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ABSTRACT	This document is a report accompanying the first version of the Open Knowledge Inventory for Inland Water Systems (OpenKIWAS). It first discusses OpenKIWAS and its usage. It presents the purpose, schema and structure, compilation methodology and analysis of OpenKIWAS. It also presents the file formats of the inventory.		



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List of Acronyms

Short name / Acronym	Full name / Description
API	Application Programming Interface
C3S	Copernicus Climate Data Store
CEMS	Copernicus Emergency Management Service
CMS	Content Management System
DEFRA	Department for Environment, Food & Rural Affairs
DoA	Document of Actions
DT	Digital Twin
DTO	Digital Twin Ocean
EAWAG	Swiss Aquatic Research Institute
ECMWF	European Centre for Medium-Range Weather Forecasts
EEA	European Environment Agency
EO	Earth Observation
EU	European Union
EWA	Energy Water Agency
FOEN/BAFU	Swiss Federal Office for the Environment
H2020	Horizon 2020
HEU	Horizon Europe
LLM	Large Language Model
Mission Ocean	Mission Ocean, Seas and Waters
MSF	Multi-Stakeholder Forum
NGO	Non-Governmental Organisation
OpenKIWAS	Open Knowledge Inventory for Inland Water Systems
QH	Quintuple Helix
R&D	Research and Development
SH	Stakeholder
SME	Small Medium Enterprise
TBC	To Be Confirmed
UN	United Nations
WHO	World Health Organisation



www.ideation-euproject.eu

WMO	World Meteorological Organization
WP	Work Package

Executive Summary

This report accompanies the first version of the Open Knowledge Inventory for Inland Water Systems (OpenKIWAS). OpenKIWAS is an inventory of regulatory, scientific, and technological information. It includes the following catalogues:

1. Catalogue EU and international policies and standards for inland waters
2. Catalogue of projects and information systems outputs
3. Catalogue of scientific research results
4. Catalogue of data models, AI technologies, simulations, intelligent systems and Digital Twins related to inland water
5. Catalogue of inland water open data and sensing sources
6. Catalogue of data and services from national meteorological organisations

OpenKIWAS is compiled using a methodology that involves identifying data sources, keyword searches, and Large Language Model metadata analysis to characterise large datasets automatically.

The inventory is available in .xlsx (Excel spreadsheets) format at the following link: <https://68.221.171.16/openkiwas-first-version>. The tools used for searching and analysing the inventory are also available, along with instructions for recompiling or maintaining OpenKIWAS.

1. Introduction

1.1 Scope

The Open Knowledge Inventory for Inland Water Systems (OpenKIWAS) is a structured inventory derived from systematically analysing and cataloguing the regulatory, scientific, and data landscape of inland water management. This process includes evaluating existing policies, identifying technological advancements, and open data and meteorological services compiling inventories to support digital twin applications.

OpenKIWAS contributes to the IDEATION initiative by mapping the most relevant solutions—spanning policies, technologies, projects, and data spaces—while identifying gaps and proposing new approaches to address unresolved challenges. This report presents a preliminary OpenKIWAS inventory of existing solutions, serving as a foundation for developing the IDEATION reference architecture (WP4) and the IDEATION roadmap (WP5). The inventory will be continuously updated until M21.

1.2 Objectives

The outputs from WP3 will directly support the future development of digital twin applications, ensuring inland water management decisions are informed by a comprehensive, structured, and continuously updated knowledge base.

The primary objective of WP3 is to systematically analyse, catalogue, and integrate knowledge on policies, research, technological tools, and open data related to inland water management, ensuring a structured foundation for digital twin applications. This will be achieved through:

1. Mapping the Policy and Regulatory Landscape
 - Identify and analyse relevant EU and international policies, standards, and regulations governing inland water management.
 - Assess policy frameworks concerning monitoring, forecasting, simulation, and management of inland water systems.
 - Classify policies based on static (slow-changing) and dynamic (fast-changing) parameters affecting water resources.
2. Cataloguing Research Outputs and Innovation Projects
 - Systematically review outputs from past and ongoing research and innovation projects related to inland water management.
 - Compile an inventory of datasets, reports, software, sensors, infrastructures, and digital platforms from various European funding schemes (e.g., FP7, H2020, HEU, LIFE, Interreg).

- Establish connections to open-access information systems (e.g., WISE, Copernicus) to enhance data accessibility.
3. Mapping Scientific Expertise and Advanced Technological Tools
 - Conduct a literature review to classify inland water research based on water type, application focus, and geographical scope.
 - Identify and catalogue AI technologies, simulation tools, intelligent systems, and digital twins supporting inland water management.
 - Assess the applicability of hydrological, hydraulic, and social models in digital twin frameworks.
 4. Creating Inventories of Open Data and Meteorological Services
 - Identify and evaluate open data sources (e.g., environmental, socio-economic, citizen science) relevant to inland waters.
 - Assess data sources from national meteorological organisations, evaluating their accessibility, interoperability, and relevance to digital twin applications.
 5. Supporting the Development of the IDEATION Reference Architecture, by providing a structured and continuously updated OpenKIWAS inventory as a reference for digital twin applications.
 6. Contribute to the IDEATION roadmap (WP5) by integrating the collected data, research, and technological insights.

2 OpenKIWAS Usage Analysis

This section analyses the usage of OpenKIWAS, exploring different use scenarios and user profiles for each case. It also examines the use of Large Language Models (LLMs) in analysing OpenKIWAS results and provides guidelines for extracting relevant information.

In the coming months, OpenKIWAS will implement a Content Management System (CMS) for data access. This section describes the OpenKIWAS CMS.

2.1 Use Case Analysis

In the Document of Action (DoA), seven target groups have been identified (see Table 1) as potential end-users of the future Digital Twin (DT) for inland waters and its components, including the OpenKIWAS. These groups include stakeholders from academia, government, water utilities, industry, further projects, civil society, and non-governmental organisations.

To understand how these end-users might use the inland water DT and OpenKIWAS, for each group a use case has been defined. These use cases highlight specific goals and applications relevant to each group. We considered how a representative user from each target group might use the repository to determine the best way to select project and system information outputs.

In the following, an example use case for each of the seven target groups is presented.

Table 1 - The Target Groups of the future Digital Twin users

Target group	Description
TG1_ARC	Academia and research community Hydrogeology, hydroinformatics and Digital Twin experts, data and computer scientists, AI researchers, data space experts, environmental scientists, biologists, socio-economists
TG2_GOV	Governmental Water regulators, river basin authorities, coastal authorities, government; local, regional, national and EU level), international organisation climate/global change & policy makers
TG3_WUT	Water Utilities Drinking water suppliers/wastewater managers and operators
TG4_IND	Industrial Water domain-related SMEs and large companies, IT solution integrators, data users/modelling experts;
TG5_PRJ	Projects



	National, European and International Projects related to MISSION-OCEAN, IDEATION, and the DTO
TG6_CIV	Civil Citizens/Civil society/student community and media professionals (journalists)
TG7_NGO	Non-governmental organisations Foundations/NGO/environmental organisations

TG1_ARC (Academia and Research Community)

User: Hydrological researcher

Type of affiliation: Research Centre

A hydrological researcher working at a research centre could enhance their understanding of inland water systems and improve predictive models by seeking to integrate various data sources and utilize advanced analytics to study the impacts of climate change on water resources. Their goals and how IDEATION could help are presented in Table 2.

Table 2 - TG1_ARC (Academia and Research Community) – Hydrological centre use case.

Goals	How IDEATION helps to identify
To develop more accurate predictive models for water quality and quantity	Access to diverse datasets and case studies from multiple regions
To study the long-term effects of climate change on inland water systems	Climate historical data for trend analysis
To collaborate with international researchers on water-related projects	OpenKIWAS allows identifying ongoing projects in the field
To publish high-impact research papers on inland water management	Latest research findings and scientific articles in the field

TG2_GOV (Government)

User: Planning Technician

Type of affiliation: State Government

A planning technician working for a state government that uses IDEATION to develop and implement strategies for flood prevention, resilient urban planning, and nature-based solutions (NBS) in their region of interest. They aim to improve the area's resilience to extreme hydrological events and promote sustainable water management practices (see Table 3).

