Co-financed by the European Union
Connecting Europe Facility

Water Health Open knoWledge (WHOW)

Use Cases Definition

Project number	**Agreement number: INEA/CEF/ICT/A2019/2063229** **Action No: 2019-EU-IA-0089**
Project acronym	**WHOW**
Project title	**Water Health Open knowledge**
Project duration	**36 months (01/09/2020 – 31/08/2023)**
Programme	**Connecting Europe Facility (CEF) Telecom**

Activity title	**Requirements definition**
Deliverable number	**2.1**
Version (date)	**0.67(31/12/2021)**
Due date	**31/12/2021**

Responsible organisation	**ISPRA**
Editors	**Marco Picone, Gianluca Carletti, Carmen Ciciriello, Paola Esposito**

Abstract	**This deliverable contains the description of the WHOW Use Cases**
Keywords	**Water, Health, Floods, Contaminants, Drought**

Editors

Marco Picone, Roberta De Angelis, Emanuela Spada, Patrizia Borrello - *ISPRA*

Gianluca Carletti, Giovanni Peditto, Sonia Papoccia - *ARIA Spa*

Carmen Ciciriello, Paola Esposito – *Celeris Advisory*

Reviewers

Carmen Ciciriello, Marco Picone, Gabriele Nardone

Contributors

Alessandra Casali, Giulio Settanta, Elio Giulianelli, Stefano de Corso (ISPRA), Anita De Cesaris (MiTE), Alessandra Gelmini (Regione Lombardia), Enzo Lo Piccolo, Giacomo Scala (Regione Siciliana), Antonella D'Amore (Arpa Sardegna), Susanna Alloisio, Francesco Misurale (ETT S.p.a.), Davide Del Monte (REACT), Daniela Iasillo, Massimo Zotti (Planetek), Franco Amigoni (Formez OECD), Ana Pasian (ESG), Girolamo Da Schio.

Acknowledgement

This work was partially supported by the European Commission (EC) through the Connecting Europe Facility (CEF) programme under the WHOW project WHOW (grant agreement no. INEA/CEF/ICT/A2019/2063229).

Change Log

Version	Date	Author(s)	Organisation(s)	Description
0.1	07/10/2021	C. Ciciriello; P. Esposito M. Picone; R. De Angelis; G. Carletti; G. Peditto	Celeris ISPRA ARIA	Creation of table of content, legal framework and initial content for the first two use cases
0.2	29/11/2021	C. Ciciriello; P. Esposito	Celeris	Updated legal framework (incl. extreme events related aspects)
0.3	15/12/2021	C. Ciciriello; P. Esposito	Celeris	Creation of Use Case 3 - Extreme Events
0.4	21/12/2021	G. Carletti; M. Picone; C. Ciciriello	Celeris ISPRA ARIA	Draft document with main sections updated
0.5	22/12/2021	C. Ciciriello; C. Ripamonti	Celeris	Finalised document with all sections completed ready for review
0.6	28/12/2021	M. Picone	ISPRA	Review of contents and layout
0.7	31/12/2021	C. Ciciriello	Celeris	Final review

Executive Summary

The WHOW project aims to foster the creation of the first European knowledge graph on water consumption and quality, health parameters and diseases diffusion to be reused for advanced analysis and development of innovative services. The project leverages the use of the Linked Open Data paradigm. In particular, water and environment related datasets from different European data sources will be linked to selected health related datasets from Italian data providers.

This document describes the project's Use Cases and related datasets that will be used for modelling the knowledge graph. The Use Cases have been gradually developed and fine tuned using a dual approach:

- *Top-down*: identifying legislative and policy requirements at the EU and Italian level in the water and health domains;
- *Bottom-up:* gathering requirements through a co-creation programme where interested stakeholders and users have been involved from the initial phases of the project.

The following three Use Cases have been identified:

1. *Contaminants in marine waters*: Linking data on bioaccumulation and human exposure to chemicals and biological contaminants in marine waters; ingestion of contaminated fish products; and airborne exposure (e.g. Ostreopsis Ovata).
2. *Water for human consumption*: Linking data on drinking water quality, measured by compliance with new EU microbiological, chemical and physical parameters, with data on water-related diseases and pathogens.
3. *Extreme events*: Linking data on floods, sea storms, storm surges, coastal floods and drought to human health, alteration of the hydrological cycle, agriculture and fisheries industries.

