Interreg Sudoe AQUIFER

European Regional Development Fund

SUDOE-AQUIFER Project - Report of the Results fo the Survey Analysis

Final Report

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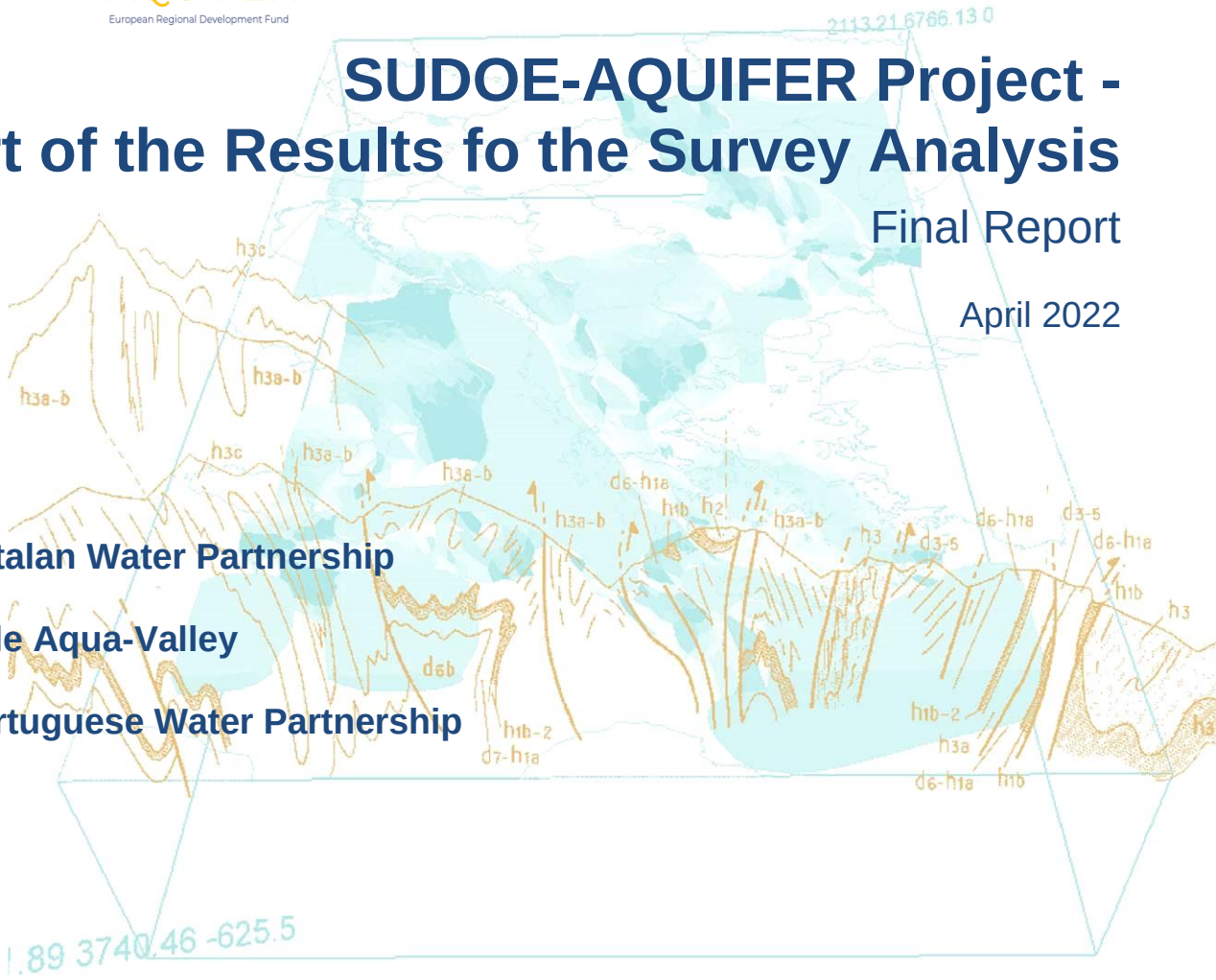


