Database of Wallonia - Geoportrail - Service Geologique de Luxemburg - Region Wallonne DGO3-DGARNE - Automatic piezometric monitoring network	www.belgium.iah.org
Croatia	- Croatian Geological Survey (HGI-CGS) - Faculty of Mining Geology and Oil Engineering (RGNF), University of Zagreb - Croatian waters (Hrvatske vode) d.d.	- Groundwater monitoring was conducted by a few experts from GHI-CGS, and also from Croatian waters - Local water management companies	
Czech Republic	- Section of Deputy Prime minister for Science, Research and Innovation - Ministry of the Environment of the Czech Republic - Ministry of the Industry and Trade of the Czech Republic - Czech Environmental Information Agency - Nature Conservation Agency of the Czech Republic - The Czech Science Foundation - TA CR - Czech Hydrometeorological Institute - Czech Geology Survey T. G. Masaryk Water Research Institute	- Czech Environmental Information Agency - Nature Conservation Agency of the Czech Republic - Czech Geology Survey T. G. Masaryk Water Research Institute - Czech Hydrometeorological Institute	- National repository of grey literature - Geofond - Geopub - Information Register of R&D result - The Central Register of R&D projects - National Library of Technology
Denmark	Geological Survey of Denmark		
Finland	- Geological Survey of Finland (GTK) - University of Helsinki, Finland - Finnish Environment Institute (SYKE) - Regional Centres for Economic Development, Transport and the Environment - Radiation and Nuclear Safety Authority - Regional Water Supply Enterprises - Ramboll Finland Oy (Ltd.)	- Geological Survey of Finland (GTK) - Finnish Environment Institute (SYKE) - Regional Centres for Economic Development, Transport and the Environment	- HAKKU (archives of Geological Survey of Finland) - HELDA (archives of Helsinki University) - OIVA (archives of the Finnish Environment Institute)

France	• French Geological Survey • www.cordis.europa.eu	• ADES database for groundwater	• Science Direct • Springer • Google Scholar
Germany	• www.umweltbundesamt.de • www.bgr.bund.de	• www.bgr.bund.de	• Grundwasser (Springer journal)
Greece	• Institute of Geology and Mineral Exploration	• Aristotle University of Thessaloniki • National Documentation Centre	• Special Secretariat of Water
Hungary	• Geological and Geophysical Institute of Hungary (MAFI) • National Archive of the Office of Mining and Geology	• Geological and Geophysical Institute of Hungary (MAFI)	• Acta Geologica Hungarica • National Archive of the Office of Mining and Geology
Italy	• ISPRA (National Institute for Environmental Protection and Research) • ISTAT (National Statistics Institute) • IRSA-CNR (Water Research Institute of the National Research Council) • Regional and Basin Authorities	Interregional and regional monitoring networks	• Italian Journal of Groundwater • Italian Journal of Engineering Geology and Environment • L'Acqua journal
Netherlands	• Geological Survey of the Netherlands • Deltares • Alterra • KWR Watercycle Research • Netherlands Hydrological Instrument • Utrecht University • VU University Amsterdam • Wageningen University and Research • Dutch Provinces • Dutch Water Boards	• DINOIoklet	• Stromingen Journal • NJG: Netherlands Journal of Geosciences • H2O Journal, by KNW
Poland	• Polish Hydrogeological Survey • Ministry of Environment • Polish Geological Institute • Chief Inspectorate of Environmental Protection • Universities		
Portugal	• Universidade dos Açores • Universidade do Algarve • Universidade de Lisboa • Universidade Lusíada • Universidade NOVA de Lisboa • Universidade da Madeira • Universidade do Porto	• APA: Portuguese Environmental Agency • SNIAmb	• International Journals (Journal of Hydrology, Chemie der Erde, Engineering Geology, Geofísica Internacional, Journal of Volcanology and Geothermal Research, Agricultural Water Management; Chemosphere, Science of the Total Environment, Estuarine, Coastal and Shelf Science, Geothermics, Journal of Geochemical

	- Universidade de Trás-os-Montes e Alto Douro - APRH - Associação Portuguesa dos Recursos Hídricos - Universidade de Aveiro - Universidade de Coimbra - Universidade da Covilhã - Instituto Politécnico de Beja - Instituto Politécnico de Castelo Branco - Instituto Politécnico do Porto - Câmara Municipal do Porto - CCDR-Algarve - DGEG – Direção Geral de Energia e Geologia - Direção Regional do Ambiente - Açores - EMAS Beja - LNEG – Laboratório Nacional de Energia e Geologia - SMAS Ponta Delgada		- Exploration, Applied Geochemistry, Sensors and Actuators A: Physical - Project Report (WAT – Water and Territories - International Proceedings Journals (Procedia Engineering, Procedia Earth Science and Planetary Science, Materials Today: Proceedings - National Journals (Recursos Hídricos (APRH), GEONOVAS (APG)
Serbia			- National journals (Vodoprivreda, Tehnika, Anali Balkanskog poluostrva) - International journals (Hydrogeology Journal, Environmental and Earth Science, Archives of Mining Sciences) - Papers presented at national and international conferences in the fields of geology and hydrogeology.
Slovenia	- Slovenian Geological Survey - Ministry of Environment		
Spain	Geological Survey of Spain (IGME)	Public information from monitoring networks	Research Gate platform
Ukraine	- EA UAG - Institute of Geological Sciences of NAS of Ukraine - Institute of Geology - Taras Schevchenko National University - Oles Honchar Dnipropetrovsk National University - State Geological Survey of Ukraine "State Informational Geological Fund of Ukraine" - V.N. Karasin Kharkiv National University - M.P.Semenenka Institute of Geochemistry, Mineralogy and Ore Formation of NAS of Ukraine		- Geological Journal - Dnipropetrovsk University bulletin. Geology, geography - Bulletin of Taras Shevchenko National University, Series "Geology" - V.N. Karasin Kharkiv National University Bulletin, series "Geology, Geography, Ecology" - Geochemistry and Ore Formation Journal - Maksymovych Scientific Library - Vernadsky National Library of Ukraine
Ireland, Switzerland and **UK** will provide the Country reports in 2017			

2.2   TYPE OF INFORMATION

The LTPs classified the information they gathered according to the previously defined research and knowledge classes (**Figure 1**). Most of the data from universities and research institutes were ranked as Class 1 or Class 2 and the information gathered from the regional authorities usually valued as Class 3 and Class 4. From the number of 1999 EIGR entries uploaded by LTPs, 1540 metadata (77 %) were ranked into the research and knowledge classes (**Figure 2**).

45.6 % of the metadata (747 entries) are related to Class 4, mainly because the Czech LTP inserted information on a large number of projects (586 entries) to the EIGR which were all ranked as Class 4. The number of peer-reviewed articles in scientific journals (Class 1) and the number of reports from research projects and publications in national technical journals (Class 3) has a similar occurrence, 23% and 24.2% respectively. The Class 2 resources have the lowest number of EIGR records inserted by LTPs, only 118 records (7.2%) were classified into Class 2. The reason for that, is that the LTPs focus on publications and data sources which are not already available through the well-known and most appreciated research databases (i.e. Web of Science and Scopus)
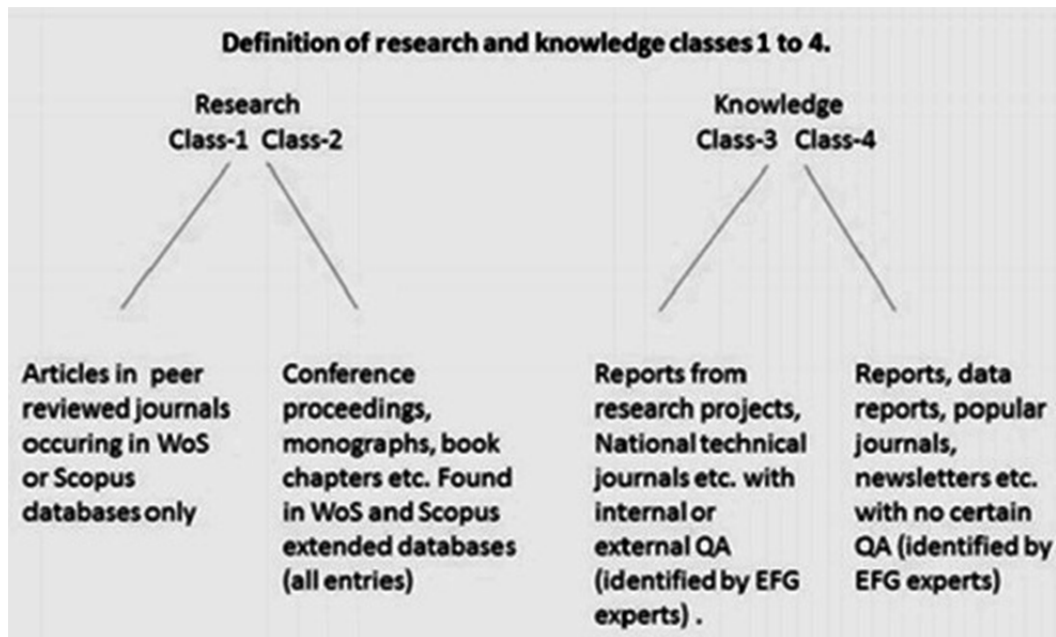
Figure 1. Research and knowledge classes identified in the KINDRA project
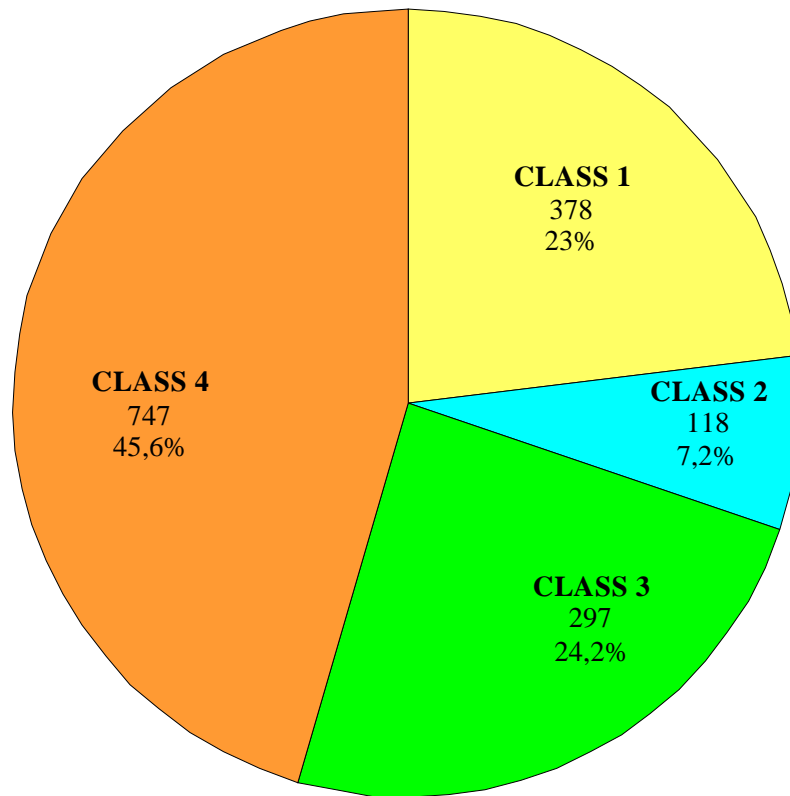
Figure 2. The distribution of Research and knowledge classes in EIGR entries uploaded by LTPs until 28 February 2017