The required data necessary for the implementation of each Use Case have been outlined, while a detailed list of available datasets and data quality aspects to be taken into account for further analysis has been included in the final chapters of the document.

Europe is still struggling to provide a holistic view of these issues and fully harmonize data in terms of semantics, formats and licenses. The databases currently available demonstrate insufficient granularity and combinations of data. Even at the national level, datasets from different administrative levels show a fragmented context. WHOW is addressing these issues by creating a framework of data, data models and supporting services to provide a consistent view on water and health data to be effectively re-used.

The project will also support the implementation of the European policies and directives. In particular, the Use Case 2 on Water for human consumption could support EU institutions and Member States in the implementation of Drinking Water Directive (2020/2184); while the Use Case 3 on Extreme Events will contribute to close to the gap in data availability on climate-related events and climate adaptation strategies, achieving higher data quality and consistency, developing the information layer necessary for the design, implementation and verification of any warning systems in case of extreme events, such as flooding and droughts.

Wider availability and higher quality of data on water pollution, water consumption and extreme events can help in better assessing the impact on human health and the environment, fostering the development of innovative services, allowing decision makers and communities to make more informed decisions on policies and lifestyles. The WHOW project has already attracted a community of over one-hundred participants in its co-creation programme. It could serve as a reference model also at the international level.

Table of contents

List of tables

List of figures

Definitions and Acronyms

Flood	The Floods Directive (2007/69/CE) defines "flood" as the temporary covering by water of land not normally covered by water. This shall include floods from rivers, mountain torrents, Mediterranean ephemeral water courses, and floods from the sea in coastal areas, and may exclude floods from sewerage systems.
Flood risk	The Floods Directive (2007/69/CE) defines 'flood risk' as the combination of the probability of a flood event and of its potential adverse consequences for human health, the environment, cultural heritage, and economic activity associated with a flood event.
Health	"A state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity." Source: Constitution of the World Health Organization, 1948. During the last decades, this definition was changed and integrated several times to consider even other aspects, essentially: - the absence of any disease or impairment; - the state that allows the individual to adequately deal with all demands of everyday life; - the state of balance, an equilibrium that an individual has established within himself and between himself and his social and physical environment.
Knowledge graph	A knowledge base which, thanks to the graph data structure, is able to link both descriptions of real-world entities with their relations and facts about these entities and relations. A semantic knowledge graph is usually represented in RDF, thus allowing for the sharing of a fluent representation of various types of data and content.
Linked Data	A set of design principles for sharing machine-readable interlinked data on the Web. It is one of the core pillars of the Semantic Web, also known as the Web of Data, and is based on four design principles according to Tim Berners-Lee: (i) the use of Uniform Resource Identifiers (URIs) to refer to any resource, (ii) the use of HTTP URIs for effective retrieval of said resources, (iii) the use of RDF and SPARQL standards to respectively publish and retrieve data, (iv) the interconnection of URIs to interlink existing data in a shared network of machine-processable meaning.

1 Introduction

The document discusses the use cases of the WHOW project. The use cases' requirements, as well as their related datasets, have been outlined. They represent the basis for the technical development activities and will be further fine tuned in alignment with the future project milestones.

1.1 Project Overview

The WHOW project aims to foster the creation of the first open and distributed European knowledge graph on water consumption and quality, health parameters and diffusion of diseases to be reused for advanced analysis and development of innovative services.

The project leverages the Linked Open Data paradigm. Water related datasets from Italy and other European countries and Copernicus (the European Union's Earth observation programme) will be used to support the construction of WHOW's knowledge graph, intended as a federation of knowledge graphs deployed at each data provider willing to join the WHOW community. The knowledge graph will be documented on data.europa.eu, the official portal for European data, thanks to the adoption of shared metadata models such as (Geo)DCAT-AP. Selected health related datasets from Italy will be linked to specific water datasets.

WHOW focuses on specific use cases for the development of the knowledge graph, identifying and integrating the relevant set of indicators for Sustainable Development Goals (SDGs), deploying a co-creation programme where interested stakeholders and users are engaged from the initial phases of the project.

The initiative supports the Public Open Data Digital Service Infrastructure by helping to boost the development of information products and services based on the re-use of *high value datasets,* as foreseen by the Directive on open data and the re-use of public sector information (EU) 2019/1024.