Table 3 - TG2_GOV (Government) – Planning technician use case

Goals	How IDEATION helps to identify
To improve flood prediction and prevention strategies	Floods mitigation cases in other cities
To develop new urbanisation programmes resilient to extreme hydrological events	Data for modelling runoff events with defined return periods
To implement NBS in the Region of interest	NBS implementations and results
To stay updated on the latest water management innovations	Latest innovation in NBS

TG3_WUT (Water Utilities)

User: Water service operator

Type of affiliation: Municipal Water Utility

A Water service operator ensures a correct water supply service for the community. They could use IDEATION to optimize water distribution, model different network scenarios (i.e. in case of pump station failure to see what can be expected) and improve water quality monitoring (see Table 4).

Table 4 - TG3_WUT (Water Utilities) – Water service operator use case

Goals	How IDEATION helps to identify
To optimize water distribution and reduce water loss	Articles or projects about new technologies for leak detection or water losses reduction
To improve water quality monitoring	Advanced sensors and tools for contaminants monitoring
To develop sustainable water management strategies	Case studies of successful water management programs
Managing water data: consumptions, metered flow, pressures, etcetera	Existing off-the-shelf tools or platforms for data processing

TG4_IND (Industrial)

User: Agriculture engineer

Type of affiliation: Consulting company

Agriculture engineers working in consulting companies specialised in agriculture services or irrigation could use IDEATION to enhance water resource management through advanced analytics and create data-driven tools for comprehensive water system analysis (see Table 5).

Table 5 - TG4_IND (Industrial) – Expert related to water management in agriculture use case

Goals	How IDEATION helps to identify
Find water resource management tool	Access to existing available tools developed from other cases
Find best locations for small water reservoirs or irrigation ponds	Open data related to topography or precipitations for detecting best locations and modelling their recharge-runoff
Estimate future groundwater availability	Access to meteorological data for estimating groundwater recharge
Optimising water efficiency in agriculture	Latest practices respect to irrigation efficiency and experiences in different countries

TG5_PROJ (Projects)

User: Project Coordinator of a Horizon Europe project

Type of affiliation: Technology centre

A project coordinator working on an EU-funded water management project uses IDEATION to align their project goals with broader European water initiatives and to identify potential synergies with other ongoing projects (see Table 6).

Table 6 - TG5_PROJ (Projects) – Project Coordinator of a Horizon Europe project use case

Goals	How IDEATION helps to identify
To align project objectives with EU water policies	Latest EU water directives and policy frameworks
To identify potential projects for networking and future collaborations	Provide ongoing projects and related information about them (consortium, call, objective, among others)
To access and integrate relevant datasets for the project	Sources of water-related databases

Find latest projects in specific topics related to DT for inland water	OpenKIWAS filtered list of projects
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TG6_CIV (Citizens/Civil Society)

User: Journalist

Type of affiliation: Media

A journalist could use IDEATION to gather accurate and up-to-date information on inland water issues, helping to inform the public about water-related challenges or for having a stronger background of a situation (see Table 7).

Table 7 - TG6_CIV (Citizens/Civil Society) - Journalist use case

Goals	How IDEATION helps to identify
Obtain support on visualisation of water-related or meteorological phenomena	Visualisation of already elaborated data (i.e. flood extension map product from Copernicus or another service)
To understand and explain complex water management concepts	Access to simplified explanations or concept definitions in scientific articles
Check latest European efforts in research about water management related projects	Access to a compilation of water management projects started the current year
Obtain background on specific water aspects	Case studies or selection of projects, scientific articles, policies, etcetera of specific aspects

TG7_NGO (Foundations/NGO)

Title: Water Program Director

Industry: Environmental NGO

A water program director at an environmental NGO uses IDEATION to develop and implement water conservation and protection programs, as well as to advocate for sustainable water policies at different levels (local, national). Details in Table 8.

Table 8 - TG7_NGO (Foundations/NGO) Water program director use case

Goals	How IDEATION helps to identify
To develop effective water conservation programs	Successful conservation strategies and best practices

To advocate for sustainable water policies	Case studies of effective regulations and latest policies
Implement water treatment technologies in remote areas	Cases where new treatment technologies are applied
To monitor and report on water quality in vulnerable areas	Access to water quality data and monitoring methodologies

2.2 *OpenKIWAS Content Management System*

The project aims to create an open inventory of knowledge dedicated to inland water systems, an ambitious initiative to collect, organise and make accessible a wide range of information to researchers, administrators and citizens. A Content Management System (CMS) is responsible for accessing and retrieving data from the OpenKIWAS. Following the DoA the CMS will be ready by M21, coinciding with the final version of the OpenKIWAS. This section presents an overview of the CMS, describing its usage and high-level functionalities.

The aim is to create a centralised system that, due to its open nature, allows anyone to access and consult data, documents, metadata, and links related to inland water resources. This system is characterised by its ability to manage and catalogue different types of content in a flexible and scalable manner. Whether it is a reference to a technical document, an environmental report or a simple link, all data will be enriched with specific metadata. Such metadata includes, for example, geographical location, water type, conservation status, hydrogeological characteristics and other relevant details. This additional information not only facilitates a more intuitive and targeted search but also enables the creation of logical links between related data, thus providing an integrated and in-depth view of the water context.

The result, however, should not be a static catalogue, where, once entered, information remains immutable and risks quickly becoming obsolete. It should be conceived as a dynamic system, where transparency translates into the possibility of verifying and supplementing information even after the catalogue has been published. The catalogue will be characterised by user-friendly interfaces that can be used by any type of user regardless of their background.

The system interfaces are designed to go beyond simply browsing information. They offer intuitive tools that allow different types of users to update and enrich data in an immediate and user-friendly manner. In this way, not only can anyone easily access the catalogue, but also those authorized to act can make changes, additions and updates in real time, thus ensuring the freshness and accuracy of the information. The “two-core” structure is the core of the project, allowing the catalogue to continuously evolve through targeted and timely contributions. The reference mode allows researchers, citizens, and enthusiasts to easily



navigate between entities, explore data, and gain an in-depth view of inland water systems. The update mode, reserved for specialized users and managers, provides a clear and accessible interface for entering new data or modifying existing ones.

This dual approach ensures that the catalogue is never static, but rather a dynamic system, always aligned with the latest knowledge and developments in the field. The combination of intuitive consultation and advanced tools for direct updating allows for a perfect balance between ease of use and rigorous data management, thus ensuring the quality, relevance and reliability of the information collected.

The system will be designed to offer a highly personalized and interactive experience, adapting to different user needs. For example, based on profile-whether researchers, administrators, or citizens-can create different views so that everyone can access the information most relevant to their area of interest. This customisation capability allows content to be organized into specific views, dividing data into thematic or typological categories, such as technical documents, environmental reports, maps and links, thus making the archive extremely navigable and targeted.

A key aspect of the platform will be the presence of advanced contextual filters, which allow users to narrow their search by specific criteria, such as type of water resource, conservation status, and other relevant parameters. These search tools not only make it easier to find the desired entities, but also allow users to delve deeper into the context in which they fit, greatly improving the accuracy and effectiveness of searches.

In addition, the system will promote smooth navigation between related entities, users will be able to easily move from one section to another thanks to internal links that will relate data, thus enabling them to move smoothly from one document to a related report, or from a map to a detailed description of a specific area. This navigation will be further enhanced by the creation of a specific taxonomy, which will map different types of water in a structured way. With this classification, it will be possible to distinguish between freshwater streams, lakes, underground aquifers, wetlands, and other categories, thus facilitating the organisation and correlation of information. The use of a clear taxonomy will make it possible to highlight the common features and specificities of different water resources, giving users a more detailed and consistent view of the water system.

