KINDRA DELIVERABLE D1.7

SELECTION OF GROUNDWATER RELATED ASPECTS RELEVANT FOR IMPLEMENTATION OF WFD AND GWD

Summary:

A groundwater research classification system (HRC-SYS) has been developed using the three main categories 1) Societal challenges of Horizon 2020, 2) Operational actions widely used in groundwater investigations and management and 3) Groundwater research topics related to the major natural science disciplines. More than 200 keywords selected from important EU policy documents (primarily the Water Framework and Groundwater directives etc.) and major groundwater research journals have been included in the classification. The adopted system is used for classification of research for which metadata are uploaded to the developed European Inventory of Groundwater Research (EIGR) and for assessment of groundwater research stored by Elsevier and Thompson-Reuters, which is accessible through Scopus and Web of Science. The HRC-SYS and the contents and structure of the EIGR are developed through discussions between the KINDRA partners and the Joint Panel of Experts in order to enable and facilitate assessments of groundwater research needs relevant for the implementation of the Water Framework and Groundwater directives and to provide relevant data for development of future research programs related to groundwater.

Authors:

SAPIENZA, Marco Petitta

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All partners + Project repository	
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1. INTRODUCTION

At the end of the first year of activity, the WP1 has been completed, developing the Classification System (HRC-SYS), as explained in D1.1 and D1.2, and launching the European Inventory of Groundwater Research, as detailed in D1.3, D1.5 and D1.6. Collected information related to WP1 include also the inventory of information sources described in D1.4.

To finalize the performed activities in relationships with possible relevance for European Directives (mainly the Water Framework Directive and Groundwater Directive), results obtained by Task 1.1 (namely Classification of groundwater R&D results and activities by keywords) and Task 1.2 (Inventory of information sources) have been analyzed to focusing the following activities on the definition of the specific groundwater-related aspects that are relevant to the implementation of the Water Framework Directive (European Commission, 2000) and the Groundwater Directive (European Commission, 2006). From the obtained classification and the list of results, included in the European Inventory of Groundwater Research (EIGR), an evaluation has been made to highlight the main keywords related to main societal challenges, operational actions and research topics, which are considered relevant at EU policy level. To perform this activity, reports and documents realized from the technical bodies of the EC, as the CIS Working Groups, have been compared with the EIGR structure and content, and a limited list of significant results has been selected.

2. RELEVANCE OF THE PROPOSED CLASSIFICATION SYSTEM (HRC-SYS)

The entire structure of the groundwater research classification system (HRC-SYS) is based on the relationships of groundwater research and knowledge with the EC policies, to ensure easy correlation with the related Directives.

In fact, the classification system grouped the relevant research in three basic overarching categories: societal challenges, operational actions and research topics. The selection was made based on the most important general research topics and operational actions in relation to the major natural science disciplines or research topics to which groundwater research primarily belongs and relates.

Further, to compare results of groundwater research with the societal challenges, a fundamental category has been established using the list of societal challenges defined by EC in the EU Framework Programme for Research and Innovation (Horizon 2020), to make the classification as relevant as possible for the main challenges of the EU research programmes, and to facilitate the evaluation of groundwater research importance within the context of mainly the Horizon 2020 challenges and visions. There are originally 7 societal challenges (SC) in Horizon 2020, but one of them (SC4 = transport) has no groundwater relevance and the last two SC6 and SC7 have many overlapping issues of relevance for groundwater

research. Hence is was decided to merge these two. This therefore resulted in the following five societal challenges for groundwater research classification and evaluation: 1. Health, 2. Food, 3. Energy, 4. Climate/Environment/Resources (corresponds to SC5 of H2020), 5. Policy/Innovation/Society (corresponds to SC6 and 7 of H2020).

Consequently, the entire Classification System results have been based on the immediate comparison of the two "technical categories" (research topics and operational actions) with the modified version as described above of the main Societal Challenges previously identified by the European Commission in the Horizon 2020 programme. This is illustrated in figure 2.1 below.