2.3 TYPES OF DATA AND RESOURCES (TOPICS OF THE DATA)

The LTPs grouped the resources, they inserted to EIGR into the following 7 data types or resource categories. The type of the resources included in this wide range of information with different accessibility and formats are:

a) National databases;
b) National and local reports containing facts and data;
c) Hydrogeological maps;
d) Technical reports, guidelines, manuals, etc.;
e) Books and book chapters;
f) Position papers and/or important papers on PR journals;
g) Others.

The number of entries per LTP related to each of the data types or resource categories were summarized in **Table 3** (taken from D2.3). These numbers were reported in the Country reports until 31/12/2016. Belgium/Luxembourg provided the number of the inserted metadata but not specifying the data type/resource category separately. The Irish, the Swiss and the British LTPs provide their reports in 2017.

Figure 3 shows the distribution of data type/resource category in the EIGR entries. The most dominant resource category is the "National and local reports containing facts and data" with 769 entries, it covers the 47.9% of the metadata. The "Position papers and/or important papers in peer reviewed journals" data type has also a significant number of

entries (417 metadata), 26%. The remaining 26.1% distributed between the "National databases" (2.9%), "Hydrogeological maps" (4%), "Technical reports, guidelines, manuals, etc."(2.9%), "Books and book chapters (6.4%)" and "Other" (9.9%) topics.

Table 3. Summary of the topics of data with the numbers of entries reported by the LTPs until 31/12/2016 (source: D2.3)

Country	DATA TYPE/RESOURCE CATEGORY						
	Databases	Reports	Maps	Technical reports	Books	Papers	Others
Belgium/ Luxembourg	not specifying the topic/related number of entries separately						
Croatia	-	-	1	1	1	4	-
Czech Republic	12	587	11	10	55	-	98
Denmark	3	16	4	-	-	6	25
Finland	3	78	4	15	10	2	-
France	2	2	2		1	82	8
Germany	-	4	3	-	-	9	-
Greece	1	10	-	-	-	-	3
Hungary	2	10	3	-	-	-	-
Ireland	Report in 2017						
Italy	5		3	1	-	88	3
Netherlands	4	20	21				7
Poland	-	16	6	9	17	-	2
Portugal	-	-	-	1	-	45	9
Slovenia	1	3	-	6	10	42	-
Serbia	1	7	-	-	3	87	-
Spain	4	4	1	3	5	28	4
Switzerland	Report in 2017						
Ukraine	9	12	6	-	-	24	-
UK	Report in 2017						

Others
9.9%
159

Databases
2.9%
47

Papers
26.0%
417

769
Reports
47.9%

Books
6.4%
102

46
Technical reports
2.9%

65
Maps
4.0%
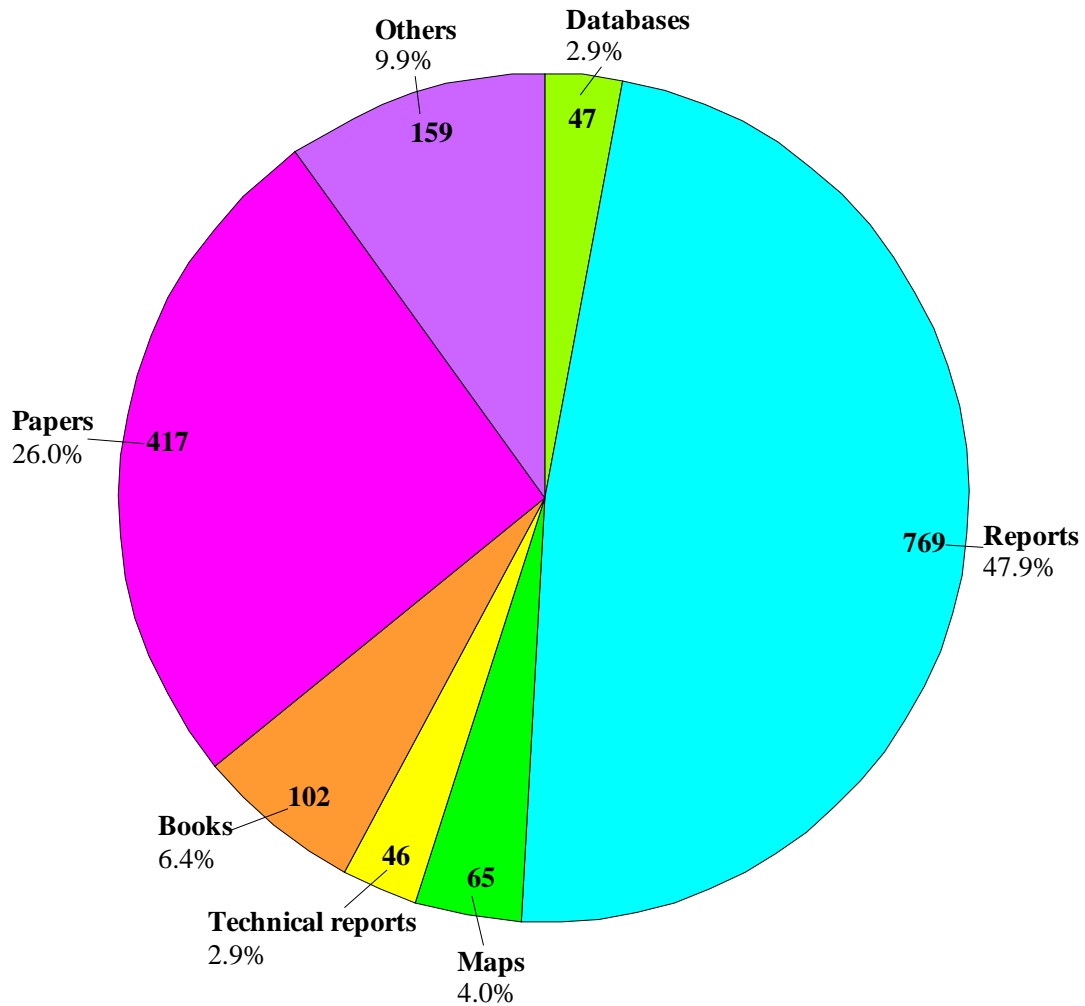
Figure 3. The distribution of data types/resource categories in the EIGR entries inserted by LTP's until 31/12/2016

2.4 GAPS AND BARRIERS

The barriers to find the data and the gaps in finding the information are different in each country. The barriers reported the most by LTPs are (1) the language as most of the relevant information is in national languages and (2) the confidential-copyright issues. Another barrier is the scattering of data among national, regional and local authorities, as there is typically no national public database or the data concerning the groundwater is outdated.

In case of the Czech LTP, who provided the most of the entries to EIGR, the main barriers are (1) the classification and selection of relevant data due to its abundance and (2) the language issues, resulting in that Czech is the dominant language of the reported data.

Many of the LTPs haven't reported gaps (Finland, Denmark, Germany, Hungary, and Ukraine). In case of the other LTPs the main gaps in finding the data are the scattering of information-which makes the data gathering more complex and time consuming as a huge amount of information exists at various sources that are hard to find and review the past and recent hydrogeological research on national level.

The Czech LTP identified the abundance of relevant data and limited human resource as a gap.

The detailed description of gaps and barriers for each country are in D2.3 (Country reports).

3   OVERVIEW OF EIGR METADATA

The number of EIGR records shows a significant increasing trend from 15/6/2016. Until 28/02/2017 2265 metadata were inserted to the EIGR by LTPs and the KINDRA consortium partners. The total number of entries by each partner is summarized in **Table 4**. From the records, 1955 classified into the HRC-SYS three main categories, the data assessment based on these records, found 310 metadata inadequate for the analysis. In the EIGR 1666 completed metadata can be found, which are classified into HRC-SYS main categories (OA, RT, SC), Research and knowledge classes (Class 1 - Class 4), Technological readiness level (TRL 1 - TRL 9) and Policy readiness level (PRL 1 - PRL 4). The development of EIGR content is illustrated in **Figure 4**.