3 Methodology for Compiling OpenKIWAS

This section outlines the methodology for compiling OpenKIWAS. The process first identifies the OpenKIWAS catalogues and defines the database schema. OpenKIWAS includes six catalogues in total:

- Catalogue EU and international policies and standards for inland waters
- Catalogue of projects and information systems outputs
- Catalogue of scientific research results
- Catalogue of data models, AI technologies, simulations, intelligent systems and Digital Twins related to inland water
- Catalogue of inland water open data and sensing sources
- Catalogue of data and services from national meteorological organisations

The next step is to identify data sources for compiling each catalogue. Key sources include the CORDIS webpage of the European Commission, open-access repositories such as Scopus and Zenodo, and European and national repositories for policies and open data.

OpenKIWAS entries from each data source are identified using a specific search methodology. This involves searching description metadata, using keywords, or applying Large Language Model (LLM) analysis. For search and characterisation of each entry, two keyword lists were compiled. The first defines the technology, tool, or mode type of each OpenKIWAS entry. The second categorises entries by relevant inland water types. Table 9 presents both lists. Following the Table, whenever a keyword can be used in other textual forms, a stemming process took place to derive the root of the keyword.

Table 9 - Search Keywords for filtering and characterising OpenKIWAS results

Technology/Tool/Mode	Inland Water Type
copernicus	water
modelling (root "model")	river
management (root "manag")	water reservoir
sediment (root "sedimen")	reservoir
optimization	lake
prediction	snow
detection	groundwater
statistical analysis	wetlands
forecast	snow and ice



spatial analysis	coastal water
mapping	urban water
visualization	basin
satellite imagery	rainfall
aerial photography	ice
Cyber-Physical Systems with IoT Devices	glacier
automation	lagoon
risk assessment	transitional water
control	
water usage	
monitoring	
simulation	

The consolidation of entries for each OpenKIWAS catalogue involved a data validation process, including manual screening. If necessary, the search and filtering methodology was adjusted and repeated until an acceptable number of entries were included.

The following subsections analyse the methodology used to compile OpenKIWAS entries for each subtask and catalogue.

3.1 Policy, regulatory framework and project outputs

This task focuses on compiling and analysing EU and international policies, as well as project outputs related to inland water management.

3.1.1 Catalogue EU and international policies and standards for inland waters

This catalogue collects and analyses existing and upcoming EU policies that include inland waters, as well as policies from the United Kingdom and Switzerland as these countries are part of the IDEATION project but not in the EU.

OpenKIWAS Schema

The OpenKIWAS schema for the catalogue of policies and legislation supports entries for policies obtained from different data sources related to IDEATION's aim and scope. Table 10 describes the columns in the catalogue.

Table 10 - OpenKIWAS Schema for the catalogue of legislation and policies

Column Name	Description
ID	Unique Identifier for OpenKIWAS
Name	Name of the legislation
Issuing organisation	Country, international organisation, or union that has published the legislation or policy
Type	Type of policy, e.g., Legislative, Directive, ISO/CEN standards, UN/WHO recommendations, etc.
Scientific domain	Discipline within science e.g., physical states, chemistry, geology, and biology
Type of water	Classification of water based on its source, composition, or intended use e.g., surface and groundwater, drinking water, wastewater and treated water
Water management focus	Key areas or priorities in managing water resources effectively
Parameter change rate assumption	Water resource policies based on how frequently the factors influencing them change, e.g., static (slow-changing) parameters or dynamic (fast-changing) parameters. Parameter change refers to a specific measurable factor or variable that influences a system and can change over time e.g., flow, level, pressure
Description	Overview of the policy
Status	Refers to if the policy is upcoming, effective, non-effective
Effect Date	When the policy or legislation comes into force
Resource	Links to more information
Recommendations	Proposals for actions or strategies aimed at addressing a specific issue

Data Sources

The policies listed in the OpenKIWAS were found using official government and institutional data sources related to water management in the EU, England, and Switzerland.

1. European Union (EU): The EU has extensive legislation on water, the following official data sources were used:
 - EUR-Lex (EU Law Database) – Provides access to all EU laws, directives, and regulations. Search for terms like "Water Directive" or "Water Framework Directive."
 - European Environment Agency (EEA) – Reports on water policies, quality, and sustainability.
 - European Commission – Water Policy – Information on EU water policies and ongoing initiatives
2. England: England follows its own water regulations post-Brexit, with policies under the Environment Agency (England). The data sources used include:
 - UK Government Legislation Portal – Full database of UK water laws and regulations.
 - Department for Environment, Food & Rural Affairs (DEFRA) – Water policies and environmental regulations.
 - Environment Agency (England) – Manages water resources, flood risks, and pollution control
3. Switzerland: follows independent water regulations under the Federal Office for the Environment (FOEN/Bafu). The data sources used include:
 - Swiss Federal Office for the Environment (FOEN / BAFU) – National water policies, legislation, and reports.
 - Swiss Confederation – Legislation Database – Official Swiss laws, including water management acts.
 - Eawag (Swiss Aquatic Research Institute) – Scientific research and policy recommendations on Swiss water management.

Searching, Filtering and Keywords

Emphasis was placed on policies that call for monitoring, forecasting, projection and simulation, and the management of the inland water cycle. Keywords were used to search for the policies, including digital water, water quality, flooding, water management, water quality, drinking water, water and agriculture, ecosystems, conservation, and water protection.

3.1.2 Catalogue of projects and information systems outputs

This catalogue collects metadata from outputs of past and ongoing research and innovation projects related to inland water monitoring and management, as well as digital twins and

associated aspects. These projects have been funded by the European Union and other entities.

A standardised methodology, defined at the project's inception, was employed to search for and select projects to be included in OpenKIWAS. For this initial version of OpenKIWAS, the methodology involved searching project databases from FP7, Horizon 2020, and Horizon Europe programs.

OpenKIWAS Schema

The OpenKIWAS schema for the catalogue of projects and information system outputs accommodates entries from various data sources relevant to IDEATION's aim and scope. Table 11 describes the columns in the catalogue.

Table 11 - OpenKIWAS Schema for the Catalogue of Projects and Information System Outputs

Column Name	Description
ID	Unique Identifier for OpenKIWAS
Project_ID	Cordis Grant agreement ID
Project_Acronym	Acronym used to identify the project
Project_Name	Full name of the project
Funding Authority	Project funding
Call for proposals	Specific call under which the project was funded
Focus Area	Specific topic or sub-topic addressed by the project
Begin Date	Date on which the project started or will start
End Date	Date on which the project ended or will end
Status	Current status of the project
Budget	Total cost of the project
Description	Objective of the project
Resource	URL linking to the project's online resources and information
Inland water types	Label identifying the main water type(s) addressed by the project

Data Sources

The initial version of the catalogue of projects and information system outputs incorporates the following [CORDIS](#) data sources:

- Seventh Framework Programme (FP7): this programme aimed to enhance industrial competitiveness and promote excellence in scientific and technological research in Europe. It consisted of four main areas: Cooperation, Ideas, People, and Capacities, which supported various thematic areas related to research and technology while also strengthening human potential in research and technology.
- Horizon 2020 (H2020): The objectives of this programme were to strengthen the EU's scientific and technological foundations, create a European Research Area with free circulation of researchers and knowledge, and drive the EU towards a knowledge society and competitive economy. Specific goals included implementing research, technological development, and innovation; promoting international cooperation; disseminating and optimizing research results; stimulating training and mobility; fostering better exploitation of industrial potential; and supporting the Europe 2020 strategy for smart, sustainable, and inclusive growth.
- Horizon Europe (HEU): EU's main funding program for research and innovation from 2021 to 2027. It tackles climate change, helps to achieve the UN's Sustainable Development Goals and boosts the EU's competitiveness and growth. The programme facilitates collaboration and strengthens the impact of research and innovation in developing, supporting and implementing EU policies while tackling global challenges. It supports creating and better dispersing of excellent knowledge and technologies.

