iMERMAID

D5.4: Final release of multi-stakeholder web interface

Task 5.5: Multi-stakeholder web interface with solutions' Showcase

WP5: Roadmaps for uptake and scalability of the innovative solutions

Authors: Marco Micotti, Elena Matta, Elisa Bozzolan, Simone Corti, Davide Cantaluppi and Enrico Weber, SoftWater

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CONTRIBUTORS	ZEN, ITCL
ABSTRACT	This deliverable presents the release of the **iWIRE multi-stakeholder web interface**, developed to support the exploration of monitoring and remediation results across Mediterranean demonstration sites. iWIRE integrates heterogeneous environmental data into interactive dashboards and provides public and restricted access to project outcomes. The platform supports data-driven assessment, comparison across use cases, and dissemination to stakeholders and decision makers.

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Document history

Version	Description of changes	Author	Role in the project
0.1	Table of content and structure of the document	Elena Matta, Marco Micotti (softwater)	Beneficiary
0.2	First draft	Elena Matta, Marco Micotti, Elisa Bozzolan, Simone Corti, Davide Cantaluppi and Enrico Weber (Softwater)	Beneficiary
0.3	Internal review	Andjela Markovic (ZENTRIX)	Beneficiary
0.4	Final draft	Marco Micotti (SoftWater)	Beneficiary
1.0	Final review and formatting	Rodrigo Sedano (ITCL)	Project Coordinator

Executive Summary

Deliverable 5.4 reports on the release of the Water Information and Remediation Platform (iWIRE), developed under Task 5.5 of the iMERMAID project. iWIRE is a multi-stakeholder web interface designed to enable the effective exploration of project results across the project's demonstration sites.

The platform combines a content management system with interactive data visualisation dashboards to integrate laboratory analyses, in situ and sensor data, climate datasets, and contextual information. Its modular and fully open-source architecture ensures interoperability, scalability, and reusability.

Five public dashboards have been co-developed with Use Case Leaders, each representing a Mediterranean use case (Spain, Tunisia, Italy, Cyprus, and Greece), and providing site overviews, water quality indicators, climate conditions, and monitoring highlights. Additional dashboards include those related to the Associated Projects and the European Junior Water Programme (EJWP) dataset. Dashboards support predefined visualisations and facilitate comparison across sites and technologies.

iWIRE includes differentiated access levels to address data sensitivity constraints and supports dissemination and outreach activities by providing public access to key project outcomes. The platform represents the final release foreseen in Task 5.5 and establishes a robust digital infrastructure to support environmental monitoring, remediation assessment, and decision-making at the Mediterranean scale.

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Acronyms

AoI	Areas of Interest
API	Application Programming Interface
ARPA	Agenzia Regionale per la Protezione Ambientale
CMMI	Cyprus Marine and Maritime Institute
CMS	Content Management System
CoEC	Contaminants of Emerging Concern
D	Deliverable
DoA	Description of the Action
ESDAK	Unified Waste Management Association of Crete
EU	European Union
FAIR	Findable, Accessible, Interoperable, and Reusable
GA	Grant Agreement
GDPR	General Data Protection Regulation
IPR	Intellectual Property Rights
ISO	International Organization for Standardisation
iWIRE	Water Information and Remediation Platform
M	Month
MS	Milestone
MSFD	Marine Strategy Framework Directive
T	Task
TBD	To be determined/To be defined
SMAT	Società Metropolitana Acque Torino S.p.A.
UC	Use Case
WFD	Water Framework Directive
WP	Work Package
WPL	Work Package Leader
WWTP	Waste Water Treatment Plant

1. Introduction

1.1 Purpose of the deliverable

This deliverable reports on the final release of the Water Information and Remediation Platform (iWIRE), developed within the iMERMAID project as the main output of Task 5.5 Multi-stakeholder web interface with solutions' Showcase. The purpose of this document is to describe the current structure, functionalities and technical implementation of iWIRE, and to demonstrate how it addresses the objectives defined in the Grant Agreement (GA).

In particular, the deliverable provides an overview of the system architecture, the data integration and management approach, the interactive dashboards and solution showcase currently available on the platform.

iWIRE is publicly available and fully operative[1], also directly accessible from the iMERMAID project's website[2].

1.2 Relation to Task 5.5 and Other Project Tasks

This deliverable is directly linked to Task 5.5 – Multi-stakeholder web interface with solutions' showcase and represents its main final output. Task 5.5 aims at implementing a web-based platform to support the exploration of project outcomes, the integration of heterogeneous datasets and the dissemination of chemical monitoring and remediation solutions developed within iMERMAID.

The iWIRE platform builds upon requirements collected by Use Cases Leader, presented in report MS10 "First prototype of the multi-stakeholder web interface", and contributions from other project tasks: report D4.2 "Benchmarking and Analysis of current aspects, requirements, specifications & conceptual architecture in particular" provided input on technologies development, the data life cycle in iMERMAID and the general architecture of iMERMAID platform. Moreover, data exchange format specification set up in Task 2.5, provided the framework to automate data exchange through APIs. Additional contributions originate from Associated projects involved in Open Call activities managed by WP6.

Through this integration, iWIRE acts as a transversal digital layer within the project, connecting data generation, technological innovation and dissemination activities into a unified, interoperable and user-oriented platform.

[1] https://iwire.soft-water.it/
[2] https://imermaid.eu/

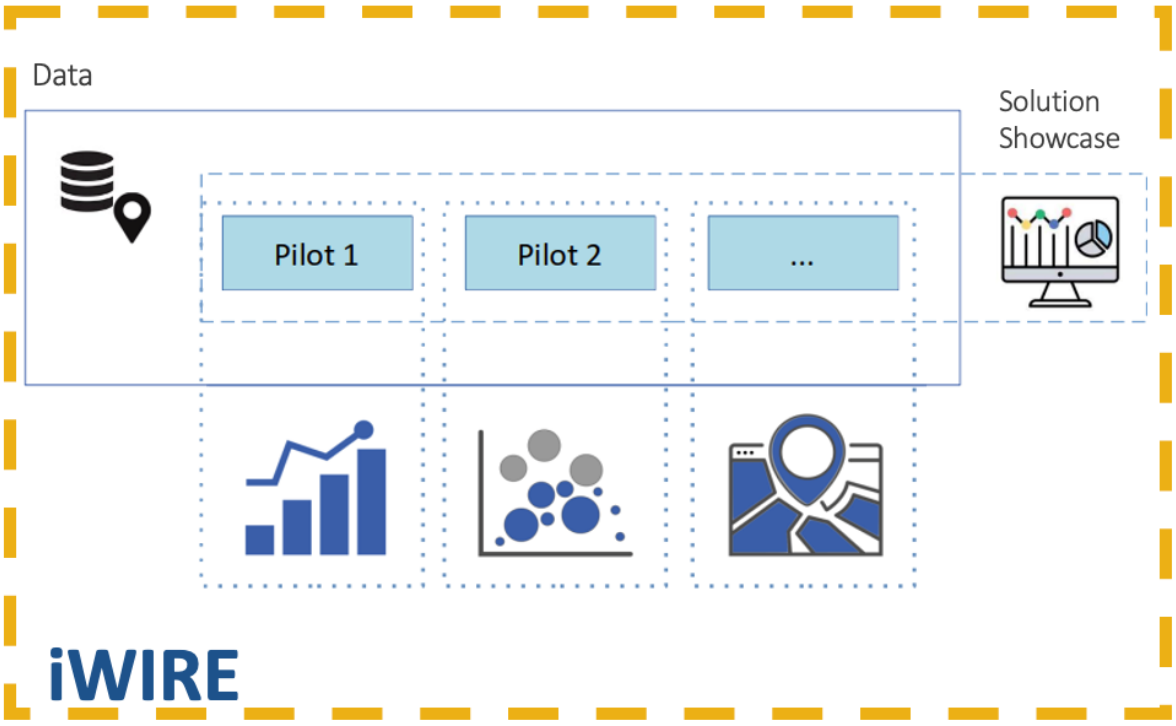

Figure 1: iWIRE conceptual scheme: vertical visual analytics dedicated to each Pilot area are integrated into a unique visualization environment.