Table 4. Number of EIGR entries inserted by the LTPs and the KINDRA partners until 28/02/2017

EFG Third parties	Total number of EIGR metadata	Metadata with main categories (OA, SC, RT)	Complete metadata with main categories, KC,TRL, PRL
Belgium/Luxemburg	53	53	53
Croatia	51	3	3
Czech Republic	796	647	584
Denmark	51	50	47
Finland	155	151	143
France	119	117	117
Germany	61	56	51
Greece	50	50	49
Hungary	53	47	43
Ireland	10	3	0
Italy	102	102	99
Netherlands	54	21	0
Poland	50	50	0
Portugal	57	52	52
Serbia	143	134	89
Slovenia	62	59	54
Spain	51	51	30
Switzerland	18	18	18
Ukraine	51	51	50
UK	12	12	10
Project partners			
Sapienza	139	117	117
GEUS	2	0	0
EFG	24	17	9
UM	101	94	48
Total	**2265**	**1955**	**1666**
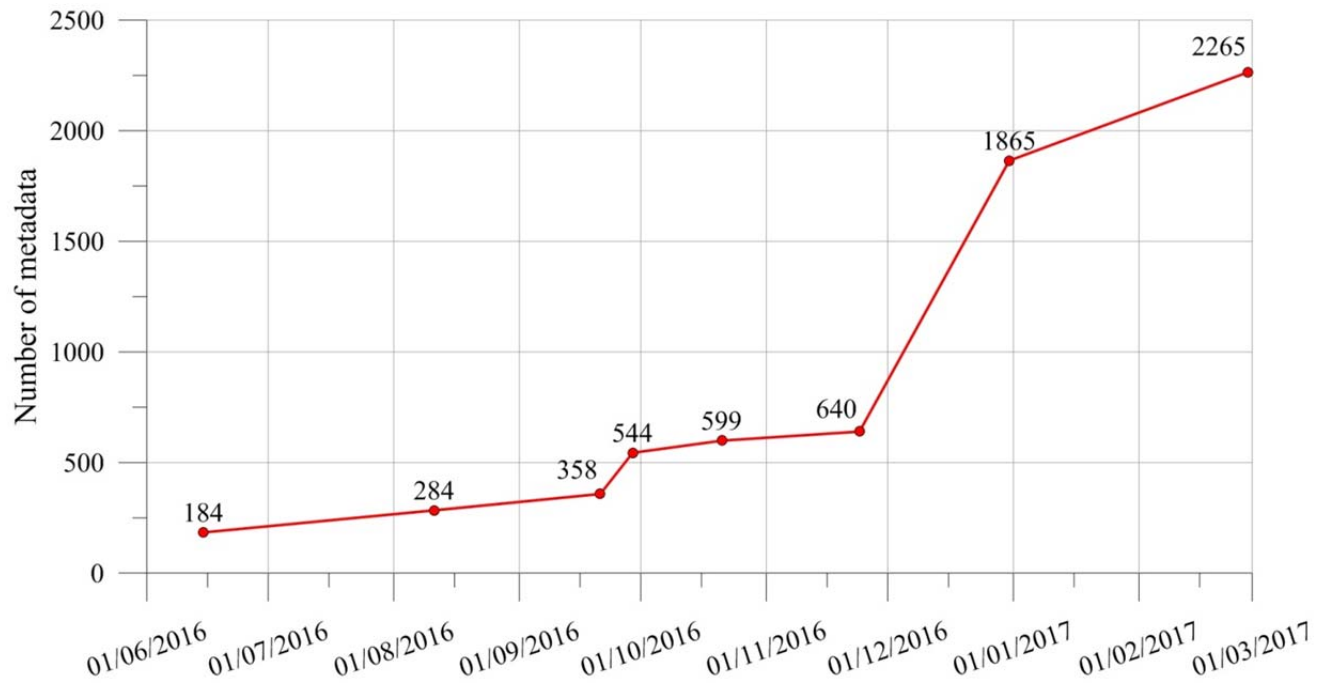
Figure 4. The Total number of EIGR contents inserted by the LTPs and KINDRA consortium partners until 28/02/2017

4   ANALYTICAL TOOLS FOR DATA ASSESSMENT

4.1   DEVELOPED EIGR TOOLS FOR DATA ANALYSIS AND VISUALISATION

This chapter describes the three EIGR tools developed for analyzing and visualizing groundwater related research and information stored in the EIGR database. These tools are:

- "Keywords cloud"

- "Resource Distribution Map"

- "Topics 2D Chart"

The tools are in testing phase now, and not yet available to data assessment for the users.
The **Keywords Cloud** section indicate the relative importance of keywords, it shows the 10 most popular keywords in the EIGR, related to the records which have been uploaded to the Inventory. Clicking on each one of these keywords will take users to the selection of records that include them (**Figure 5**).
The dominant keyword in EIGR metadata is the "Climate, environment and resources" with 1862 hits, closely followed by "Geology" with 1540 records. The size and colors of the fonts are related to the popularity of the keywords, the frequent keywords have dark red colour and larger fonts, whereas the keywords with lower number of hits have light orange colour and small font size.
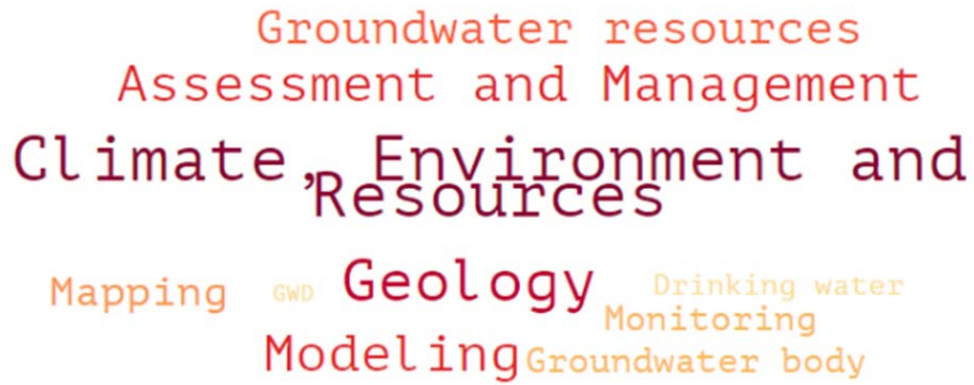
Figure 5. The Keywords Cloud

The **Resource Distribution Map** will show the number of contributions to the Inventory by country. When selecting a specific territory this tool shows all the resources that were uploaded to the EIGR which have been generated by a specific country (**Figure 6**).
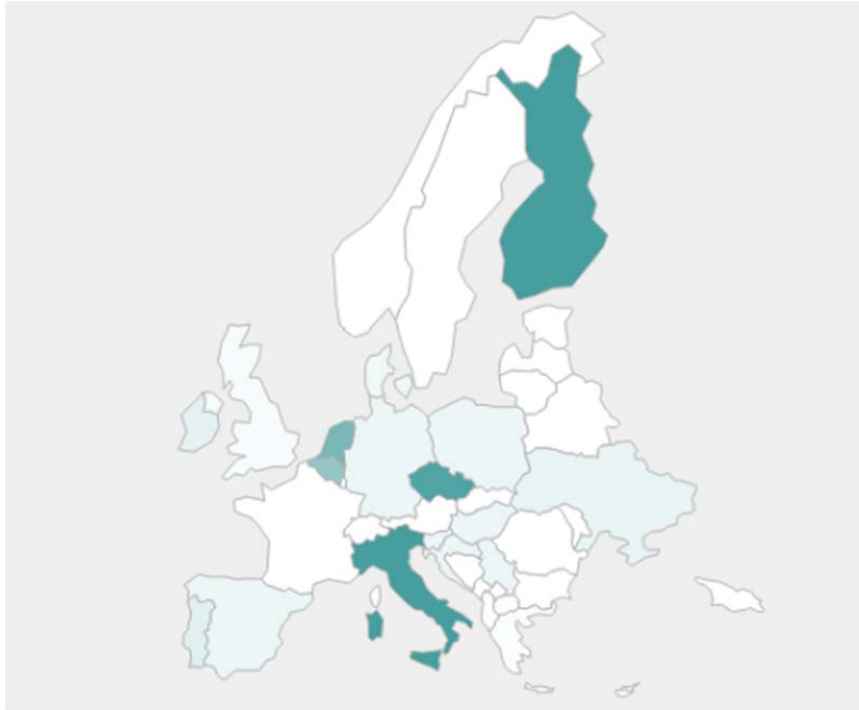
Figure 6. The Resource Distribution Map

The section related to the Research Topics (RT)-Operational Actions (OA) 2D Chart is a quick tool, which allows all users to quickly view the number of resources classified according to the main Hydrological Research Classification System (HRC-SYS) and the three overarching categories: Operational Actions, Research Topics and Societal Challenges. When selecting a specific Societal Challenge from the drop-down menu, the 2D Chart will represent the number of resources which has been uploaded to EIGR and classified for the corresponding Research Topic (RT) - Operational Actions (OA) Categories. Users will be able to access the specific records that match the criteria by clicking on the values represented in the graph (**Figure 7**).
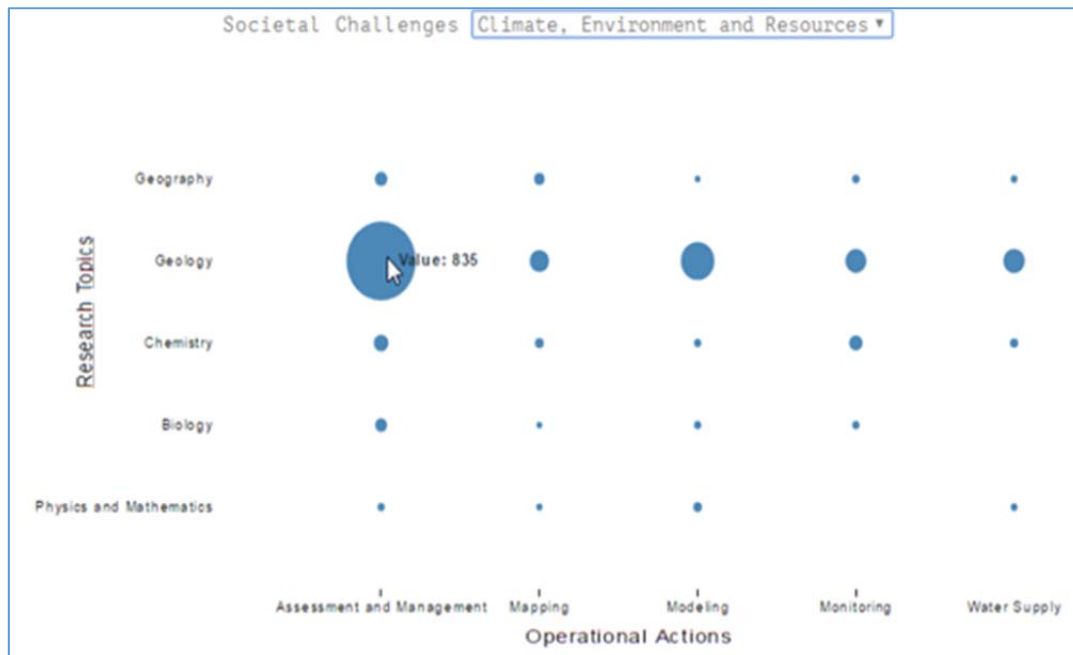
Figure 7. The Research Topics -Operational Actions 2D Chart (for each of the five Societal Challenges) of EIGR

4.2   EXTERNAL TOOLS

External, standalone tools can also be used for EIGR data analysis, but the metadata must be exported in an appropriate format to import data to such tools. From the different kind of available external tools, this chapter describes the bibliographic map features of the freely available, open source visualization tool, the VOSviewer. The VOSviewer (http://www.vosviewer.com) was created for bibliometric networks, developed at Leiden University, The Netherlands. The software requires Java version 6 or higher to be installed on your system.