Searching, Filtering, and Keywords

Project selection involved developing and implementing a methodology capable of analysing and screening thousands of projects efficiently. The approach aimed to include all projects related to IDEATION, prioritizing comprehensiveness over strict accuracy to avoid missing relevant projects. This methodology was designed to be flexible, allowing for the incorporation of new keywords that emerged during the project's development.

OpenKIWAS is planned to have two versions. The first version, presented with this delivery, will include finished or ongoing projects from FP7, H2020, and HEU programs, as well as funded projects under the Copernicus programme. The second and final version, starting in February 2025, will incorporate finished or ongoing projects from DEP, ERDF, LIFE, CHIST-ERA, and CEF funding schemes, along with projects from Interreg and ERICs. To create the most comprehensive inventory possible, there will be no age limitation on the projects included.

The search process began with the FP7, HEU, and H2020 databases. Each project description was searched for matches between two sets of keywords: one set comprising relevant technical terms, and the other related to water types, as found in **Table 9**.

The search process involved checking each keyword from the Tool/Mode table in combination with water type keywords (word by word) within project objectives. This process was repeated for all keywords from the Tool/Mode table.

Selected results were compiled in separate sheets and cleaned to eliminate duplicates, as the methodology could select the same project multiple times with different keyword combinations.

After removing duplicates, a manual screening was performed to eliminate projects unrelated to the project's aim. This step was necessary because the keyword-based methodology sometimes selected projects from unrelated fields like biology or commerce. In consequence, a project containing the words "water" and "management" might be selected but could be irrelevant to our focus.

During the manual screening, the types of projects included were:

- Projects serving as guidance, practical examples, or background for new models, studies, or projects related to Digital Twins for Inland Waters.
- Projects proposing Digital Twin implementations for Inland Waters.
- Innovation projects providing new outcomes, technologies, analyses of current situations, and solutions addressing water-related issues.
- Digital Twin applications for hydrology-related systems or services where water bodies' behaviour plays a significant role.
- Studies on water bodies' behaviour, physical phenomena, interrelations with external factors, and environmental issues related to inland waters.
- Projects that have developed useful services, such as Copernicus.

Additionally, the following projects were included:

- Projects identified through networking activities or Multi-Stakeholder Forums.
- Information from open-access European digital information systems and platforms related to inland waters, including technical/operational programs.
- Projects primarily from European territories, but also including relevant non-European projects mentioned in Multi-Stakeholder Forums.
- Projects resulting in open-source tools, with commercial tools not excluded but left to the discretion of Inland Water DT users.

After manual screening, all files from different data sources were merged, and a final duplicate removal was performed to create a single, unique list of projects.

Finally, to complete the project list a "Water type" column was added. This field was populated using a Large Language Model (LLM) with the GPT-4 engine to label projects according to their focus. The LLM was provided with instructions and definitions of different water types. Post-labelling controls were applied to avoid hallucinations and ensure accuracy. For projects not labelled by the LLM, manual labelling was performed based on the most relevant water type.

Data Validation

To validate the final project selection list, a comparison was made with the current project list from the ICT4Water Cluster, a hub for EU-funded research and innovation projects on ICT applied to water management. The ICT4Water Cluster project list, which can be found in Annex I, contains a total of 83 projects (including IDEATION).

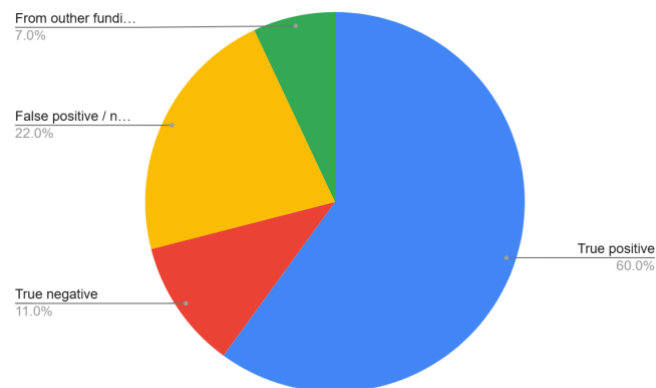


Figure 1 - Results of the validation process

The pie-chart in Figure 1 shows the results of the validation process, where 71% of the ICT4Water Cluster projects were included in OpenKIWAS, while 29% were not. Upon further investigation of the excluded projects, it was determined that:

- Five projects belonged to the LIFE funding scheme, which has not yet been evaluated for inclusion in OpenKIWAS.
- One project corresponded to an EIT Climate-KIC funded activity.
- Nineteen projects were deemed out of scope for IDEATION.

Based on these findings, it can be concluded that the approach for project selection was appropriate and effective. Most relevant projects were captured, and those excluded had valid reasons for omission, such as belonging to funding schemes not yet considered or falling outside the scope of IDEATION. This validation process reinforces the reliability of the OpenKIWAS project selection methodology.

3.2 Research and technological tools

This task aims to compile a comprehensive knowledge base on scientific advancements and technological tools for digital twin applications in inland water. It systematically analyses scientific literature on inland water management to map scientific expertise, identify research gaps, and catalogue advanced technological tools that support digital twins.

3.2.1 Catalogue of scientific research results

This catalogue is obtained by conducting a systematic literature review of scientific studies and reviews related to monitoring, forecasting, and simulating the inland water cycle. The analysis maps scientific expertise across research groups and classifies findings by the type of inland water studied, application focus, and geographical scope. A gap analysis will identify missing research areas and assess their relevance to policymaking.

OpenKIWAS Schema

The OpenKIWAS schema for the catalogue of scientific research results supports entries for scientific papers and reports. It includes publication details such as the abstract and Digital Object Identifier (DOI) and specifies the relevant water and technology domain. Additionally, it records correlations with projects, tools, technologies, and policies listed in OpenKIWAS. Table 12 describes the columns in the catalogue of scientific research results.

Table 12 - OpenKIWAS Schema for the catalogue of scientific research results

Column Name	Description
ID	Unique Identifier.
Type	The scientific entry type, including article, report, or conference paper.
Year	The publication year of the paper.
Authors	The authors of the paper.
Title	The title of the paper.
Venue/Journal	The publication venue or journal of the paper.
DOI	The Digital Object Identifier of the paper.
Research type	The domain of research.
Water System	The specific water system.

Technical Focus	The technical focus, including relevant technology.
Abstract	The abstract of the paper.
Link with Projects	Indicates whether the publication received funding from a project from the catalogue of projects.
Link with Tools	Indicates whether the publication describes a specific tool from the catalogue of tools.
Related Policies	Indicates whether the publication relates to a specific policy from the catalogue of policies

Data Sources

The first version of the catalogue of scientific research results includes the following data sources:

- [Scopus](#): A comprehensive database of academic metadata, including scientific keywords and abstracts.
- [CORDIS](#): The European Commission's database for accessing detailed EU Research & Development project information. It organises scientific research results under seven-year funding frameworks like FP7, Horizon 2020, and Horizon Europe.

Searching, Filtering and Keywords

Compiling the catalogue of scientific research results follows two search methods. The first method searches database metadata for OpenKIWAS keywords, as in Table 9. Scopus enables keyword searches in titles, scientific keywords, and abstracts. This process generates multiple paper lists based on the search terms.

For CORDIS, a separate search was conducted for each scientific results database corresponding to the EU's seven-year funding frameworks. However, many CORDIS entries, such as abstracts and scientific keywords, lack critical metadata. To address this, the DOI API (<https://api.crossref.org/works/{doi}>) was used to retrieve the missing metadata. The next step was to identify OpenKIWAS keywords within the retrieved metadata.

The final search method cross-references the catalogue of projects and information system outputs to identify related publications. These publications are then added as entries in the catalogue of scientific research results.

The final catalogue has undergone processing to remove any duplicate entries.

Data Validation

The first version of OpenKIWAS lacks information regarding each paper's Research Type, Water System, and Technical Focus. Addressing this, an automatic method is developed using a LLM to analyse paper metadata, including the title and abstract, and retrieve this

information. In the case of satisfactory results, these will be included in the final version of the OpenKIWAS.