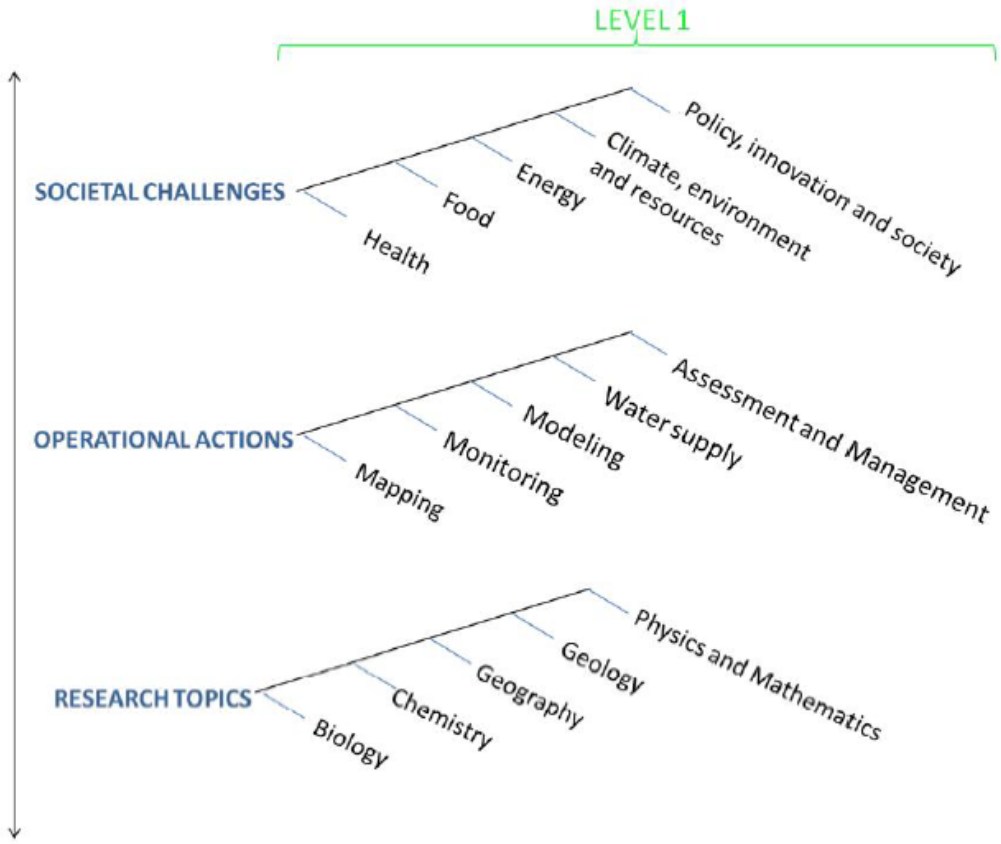

Figure 2.1. The main overarching themes of the three main categories societal challenges, operational actions and research topics used in the KINDRA groundwater research classification system (HRC-SYS) for classification of research and knowledge information uploaded to the European Inventory of Groundwater Research (EIGR).

Our approach is based on the assumption that most current and future research, defined by selected main keywords describing the most important topics of the classified research, should fit into at least one of these overarching societal challenges, operational actions and research topics, which will be the main entrance when classifying current or ongoing groundwater research in the developed European Inventory of Groundwater Research (EIGR).

The classification system can map the relation between the three main categories through a 3D approach (CUBE), where along each axis the 5 overarching groups within each category can be represented (Fig. 2.1).

This approach allows for a more simple 2D representation, for each of the Societal Challenges (SC), where Operational Actions (OA) and Research Topics (RT) intersect in a 5x5 matrix. By this way, each one of the 2D graphs related to a single Societal Challenge, will include research and knowledge attributed to one RT and one OA.

The HRC-SYS is also consistent with the review of previous and current international projects related to groundwater, supporting the population of the European Inventory of Groundwater Research and Innovation (EIGR) (see Chapter 2, Deliverable 1.2).