The **Heat map** feature gives a quick overview of the co-occurrence of the most often used keywords. In this view the keywords are represented by their labels. Each of these keywords in a map has a colour, ranging from blue to red, which depends on the density of keywords at that point. The larger the number of keywords in the neighborhood of a point and the higher the weights of the neighboring items the closer the color of the point is to red. Accordingly, the smaller number of keywords is indicated as blue. The Heat map feature is also suitable to analyse trends in data co-occurrence. **Figure 8** presents an example of heat map derived from Scopus data. It shows the co-occurrences of the most frequent keywords for the Societal Challenge (SC) "Climate, Environment and Resources" between 1997-2016. The analysis did not include the "Groundwater" and "Ground water" keywords.

Figure 8. Vosviewer heat map for co-occurrences of the most often used keywords for the Societal Challenge (SC) - Climate, Environment, and Resources, 1997-2016 (Mads Breum, 2016)

The **Network map** was derived from the same data as the previous Heat map. In this feature the keywords are indicated by their labels and by a circle. The font size of the keyword's label and the radius of the keyword's circle depend on the frequency (weight) of the keyword. The colour of the circles can be determined by different ways, coloring by scores, clusters etc. **Figure 9** presents an example of a Network map. It shows the co-occurrences of the most frequent keywords for the Societal Challenge (SC) "Climate, Environment and Resources", between 1997-2016. The analysis was not included the "Groundwater" and "Ground water" keywords.

Both maps show, that the most popular keywords in the HRC-SYS Societal Challenge (SC) "Climate, Environment and Resources" class are the "Groundwater resources" and the "Aquifers", and these keywords frequently occur together in the Scopus database.

These external tools with the native EIGR features enable the EIGR for bibliometric analysis and data mining for a wide range of end-users, from scientists to professionals in groundwater research and management.

Figure 9. Vosviewer network map for co-occurrences of the most often used keywords for the Societal Challenge (SC) - Climate, Environment, and Resources, 1997-2016 (Mads Breum, 2016)

5   ASSESSMENT OF EIGR METADATA

For the analysis of EIGR metadata, the records inserted by LTPs and the KINDRA consortium partners until 28/02/2017 have been included. 2265 entries were uploaded to the EIGR, but only 1955 metadata were correctly classified into the HRC-SYS three main categories, 310 metadata records are inadequate for the data assessment.

5.1   DATA ASSESSMENT FOR HRC-SYS CLASSIFICATION

The major part of the data uploaded to EIGR has been classified in the KINDRA HRC-SYS classification system using five main classes for each of the three overarching categories, as mentioned previously: 1) "Societal challenges" (SCs), 2) "Operational Actions" (OAs) and 3) "Research Topics" (RTs) as illustrated in **Figure 10**.
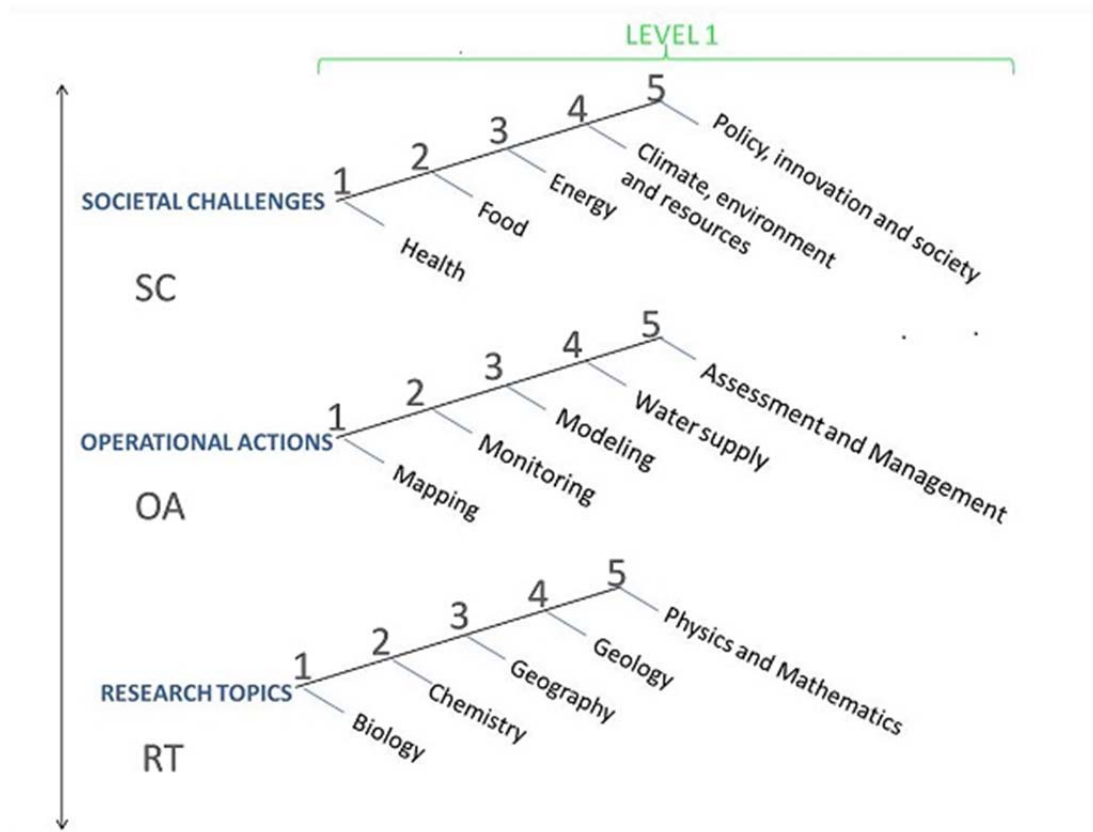
Figure 10. The HRC-SYS three overarching categories: 1) Societal Challenges, 2) Operational Actions and 3) Research Topics and their five main sub-categories ("keywords") used for classification of the resources uploaded to EIGR.

The majority (1749 entries, 89.5%) of the metadata uploaded to EIGR were related to and classified in **Societal Challenges** (SC), Climate, environment and resources. The number of records in the other four challenges (i Health, ii Food, iii Energy and iv Policy, innovation and society) varies between 0.6%-5.8% (**Figure 11**).

In total 1955 metadata were classified into **Operational actions** (OA) sub-categories as illustrated in **Figure 12**. More than the half (56.8 %) of EIGR metadata (1110 entries) were classified into the Assessment and management category, and the Modeling actions also has a relative high number of entries (333 entries, 17%). The OAs "Mapping" (144 entries) and "Water supply" (155 entries) categories have a similar number of entries classified in HRC-SYS.

For the **Research topics** (RT), "Geology" (1563 entries) is the dominant category, with the 79.9% of the total number of records (1955 entries). The "Biology", "Geography" and "Physics and Mathematics" collectively reached 192 entries, 9.8% of the total number of metadata (**Figure 13**).
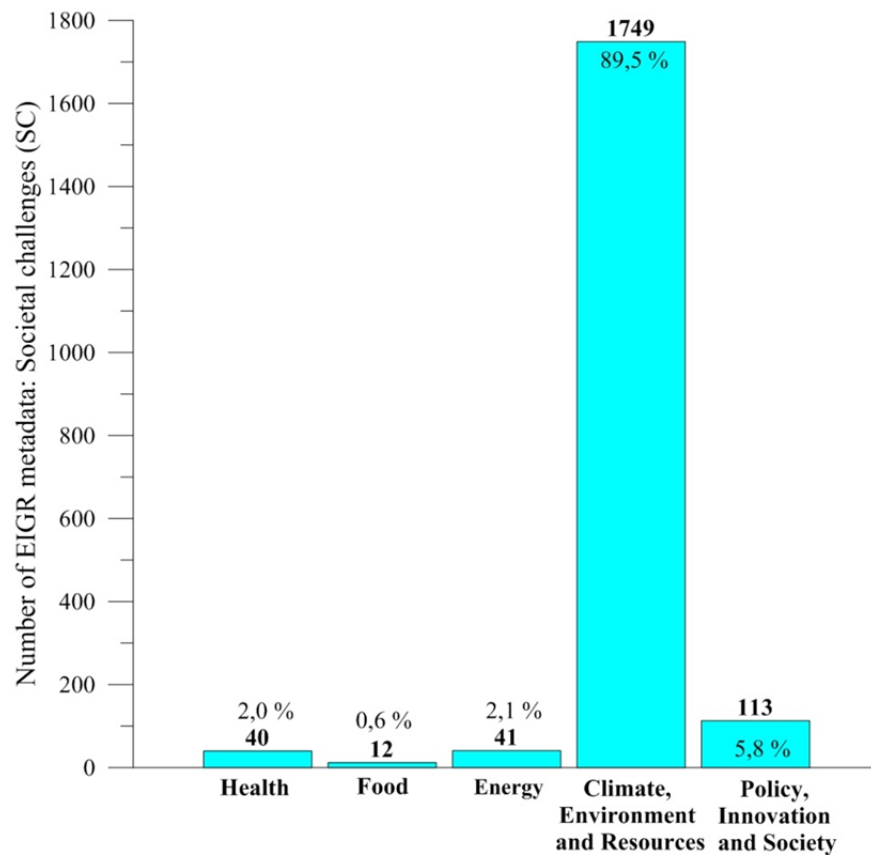
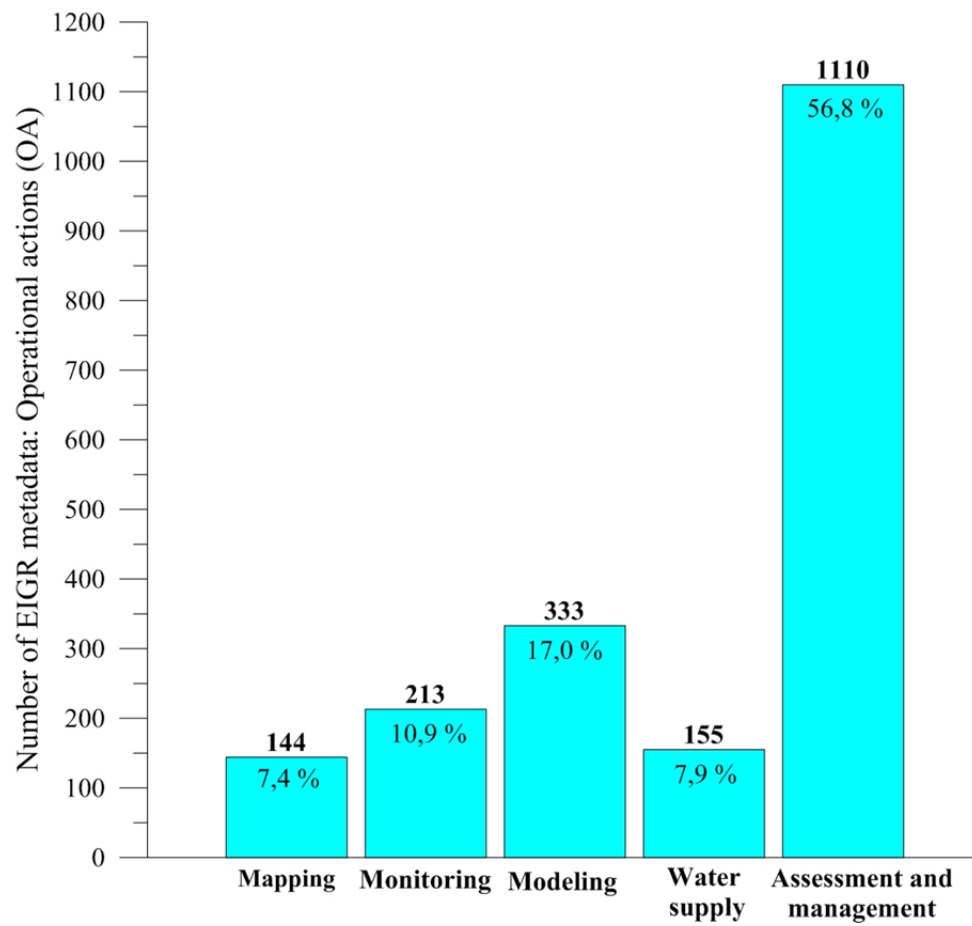Figure 11. The distribution of EIGR metadata related to Societal Challenges (SC)