2. Overview of the iWIRE Platform

2.1 Concept and Objectives of iWIRE

iWIRE is a web-based platform designed to collect, harmonise, and visualise environmental and water quality data, providing a unified entry point to explore site-specific characteristics, monitoring data, climate conditions, and the performance of remediation activities.

The platform supports interoperability by integrating heterogeneous datasets from laboratory analyses, in situ sensors, climate services and regulatory sources. Data ingestion is enabled through a wide range of input formats, from simple text files to standardised data structures and API-based connections. This approach enables seamless data exchange between tools and facilitates cross-disciplinary analyses spanning hydrology, environmental monitoring, and water treatment processes.

The platform software architecture combines a modular Content Management System with interactive data-visualisation dashboards. Public-facing content and access management are handled through a Drupal[3]-based frontend, while use-case dashboards are developed in Redash[4] and dynamically connected to structured datasets hosted in the iMERMAID Backend platform and connected via API, or stored into online spreadsheets. This architecture enables both near-real-time updates and flexible data integration and visualisation across heterogeneous data sources.

To address data-sensitivity constraints, the platform supports differentiated access levels, combining publicly accessible dashboards with restricted views for confidential wastewater treatment plant data.

Figure 2 presents the iWIRE Landing page[5]:

[3] www.drupal.org
[4] https://redash.io/

[5] https://iwire.soft-water.it/

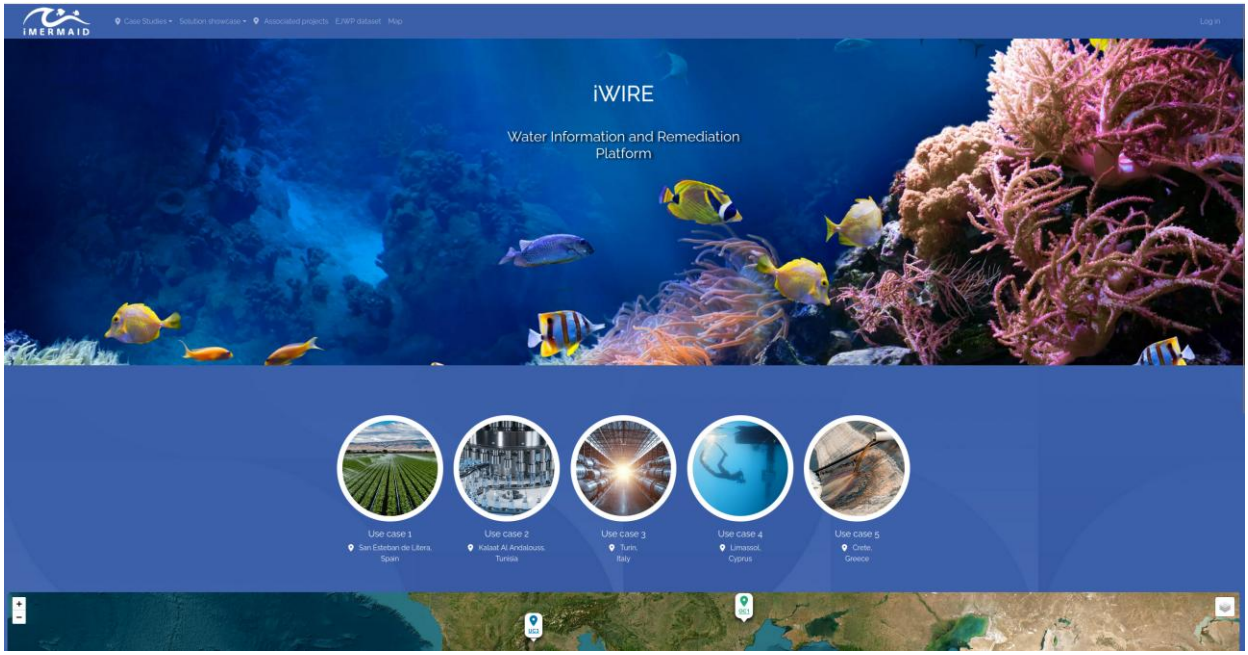

Figure 2: Landing page of iWIRE platform, available at https://iwire.soft-water.it/

The Landing page provides quick access to all platform content, both through the top menu bar and contents displayed:

- Case studies: interactive dashboards, providing useful insights and monitoring data for each case study (see Section 4.2).
- Solution showcase: a collection of descriptive pages providing highlights of technologies developed inside iMERMAID (see Section 4.4).
- Associated Projects: a summary dashboard reporting information gathered from associated regions implementing the open calls cascading fund (see Section 4.3).
- EJWP dataset: a summary dashboard resulting from the European Junior Water Programme project on *Environmental Data Exploration for iMERMAID Demo Sites - Supporting Data-Driven Environmental Insights Across Mediterranean Case Studies.*
- Map: Interactive Map showing the location of all Use Case studies and Associated projects, giving direct access to related dashboards (see Figure 3).

Figure 3: Interactive Map showing the location of the five use cases (UC1-5) and associated regions (OC1) and giving direct access to related dashboards.

2.2. Data Integration & Visualization Layer (Redash)

Data visualization and dashboards are managed by Redash, a component of iWIRE designed to make data access and analysis easier for both technical and non-technical users. Its core functionality is built around querying data from multiple sources, visualizing results, and sharing insights through interactive dashboards.

One of Redash's main strengths is its broad support for data source integration. It can connect to relational databases (such as PostgreSQL, MySQL, or SQL Server) as well as lighter, file-based or external data sources. In iWIRE, several data sources have been used:

- iMERMAID JSON API: the iMERMAID backend platform provide standard API, able to publish both real-time and file-based data streams in a JSON format (see Section 3.3).
- Partners custom APIs: on request of specific partner, dedicated API connection have been created, to integrate partner dataset into iWIRE.
- Online spreadsheets are used to collect context data from pilot areas in a simple and accessible way. Each pilot area owner has direct access to their own spreadsheet, allowing them to update data autonomously. This approach relies on a low-technical barrier tool that is easy to use, while still being effective for data integration and analysis.
- Redash internal data source: a virtual layer created directly into redash to merge seamlessly data from different sources and use them in the same query or visualization.