3.2.2 Catalogue of data models, AI technologies, simulations, intelligent systems and Digital Twins related to inland water

This catalogue is a dataset of data models, AI technologies, simulation tools, intelligent systems, and digital twins for inland water management.

The catalogue includes hydrological models for predicting flow and quality, social models for water usage, and hydraulic models for urban distribution. AI technologies, such as machine learning algorithms for processing hydrological data and analysing satellite images, are identified. Simulation tools are catalogued based on their ability to predict event outcomes. Intelligent systems integrating cyber-physical architectures, sensors, actuators, and software are analysed for their roles in monitoring, event detection, risk assessment, and decision support. Digital twins, which combine real data with models and simulations to create virtual system replicas, are also included.

The catalogue connects to relevant data spaces and services, such as [WATERVERSE](#) and [DSBA](#) (Data Space Business Alliance), to enhance accessibility and interoperability.

OpenKIWAS Schema

The OpenKIWAS schema for the catalogue of data models, AI technologies, simulations, intelligent systems, and digital twins related to inland water includes information on its inputs and outputs in addition to the basic metadata of each tool. It also provides cross-references to relevant scientific results and projects from OpenKIWAS when available. Table 13 describes the columns in the catalogue of data models, AI technologies, simulations, intelligent systems, and digital twins related to inland water.

Table 13 - OpenKIWAS Schema for the catalogue of data models, AI technologies, simulations, intelligent systems, and digital twins related to inland water.

Column Name	Description
ID	Unique ID.
Name	Name of the tool/technology.
Technology	Technology domain.
Type	Type of technology, including data models, AI technologies, simulation tools, intelligent systems, and digital twins.
Data used as input	Input data of the tool/technology.

Produced datasets (openly available)	Datasets produced by the tool/technology, if openly available.
Demo (video if available)	Demo video of the tool/technology if available.
Paper (if available)	Cross-reference to the scientific results catalogue, if available.
Project ID (if available)	Cross-reference to the projects and information systems catalogue, if available.
Service description	Description of the tool/technology.

Data Sources

The first data source includes relevant catalogues from each IDEATION partner organisation. These catalogues list technologies and tools that are part of the organisation's intellectual property or are used in its activities.

However, the main data sources for compiling the catalogue are the metadata from projects identified and listed in OpenKIWAS. Project webpages often provide metadata on objectives, result summaries, and outputs, including tools, technologies, and scientific publications. Analysing these results helps identify tools and technologies for inclusion in OpenKIWAS.

Searching, Filtering and Keywords

A manual analysis of project metadata is infeasible due to the required man-hours. To address this, a LLM processes project metadata automatically to identify tools and technologies. A Python script performs this analysis by parsing each project's metadata and generating a prompt for the LLM.

The prompt includes project objectives, results, publications, deliverables, and other outputs. It also contains explicit queries to identify data models, AI technologies, simulations, intelligent systems, and digital twins related to inland water. Additionally, the query instructs the LLM to extract information for each column of the OpenKIWAS schema. The prompt is sent to the LLM API, which returns a structured response.

For the first version of OpenKIWAS, the Google Gemini LLM API is used. For example, the CORDIS database provides project metadata in XML format, which can be downloaded and parsed.

Data Validation

A manual screening of a random sample confirmed that the LLM results were acceptable, as all identified tools and technologies were listed in the objectives and results of the corresponding projects. However, further investigation is needed to assess the maturity level of each tool or technology and its usefulness for OpenKIWAS users.

3.3 Sensing and Open Data Services

The objectives of this task are dual. It focuses on creating a catalogue of open data and sensing sources for inland water, including Earth Observation data from satellites, environmental, socio-economic, and citizen data. Additionally, it focuses on creating a catalogue of meteorological services relevant to inland water systems. The information being catalogued will be evaluated to determine its applicability for digital twin applications. The resulting assessment will then be integrated into the OpenKIWAS database.

It is worth mentioning that a Data Source refers to the location or system from which data originates. It can be a physical or digital repository where data is stored, such as databases, files, web services (APIs), sensors, or even manual inputs. Data sources provide raw data that can be processed and analysed to gain insights. They play a crucial role by enabling the collection of diverse data formats for comprehensive analytics. While a Dataset is a collection of organized data that typically includes related information grouped together for analysis or reporting. Datasets are often derived from one or more data sources and may undergo processing such as cleaning, transformation, and aggregation before being used in applications like machine learning models or statistical analyses. An Open Data Service refers to the service that makes open data accessible through standardized interfaces (e.g., APIs), allowing users to easily retrieve, manipulate, and integrate this data into their applications. Such services typically ensure that the provided data is machine-readable and non-proprietary, facilitating interoperability across different systems.

In the following subsections, our primary goal is to catalogue data sources that contain datasets (raw or processed) as well as the way that these data are accessible and interoperable.

3.3.1 Catalogue of inland water open data and sensing sources

This task aims to develop a comprehensive catalogue of open data and sensing sources that will facilitate the future foundation of digital twins for inland water systems. The process involves identifying relevant open data sources, including Earth Observation (EO) data from satellites, environmental, socio-economic, and citizen-generated data. These data originate from various sources: sensors (both local and remote, such as satellite images, weather stations, and water quality monitoring devices), surveys and research (e.g., census reports, land use maps, and economic indicators), as well as platforms or applications (e.g., social media feeds, crowdsourcing platforms, and citizen science projects). Each resource will be assessed for quality, update frequency, accessibility, and any applicable legal constraints. This information, along with its endpoint, will be documented in its metadata. The methodology that will be adopted includes the following steps:

1. Identify the open data sources for EO, satellite, environmental, socio-economic, and citizen data.

2. Apply filters to identify the most appropriate datasets. Keywords to be used are related to type of water, method, technology, etc.
3. Classify datasets in terms of their relevance in the IDEATION Reference Scenarios.

OpenKIWAS Schema

The OpenKIWAS schema for the catalogue of open data sources for EO satellite data, environmental, socio-economic and citizen data is presented in Table 14. It should be noted that this is a general schema, however, it will be tailored to accommodate the specific data source and the unique information it provides.

Table 14 - Schema for the catalogue of inland water open data and sensing sources

Column Name	Description
ID	Unique ID in OpenKIWAS database
Source Organisation	Name of organisation that provides the Data Source
Name	Name of the Data Source
Type	Type of the Data Source, i.e. sensors, local or remote (e.g., satellite images, weather stations, quality measurements), surveys and research (e.g., census land use, economic indicators), platforms or apps (e.g, social media posts, crowdsourcing, citizen science)
Area	Indicates the area of coverage
Quality	Indicates the quality of the data/metadata in the Data Source
Availability	Specifies whether the Data Source is publicly available
Update frequency	How often the data are updated
Legal restrictions	Indicates the type of licence
Description	Brief description of the Data Source
Variable(s)	General description of the available variables
Spatial coverage	Country or area covered
Spatial resolution	Indication with spatial granularity units (m, km, °, etc.)
Temporal coverage	The period covered by the dataset
Temporal resolution	Indication with units (h, day, year, etc.) of temporal granularity
Resource	URL to find the data
API Protocol	Indication of the API protocol if available or URL to guidelines
Limitations	Specific comments or usage restrictions that a particular data source obeys for.

Data Sources

Earth Observation data from satellites: Copernicus, the Earth Observation component of the EU Space Programme, provides a constellation of Sentinel satellites that deliver extensive daily observations of the Earth's ecosystem.

The source of satellite data for analysing inland waters is Copernicus Dataspace¹, a platform for sharing remote sensing data from Sentinel missions (and other complementary datasets). It is worth noting that the provided data is open access, and APIs are available to automate the data acquisition process. In this case,

Python package called EODAG (Earth Observation Data Access Gateway)² is utilised, which offers high-level access to a wide range of satellite image providers, including Copernicus Dataspace. Through this library, Sentinel-2 images can be requested, with the only requirement being an account on Copernicus Dataspace. EODAG provides an easy solution for interfacing with the Dataspace API, allowing users to filter the required images.