1.2 Methodology

The definition of the WHOW Use Cases has as a starting point the three use cases identified in the original project proposal. However, the use cases presented in this document have been shaped and fine tuned taking into account:

1) the most recent legislative and policy developments in Europe, namely the Drinking Water Directive (EU) 2020/2184 and the New Climate Adaptation Strategy; and

2) a co-creation program, officially launched on 10 May 2021, with the main purpose of creating a community of institutional and non-institutional actors, at national and international level, to be involved in the definition of use cases and the identification of the related datasets.

The involvement of the stakeholders on the main themes of the project was aimed at supporting and directing the development of WHOW research activities and the achievement of its results, aligning its objectives with the needs and expectations of the entities responsible for monitoring data in the water and health sectors and disease diffusion according to the Open Data paradigm.

The WHOW community includes local authorities, Regional Agencies for the Protection of the Environment, research institutes, the civil society and private companies in their roles as Data Providers and Data Consumers. Targeting meetings with specific communities have been regularly organised.

As of December 2021, over 100 stakeholders have been involved in the co-creation program significantly contributing to define the requirements for the use cases and to reshape them.

1.3 Document structure

Chapter 2 discusses the regulatory framework of the identified use cases. The framework is necessary first of all to identify the formal definitions and legal requirements. The framework makes it possible to support the development of a semantic layer for the correct definition of concepts and relationship between them, which is necessary in a Linked Open Data context.

Chapter 3 is dedicated to the use cases. Each use case is elaborated in terms of definition and context in which it generates value, reference to the related regulatory framework, and impact on human health and, where appropriate, on the environment. For each use case, the requirements are indicated, in terms of desirable datasets necessary for its implementation.

Chapter 4 indicates the datasets currently published, or in the process of being published, which potentially meet the requirements of each use case. This list must be considered as the result of the exploratory phase of the co-creation program, where each participant has provided input that has been integrated. The list must now be subject to an assessment phase in terms of legal, privacy and data quality, from which datasets that do not meet the minimum requirements will be excluded.

Chapter 5 contains the checklists for the legal, privacy and data quality assessment that will be applied in order to consolidate the list of candidate data sets for the implementation of the use cases. The datasets that will pass the established criteria will be included in the next deliverable.

1.4 Relationship with other deliverables

The present deliverable D 2.1 is an important milestone (#2) of the WHOW project. It represents the foundation for the development of the future activities of the overall WHOW project. In particular, Chapter 3 and Chapter 4 - use cases and requirements will be used for modelling the knowledge graph (under Activity 3) and for the implementation of the use cases (under Activity 5).

The co-creation program (under Activity 6) provides critical input for the definition of the requirements for the use cases (Activity 2) and other technical activities.

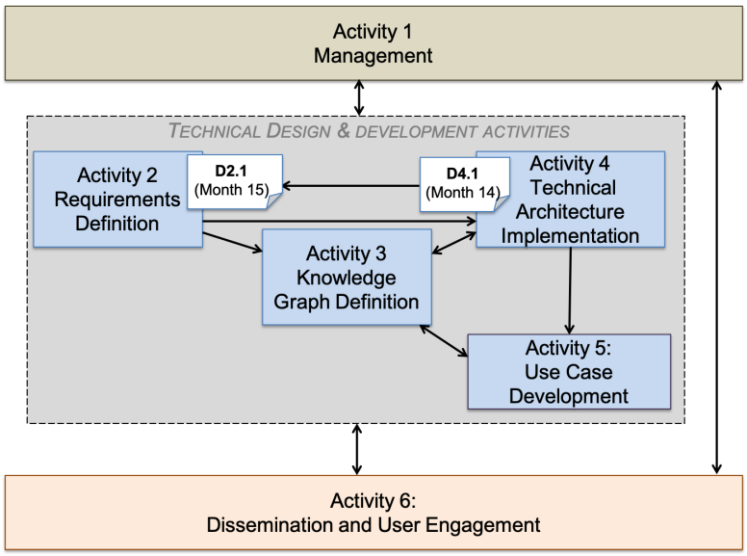

Figure 1 - Relationships between activities and deliverables

2 Legal Framework

Water resources protection has been on the agenda of the European Commission since the first wave of European water legislation began with standards for the rivers and lakes used for drinking water in 1975, and culminating in 1980 with the setting of binding quality targets for drinking water. EU legislation included quality objectives for fish waters (Directive 78/659/EEC), shellfish waters (Directive 79/923/EEC), bathing waters (Directive 76/160/EEC).