The wide data format supported by Redash makes it easy to eventually extend it to work with other datasets or data extracts generated by other systems.

2.3 Modularity and Reusability in Redash

Redash is designed with a high level of modularity, which increases flexibility and reuse across analyses. A single query can combine or be replicated across different data sources, depending on the connector used.

The same query result can then be represented through multiple visualizations such as tables, line charts, bar charts, or pie charts, without rewriting the underlying query.

These visualizations are independent components that can be reused across multiple dashboards. A single dashboard can integrate visualizations coming from different queries and different data sources, while the same visualization can also appear in multiple dashboards if needed. This modular structure allows teams to maintain consistency, reduce duplication, and adapt dashboards to different audiences while relying on the same underlying data logic.

Overall, Redash's combination of flexible data source integration and modular design makes it a practical tool for building scalable, maintainable, and collaborative data reporting environments.

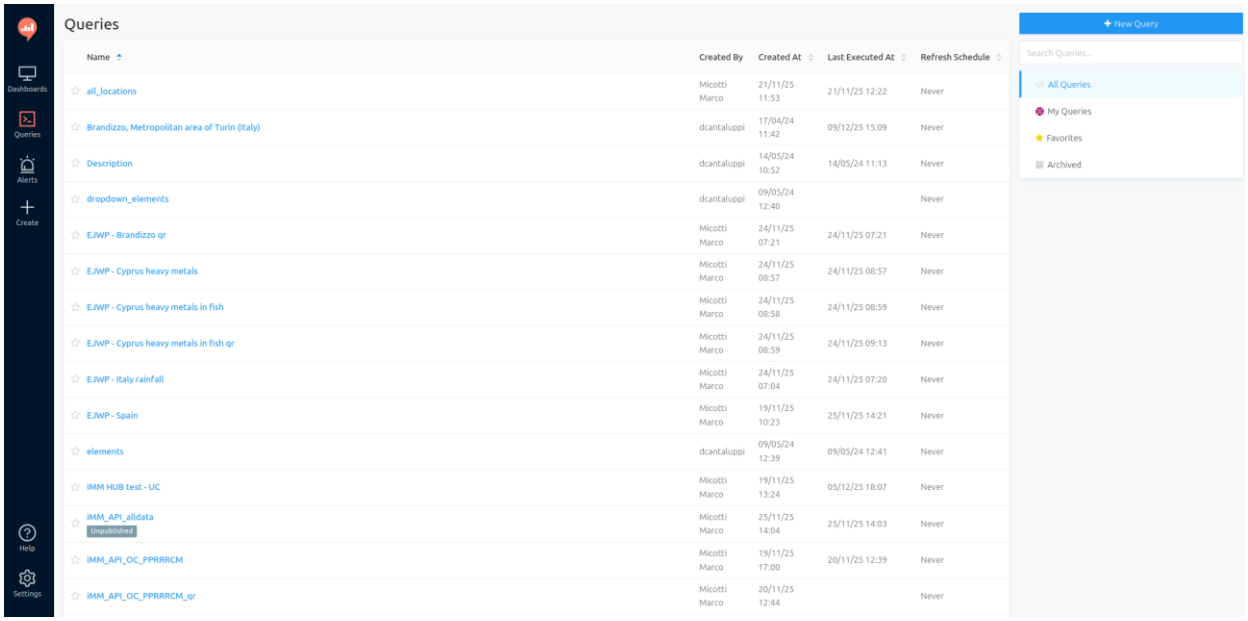

Figure 4: Example of Redash internal catalogue of Queries: each query can be created using one or more data sources and generating several visualizations.

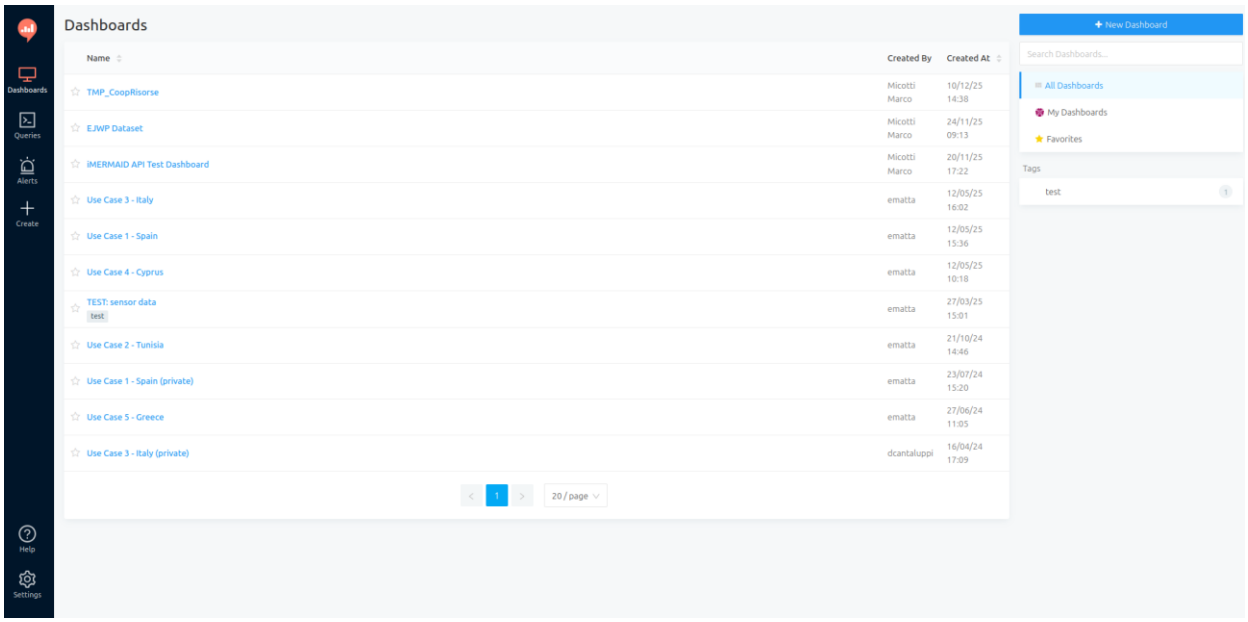

Figure 5: Example of Redash internal catalogue of Dashboards: each dashboard is a collection of query visualizations.

3. Data Integration and Management

3.1 Types of Integrated Data

The iWIRE platform integrates different datasets in a heterogeneous variety of formats and sources with the objective of providing a unified and user-friendly view of monitoring and remeditationa ctivities across the project demonstration sites. Figure 6 shows the flow of data generated in the context of the iMERMAID project, tested in the different Use Cases produces data that flow first through the ITCL Hub and then, into the iMM Backend to end in the dashboard and visualizations of iWIRE frontend.

Moreover, iWIRE have capabilities to include also data coming from external source but useful, according to Use Case Leaders, to present information related to their site, like:

- **Laboratory and water quality data**, derived from regular measurements and analyses conducted by Use Case leaders and/or their subcontractors (e.g., wastewater treatment plant laboratories), as well as by Associated Regions, including key physical and chemical parameters such as BOD, COD, pH, conductivity and nutrients.
- **Climate and environmental datasets**, mainly based on observations from ground stations and online weather services (e.g. ARPA, Visual Crossing), providing contextual information on temperature, precipitation and other climatic variables of interest.
- **Ancillary and contextual data**, including site descriptions, geographic information and qualitative metadata supporting the interpretation of monitoring results.