The adoption of the above mentioned classification system allows a comparison of bibliometric and other indicators for each sub-field of research and knowledge, for trend and gap analysis to be conducted during the last stage of the project (WP3), taking into account the Common Implementation Strategy (CIS) of the Water Framework Directive (WFD). The obtained results will be summarized or specifically rearranged, by suitable tools, to be used at EU level for Directive revisions, for the CIS River Basin Management Plans, for driving monitoring procedures and activities, as previewed by the recent strategic documents of EU e.g. the Blueprint to Safeguard Europes' Water Resources (European Commission, 2012). The identification of research gaps will give useful suggestions for the actualisation and continuous development of research and innovation agendas in line with WFD.

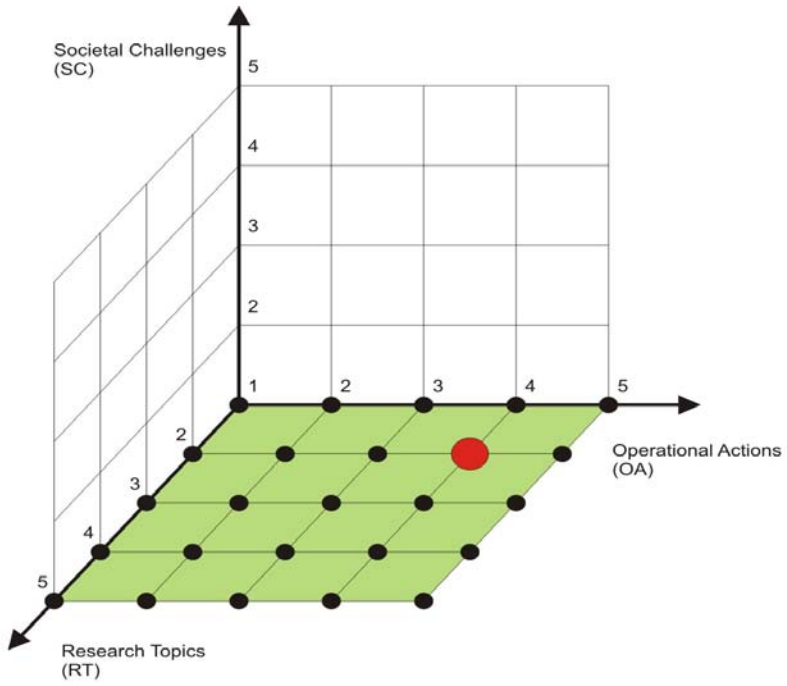

Fig. 2.2. 3D representation of HRC-SYS (refer to KINDRA D1.2). In green the 2D field of SC1 (Health) and in red the field related to the intersection of OA4 (Water supply) & RT2 (Chemistry).

3. RELEVANCE OF THE SELECTED KEYWORDS

Selection of the keywords to be used in the Classification System and in the European Inventory for Groundwater Research (EIGR) has been conducted from searches in the EU directives (Water Framework Directive, Groundwater Directive and Blueprint Document) and in the scientific peer-reviewed journals dealing with the evolution of groundwater resources quantity and quality or groundwater quantitative and chemical status using the terminology of the Groundwater Directive.

The initial work in the KINDRA project defined a list of more than 200 keywords (see D1.3) related to groundwater research, which all could be grouped into sub-levels of the overarching categories in Figure 2.1, and which could be evaluated in terms of amount of existing research papers or publications for each keyword.

The selected list of keywords has been organized by sub topics as described in tables. The adopted list of keywords would be extended during the project, following suggestions by the Joint Panel of Experts, the national experts, chosen by EFG among third parties and possibly other groundwater scientists uploading data to the EIGR. For this reason, insertion of records in the EIGR allows the use of new proposed keywords, in addition to those pre-selected during WP1.

The use of keywords identified in the WFD and GWD, and the recent Blueprint to Safeguard Europe's Water Resources (BWR, European Commission, 2012), for the classification of groundwater research, covering the periods 2000-2006 and 2006-2015 for citation analyses, surely ensures that this approach provides information that can be used for the assessment of the Directives importance as research drivers.