Its main instrument for emission control was the Dangerous Substances Directive (Directive 76/464/EEC). This Directive was significantly amended in 1991 and 2000, and repealed in 2006 (Dir. 2006/11/EC).

In 1988, a number of potential improvements to this legislation were identified, resulting in a second wave of water legislation in the 1990's, namely, the Urban Waste Water Treatment Directive (Dir. 91/271/EEC) (UWWTD), providing for secondary (biological) wastewater treatment, and even more stringent treatment where necessary, and the Nitrates Directive (91/676/EEC), addressing water pollution caused by nitrates used in agriculture. Both directives were adopted in 1991. In particular, the Nitrates Directive mandates EU member states to designate as vulnerable zones all land areas draining into waters that are or are likely to become affected by pollution ("nitrate-sensitive" areas). Member States are also called upon to establish codes of good agricultural practices binding on farmers and to implement programmes of measures relevant to the prevention of non-point source pollution. Monitoring obligations are also provided for in this directive.

Other developments were included in a Directive for Integrated Pollution and Prevention Control (IPPC), adopted in 1996 (96/61/EC), addressing pollution from large industrial installations, and a Drinking Water Directive adopted in 1998, reviewing quality standards and provisions for tightening them where necessary. This Directive, which was amended in 2003, 2009 and 2015, has been recently revised to provide for better access to safe drinking water to all, as well as better public information. Directive (EU) 2020/2184 on the quality of water intended for human consumption (recast) entered into force on 12 January 2021, and Member States have two years to transpose it into national legislation. The Directive lays down the essential quality standards at EU level. A total of 48 microbiological, chemical and indicator parameters must be monitored and tested regularly.

In the mid-1990's, a more global approach to water resources management was considered in order to address the increasing demand by citizens and environmental organizations for cleaner rivers and lakes, groundwater and coastal beaches. Thus, the Commission initiated a process of consultation leading to a widespread consensus that, while considerable progress had been made in tackling individual issues, the current water policy was fragmented, both in terms of objectives and of means. All parties agreed on the need for a comprehensive framework.

In response to this, the Commission presented a Proposal for a Water Framework Directive with the following key aims:

(i) expanding the scope of water protection to all waters, including surface water and groundwater, considered within defined "river basin districts";

(ii) achieving "good status" for all waters by fixed deadlines, through the setting and coordination of objectives within each river basin, and the introduction and implementation of programmes of measures;

(iii) establishing a river basin management plan for each river basin district.

The plan is essentially a detailed account of how the objectives set for a river basin (ecological status, quantitative status, chemical status and protected area objectives) are to be reached within set deadlines. The plan provides an analysis of the characteristics of the river basin, a review of the impact of human activity on the status of waters in the basin, an estimation of the effects of existing legislation and of what remains to be done to meet the objectives, and an indication of the measures required to fill the gap. An economic analysis of water use within the basin must be carried out in order to facilitate an assessment of the cost-effectiveness of the various measures;

(iv) a "combined approach" to emission limit values (effluent standards) and water quality standards requiring the adoption of the best available technology for point-sources and, on the effect side, the coordination of environmental objectives with a view to achieving the overall status objective;

(v) water prices reflecting the true cost and acting as an incentive for sustainable water use, thus helping to achieve the environmental objectives set under the directive;

(vi) public participation in river basin planning and management, to balance the interests of various groups and ensure plan implementation and enforceability;

(vii) streamlining legislation by repealing seven of the first wave directives.

The Water Framework Directive (2000/60/EC) (WFD), which for the first time provides for the management of surface water and groundwater at the EU level in a comprehensive manner, was adopted in 2000. Since then, EU Member States have taken action to align their respective legal systems and institutional arrangements to its requirements and to those of the "second wave" directives which remain in force.

Since the implementation of the Water Framework Directive has resulted to be more complex than originally envisaged, in 2001 the Member States have agreed with the Commission and Norway on a common implementation strategy that aims at developing a common understanding of approaches and informal technical guidance on best practices, thereby reducing the changes of wrong application. The strategy is largely based on the sharing of information and experiences and the production of guidelines on technical issues.