These data are not integrated in the iMM Backend but provided and managed directly by partners leading the different Use Cases. This combination of datasets allows iWIRE to support cross-disciplinary analyses spanning water quality monitoring, environmental conditions and remediation processes.

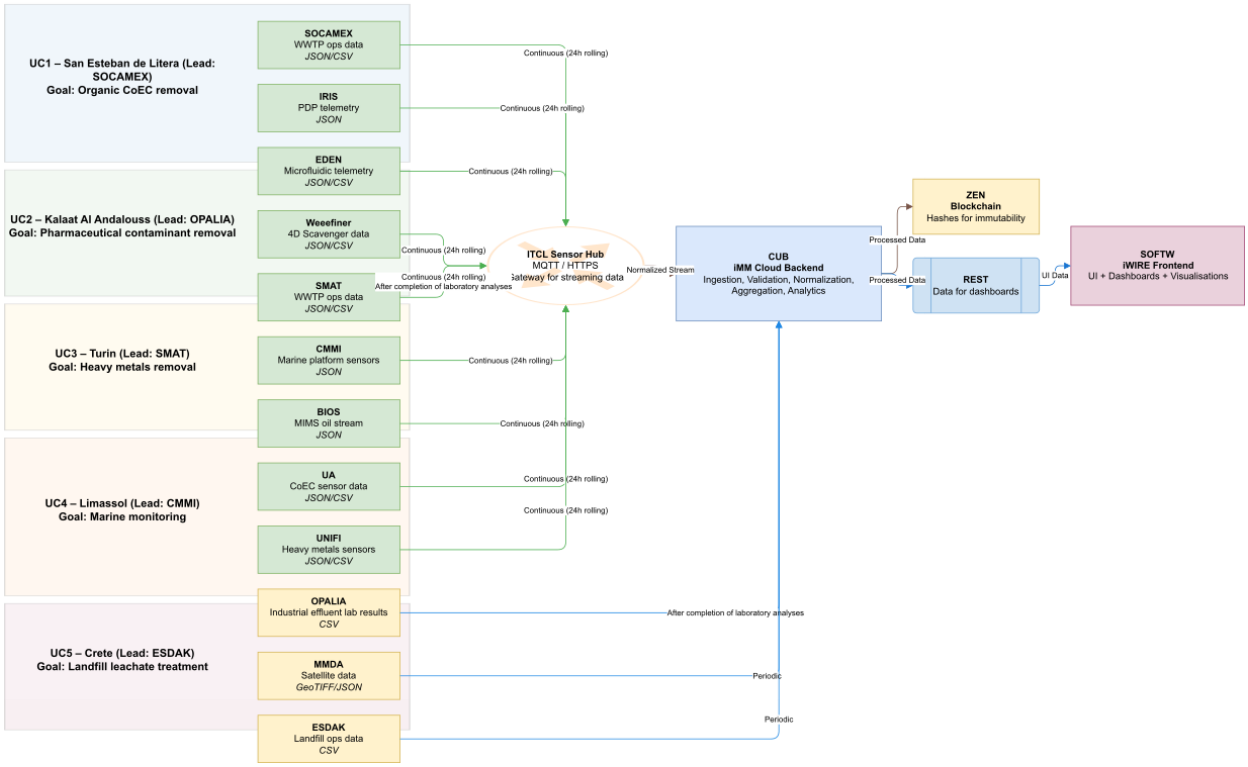

Figure 6: iMERMAID Data Flow, from use cases and technology providers to iWIRE.

3.2 Data Sources and Input Formats

Data integrated into iWIRE originate from multiple sources, including Use Case leaders, technology providers, external climate services, and Associated Projects[6]. During Task 5.5, data collection was coordinated through dedicated exchanges with Use Case leaders (SOCAMEX, OPALIA, SMAT, CMMI and ESDAK), aimed at identifying relevant water quality parameters and harmonising data formats.

Input data from use cases and associated regions are currently provided through structured spreadsheets and tabular datasets, which are stored in shared project repositories (Google Drive) and linked to the visualisation layer (see Section 2.2). This approach enables collaborative data updates (usually monthly or seasonal) and progressive enrichment of the datasets over time, while maintaining traceability and consistency across use cases. Manually collected data, including laboratory measurements and water quality parameters, are uploaded by the Use Case Leaders to dedicated folders within the shared Google Drive. These datasets are then refined and post-processed by the softwater team, which also periodically

[6] https://imermaid.eu/associated-projects/

retrieves meteorological data from external weather services (either manually or via API) and stores them in the corresponding project folders.

Table 1: Example of information collected on type of data, source, and access requirements for UC1 (Italy, SMAT), reported in the Excel file "iMERMAID_dashboard_requirements.xlsx" on the project's internal SharePoint.

Type of Data	Analysis	Source	Access requirement	Additional request and/or specifications
Water quality	SMAT Lab analysis	UC leader	Open / Restricted	Lab analysis used for validation of the HM monitoring box could have the same access requirement of sensor data (Open? TO be discussed also with UNIFI) Other water quality data should be accessed only within iMERMAID consortium Data can be accessed through API - For some data (BOD, COD, SST, N, P - actually not included in the dashboard), it could be useful to calculate some index (mean abatment percentage).
Water quality	Sensor data	iMERMAID	Open	
Climate	Web	ARPA Piemonte	Open	
WWTP Flow rate	SMAT sensor data	UC leader	Open (if needed)	Access through API

3.3 API Connection to iMERMAID Backend

The iWIRE platform is designed to be interoperable with the data collection framework developed within Task 2.5 and led by CUB (see Figure 7). Data integration is achieved through API-based connections, enabling automated data exchange between the iMM backend infrastructure and the iWIRE visualisation layer.

This architecture allows near real-time updates of selected parameters measured through sensors to monitor the performance of iMERMAID technological solutions and supports the progressive transition from manual data ingestion to dynamic data streams, as additional sensors and monitoring systems become available. The API-based approach ensures scalability and facilitates the integration of new data sources beyond the project lifetime.

The overall process from data acquisition to data publication in Redash can be structured into the following steps:

1. Data acquisition from the iMERMAID JSON API

Raw data are retrieved from the iMERMAID HUB through a JSON-based API, which exposes structured and machine-readable datasets. This interface ensures a consistent and automated data ingestion process, enabling periodic updates and integration of heterogeneous data sources into the analytics platform.