Similar procedures can be followed to acquire and process Sentinel-1 products from Copernicus Dataspace.

Eurostat is a data source for fetching Environmental, Socio-economic data, or surveys (e.g., census reports, land use maps, and economic indicators). The Eurostat database³ encompasses a wide array of statistical categories and subcategories, providing valuable insights into various aspects of the European Union. Key components include:

- a. Environment (env) Category: This category features the Water (env_wat) Subcategory, which offers statistics at both national and river basin levels. These statistics are crucial for understanding water quality, availability, and management across different regions.
- b. Economy and Finance: This section includes data on economic indicators, government finance, and other financial metrics that inform policy-making and economic planning.
- c. Population and Social Conditions: This category provides demographic data, including population trends, migration statistics, social welfare indicators, and health-related information, which are essential for addressing social challenges.
- d. General and Regional Statistics: This section covers a broad range of statistics that provide insights into regional disparities, development indicators, and overall societal conditions across the EU.

¹ <https://dataspace.copernicus.eu/explore-data>

² <https://eodag.readthedocs.io/en/stable/>

³ <https://ec.europa.eu/eurostat/web/main/data/database>

The **EU data portal**⁴ is another valuable data source serving as a central access point to European open data from international, European Union, national, regional, local and geodata portals. The EU Data Portal provides the Hub-Search API⁵ which is a robust metadata search service for the Open Data Portal, designed to streamline the discovery and retrieval of metadata. By integrating with Elastic Search, it offers precise and powerful search capabilities. This API not only simplifies dataset searches but also promotes transparency and knowledge sharing by empowering users to easily find valuable data resources, thereby enhancing data accessibility and utilisation. The Registry API⁶ allows the efficient management of datasets and metadata utilising to the DCAT-AP standard for structured data descriptions. This API streamlines the process of making datasets accessible to a broader audience, thereby fostering transparency, knowledge sharing, and collaboration.

The results can be filtered by multiple criteria, including High-Value Dataset (HVD), Provenance, Categories, Format, and more. Additionally, the results can be sorted and visualized based on relevance, last modified date, name (in ascending or descending order), or creation date, while the datasets can be downloaded in one of the available formats like CSV or JSON.

3.3.2 Catalogue of data and services from national meteorological organisations

Task 3.3.2 aims to compile a catalogue of data and services from national meteorological organisations within the OpenKIWAS database. It focuses on data relevant to the inland water digital twin, including weather forecasts, climate data, and hydrological data and services.

OpenKIWAS Schema

The OpenKIWAS stores this catalogue as a table. Its schema partially follows the one described in the previous section and includes additional columns for spatial and temporal granularity and data coverage. These columns help characterise datasets, allowing users to select those that fit their needs.

Columns on quality availability, update frequency, legal restrictions, and API protocols support the assessment of data availability, accessibility, and interoperability. They highlight the data's relevance for a digital twin. Table 15 presents the OpenKIWAS schema.

⁴ <https://data.europa.eu/>

⁵ <https://data.europa.eu/api/hub/search/>

⁶ <https://data.europa.eu/api/hub/repo/>

Table 15 - Schema for OpenKIWAS catalogue of data and services from national meteorological organisations.

Column name	Description
ID	Sequential univocal ID within the OpenKIWAS database.
Source organisation	Name of the organisation.
Name	Name and/or acronym of the dataset.
Type	Data or service.
Area	Label for the typology of information provided (weather forecast, hydrological data, climate data, snow and ice data, evaporation rates)
Quality	Link to the official documentation for quality assessment and/or validation.
Availability	To indicate if the dataset is open.
Update frequency	Frequency of update with precise time indication if available.
Legal restrictions	Indicate if there are any usage restrictions.
Description	A short description of the dataset, generally summarising the main features reported on the related website.
Variable(s)	General description of the available variables.
Spatial coverage	Country or area covered.
Spatial resolution	Indication with spatial granularity units (m, km, °, etc.).
Temporal coverage	The period covered by the dataset.
Temporal resolution	Indication with units (h, day, year, etc.) of temporal granularity.
Resource	URL to find the data.
API protocol	Indication of the API protocol if available or URL to guidelines.

Data Sources

National weather authorities are the primary source of data and services included in the database. Second, international weather authorities, such as the European Centre for Medium-Range Weather Forecasts (ECMWF) and the World Meteorological Organization

(WMO) were considered. Finally, other open databases from international authorities, including the Copernicus Climate Data Store, were also included.

In this version of OpenKIWAS, the database entails only gridded datasets from models, reanalysis, and interpolated observations. The final OpenKIWAS version might consider observations and time series from individual stations or measuring points.

Searching/Filtering/Keywords

Starting from a list of the EU country and non-EU countries considered relevant within the present project (e.g. Switzerland and the UK), the research of data sources was carried out through the following steps:

1. Identify the official weather authorities' websites, or other relevant authorities for each country, as well as existing national data portals or digital archives.
2. Search the catalogues of the found websites to identify potentially relevant datasets.
3. Evaluate the selected datasets based on their availability and accessibility, the provision of gridded data, the type of variables, and the time and spatial coverage.
4. Compile the OpenKIWAS database using key information.

These steps were repeated for each country. Moreover, a similar approach was applied to well-established international weather authorities and open databases.

The research results can be viewed directly in the OpenKIWAS database. There are 54 entries: 16 from national weather authorities from 9 EU countries, 2 from the UK, 7 from ECMWF, 16 from the Copernicus Climate Data Store (C3S) and 13 from the Copernicus Emergency Management Service (CEMS). Some countries and weather authorities were excluded because they do not provide free gridded datasets. In Annex II, the excluded data sources and the reasons for their exclusion have been listed.

Data validation

There is no data validation necessary, due to the availability of technical documentation related to the meteorological datasets and the reliability of the data providers.

4. Conclusions

This report accompanies the first version of the Open Knowledge Inventory for Inland Water Systems – OpenKIWAS. The main purposes of OpenKIWAS are to support the development of the IDEATION reference architecture (WP4) and the IDEATION roadmap (WP5). Moreover, OpenKIWAS is a repository with data useful to several identified categories of users based on the QH. This report presents a use case for each user category and identifies possible usages of the OpenKIWAS during and after IDEATION timeline.

Moreover, this report describes the OpenKIWAS catalogues and database schema. Each catalogue follows a structured methodology for identifying data sources, searching and filtering each category, compiling the catalogue, as well as a process for data validation and search reiteration, if needed.

The OpenKIWAS is available at the OpeKIWAS open access repository following the link: <https://68.221.171.16/openkiwas-first-version>. It supports the format for Excel spreadsheets file (.xlsx extension).

Whenever appropriate, the scripts for data analysis, as well as the scripts for converting Excel spreadsheets to/from JSON are available at the repository. These scripts follow the Python programming language technology.