Figure 12. The distribution of EIGR metadata related to Operational Actions (OA)
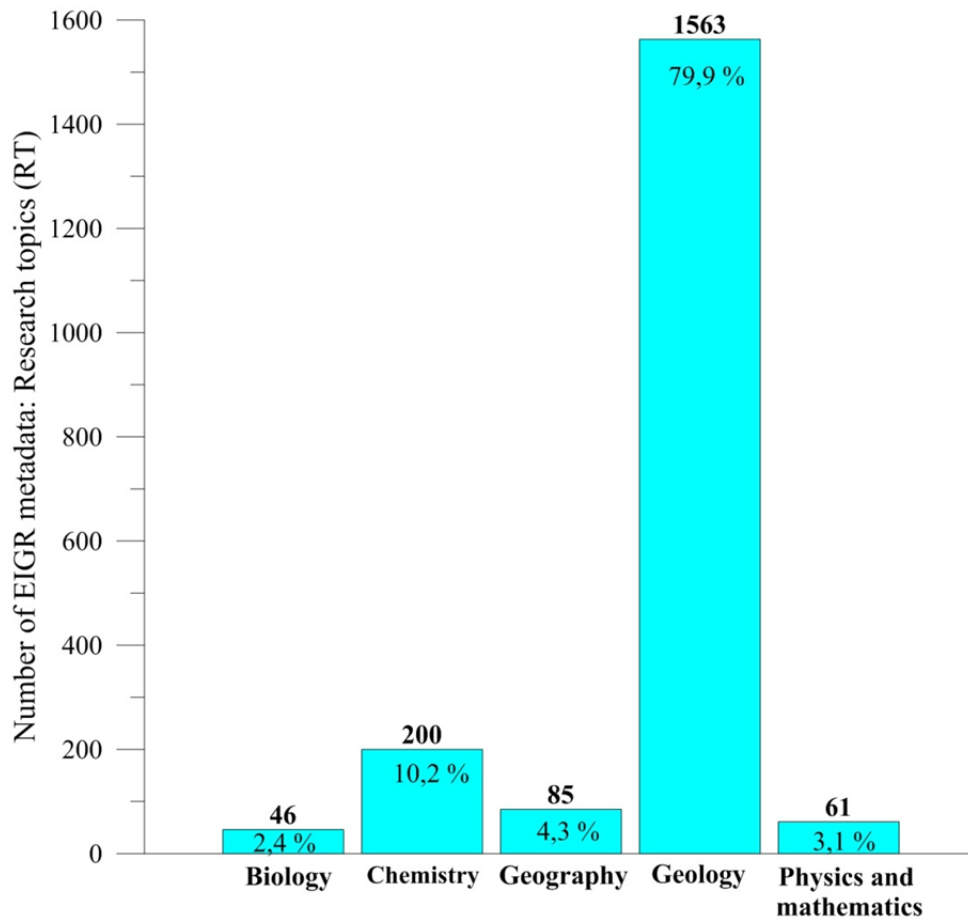
Figure 13. The distribution of EIGR metadata related to Research Topics (RT)

5.1.1 Co-occurrence analysis of HRC-SYS categories by EIGR metadata

As previously described, each of the 1955 metadata were classified into 3 of the HRC-SYS categories to which they primarily relate i.e. one societal challenge (SC), one operational action (OA), and one research topic (RT) by the national experts (LPTs) uploading metadata and information on the resources, allowing a co-occurrence analysis of these categories and estimation of the number of studies within the combination of these categories based on the uploaded metadata.

As the dedicated EIGR tools are currently in a development and testing phase and not yet available for data analysis, the following graphs are made separately outside EIGR and based on the currently existing EIGR data. This is based on the planned EIGR **2D Chart** (Figure 7) tool to perform the co-occurrence analysis of EIGR records.

Figure 14-18 shows the number of records which comply with the three specified HRC-SYS categories. The size of the bubbles relates to the number of the metadata, which belongs to the three defined categories. The gaps, i.e. combinations of categories with no studies in EIGR are indicated as red crosses.

For Operational actions (OA) categories the number of metadata belonging to Research topics (RT) and Societal challenges (SC) are plotted.

In **Figure 14** the Research topics (RT) and Societal challenges (SC) are plotted for an *Operational actions (OA)-Mapping* category. 144 EIGR records were assigned to the *Mapping* action and from this value, the 59% of the records belong to *Operational Actions-Mapping, Research Topics-Geology* and *Societal challenges-Climate, environment and resources* categories. 12 gaps can be found on the chart.
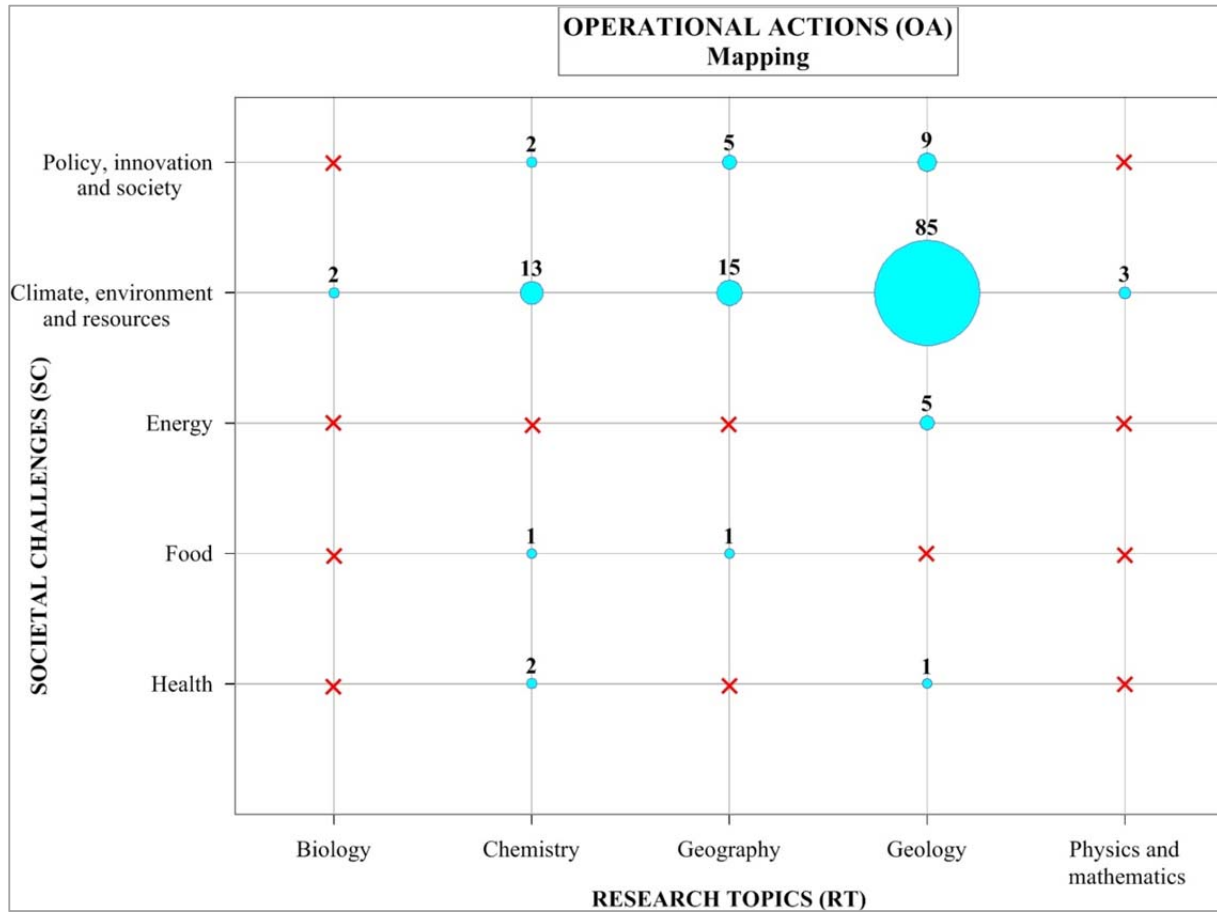

Figure 14. The number of metadata for Operational actions-Mapping and in the intersections of Research topics and Societal challenges