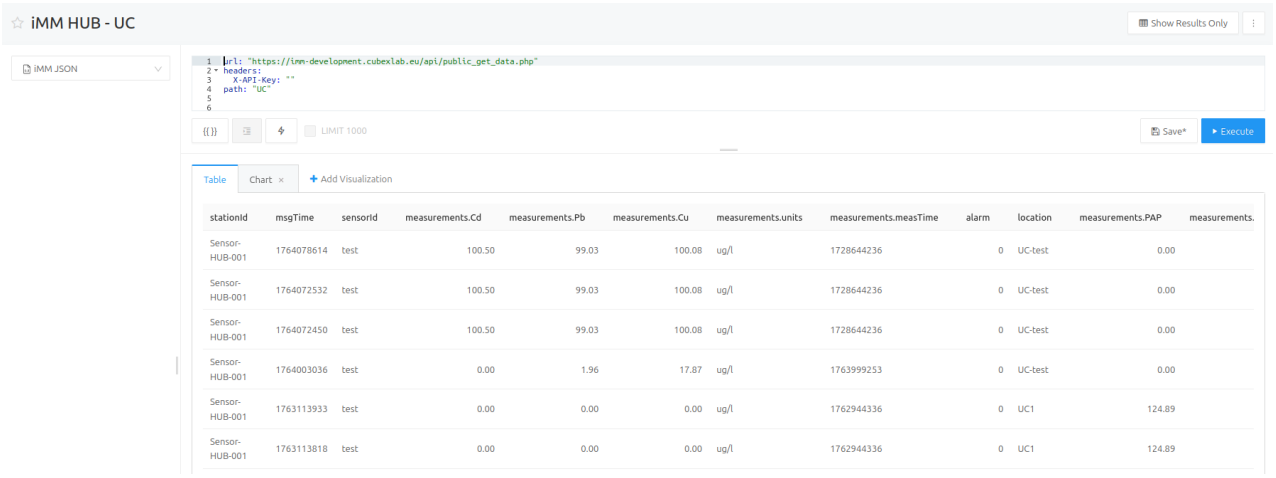

Figure 7: Example of data acquisition from iMERMAID JSON API.

2. Data refinement using Redash SQL Query Results

The ingested data are processed within Redash using SQL queries that act as a logical refinement layer. In this step, field names are standardised, data formats are cleaned and harmonised (e.g. numeric values, text encodings, and units), and temporal information is explicitly managed through date parsing and transformation. In addition, parametric filters are introduced in the queries to enable dynamic selection of time ranges, spatial units, or thematic categories. These parameters are later reused as interactive controls within dashboard visualisations, ensuring consistency across views.

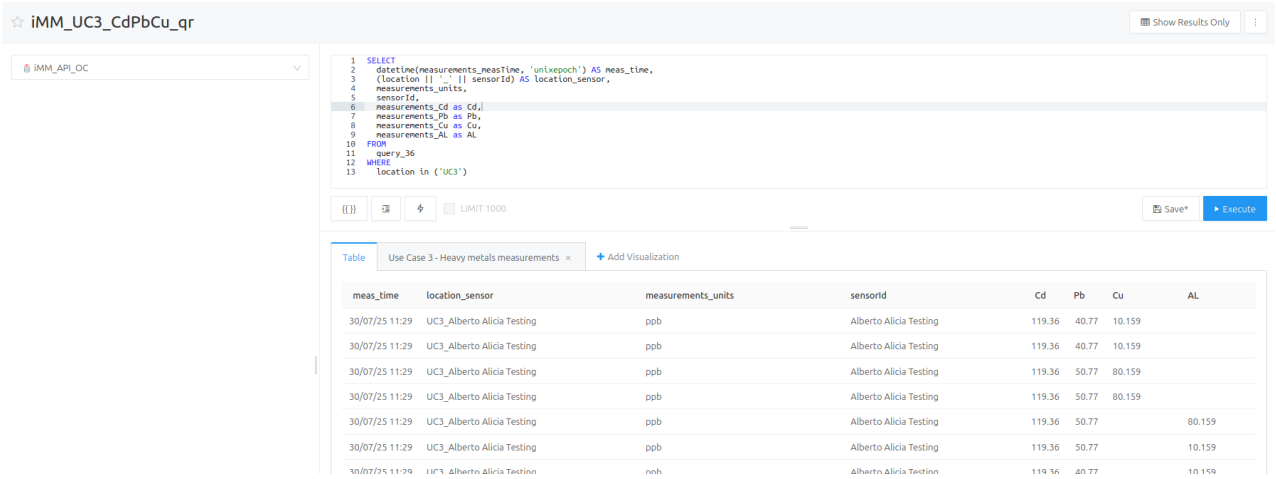

Figure 8: Example of data refinement.

3. Visualisation definition

For each refined dataset, one or more visualisations are defined by selecting the most appropriate representation (e.g. charts, maps, or tables) and configuring visual properties such as axes, legends, colour scales, and aggregations. This step translates analytical results into clear and interpretable graphical outputs tailored to the target indicators.

Figure 9: Redash visualisation editor and configuration panel.

4. Dashboard composition and publishing

The individual visualisations are finally assembled into one or more Redash dashboards, where they are organised thematically and linked through shared parameters. This enables coordinated filtering and interactive exploration of the data across multiple views. Once configured, dashboards are published and made available to end users as a unified, interactive analytical interface.

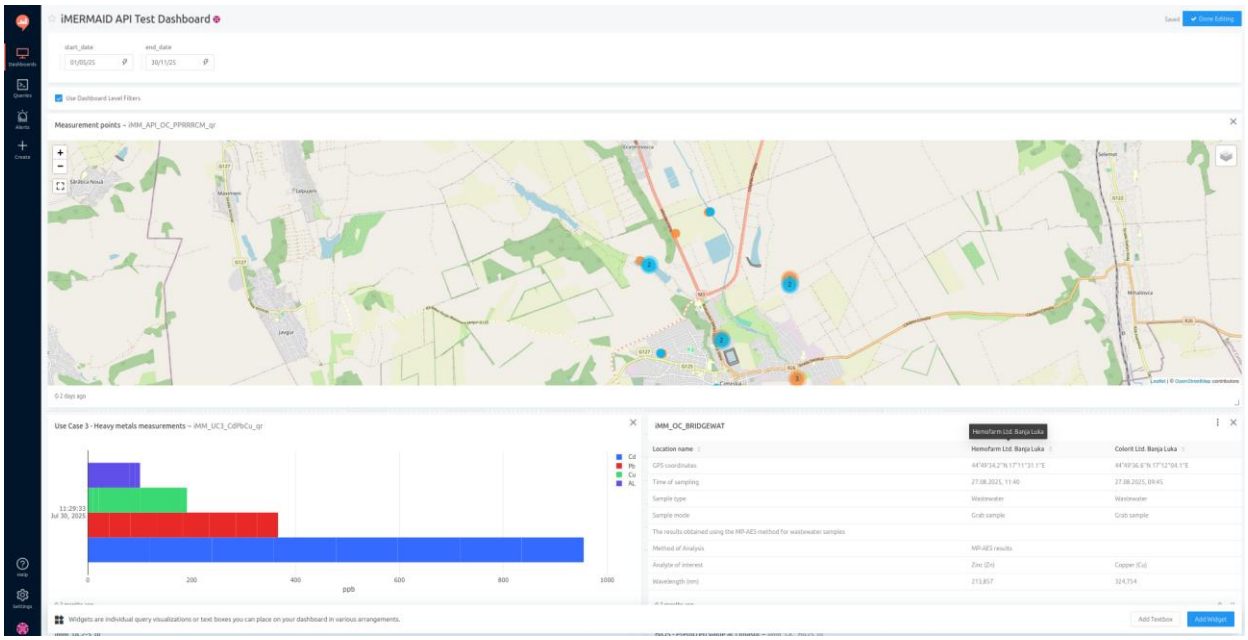

Figure 10: Redash dashboard layout with shared filters and widgets.