Annex I: ICT4Water Project List

#	Project Name	Abstract	Website
1	AquaSPICE	Aims at fostering circular water use in European Process Industries through innovative technologies and frameworks.	https://aquaspice.eu/
2	ARSINOE	Shapes pathways to climate resilience using a Systems Innovation Approach and Climate Innovation Window.	https://arsinoe-project.eu/
3	B-WaterSmart	Accelerates water-smart economies through systemic innovations and circular economy models.	https://b-watersmart.eu/
4	H2OforAll	Assesses sources of Disinfection Byproducts (DBPs) and models their spread in drinking water systems.	https://h2oforall.eu/
5	HYDROUSA	Demonstrates nature-based solutions to manage various water streams for Mediterranean areas.	www.hydrousa.org
6	iBATHWATER	Demonstrates an integrated management system to reduce rainwater impacts on urban bathing water.	https://www.ibathwater.eu/
7	ICARIA	Promotes climate impact understanding and risk reduction through sustainable adaptation solutions.	https://www.icaria-project.eu/
8	IDEATION	Prepares the development of a digital twin of inland waters to integrate with the ocean's digital twin.	https://cordis.europa.eu/project/id/101157371
9	IMPETUS	Accelerates Europe's climate adaptation strategy to meet 2050 climate neutrality goals.	https://climate-impetus.eu/
10	IntelWATT	Develops smart separation technologies for water preservation, energy production, and material recovery.	https://www.intelwatt.eu/
11	iWAYS	Develops innovations to reduce, recover, and reuse industrial waste.	https://www.iways.eu
12	MAR2PROTECT	Prevents groundwater contamination with innovative Managed Aquifer Recharge systems and AI tools.	https://mar2protect.eu/
13	NATALIE	Advances "ecosystem-based adaptation" for resilience to climate change in Europe.	https://www.natalieproject.eu/



14	NEXOGENESIS	Facilitates water-related policymaking through AI and ML for better WEF Nexus assessments.	https://nexogenesis.eu/
15	NIAGARA	Monitors chemical and biological pollutants in drinking water treatment plants and evaluates their spread.	https://www.niagara-project.eu/
16	NINFA	Develops early warning systems and solutions to prevent groundwater contamination.	https://ninfa-project.eu
17	PathoCERT	Enhances first responder coordination in pathogen-contaminated water emergencies.	https://pathocert.eu/
18	RECONNECT	Demonstrates and scales up Nature-Based Solutions in rural and natural areas.	http://www.reconnect.eu/
19	RECREATE	Facilitates water resource management by incorporating Alternative Water Resources into planning.	http://recreate4water.eu/
20	REWAISE	Develops a "smart water ecosystem" focusing on circular economy and reduced energy use.	http://rewise.eu/
21	SafeCREW	Develops tools and guidelines for disinfected and non-disinfected drinking water systems.	https://safecrew.org/
22	SCOREwater	Builds resilience in cities to climate change through smart water management practices.	https://www.scorewater.eu/
23	SEDIMARK	Designs a decentralized marketplace for secure data sharing in EU data spaces.	https://sedimark.eu/
24	ToDrinQ	Develops real-time sensing and water quality monitoring technologies to secure drinking water systems.	https://todrinq.eu/
25	ULTIMATE	Demonstrates water-smart industrial symbiosis for circular solutions at large-scale sites in Europe.	https://ultimatewater.eu/
26	WaterFutures	Creates a theoretical framework for equitable, efficient, and resilient water infrastructure systems.	https://waterfutures.eu/
27	WATERLINE	Establishes a European Digital Water Higher Education Institution Alliance.	https://waterline-project.eu/
28	WATERVERSE	Develops a Water Data Management Ecosystem for better data management in the water sector.	https://waterverse.eu/
29	AfriAlliance	Prepares Africa for climate change through	https://afrialliance.org/



		water innovation and capacity building with European partners.	
30	aqua3S	Standardizes sensor technologies for water safety and security in Europe.	https://aqua3s.eu/
31	AquaNES	Catalyzes innovations in water treatment combining natural and engineered components.	http://aquanes-h2020.eu
32	Blue RoSES	Develops innovative services for marinas and leisure boats integrating robotics and IoT.	https://bluerosesproject.wixsite.com/home
33	BlueSCities	Coordinates water and waste sectors within smart cities for better integration.	http://bluescities.eu
34	CENTAUR	Provides autonomous sewer flow control systems to reduce urban flood risk.	https://www.sheffield.ac.uk/centaur
35	CYTO-WATER	Develops new imaging cytometer platforms for detecting microorganisms in water.	http://www.cytowater.eu/
36	DAIAD	Addresses water management challenges through real-time residential water consumption monitoring.	http://daiad.eu
37	DIANA	Develops a platform to optimize the identification and inspection of unauthorized water abstractions.	https://www.diana-h2020.eu/
38	digital-water.city	Boosts water management in five European cities through digital solutions.	https://www.digital-water.city/
39	LIFE EFFIDRAIN	Demonstrates real-time control strategies for urban drainage and wastewater systems.	http://www.life-effidrain.eu/en
40	EFFINET	Optimizes urban water system control, monitoring, and demand forecasting.	http://effinet.eu
41	FIWARE	Links the water sector to the FIWARE platform, enabling cross-domain data exchange.	https://www.fiware4water.eu/
42	FREEWAT	Simulates surface and groundwater scenarios to simplify EU Water Directive application.	http://freewat.eu
43	G3P	Shows groundwater storage variations using satellite gravity data for global coverage.	https://www.g3p.eu/
44	Ground Truth 2.0	Validates citizen observatories in Europe and Africa to boost societal and economic benefits.	http://gt20.eu/
45	ICeWater	Integrates water supply and smart-grid data	http://icewater-project.eu



		to improve urban freshwater supply stability.	
46	INCOVER	Transforms wastewater treatment into bio-product recovery for sustainable water management.	http://incover-project.eu
47	INNOQUA	Develops low-cost, biologically-based water sanitation systems for local contexts.	http://innoqua-project.eu/
48	INTCATCH	Develops water quality monitoring systems using autonomous boats and citizen scientists.	http://intcatch.eu/
49	isswatus	Develops integrated ICT methods for water-saving in Europe.	http://issewatus.eu
50	INTEGROIL	Develops integrated water treatment solutions for the Oil & Gas industry.	http://integroil.eu/
51	iWIDGET	Improves water efficiencies through novel ICT technologies for supply-demand management.	http://i-widget.eu
52	KINDRA	Takes stock of Europe's hydrogeology research for better water management innovation.	http://kindraproject.eu
53	MONOCLE	Develops in-situ optical water quality sensors for Earth Observation of water bodies.	https://monocle-h2020.eu/
54	NAIADES	Modernizes the water sector through holistic ICT solutions for ecosystem management.	https://naiades-project.eu/
55	NextGen	Champions circular economy solutions in the water sector.	http://nextgenwater.eu
56	POWER	Establishes a user-driven digital social platform for water network governance.	http://power-h2020.eu
57	PrimeWater	Develops operational services to predict upstream changes in water quality and quantity.	https://primewater.eu/
58	Project Ô	Demonstrates small-scale water management loops to support circular economy visions.	http://eu-project-o.eu/
59	PROTEUS	Develops autonomous MEMS-enabled sensor nodes for water quality monitoring.	http://www.proteus-sensor.eu
60	RESCCUE	Helps urban areas become resilient to climate change with new models and tools.	http://www.resccue.eu/
61	Run4Life	Develops decentralized wastewater treatment systems for resource recovery.	http://run4life-project.eu/



62	SAFEWATER	Develops a platform to manage drinking water safety and security crises.	https://www.safewater-project.eu/
63	SAPIENCE	Uses IoT technologies to monitor sustainable agricultural water use practices.	https://sapience.fbk.eu/home
64	SIM4NEXUS	Develops innovative methodologies to design policies addressing the water-land-food-energy-climate Nexus under climate change.	http://www.sim4nexus.eu/
65	Smarth2O	Builds an ICT platform to apply social computing and flexible pricing to improve residential water consumption.	http://smarth2o.deib.polimi.it/
66	Smart.met	Develops an interoperable solution for smart metering in drinking water systems.	http://www.smart-met.eu/
67	SMART-Plant	Validates technologies to renovate wastewater treatment plants and transition to bio-refineries.	http://www.smart-plant.eu/
68	LIFE SmartWater	Demonstrates water-saving capabilities through Active Leakage Control in water distribution.	https://www.life-smartwater.com/
69	Smartwater4Europe	Focuses on creating a business case for smart water supply networks globally.	http://www.sw4eu.com/
70	SPACE-O	Integrates satellite technology with water quality models to support decision-making in water supply services.	http://www.space-o.eu/
71	STOP-IT	Protects critical water infrastructures against physical and cyber threats.	http://www.stop-it-project.eu/
72	SWAMP	Develops IoT-based methods for smart water management in precision irrigation.	http://swamp-project.org/
73	SUBSOL	Establishes subsurface water solutions for coastal areas to address freshwater challenges.	http://www.subsol.org/
74	LIFE SWSS	Demonstrates an innovative platform for reducing energy consumption and water leakage in supply systems.	http://www.life-swss.eu/
75	UrbanWater	Develops a platform to improve urban water management for better end-to-end water distribution.	http://urbanwater-ict.eu/
76	WADI	Provides water utilities with airborne leak detection services for transmission systems.	http://www.waditech.eu/