Figure 15 shows the intersections between the Research topics (RT) and Societal challenges (SC) categories for the *Operational actions (OA)-Monitoring* category. 213 records belong to the *Operational actions (OA)-Monitoring action.* Most of the records (56%) were assigned to *Operational Actions-Monitoring* and *Research Topics-Geology* and *Societal challenges-Climate, environment and resources* categories. In 11 intersections gaps can be found.
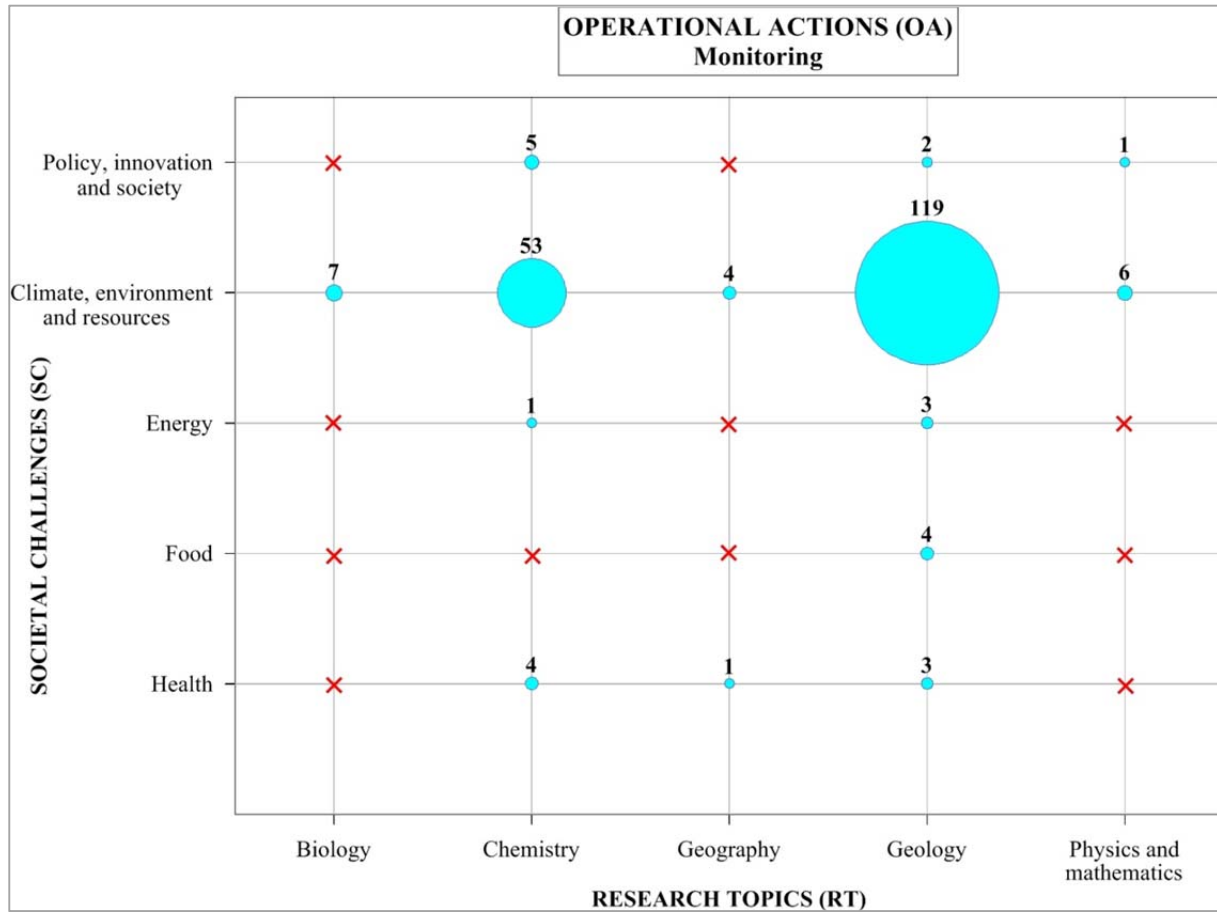

Figure 15. The number of metadata in the intersections of *Operational actions-Monitoring* and the 5-5 classes of *Research topics* and *Societal challenges*

Figure 16 illustrates the Research topics (RT) and Societal challenges (SC) for the *Operational actions (OA)-Modeling* category. 333 EIGR records were assigned to the *Modeling* action. In the figure, it could be seen, that the majority of the entries were classified into the *Operational Actions-Modeling* and *Research Topics-Geology* and *Societal challenges-Climate, environment and resources* categories, but in case of 11 intersections, there are research gaps.
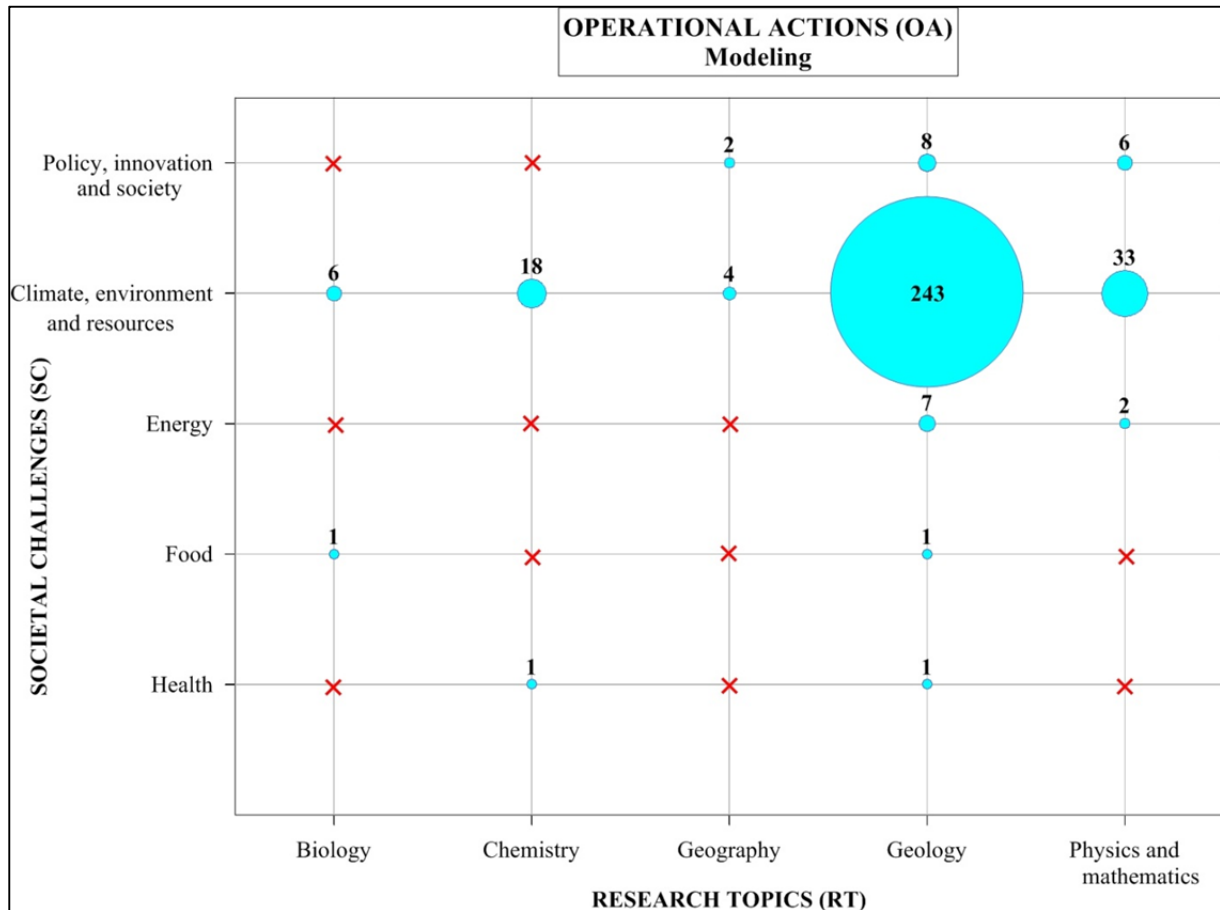

Figure 16. The number of metadata in the intersections of *Operational actions-Modeling* and the 5-5 classes of *Research topics* and *Societal challenges*

Figure 17 shows the intersections between the Research topics (RT) and Societal challenges (SC) categories for the *Operational actions (OA)-Water supply* category. 155 records were assigned the *Operational actions (OA)-Water supply action.* The dominant intersection (65%) for the *Operational Actions-Water supply* is the *Research Topics-Geology* and *Societal challenges-Climate, environment and resources* Gaps can be found in case of 9 intersections.
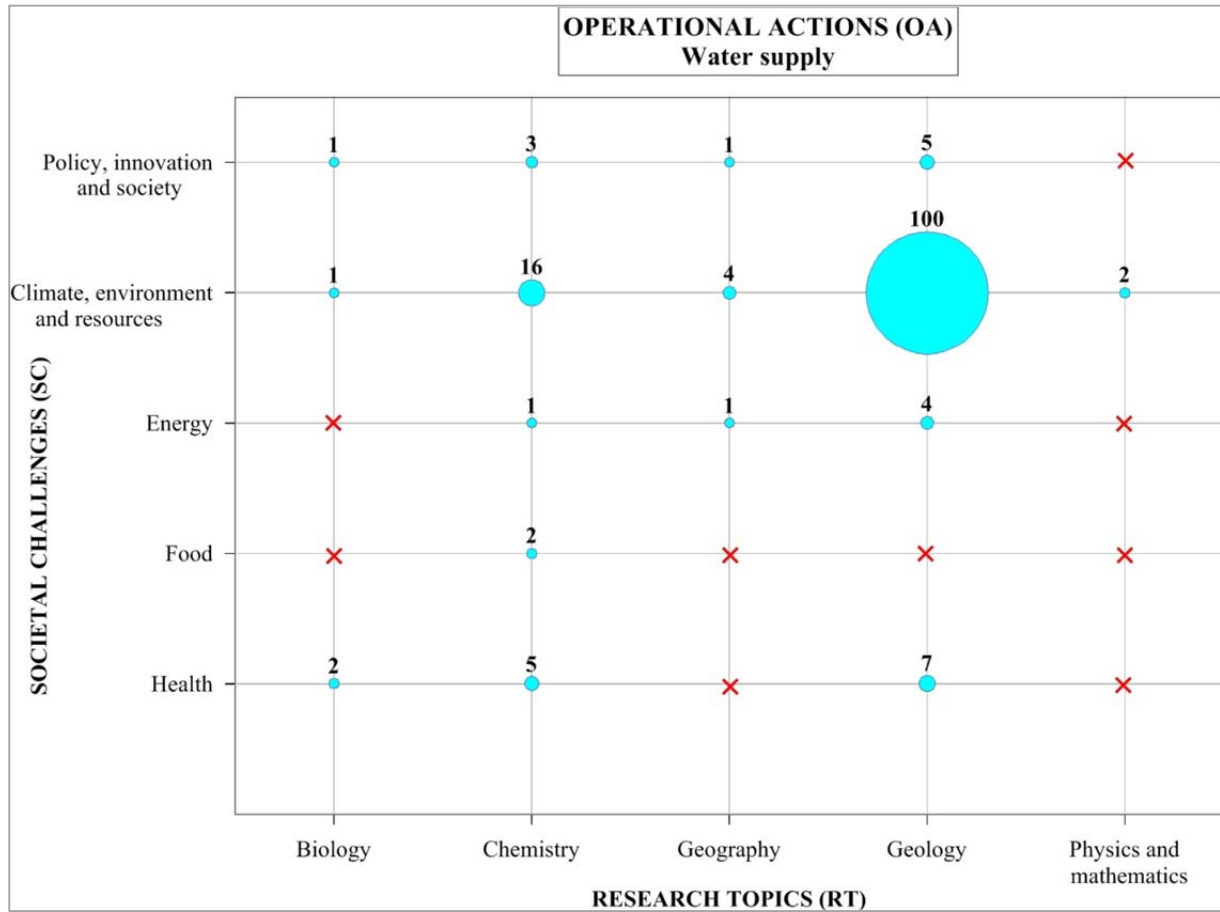

