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## "A project on groundwater research inventory and classification to make groundwater visible"

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### INTRODUCTION

Water is a key-topic in modern society: not only is it a pivotal human, biological and environmental requirement, it also represents the engine for several research topics which are interconnected, covering the water-food-energy-climate nexus, and it has even a fundamental impact on urban systems. Groundwater is the hidden component of the water cycle, difficult to assess, evaluate and communicate. It plays a fundamental role by sustaining the health of our ecosystems, ourselves and our industrial and agricultural production. KINDRA seeks to help achieve a better understanding of the groundwater topic by providing an overall view of the scientific knowledge that exists across Europe.

### AIM OF THE PROJECT

Practical and scientific knowledge related to groundwater research and innovation is scattered amongst various actors throughout Europe. KINDRA will develop an inventory of this groundwater knowledge-base, following a newly developed EU Harmonised Research Classification System (HRC-SYS) (Fig.1). This requires an effective assessment of the state-of-the-art of hydrogeology research across different geographical and geo-environmental settings, allowing for direct comparison and identifying synergies in groundwater research.

A European Inventory of Groundwater Research results (EIGR) will be compiled, including survey results and research activities, projects and programmes, all of which are essential to identify and determine future trends, critical challenges and research gaps (Fig.1).

The objective is to improve management and policy development for groundwater resources on a EU level coherently with the Water Framework Directive<sup>1</sup> (WFD) and the Groundwater Directive<sup>2</sup> (GWD). Following this classification, the inventory will provide a public-access service for European hydrogeological research in progress (Fig.1).

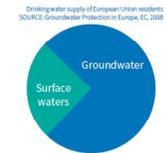
- Create a uniform EU-harmonised categorisation approach / terminology for reporting groundwater research (a Hydrogeological Research Classification System – HRC-SYS)
- Carry out EU-wide assessment of existing practical and scientific knowledge (using the developed HRC-SYS) focusing on EU, national, regional, international and EU-third party scientific activities
- Create a European Inventory of Groundwater Research and Innovation (EIGR). This register will be supported by a web-service that will be searchable by selected key-words and will support users with query functions for statistics, diagrams, and others concise data elaboration
- Use the data in the register and the developed analytical tools (qualitative/quantitative) to assess the performance of key ongoing EU, national, regional, international and EU-third party hydrogeological scientific and innovation activities and results
- Compare the results with existing recommendations and position papers, outcomes of past Projects workshops, recommendations by the EIP on Water/WsSTP, and other networks/groups/etc.
- Define research gaps and corresponding suggestions for research agendas in line with WFD<sup>1</sup>
- Deploy the Register as a public-access service, to be used as a permanent, searchable service on ongoing hydrogeological research and innovation



Figure 1 KINDRA project approach.

### PROJECT OVERVIEW

Raising awareness on the importance of groundwater is our priority. KINDRA will work together/or in close collaboration with the technical and scientific community, stakeholder groups and with the general public.



KINDRA counts on the direct involvement of the European Federation of Geologists (EFG), which will provide the technical expertise of its national members actively cooperating within the project (Fig.2).

The project will also benefit from the support of a Joint Panel of Experts (JPE), will be in close interaction with different EU Groundwater Associations, Networks and Working Groups (Fig.2). This will facilitate community involvement and dissemination.

Classification	• Joint Panel of Experts
Inventory	• 20 third parties (national representatives of EFG network)
Dissemination	• EFG dissemination capacity • Collaboration with JPE, CIS WG-C, IAH, WsSTP, ICT4water cluster, etc.

### Who helps us?

Figure 2 External communities involved in KINDRA project. CIS WG-C: Common Implementation Strategy Working Group C; IAH: International Association of Hydrogeologists; WsSTP: Water supply and sanitation Technology Platform; ICT4water cluster: Information and Communication Technologies for Water Cluster

The project started on January 1<sup>st</sup> 2015 and lasts for 36 months; work is organized into five work packages (Fig. 3)

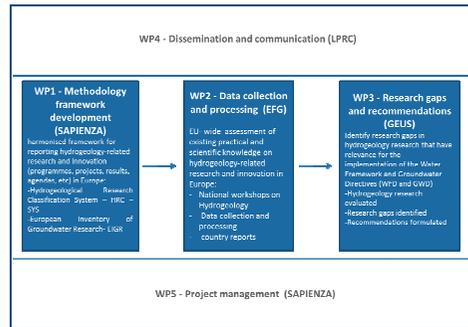


Figure 3 KINDRA workflow.