77	waterInnEU	Spreads innovations in water ICT models and tools across river basin networks.	http://waterinneu.org/
78	WatERP	Develops an open management platform for integrated water supply-demand management.	http://waterp-fp7.eu/
79	WATERNOMICS	Provides water management tools that offer personalized usage, price, and availability information to users.	http://waternomics.eu/
80	WEAM4i	Balances and optimizes the Water-Energy-Food Nexus for irrigated agriculture.	http://www.weam4i.eu/
81	WIDEST	Promotes the dissemination of EU-funded ICT water activities and results.	http://widest.eu/
82	WISDOM	Integrates water distribution with real-time sensor monitoring for efficient management.	http://wisdom-project.eu/
83	ZERO BRINE	Redesigns industrial saline wastewater streams to recover and reuse minerals and water.	https://zerobrine.eu/

Annex II: Excluded meteorological datasets

Countries and authorities excluded from OpenKIWAS due to the absence of free, gridded meteorological or hydrological datasets, along with annotations for refining OpenKIWAS.

Country	Organisation	Website	Reason for exclusion
Austria	Central Institution for Meteorology and Geodynamics (Zentralanstalt für Meteorologie und Geodynamik, ZAMG)	https://www.zamg.ac.at/cms/en/news	For a fee.
Bulgaria	National Institute of Meteorology and Hydrology - branch Plovdiv (NIMH-Plovdiv)	http://www.weather.bg/1en/index.php	No data to download, only online visualisation.
Croatia	Croatian Meteorological and Hydrological Service (Državni hidrometeorološki zavod, DHMZ)	DHMZ - Croatian Meteorological and Hydrological Service	No gridded datasets are available. Hydrological and meteorological daily observations can be downloaded manually.
Republic of Cyprus	Cyprus Department of Meteorology of the Ministry of Agriculture, Rural Development and Environment	https://www.data.gov.cy/en	No gridded data is available. Meteorological observations are available through API.
Czech Republic	Czech Hydrometeorological Institute (Český Hydrometeorologický ústav)	https://www.chmi.cz/aktualni-situace/aktualni-stav-pocasi/ceska-republika/souhrnny-prehled?l=en	No data to download, only online visualisation.
Denmark	Danish Meteorological Institute - DMI	http://research.dmi.dk/data/	No data is available for download.
Estonia	Estonian Environment Agency (Keskkonnaagentuur)	https://keskkonnaportaal.ee/et/avaandmed	The latest weather observations and forecasts can be downloaded manually.

		https://www.ilmateenistus.ee/kliima/ajaloolised-ilmaandmed/	Also, hydrological and climate time series can be downloaded manually.
France	MeteoFrance	https://meteo.data.gouv.fr/	Observations and other data can be downloaded manually.
Germany	German Meteorological Service (Deutscher Wetterdienst, DWD)	https://www.dwd.de/EN/ourservices/cdc/cdc_ueberblick-klimadaten_en.html https://opendata.dwd.de/	Observations and other data can be downloaded manually.
Greece	Hellenic National Meteorological Service (HNMS)	https://emy.gr/en?area=forecast	Data not available at the moment [Accessed on 23 January 2025]
Hungary	Hungarian Meteorological Service - HungaroMet	https://www.met.hu/en/eghajlat/	Observations time series can be downloaded manually.
Ireland	The Irish Meteorological Service (MET éireann)	https://www.met.ie/	Some observation data is available for manual download, in addition to online visualisation of observations and forecasts. Time series and gridded data are available on DATA.GOV.IE (included in OpenKIWAS).
	DATA.GOV.IE	https://data.gov.ie/organization/meteireann?	Also, observations time series for several data are available.
	The Irish Meteorological Service (MET éireann)	https://opendata.met.ie/nwp/primary-info	It requires registration.
Italy	Italian Air Force (Aeronautica Militare)	https://www.meteoam.it/it/home	No data to download, only online visualisation.

	Italian Meteorological Service (Italia Meteo)	https://www.agenziaitaliameteo.it/	Data is made available through MISTRAL Meteo-Hub (included in OpenKIWAS).
	MISTRAL Meteo-Hub	https://www.mistralportal.it/it/	Also observations time series for several data are available.
Latvia	Latvian Environment, Geology and Meteorology Center (Latvijas Vides, ģeoloģijas un meteoroloģijas centrs)	https://klimats.meteo.lv/	No data to download, only online visualisation.
Lithuania	Lithuanian Hydrometeorological Service (Lietuvos hidrometeorologijos tarnyba)	https://www.meteo.lt/	No gridded data to download, only online visualisation. API only for punctual observations and forecasts.
Luxembourg	MeteoLux	https://www.meteolux.lu/fr/produits-et-services/applications/api-meteolux/	API service to download meteorological data.
	The Luxembourgish open data platform (data.public.lu)	https://data.public.lu/en/pages/topics/meteo/	No gridded/interpolated data is available.
Malta	-	-	No sources were found.
Netherlands	Royal Netherlands Meteorological Institute (Koninklijk Nederlands Meteorologisch Instituut, KNMI)	https://english.knmidata.nl/open-data	Also, observations are available with API.
Poland	Polish Institute of Meteorology and Water Management (Instytut Meteorologii i Gospodarki Wodnej, IMGW)	https://danepubliczne.imgw.pl/pl/apiinfo	Meteorological and hydrological data available through AAPI
		https://histklim.imgw.pl/pl/charts/BB	Digital archive of data.

Romania	MeteoRomania	https://www.meteoromania.ro/	Only online visualisation for gridded/interpolated data. Observations can be downloaded for free or for a fee.
Slovakia	Slovak Hydrometeorological Institute (Slovenský hydrometeorologický ústav, SHMU)	https://www.shmu.sk/en/?page=1	No gridded data to download, only online visualisation.
Slovenia	ARSO Meteo (Agencija Republike Slovenije za okolje, Agency of the Republic of Slovenia for the Environment)	https://meteo.arso.gov.si/met/en/climate/ https://github.com/ZeevoX/arso-meteo-dl	No gridded data to download, only online visualisation. Github code to download observations and measurements from local stations.
Spain	Spanish National Meteorological Agency (Agencia Estatal de Meteorologia, AEMET)	https://www.aemet.es/en/datos_abiertos	Gridded data and observation can be downloaded through API for a fee. Manual download of some punctual data at https://opendata.aemet.es/centrodedesargas/productosAEMET?
Sweden	Swedish Meteorological and Hydrological Institute (SMHI)	https://www.smhi.se/en	Only online visualisation. Hydrological Forecasting (HYFO) and other data and services for a fee.
Non-EU country	Organisation	Link	Available data
Switzerland	MeteoSwiss	https://www.meteoswiss.admin.ch/#tab=forecast-map	For a fee.

UK	UK Meteorological Office (Met Office)	https://www.metoffice.gov.uk/	Other data available but without API; Forecast for a fee.
Level	Organisation	Link	Available data
European	European Centre for Medium-Range Weather Forecasts (ECMWF)	https://www.ecmwf.int/en/forecasts/datasets	New datasets or dataset updates to check in the future.
European	Copernicus, ECMWF, Climate Change Service (Climate Data Store)	https://cds.climate.copernicus.eu/	New datasets or dataset updates to check in the future.
Global	World Meteorological Organization (WMO)	https://climatedata-catalogue-wmo.org/	Catalogue of datasets referring to some of the sources already quoted in OpenKIWAS.