Catalan Water Partnership

Pôle Aqua-Valley

Portuguese Water Partnership

AQUA VALLEY MEMBRE

CATALANWATERPARTNERSHIP

Parceria Portuguesa para a Água

Contents

1. Summary

The gathering of innovative practices for the managing of groundwater was done in the context of the research project SUDOE AQUIFER in which CWP (the Catalan Water Partnership) is a partner. The consortium also comprises the following partners: IGME (Instituto Geológico y Minero de España), as leader, ISA-UL (Instituto Superior de Agronomía da Universidade de Lisboa), Pôle Aqua-Valley, PWP (Portuguese Water Partnership), BRGM (Bureau de recherches Geologiques et Minières), CUADLL (Comunitat d'Usuaris d'Aigua de la Vall Baixa i Delta del Llobregat), CRCC (Comunidad de Regantes del Campo de Cartagena) and AR (Águas do Ribatejo).

The objective of this report is to present the selected practices of innovative groundwater management practices selected in this task, that in turn, are going to be gathered in a reference eBook to be distributed among relevant stakeholders in the SUDOE territory and abroad that corresponds to the deliverable E 4.1.2 of the project. They are also going to be showcased in the transnational web platform of the project that corresponds to the activity 4.2.

The information for the elaboration of this report was collected through the dissemination of a good practice survey among a database of pre-identified stakeholders from Spain, France and Portugal, as described in the deliverable E 4.1.1. After a step of information structuration, the selection of the final success stories was conducted by each one of the project clusters with the support of the experts from the external institutions.

The practices are from a total of 22 countries and encompass examples of initiatives related to groundwater use governance, implementation of sensors and IoT systems and the improving and enhancement of Managed Aquifer Recharge actions. In turn, these initiatives are related with:

- The maintenance of the water quality and quantity.
- The improvement of data acquisition.

- The development of new tools for the groundwater management.
- The improvement of water governance.

All these actions depict how different stakeholders from different territories, needs and capabilities assessed their respective groundwater challenges, implementing a wide range of solutions, systems, and collaborative initiatives.

2. Context and objectives

Groundwater management is the process that aims to make groundwater a sustainable resource to guarantee its maintenance during the time. In the most recent years the need for strong groundwater management practices has gained relevance as the threats for the quality and sustainability of the use of this resource have increased as well. Most of these threats are somehow linked to the effects of climate change and in some areas to the increase of human activity.

In many world regions, the effects of climate change imply a reduction of precipitation that diminishes the inputs to the groundwater reserves. This decrease of piezometric levels also favours, especially in coastal areas, the intrusion of saline water that also hampers the quality of these subsurface water reserves. In line with the increase of water use, major threats are the increase of groundwater extraction and the generation of pollutants and by-products which, in case they reach the subsurface waterbodies, can decrease their quality making them unfit for some uses.

In this context, groundwater management actions are becoming crucial in more and more regions throughout the world to guarantee the availability of quality water. These actions can be of different types:

- Governance
- New management Tools
- Improvements in data acquisition
- Evaluation of the quality and quantity

For instance, those related with **governance** are important to determine the well location and spacing, abstractions quotas or the extraction technologies used.

The **improvement of data acquisition** can be achieved through the implementation and improvement of sensor systems (for example with the implementation of IoT tools).

The **implementation of new management tools** allows the collaborative and informed management and exploitation of groundwater resources by the final users.

The research and implementation of new methods to **evaluate the quality and quantity** of water resources is also crucial to guarantee the availability of these resources in the next decades.

AQUIFER's main objective is to capitalize, test, disseminate and transfer innovative practices to the preservation, monitoring and integrated management of aquifers that help in decision making about the management of groundwater resources, improving technology transfer to agents and create new synergies and develop common tools in a water resources scarcity context.

Hence, the aim of this task is to identify and select relevant groundwater management practices that to be showcased and presented

3. Methodology

This report feeds from the results generated in the first part of this task where a good practice survey was designed by the project partners and distributed among a database of pre-identified stakeholders. This research was mainly conducted by three active partners in Spain, France and Portugal, namely CWP, AV and PWP, respectively and supported by the rest of the partners of the project.