It also helps evaluate the relevance of groundwater research in relation to the objectives of the WFD/GWD and the societal challenges defined in the Horizon 2020, group them by categories and evaluate Science-Policy feedback within water research, policy and management. Additionally, the integrated perspective of the WFD and GWD provides good possibilities for demonstrating the important links in the water-food-energy nexus, between surface and subsurface waters and dependent or associated terrestrial and aquatic ecosystems. Hence, it emphasizes the importance of groundwater in the hydrological cycle not only for drinking water and other legitimate uses but also for sustaining terrestrial and aquatic ecosystems (e.g. European Commission, 2015) in a changing climate where freshwater availability is under pressure. Two recent technical reports from the European Commission / Working Group Groundwater within CIS (European Commission, 2015, 2016) clearly indicate that there’s a research gap for understanding the link between groundwater quantitative and chemical status and the ecological status of groundwater associated aquatic ecosystems. As an example work package 3 of KINDRA will conduct analyses evaluating this statement based on the developed classification system and the information uploaded to the EIGR and available from professional science evaluation tools SciVal and

Incite created by Elsevier and Thompsons as plug-ins to Scopus and Web of Science, respectively.

The identification of groundwater related research keywords from the EU WFD, GWD, and BWR (as detailed in D1.2) was performed based on expert judgment by the KINDRA project group. Partners from the KINDRA project group have been involved in EU groundwater research projects since 1995 as well as in the Working Group on Groundwater within the Common Implementation Strategy (CIS) of the Water Framework Directive since 2004. Initially, as part of the BRIDGE (Background CRIteria for IDentification of Groundwater ThrEsholds) project, which was a research project providing technical support to the development of the Groundwater Directive, and at a later state representing other research projects (e.g. CLIWAT, www.cliwat.eu), GEUS, and lately the Water Resources Expert Group of the EuroGeoSurveys.

The identification of relevant keywords first takes into account the WFD because of the purpose of the KINDRA project: the project focuses on groundwater, which is the “hidden” part of the water cycle, and takes stock of several top-priority research issues that are fundamental for the implementation of the WFD. The daughter directive on groundwater GWD reinforces the importance of groundwater within the WFD.

According to the requirements of the WFD and GWD it is necessary to improve the understanding of the relations between groundwater quantitative and chemical status and ecological status of groundwater dependent terrestrial and associated aquatic ecosystems.

The list of relevant keywords identified and extracted from the Water Framework and Groundwater Directives and the Blueprint to protect Europe’s Water Resources for the development of the Hydrogeological Research Classification System - (HRC-SYS) is shown in Table 3.1.

Table 3.1 Keywords selected from WFD (Water Framework Directive), GWD (Groundwater Directive) and BWR (Blueprint to Protect Europe's Water Resources) for the HRC-SYS.

abstraction	energy production	Mercury	Sulphate
agriculture	environment	mitigation	surface water interaction
Ammonium	environmental flow	models	sustainable
aquatic ecosystems	extraction	monitoring	sustainable water use
Arsenic	floods	Natural background	synthetic substances
biological status	groundwater bodies	nitrate	techniques
Cadmium	Groundwater Directive	over-use	terrestrial ecosystems
characterisation	hazards	overuse	territorial waters
chemical status	human health	pesticides	Tetrachloroethylene
chloride	human toxicology	pharmaceuticals	threshold
climate change	hydrological cycle	policy	tourism
coastal waters	indicators	pollution	transboundary
ecosystems	industry	protection	transitional waters
deterioration	innovation	quality	treatment
drinking water	integrated management	quantitative status	trends
droughts	integrated water resources	quantity	Trichloroethylene
e-flows	management	review	vulnerability
ecological flows	intrusion	river basins	Water Framework
ecological status	land subsidence	rivers	Directive
ecoregions	land use	salinity	water services
ecosystems	Lead	salt water	water supply
ecotoxicology	management	scarcity	water table decline
electrical	mapping	shale gas	wetlands
conductivity	marine waters	status	
	measures	storage	
		stygofauna	