4. Interactive Dashboards and Solution Showcase

4.1 Design Principles and Functionalities

The interactive dashboards represent the core user-facing component of the iWIRE platform. Their design is based on a user-oriented and co-development approach, supported by several online meetings and exchanges with Use Case leaders and project partners. Requirements collected have been included in the Annex I of Report MS10 First prototype of the multi-stakeholder web interface: beyond specific requirements in term of type of charts and data to be displayed on each map, use case leader expressed the need to have visual tool able to: integrate project data with their own internal laboratory datasets, include reference threshold for quick detection of anomalies, give them the possibility to frame the analysis in the territorial and meteorological context where each case study is located.

Following these suggestions, iWIRE dashboard design has been drive by these key principles:

- Clarity and accessibility of information for non-technical users.
- Consistency of visual elements across Use Cases.,
- Support for comparative analysis.
- Flexibility to accommodate different data availability levels.

Dashboards provide predefined visualisations and filtering options, enabling users to explore monitoring results according to specific parameters, time periods and sites.

Figure 11 reports an example of admin view in Redash, where different datasets were combined on the same visualization plot effectively using different visualization styles (e.g., line or bar plots) to represent different components/parameters (e.g., sensor data, precipitation, heavy metals measurements). On the left-hand side bar, the admin is allowed to create and edit different queries and dashboards, as well as managing refreshing frequency and public access links.

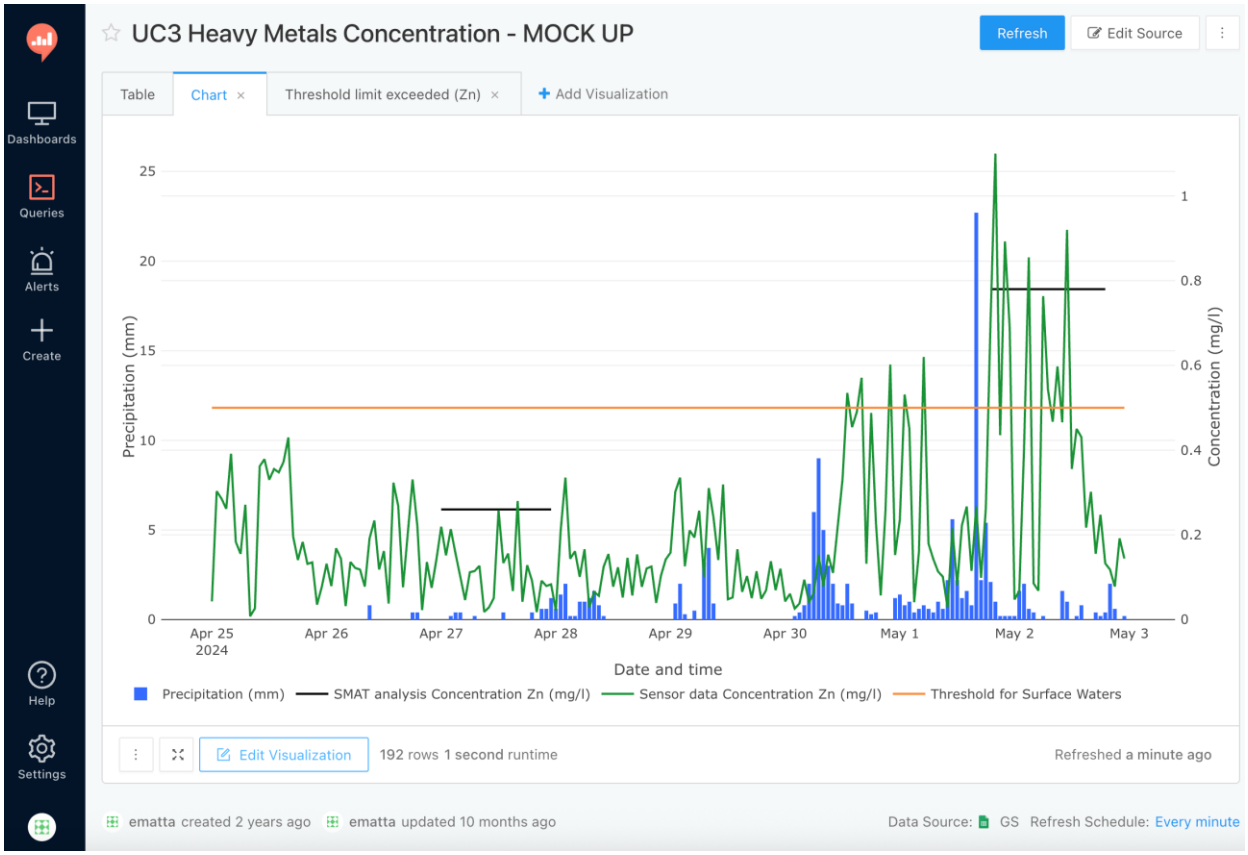

Figure 11: Screenshot of the first mock-up dashboard for UC3 (Brandizzo, Italy) showing different sources of data and plots on the same visualization layer.

4.2 Use Case Dashboards

Five dashboards corresponding to iMERMAID Use Cases (UC) have been co-designed with UC leaders and developed on Redash, characterized as follows:

- UC1 in San Esteban de Litera (Spain): Demonstration of innovative solutions for the removal of contaminants from wastewater, managed by SOCAMEX.
- UC2 in Kalaat Al Andalouss (Tunisia) Demonstration of innovative solutions for the removal of pharmaceutical contaminants from wastewater, managed by OPALIA.
- UC3 in Brandizzo (Italy) Demonstration of innovative solutions for the removal of heavy metals from wastewater, managed by SMAT.
- UC4 in Limassol (Cyprus), Monitoring platform on the Mediterranean Sea, managed by CMMI.
- UC5 in Pera Galini-Crete (Greece) Demonstration of innovative solutions for the removal of organic contaminants from landfill leachates, managed by ESDAK.

Dashboard's requirements have been discussed and agreed with UC leaders and resulting information collected in a shared Excel file (see Table 2) stored on iMERMAID internal SharePoint, as anticipated in Section 3 of this deliverable.

Table 2: Summary of UC leaders' requirements.