Thus, the steps for the collection of groundwater management good practices were as follows:

- A standardized table of contents was reviewed and validated by all the project partners.
- Each one of the partnership clusters launched a tender for the subcontracting of an external service provider to support the selection of the most relevant practices.

- An external service provider (in Spain, France and Portugal) was selected by each one of the partner clusters.
- The gathered information was shared with the external providers and a review of the innovation level of each case was done by them. The details about the selection process are described in Section 3.2.

3.1. EXTERNAL SERVICE PROVIDERS

The external providers were subcontracted by the three clusters involved in this task, CWP, AquaValley and PWP. Each one of the clusters launched a tender for the subcontracting of external experts with expertise in the field of groundwater management.

The selected external providers were the following ones:

Catalan Institute for Water Research (ICRA)→ ICRA was subcontracted by CWP. It is a research institute created on 2006 by the Government of Catalonia within the framework of the Research Centres Programme of Catalonia (CERCA), and affiliated to the University of Girona**.** It is an international reference point that focuses research of the integral water cycle, hydraulic resources, water quality (in the broadest sense of the term: chemical, microbiological, ecological, etc.) and treatment and evaluation technologies and to transfer this knowledge to society and business network..

ALTEREO→ Altereo is an independent consulting, engineering and innovation group that has existed for 32 years. Altereo has a workforce of approximately 185 employees spread over 13 sites in France, with also establishments abroad. Altereo works on differents topics: Water and environmental engineering, support for public policies, sustainable and territorial development, publishing of geographic intelligence solutions. In the field of water Altereo mainly operates in three areas: master plans, strategic water/environment studies and innovative services

Laboratório Nacional de Engenharia Civil (LNEC)→ LNEC is a is a state owned research and development (R&D) institution founded in 1946.It works in the various domains of civil engineering, giving it a multidisciplinary perspective in this field. The main goals of the LNEC are to carry out innovative research and development and to contribute to the best practices in civil engineering. LNEC also plays a key role in advising the government in technical and scientific matters of civil engineering, as an unbiased and independent body. The Laboratory has at present, 556 staff, and about 140 science research fellows with grants awarded by LNEC.

3.2. SELECTION PROCESS

As in the first survey of success stories, more than 30 actions were pre-identified. The selection of the final 30 practices (summarized in table 1) was done in three steps:

- **Distribution of the pre-selected practices among the participant clusters.**

As the number of pre-selected was large, a decision was made to divide the number of practices to be selected among the participant clusters. A decision was made to select a total of 10 practices for each cluster (CWP, AV and PWP) to reach a final number of 30. It also was agreed that each cluster would be in charge of their own pre-identified practices in order to evaluate them together with its external provider.

- **Evaluation of the practices for each cluster with its external provider.**

Each of the three clusters facilitated their pre-selected practices to their external provider. Each participant cluster maintained a kick-off meeting with the external provider to introduce them to the aims of the project and the concrete outcomes expected for this task. A common template for outputs was also agreed among the participants.

- **Selection of practices done by the external provider.**

ICRA, ALTEREO and LNEC were in charge to evaluate the practices sent by each one of the clusters. The final goal for them was to select the most relevant and innovative 10 practices to be included in the eBook. The selection was done based on the extent of

innovation of the practices and the relevance/possibility to be implemented in the SUDOE region.

- **Validation of the case selection by the participant clusters and the rest of the consortium members.**

During the selection process, the clusters maintained a continuous contact with their respective external providers. After the proposed selection by the external providers, the case selection was validated by the clusters and the rest of the project participants. A brief description of each case can be found in the next section (Table 1).

3.3. SUCCESS STORIES SHEETS

This document has the purpose to show all the selected practices (considered as success stories) collected through the survey. The 30 selected practices are shown un the next table.

Table 1. Information of the 30 good practices in groundwater management selected by the consortium members and the external providers.