Figure 17. The number of metadata in the intersections of Operational actions-Water supply and the 5-5 classes of Research topics and Societal challenges

The last figure from this co-occurrence chart series is **Figure 18,** it shows the intersections between the Research topics (RT) and Societal challenges (SC) categories for the *Operational actions (OA)-Assessment and management* category. Of the 1955 EIGR metadata, 895 records were assigned for *Operational Actions-Assessment and management* and the intersections of *Research Topics-Geology* and *Societal challenges-Climate, environment and resources*. From the 25 possible intersections of HRC-SYS categories, 7 intersections indicate research gaps for which, there were no records classified, e.g. for *Research Topics-Biology* and *Societal challenges-Food*.
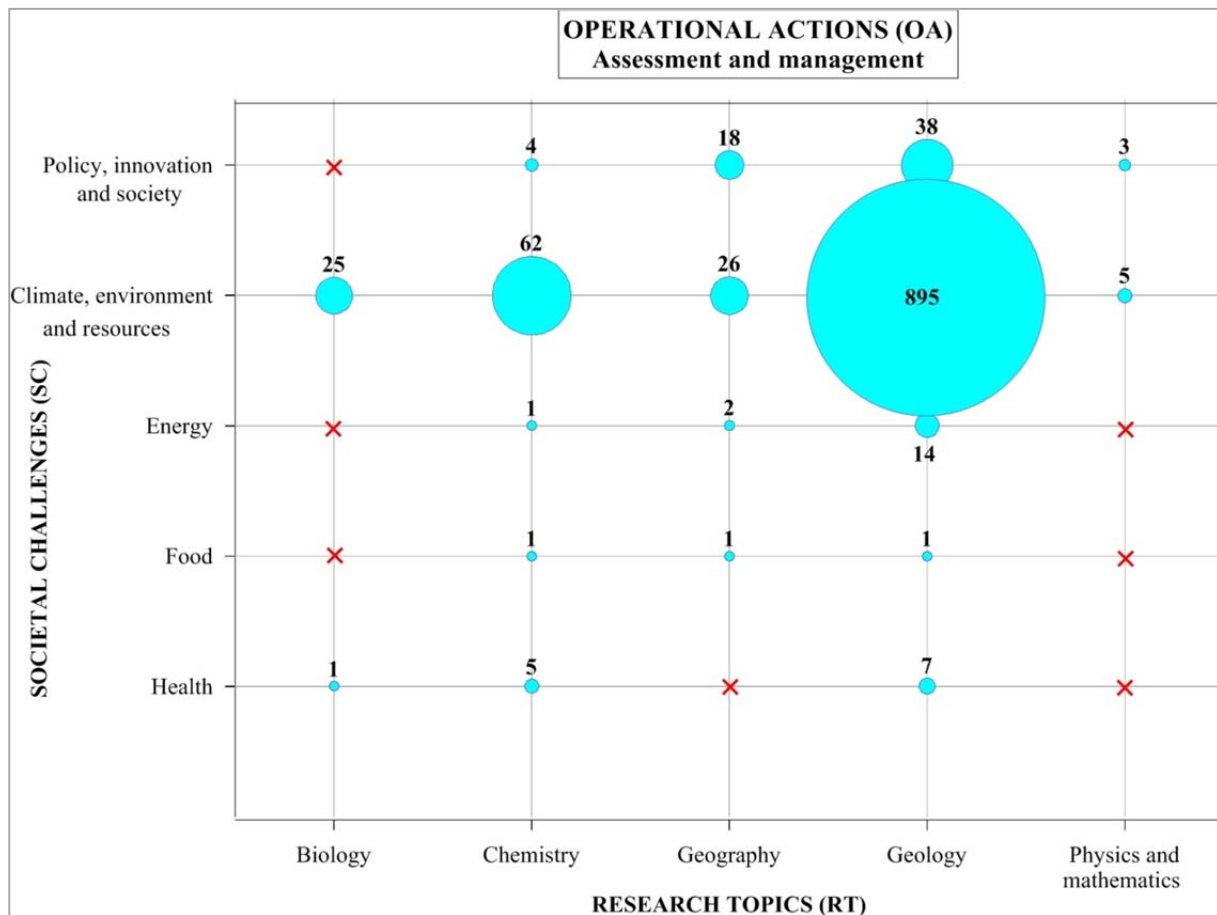

Figure 18. The number of metadata in the intersections of Operational actions-Assessment and management and the 5-5 classes of Research topics and Societal challenges

As the 2D chart series (**Figure 14-18**) illustrated the majority (895) of the EIGR records were assigned to the *Operational Actions-Assessment and management* and *Research Topics-Geology* and *Societal challenges-Climate, environment and resources* categories. In case of the other Operational actions (Mapping, Monitoring, Modeling, Water supply), also the *Research Topics-Geology* and *Societal challenges-Climate, environment and resources* co-occurrences are dominant. In many intersections (50 from the possible 125 intersections) research gaps can be found based on the EIGR metadata.

5.2   DATA ASSESSMENT FOR RESEARCH AND KNOWLEDGE CLASSES

Of the 2265 metadata in EIGR, 1860 records were classified into the defined research and knowledge classes (**Figure 1**). **Figure 19** shows the distribution of metadata between Class 1-Class 4.

44.6 % of the metadata (829 entries) are related to Class 4. The number of peer-reviewed articles - ranked as Class 1 - and the number of reports from research projects, national technical journals (valued as Class 3) have similar occurrences, 20.4% and 22.3%.

Class 2 has the lowest number of EIGR records (237 entries, 12.1%) as in case when only the LTP's metadata were taken into consideration (Chapter 2.2). It should be noted that the dataset is biased and the main reason for the observed metadata distribution is that, the users (LPTs) were asked to focus on projects, maps, reports and data sources which are not available in existing well-known and accessible scientific databases (e.g. Web of Science or Scopus).
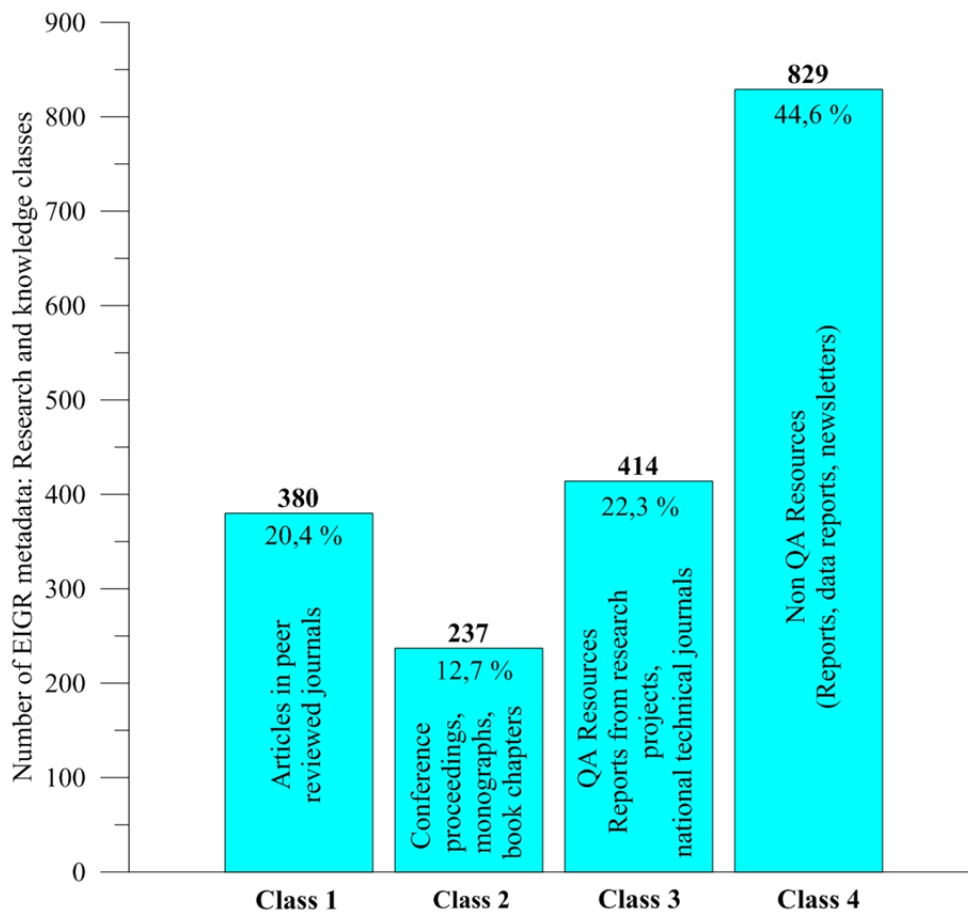

Figure 19. The distribution of EIGR metadata related to Research and knowledge classes (KC)

5.3 DATA ASSESSMENT FOR TECHNOLOGICAL READINESS LEVEL CLASSES

The EIGR database contains 1760 records, which were assigned to one of the nine Technological Readiness Levels (TRL):

- TRL 1: Basic principles observed;
- TRL 2: Technology concept formulated;
- TRL 3: Experimental proof of concept;
- TRL 4: Technology validated in lab;
- TRL 5: Technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies);
- TRL 6: Technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies);
- TRL 7: System prototype demonstration in operational environment;
- TRL 8: System complete and qualified;
- TRL 9: Actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space).