Use Case	Demo Site / Leader	Dashboard Structure & Main Content	Data Types Visualised	Temporal Coverage	Update Frequency	Data Sharing Status
Spain	SOCAMEX	Multi-level dashboard including site map, UC overview, description of target pollutants and installed technologies, water quality indicators, treatment performance (IN–OUT), and climate data. Two configurations available (internal and public).	Laboratory water quality parameters (e.g. BOD, COD), operational indicators, meteorological data (P, T); project demo data during piloting	TBD	TBD	Internal sharing approved; public sharing enabled for selected content
Tunisia	OPALIA	Four-level dashboard including site overview, regulatory context, outlet water quality indicators, performance monitoring (IN–OUT), and climate data.	Organic, inorganic and nutrient parameters, conductivity, pH, meteorological data, water temperature	TBD	Monthly	Internal and public sharing approved
Italy	SMAT	Multi-level dashboard with site overview, UC description, routine lab analyses, operational parameters, climate data,	BOD, COD, heavy metals, discharge, energy consumption, sensor data (during piloting), climate data	From 01/01/2024 to present	Daily	Internal sharing approved; public sharing enabled for selected content

		and integrated plots combining lab data, sensor data and regulatory thresholds. Internal and public versions available.				
Cyprus	CMMI	Compact two-level dashboard including site overview, UC description, climate data and dedicated panels for oil and heavy metal sensors during piloting.	Meteorological data (P, T), oil and HM sensor data (when available after piloting)	TBD	Daily	Internal and public sharing approved
Greece	ESDAK	Multi-level dashboard including site overview, outlet water quality data, operational parameters, RO technology efficiency indicators, climate data, and LOD information.	Outlet water quality parameters, conductivity, pH, RO efficiency indicators, climate data	01/06/2023 – 31/05/2026	Daily	Internal and public sharing approved

Each dashboard presents an overview of the site, including water quality indicators derived from laboratory analyses, selected climate variables and contextual information relevant to the monitoring and remediation activities.

The dashboards are dynamically linked to the underlying datasets and are progressively updated as new data become available. This ensures consistency between the visual outputs and the most recent monitoring information.

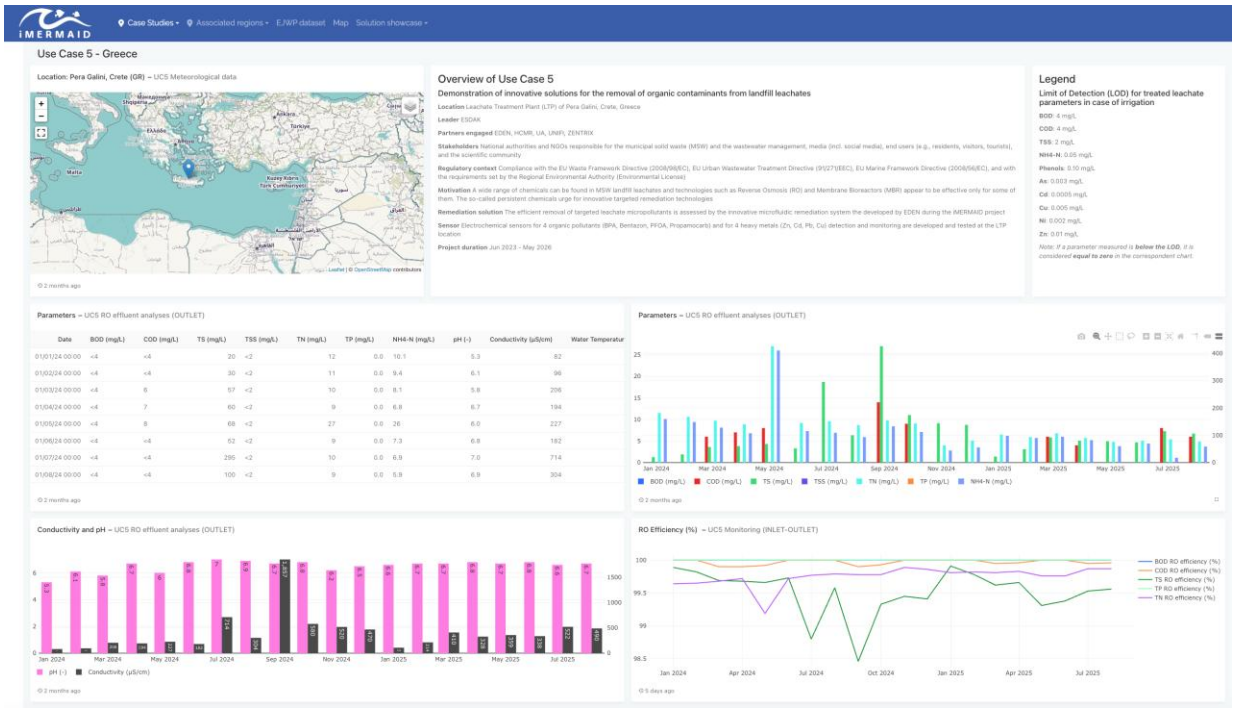

Figure 12: Screenshot of the dashboard created for UC5 located in Pera Galini, Crete (Greece).

4.3 Associated Projects and EJWP Dashboards

In addition to the main Use Case dashboards, iWIRE includes dedicated dashboards for the **Associated Projects** and for the **European Junior Water Programme (EJWP)** dataset. These dashboards extend the scope of the platform beyond the core demonstration sites, providing additional examples of data integration and visualisation.

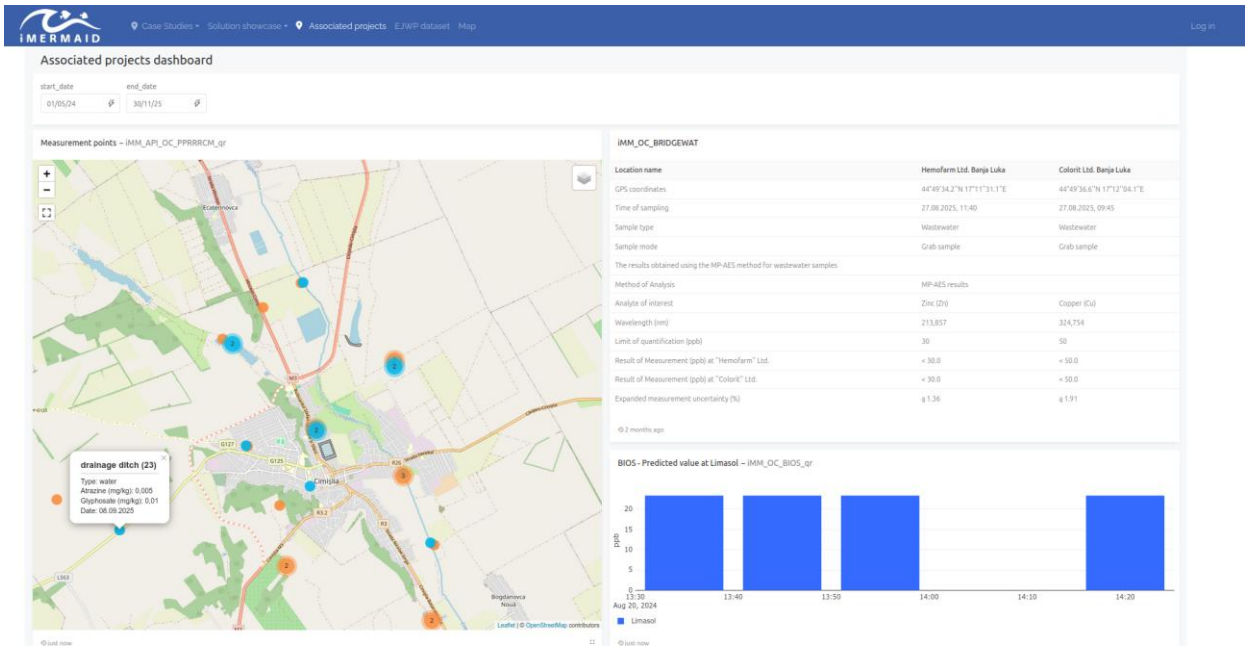

Figure 13: Associated project's outcomes dashboard.