Name of the practise	Country	Responsible entity	Brief description	Cluster in charge
Adaptive groundwater management in Benalup aquifer	Spain	University of Cadiz	Couples the quantitative and qualitative status of the Benalup aquifer and proposes managed actions based on hydrogeological knowledge, remote sensing techniques, and citizen participation. It represents a starting point for water resource governance based on a multidisciplinary perspective.	CWP
GOTHAM: A new tool for integrated groundwater management	Spain, Lebanon, and Jordan	CETAQUA	This project is based on Gtool, an innovative water management methodology based in agro-economical parameters in a bottom-up approach aiming to achieve a sustainable water use controlling demand and enhancing water savings.	CWP
Groundwater resources in Llobregat delta aquifer	Spain	CUADLL	Diverse MAR initiatives are conceived to preserve groundwater quality through a complex hydraulic barrier that avoids sea	CWP

			water intrusion in the vicinity production wells and to increase the groundwater resources, as well. Both actions involve the use of reclaimed water.	
AQUADVANCED: Improving water distribution networks' efficiency	Spain	Aigües de Rigat and SUEZ	This software tackles the improvement of withdraw groundwater distribution in its path from the well to the use to local water suppliers, permitting the efficient control of distribution network using different monitoring strategies.	CWP
AQUALEARNING: Using artificial intelligence in water resources managment	Spain	Amphos21	A platform created to predict the behaviour of aquatic systems at real time and using machine learning algorithms. Using existing databases stands a quick and reliable prediction tool that complements and overcomes the limitations of other numerical models.	CWP
Smart control of the water distribution system in Alicantes	Spain	Diputación de Alicante	An automatic monitoring system as well as data storage and treatment capacities that permits a rigorous control of all parameters with the aim to identify, prevent and solve potential problems and warrant urban water supplies.	CWP
Insitrate: In situ groundwater nitrogen removal technolgy	Spain	Eurecat	This project explores how to enhance the bioremediation processes for the in situ desnitrification. A bioredmediation technology was developed to improve nitrate removal under a low-cost operational structure.	CWP
Integrated hydrogeological models for sustainable aquifer exploitation and management in climate change scenario	Spain	Polytechnic University of Catalonia (UPC)	This project is based on careful modelling of the groundwater flow system and the hydrogeological balance. The integrated model consider possible pressures arising from the exploitation of the aquifer's groundwater resources in future climate scenarios.	CWP
Users community involvement in water resources management: The Baix Ter case	Spain	Junta Central d'Usuaris del Baix Ter	A conjunctive use of surficial and groundwater resources form Ter river has been established in a joint effort between local users and the administration to warrant the water supplies for agricultural and urban demand in an area of intense touristic activity and to protect the environment and biodiversity as well.	CWP

Data science in water resources management	Spain	IDAEA-CSIC	Groundwater data from monitoring strategies and methods is treated by a set of software packages based on the use of artificial intelligence, parameter estimation and decision-making algorithms for hydrogeological applications.	CWP
MétéEAU Nappes, a tool for monitoring and forecasting groundwater	France	BRGM	A management web platform to inform/alert on the level of water tables, anticipate droughts and foresee floods. Allows the collection and dissemination of water cycle data, display the situation of water tables in real time model future aquifer behaviour and decision support.	AV
APRONA: an observatory of the Alsace Groundwater	France	APRONA	This observatory brings together stakeholders to monitor ground and surficial water using tools to exchange information and improve knowledge through the mutualization of existing tools, GIS portal and display and dashboard indicators.	AV
Groundwater dating by CFC and SF6	France	CONDATE-EAU	A geochemical analysis methodology for estimating the mean turnover time for groundwater. It allows a fine analysis (in picograms per liter) where conventional techniques are generally in micrograms per liter. Is now used by communities, engineering companies and university laboratories.	AV
Sustain-COAST: Sustainable management of coastal groundwater and pollutions reductions through innovative governance in a context of climate change	Italy, Tunisia, Greece, and Turkey	Technical University of Crete (as leaders)	Project funded under PRIMA program. This initiative was conceived to develop a calibrated multi-criteria decision support system and a web-based geographic information system available for stakeholders related with coastal aquifers.	AV
GICRESAIT: Integrated and concreted management of water resources of the aquifer systems of Iullemeden, Taoudéni/Tanezrouft and the Niger River	Algeria, Benin, Burkina Faso, Mali, Mauritania, Niger, and Nigeria	Sahara and Sahel Observatory (OSS; as leaders)	A project focused in the integrated and concerted management of water resources of several African aquifer systems. This action aims to improve the knowledge about theses aquifers, assess their vulnerability, establish a consultation framework, capacity building, awareness, and communication.	AV
Northern Sahara aquifer system	Algeria, Tunisia, and Libya	Sahara and Sahel Observatory (OSS)	The studies conducted by Sahara and Sahel Observatory started in 1999 with the objective to acquire knowledge to about the Northern Sahara Aquifer and its uses.	AV