The **Figure 20** illustrates the distribution of metadata between the TRLs.

The majority (35.2%) of the metadata (619 entries) are related to *TRL 9: Actual system proven in operational environment*, followed by the *TRL 1: Basic principles observed*, with 461 records (26.2%). The *TRL 2: Technology concept formulated* (302 entries) and the *TRL 3: Experimental proof of concept* (188) also have a relative high number of records. The remaining levels (*TRL 4 - TRL 8*) made up 11% of the 1760 EIGR records.
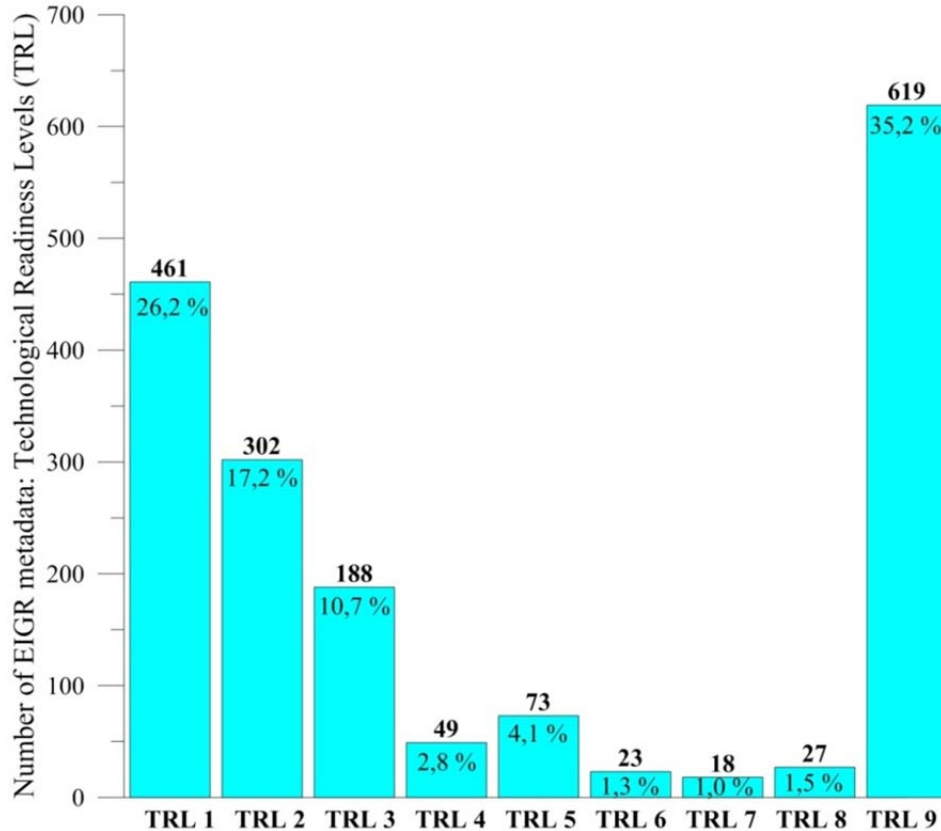

Figure 20. The distribution of EIGR metadata related to Technological Readiness level (TRL)

6   SUMMARY AND CONCLUSIONS

- The EFG Linked Third Parties (LTPs) representing 20 European countries have uploaded entries to the EIGR and 18 of these have provided Country reports.
- The Country reports involve answers for 6 questions, including information about the overview of the uploaded metadata, time consumed for uploading to EIGR, the main source of information used during the data collection, classification of their information based on the "Research and knowledge classes", classification of their entries into 7 data/resource types (database, maps, books, etc.), barriers to find data and information.
- The EIGR metadata were inserted by the LTPs and the KINDRA consortium partners. In the statistics, data uploaded until 28/02/2017 were considered. Of the 2265 records 1999 EIGR metadata were uploaded by the LTPs, but the total number of metadata has been constantly increasing. The insertion of metadata has continued from 28 of February to end of April by LTPs. In addition, it has been necessary to improve the metadata in collaboration with the LTPs, especially for the translation of titles and abstracts. This additional work of the LTPs will increase the amount of entrances complying with the standards by more than 10% before the end of April 2017. All these data will be taken into account in the gap analysis (WP3).
- Based on the LTPs information in the country reports, it appears that the barriers to find the data and the sources of information are different for country by country. The most frequent barriers were the language (most of the relevant information is in national languages) and the confidential-copyright issues, the main barriers were the scattering of huge amount of information. However, many LTPs didn't report barriers.
- Nearly half of the EIGR entries were "National and local reports containing facts and data", these entries were classified to Class 4 in the Research and Knowledge classes.
- More than the half (56.8 %) of EIGR metadata were assigned to the Operational Actions (OA) "Assessment and management" category of the HRC-SYS classification system. From the Research topics (RT) "Geology" topic was the dominant category, with ~ 80% of the total number of records. In the Societal challenges (SC) category, the majority of the metadata (~ 90%) belongs to the "Climate, environment and resources" category.
- Three EIGR visualization tools were developed and applied for detailed graphical evaluation and co-occurrence analysis of the large amount of information stored in EIGR database. To support and extend these analyses an additional external visualization tools (VOSviewer) were also applied.
- Based on the EIGR 2D category charts, a preliminary co-occurrence analysis was performed. It showed that the majority of the EIGR records were assigned to societal challenge no. 4 „Climate, environment and resources"; Operational Action no. 5 „Assessment and management" and Research Topic no. 4-„Geology". Societal challenge no. 4 „Climate, environment and resources" and Research Topic no. 4 „Geology" were also receiving the largest number of entries for all of the other

Operational actions (Mapping, Monitoring, Modeling, Water supply), For many intersections (category combinations) (50 intersections from the possible 125) of the HRC-SYS categories, "no entries" indicate areas with potential research gaps.

- The developed EIGR tools, and the external tools allow the further detailed analysis and visualization of EIGR metadata. The preliminary assessment shows that the features are suitable for the gap analysis pursued in WP3, which is one of the main purposes of KINDRA project.

ANNEX 1.

THE TEMPLATE OF COUNTRY REPORTS

KINDRA NATIONAL REPORT

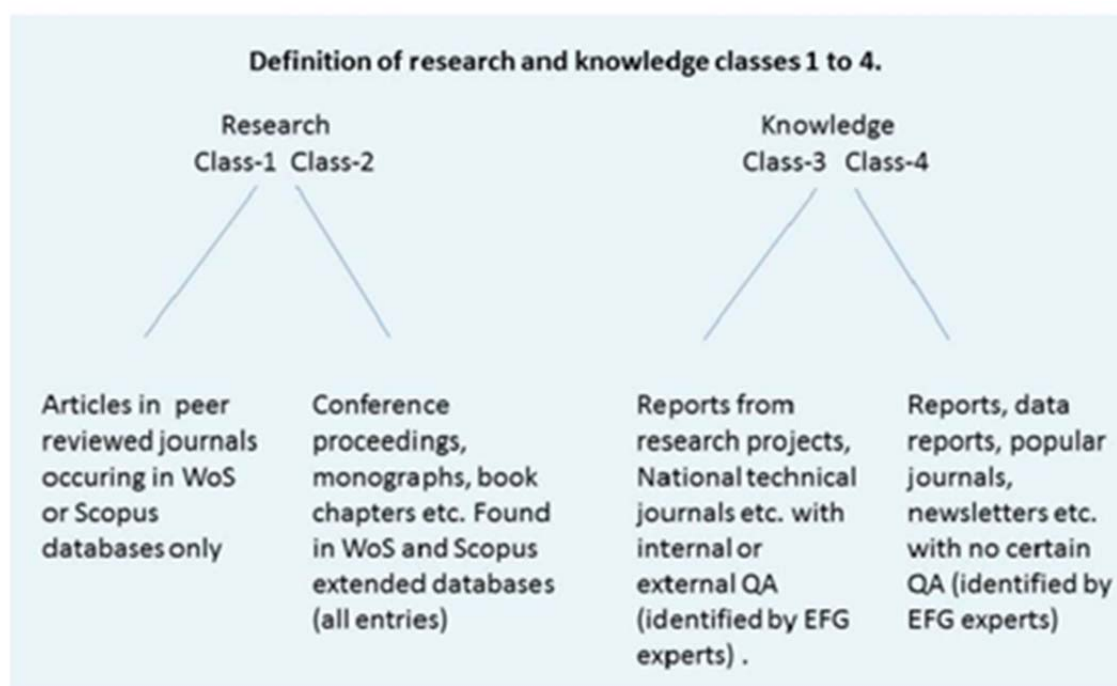Country/Association

Author:

1. Introduction

Summary on the total of data fill in the EIRG and time consumed.

2. Source of information

2.1. Institutions dealing with groundwater research/survey

2.2. Groundwater monitoring, availability of data

2.3. Journals/archives focused on hydrogeology

Please indicate here the main source of information used during the data selection

3. Type of information

Definition of research and knowledge classes 1 to 4.

Research		Knowledge	
Class-1	Class-2	Class-3	Class-4
Articles in peer reviewed journals occuring in WoS or Scopus databases only	Conference proceedings, monographs, book chapters etc. Found in WoS and Scopus extended databases (all entries)	Reports from research projects, National technical journals etc. with internal or external QA (identified by EFG experts).	Reports, data reports, popular journals, newsletters etc. with no certain QA (identified by EFG experts)

Please indicate here how you judge the info to belong to one of the classes (class 1-4)

4. Topics

Please can you indicate how many input in the inventory you have for each of this categories:

4.1.   National databases

4.2.   National and local reports containing facts and data

4.3.   Hydrogeological maps

4.4.   Technical reports, Guidelines, Manuals, etc.

4.5.   Books and book chapters

4.6.   Position Papers and/or important papers on PR Journals

4.7.   Others

5. Barriers to find data

Please can you indicate here barriers for find such data, for example: confidential, copyright issues, language, etc

6. Gaps in finding the information

To finish the report we would like to know you opinion on gaps in finding the information and perhaps suggestions on what to do about it.