4.4 Solutions Showcase

The iWIRE platform includes a **Solutions Showcase** component, designed to collect and present structured information on chemical monitoring and remediation technologies developed within the project.

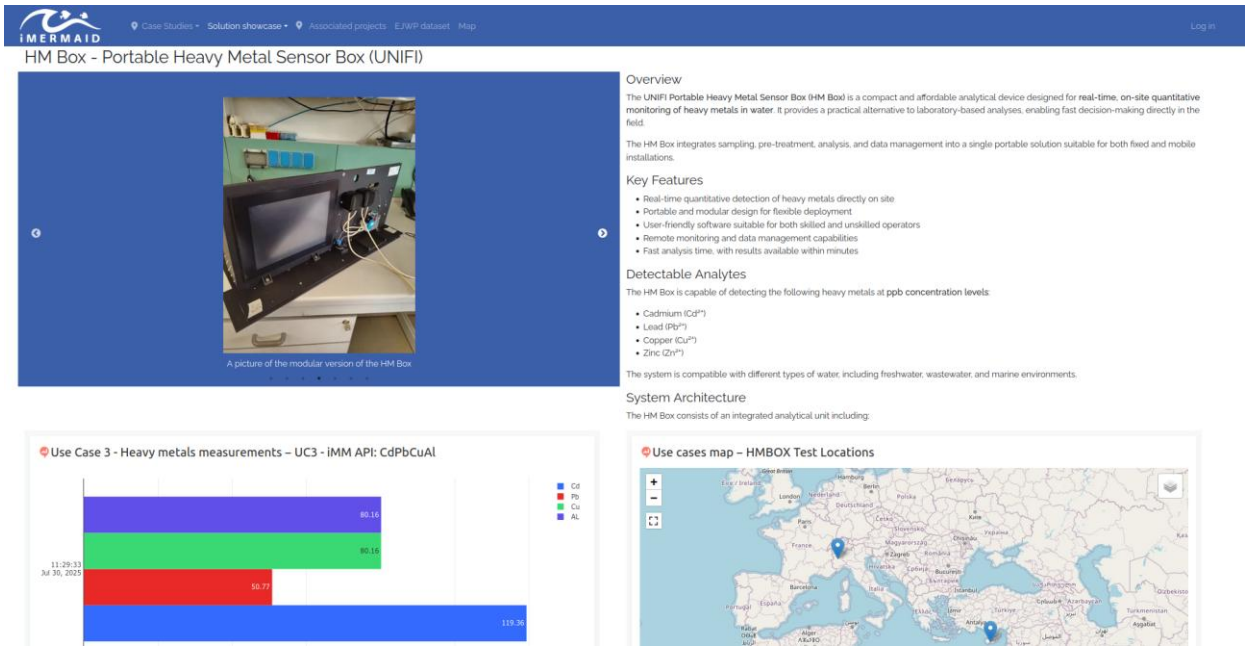

Figure 14: Solution showcase page example for the Heavy Metal Sensor Box.

The catalogue presents each solution through four distinct sections:

1. A carousel of images related to solution implementation.
2. A brief technical description, including main technical characteristics, application context, expected impacts, and contact of leading partner.
3. An interactive chart reporting sample data related to the specific solution.
4. A map with the location of Use Cases involved in the solution deployment.

This component contributes to the overall objective of Task 5.5 by enabling comparison of solutions, assessment of their potential replicability and scalability, and communication of project results to a broader audience.

5. Conclusions and Future Perspectives

5.1 Achievements with Respect to Task 5.5 Objectives

The iWIRE platform has successfully achieved the main objectives defined in Task 5.5 `Multi-stakeholder web interface with solutions' Showcase' of the iMERMAID Grant Agreement. A multi-stakeholder web interface has been implemented and made publicly accessible, enabling the exploration of project outcomes and monitoring results across all iMERMAID demonstration sites.

The platform integrates heterogeneous datasets and provides interactive dashboards and visualisation tools, supporting comparative analysis and knowledge sharing among different user groups (i.e., UC leaders and project's partners, associated partners, EC reviewers, general public). A structured Solutions Catalogue and Showcase is being implemented, contributing to the dissemination of chemical monitoring and remediation technologies developed within the project.

At the time of this deliverable, iWIRE represents a stable and operational final release, while continuous refinements are ongoing as additional data becomes available from technology solutions and from the iMERMAID backend platform. This progressive enrichment ensures that the platform remains aligned with project developments until the end of the project and preserves its relevance as a living digital infrastructure.

5.2 Potential Extensions and Reuse Beyond iMERMAID

The iWIRE platform is designed as a reusable and extensible digital infrastructure, capable of supporting environmental monitoring and remediation activities beyond the iMERMAID project, as anticipated in D6.2 (AIG). Its modular architecture and open-source technology stack facilitate long-term sustainability and the integration of new datasets, monitoring sites and analytical functionalities.

The close collaboration established with Use Case leaders during the project provides a solid basis for continued operational use of the platform in real contexts. iWIRE will be maintained online for at least one year beyond the end of the project, ensuring secure access for Use Case leaders and environmental agencies through role-specific visualisation tools, while allowing the general public to explore selected project results.

From an exploitation perspective, iWIRE builds upon methodologies and technological components developed within iMERMAID and previous European projects, and it is positioned as a transferable digital asset for future initiatives. Potential extensions include integration into European environmental frameworks, partnerships with regulatory bodies, and adoption by environmental consultancies through tailored service offerings.

By combining interactive dashboards, advanced data visualisation and analytics, and a multi-stakeholder access model, iWIRE has the potential to evolve into a long-term reference platform for monitoring and managing contaminants of emerging concern at regional and European scale.

The Mediterranean Sea and its surrounding regions support a diverse variety of essential socioeconomic activities. It is one of the highly exploited water ways and the influence of anthropogenic activities on its marine habitats and ecosystems has grown significantly since the industrial revolution. Because of this, the Mediterranean Sea basin is very vulnerable to chemical contamination and build-up. To safeguard the Mediterranean Sea basin from contaminants for emerging concerns (CoEC), iMERMAID will integrate, coordinate, and synergize innovative preventive, monitoring, and remediation solutions. iMERMAID will build an evidence-based multidimensional framework that will guide policymaking and transform societal perceptions to reduce CoEC usage, emissions, and pollution. Furthermore, next generation sensor and remediation solutions will be developed within iMERMAID to monitor and remove prioritized chemicals from its source while reducing upstream pollution. iMERMAID builds an ideal interdisciplinary team by bringing together prominent SMEs, researchers, regulators, and innovation professionals who have been essential in improving the knowledge and awareness of CoEC. Beyond state-of-the-art techniques, iMERMAID will strive to strengthen regulations against CoEC, expand economic possibilities and competitiveness, improve the standard of living for EU residents, while preventing the accumulation of chemical pollution in the Mediterranean Sea basin. iMERMAID will empower the efforts to create a zero pollution, contaminant free waters by enabling the Chemical Strategy's goals to become a practical reality.

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