			Nowadays, these works allow a continuous cooperation among countries to guarantee the availability of the resource.	
GEOAQUIFER: Improvement of the knowledge and concerted management of the Aquifer System of the Northern Sahara using satellite images.	Algeria, Tunisia, and Libya	Sahara and Sahel Observatory (OSS)	This initiative feeds on the data and information produced in SASS project. Its aim is to optimize the use of satellite data for aquifer management, provide tools to national agencies to strengthen and improve the consultation mechanism and develop their capabilities in the use of satellite data.	AV
AQUI-FR: National hydrogeological modelling platform	France	École Normale Supérieure (ENS; as coordinators)	It is a modelling platform that aims to bring together in a single platform hydrogeological models developed by different institutes. The final output is the development of better knowledge about the past, present and future of the groundwater resources.	AV
Aquanes: Advanced monitoring and modelling interface for an optimized design and operation of MAR/SAT of Agon-Coutainville	France	BRGM	A project that developed water and wastewater purification techniques combining natural and industrial treatment techniques. It aimed to promote more sustainable water purification techniques to manage situations of water scarcity.	AV
SMD: Groundwater monitoring tool for monitoring saline intrusions	France	SAUR Group	SMD (Subsurface Monitoring Device) is a tool for continuous monitoring of saline intrusions in groundwater. This is an integrated solutions that encompasses data acquisition to its processing and interpretations via a specific platform.	AV
Stormwater harvesting for aquifer storage and recovery in Adelaide	Australia	Salisbury Water Team	An integrated approach to manage urban water which consists in a wetland treatment and after that a step of aquifer storage and recover (ASR) or aquifer storage, transfer, and recovery (ASTR) in confined aquifers to provide sustainable water supply for non-potable uses.	PWP
Using MAR to mitigate saltwater intrusion in Southern Malta coastal aquifer	Malta	Maltese energy and water agency	Consists in a series of injection experiments using highly polished treated wastewater to curb the advance of salty water in the aquifer. It is applied in combination with other methods associated with agriculture and industrial water use.	PWP
Riverbank filtration for water quality improvement in a MAR scheme in Berlin	Germany	Berlinwasser Group	This initiative aims to induce the infiltration of surface water as a groundwater reserve to be used in the future as a source of potable	PWP