4. RELEVANCE OF THE EUROPEAN INVENTORY OF GROUNDWATER RESEARCH (EIGR)

The European Inventory of Groundwater Research and Innovation (EIGR) is the direct tool, which supports the EU-assessment of current scientific hydrogeological knowledge, both theoretical and applied, focusing on EU, national and regional research and knowledge, but including also international (outside the EU) and EU-third party activities. The scopes of the EIGR are: (1) to provide a tool and framework within which metadata on groundwater resources can be uploaded and stored in a efficient and user friendly way (WP1); (2) to populate the inventory itself with metadata related to groundwater research and knowledge (WP2); and (3) to enable an assessment of the state-of-the-art in groundwater research, identify gaps and trends and provide future research recommendations (WP3). In addition, the EIGR is intended to be used also after the end of the project, as a possible permanent public-access service for European hydrogeological research in progress, which will provide information on the objectives of ongoing research before results are finally published.

As stated above, the inventory (EIGR) is essential for the identification of the state-of-art, future trends and research gaps; it is at the base of a proper groundwater management and policy development, according to recommendations of policy documents like the Blueprint for Water. The selection of keywords coming from official EU documents and the structure of the classification system, based on the list of Societal Challenges identified by Horizon 2020 Program, have been completely integrated into the EIGR.

The EIGR consists of a web-service supported tool that enables users to overcome the difficulties to report and compare the research activities and derived knowledge at EU level. Operating mainly as a catalogue, the EIGR stores scientific information classified on the basis of the Harmonized Terminology and Methodology for Classification and Reporting Hydrogeology and groundwater related Research in Europe (HRC-SYS) documented in D1.2.

The procedure for populating the EIGR can be resumed as follows:

I) classify research and knowledge products (papers, reports, projects, maps etc.) into the five overarching categories of the Societal Challenges, Operational Actions and Research Topics, and identify appropriate keywords under the overarching categories, for detailed classification into the HRC-SYS (CUBE, see page 6);

II) identify the assessment criteria for future evaluation of groundwater research trends and gaps, by using the other proposed indicators.

In addition, a set of indicators has been inserted in the EIGR to allow the evaluation of the outputs and performance of research/knowledge activities. The indicators are necessary to provide an objective evaluation, based on general criteria widely adopted in research and innovation classifications. Firstly, a distinction between “research” and “knowledge” is

previewed, by identification of four classes (as stated in D1.3). Bibliometric indicators as citations will be also considered to evaluate the performances of the classified products. In addition, other indicators like Technology Readiness Level (TRL), grants received, number of patents and awards received are also taken into account in the EIGR.

5. CONCLUSIONS

To sum up, both the classification system HRC-SYS, including selected keywords, and the EIGR have been realized to allow an easy identification of findings of our project regarding groundwater research trends and gaps, which are relevant for the implementation of the related WFD and GWD.

Results achieved during WP1 have considered the goal of possible implementation of EU related Directives from the beginning of the project. With this aim, since the first stages of WP1, official EU documents, other EU funded projects, and also reports and documents realized from the technical bodies of the EC e.g. developing the Common Implementation Strategy of the Water Framework Directive, have been taken into account within the EIGR structure.

By this way, the following preliminary list of significant results about the groundwater related aspects relevant for future directive implementation has been selected:

- the Societal Challenges stated in Horizon 2020 Program are one of the three main categories at the basis of the HRC-SYS;

- the keywords applied in the classification and listed in the EIGR are coming from a review of the EU official documents;

- the EIGR requires that each document inserted must be classified in terms of Societal Challenges and by choosing one or more keywords included in the selected list;

- other indicators for classifying documents are previewed in the EIGR, to facilitate identification and evaluation of trends and gaps, leading to the identification of recommendations for European groundwater research needed for support and development of the common implementation strategy of WFD and GWD and ultimately ensuring good status of all European water bodies and ecosystems to the benefit of human well-being.

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