### REFERENCES

- 1- European Commission, 2000. Directive 2000/60/EC (Water Framework Directive) of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. OJ L 327, 22.12.2000, pp 1- 51.
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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 642047. (call WATER-4a-2014 - Coordination and Support Action) - [coordinator@kindraproject.eu](mailto:coordinator@kindraproject.eu)

### RAISE THE AWARENESS OF GROUNDWATER

KINDRA focuses simultaneously on the technical and scientific community, on stakeholder groups and on the general public too, while interacting with the wider "water-universe" in Europe, performing the following actions:

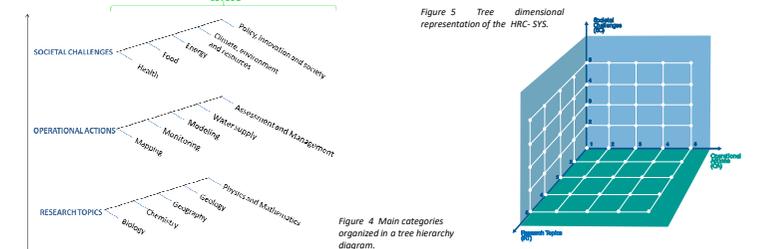
- participation in networks, groups and tables discussing the role of "water" issues in Europe, e.g. the water-food-energy-climate nexus, the smart cities concept, the role of water in the circular economy;
- adaptation of results of the project into outreach materials helping the general public to understand the importance of groundwater in daily life;
- involvement of the "groundwater" scientific community, by discussing the latest in groundwater research, highlighting the importance of knowledge from scientific and non-scientific studies, promoting interdisciplinary approaches;
- dissemination of its activity at workshops, meetings, conferences, both at national and international levels.

KINDRA is directly organising 20 National Workshops in Europe within the frame of this project in 2016, under the EFG umbrella; we may be in your country too!

### GROUNDWATER RESEARCH CLASSIFICATION

For developing the common terminology on which to base the EIGR through the HRC-SYS, keywords characterizing research on groundwater have been identified following two approaches: (1) from the most important EU directives and documents<sup>1</sup>, and (2) from groundwater related scientific literature, which has been fundamental for identifying relationships and intersections between topics, themes and activities. To assess the importance and pertinence of the keywords, these have been ranked by performing searches via the Web of Science, Scopus and Google Scholar search engines.

The complete merged list of keywords consisting of about 240 terms has been organized in a tree hierarchy, identifying three main categories: Societal Challenges (SC), Operational Actions (OA) and Research Topics (RT) (Fig.4). In each of these three categories, 5 overarching groups have been defined for easy overview of main research areas, representing level 1 (Fig. 4). All identified keywords have been categorized into one of these overarching group in up to three levels.



The classification system previews the interaction among the three main categories through a 3D approach (Fig.5), where along each axis the 5 overarching groups are indicated. This also results in a 2D representation for each of the Societal Challenges, where Operational Actions and Research Topics intersect in a 5x5 matrix.

### FILL THE INVENTORY!

Information sources related to Hydrogeological Research Knowledge, including papers, reports, maps, databases, etc., scattered around Europe and elsewhere at international and national levels, are representing the content of a new dedicated inventory (EIGR: European Inventory of Groundwater Research), where metadata identifying various information sources can be collected, added and stored, to be available as open access. In addition to the National Experts from 20 countries, selected by the European Federation of Geologists (EFG), everyone from the groundwater community will be able to add and retrieve information and records in the inventory.



The EIGR is a tool to include all possible information sources, following the principles defined by the proposed classification. The inventory will serve multiple aims:

- insertion of information pertaining to groundwater research and knowledge (including non-scientific products);
- consultation during and after the project by individuals and organisations dealing with groundwater research, possibly also by non-experts;
- analysis of collected and stored information to identify trends, challenges and gaps in groundwater research, by the KINDRA partners, to produce recommendations for the implementation of the Water and Groundwater Directives.

### PROJECT CONSORTIUM:

Project coordinator: "La Sapienza" University of Rome, Earth Sciences Dept., ITALY  
 EFG- European Federation of Geologists, BELGIUM  
 UM- University of Miskolc, Faculty of Earth Science and Eng., HUNGARY  
 REDIAM- Environment and Water Agency of Andalusia, SPAIN  
 LPRC- La Palma Research Centre for Future Studies S.L., SPAIN  
 GEUS- Geological Survey of Denmark and Greenland, DENMARK