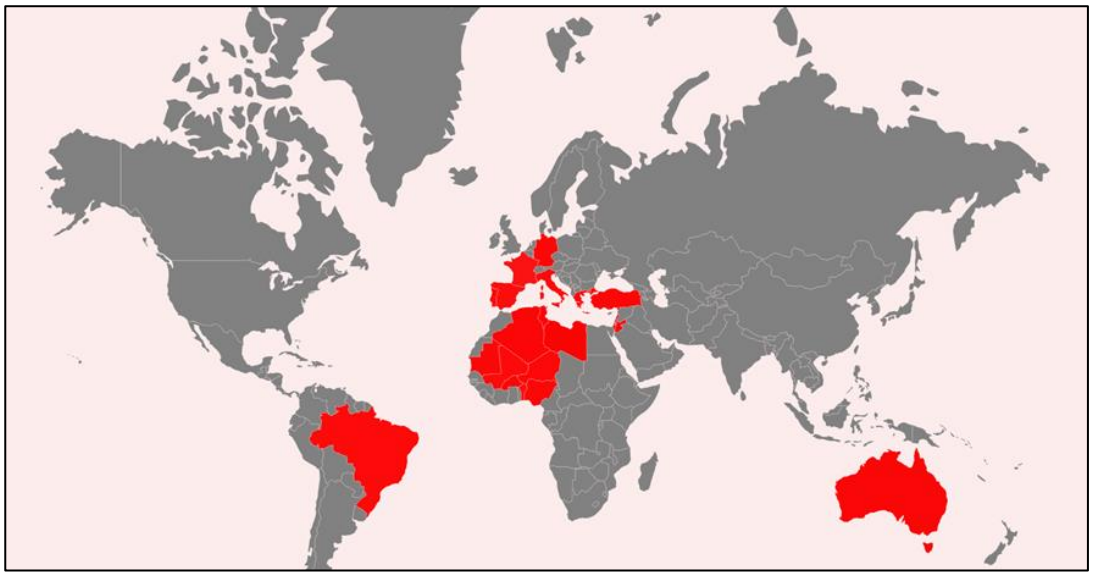
			water. It is extracted from the riverbank whose sediments and soil provide a primary treatment to the abstracted water.	
Subsurface dams for groundwater storage in semi-arid regions of Northern Brasil	Brazil	Minister of Citizenship of Brazil	Underground dams built with the objective to store and provide water supply to small villages or communities and agricultural activities. These dams are able to store larger volumes of water than natural alluvium aquifers.	PWP
Groundwater licencing and trading, the case of the state of Victoria	Australia	Victorian Ministry for Water	Groundwater entitlement emission have been increasing but faces some issues concerning the definition of sustainable volume caps and lack of knowledge. However, its private use has benefits such as no evaporation loss, pushed by the market.	PWP
The Portuguese Corporate Manifest for water stewardship	Portugal	Catolica – Lisbon Scholl Center for Responsible Business & Leadership	This association aims to create a business value from providing the correct funding and qualified staff to address water problems. Its partner entities assume the responsibility to adopt more sustainable measures for water management.	PWP
INOWAS – A web-based system to support the successful implementation of MAR methods	Germany	Dresden Technical Univsersity (TUD)	A free web-based modelling platform for planning, assessment and optimization of MAR. It comprises a set of tools for finding the optimal location of schemes, assessing parameters for optimal design and operational management, as well as the quantification of impacts.	PWP
Portuguese national water resources information system (SNIRH) – A public portal with all the available information on water resources	Portugal	Portuguese Environmental Agency (APA)	Web portal where Portuguese Environmental Agency loads, validates and makes available water resources data to the public, including hydrometeorological, quantity and quality information from surface, coastal, transnational and groundwater bodies.	PWP
Monitoring groundwater-dependent ecosystems using synthetic aperture radar (SAR) imagery in Australia	Australia	Commonwealth Scientific and Industrial Research Organization (CSIRO)	Aims to properly identify Groundwater Dependent Ecosystems (GDE) and their relations with their surrounding ecosystems to achieve an integrated water resources management. This technique provided good results for different surveillance applications.	PWP
Vadose-zone monitoring system for real-time characterization of	Israel	Ben Gurion University	This innovative system enables continuous monitoring and water sample collection directly from the vadose zone, providing real-time, continuous tracking of water	PWP

contaminants leaching to groundwater in Israel			percolation and contaminant transport from surface to groundwater.	
TOTAL NUMBER OF PRACTICES	**30**			

The selection of the practises was done to exemplify the actions taken in diverse geographic zones where groundwater scarcity is an issue in terms of quality and quantity or where the stakeholders face governance problems. The selected practices are implemented in European and African countries as well as in Brazil and Australia.

In the following map the distribution of the good practices among the abovementioned countries is showcased.

Figure 1. World distribution of success stories in the groundwater management practices listed in the Table 1.



3.4. EBOOK OF GOOD PRACTICES AND TRANSNATIONAL WEB PLATFORM

The final aim of these activity is to prepare a total of 30 good practices sheets that are going to be gathered in a final version of a good practices' eBook. This eBook

corresponds with the deliverable 4.1.2. of the project and is going to be a reference document providing a broad scope of the innovative practices in aquifer management that are currently conducted worldwide.

This eBook is going to be translated into four languages (English, Spanish, French and Portuguese) and disseminated throughout the SUDOE territory and beyond.

In addition, the 30 selected practices are going to be displayed in the trans-national web platform that is going to be launched as a part of the activity 4.2 of the project. This trans national web platform is going to be used as a reference for the future implementation of other aquifer management practices in SUDOE territory.