Since the 1970s, the EU has had rules in place to safeguard public health and clean bathing waters. In December 2000, the Commission adopted a Communication to the European Parliament and the Council on the development of a new bathing water policy. In 2006, the European Parliament and the Council adopted the Directive 2006/7/EC concerning the management of bathing water quality and repealing Directive 76/160/EEC concerning the quality of bathing water. For the public at large, the Bathing Water Directive (BWD) is key to improving water quality in general, and the health impacts in particular. Together with the Drinking Water Directive, which also requires specific results in terms of healthy water quality, this Directive is the driver for a focussed implementation of the Water Framework Directive, the Nitrates Directive and the Urban Waste Water Treatment Directive.

To complete the European legal framework, the European Parliament and the Council adopted the Groundwater Directive (2006/118/EC) and the Floods Directive (2007/60/EC); while Directive 2008/105/EC lays down environmental quality standards for priority substances and other pollutants. The Groundwater Directive aims at defining criteria for assessing the good chemical status and groundwater quality trends, identifying significant and sustained upward trends in the concentration of pollutants and defining starting points for trend reversal. For groundwater bodies which are considered to be at risk pursuant to the analysis of pressures and impacts to be carried out under the Water Framework Directive, Member States must establish threshold values and report on them to the European Commission.

The Water Framework Directive stipulates that the good quantitative and chemical status objective for groundwater is to be achieved through the prevention or limitation of the input of pollutants and the maintenance of a balance between groundwater abstraction and recharge. EU Member States have the duty to implement all the measures necessary to "reverse any significant and sustained upward trend in the concentration of any pollutant resulting from the impact of human activity in order progressively to reduce pollution of groundwater, and to establish programmes for monitoring the status of groundwater. The Directive prohibits the direct discharge of pollutants into groundwater. The Floods Directive aims to reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity. It requires Member States to carry out preliminary assessments to identify the river basins and associated coastal areas at risk of flooding and, for the areas so identified, to develop flood risk maps and establish flood risk management plans that take into consideration development in the long term, as well as the possible effects of climate change. These plans are to be coordinated with the river basin management plans prepared under the Water Framework Directive.

As mentioned above, Directive 2008/105/EC (EQSD) of the European Parliament and the Council of 16 December, 2008, on environmental quality standards in the field of water policy, lays down environmental quality standards for priority substances and other pollutants. Commission proposal (COM(2011)876) led to the adoption of Directive 2013/39/EU amending the list of priority substances (Annex X to the WFD), and the EQSD. The first list of priority substances (Annex X to the WFD) was established by way of Decision 2455/2001/EC using the approaches outlined in Article 16 of the WFD. This first list was replaced by Annex II of the EQSD, also known as the Priority Substances Directive. The list was replaced again in 2013 by Annex I to Directive 2013/39/EU, which also included EQS and some other provisions on chemical pollutants.

A "fitness check" of European directives was conducted in order to assess their relevance, effectiveness, efficiency and coherence. In December 2019, the Fitness Check concluded that water legislation is broadly fit for purpose, with room for improvement related to investments, implementation, integrating water into other policies, chemical pollution, administrative simplification and digitalisation. On 23 October 2020, an Inception Impact Assessment was launched to address the findings of the Fitness Check in relation to chemical pollution and the legal obligation to regularly review the lists of pollutants affecting surface and groundwater.

EU Member States have made significant progress towards the transposition of the Water Framework Directive and other EU directives into their legislation. Among them, Belgium, France, England and Wales and Germany have amended their water legislation or adopted new legislation between 2002 and 2004. In a nutshell, this legislation provides for enhanced resource planning within formally identified river basin districts, and introduces mechanisms and procedures for public participation in this exercise. It further provides for the establishment of environmental objectives and programmes for monitoring the water status, and for the adoption and implementation of programmes of measures within the river basin district framework. The basin management plans must include all the information specified in the Water Framework Directive.

In line with Decision No 1600/2002/EC of the European Parliament and of the Council of 22 July 2002 laying down the Sixth Community Environment Action Programme, a thematic strategy for the protection and conservation of the marine environment has been developed with the overall aim of promoting sustainable use of the seas and conserving marine ecosystems. The European Union adopted two instruments, the 2002 EU Recommendation on Integrating Coastal Zone Management, and the 2008 Marine Strategy Framework Directive (2008/56/EC) (MSFD), which is the first encompassing piece of EU legislation specifically aimed at creating a framework for community action in the field of marine environment policy.

In 2017 the European Commission adopted the Decision (EU) 2017/848 laying down criteria and methodological standards on good environmental status of marine waters (as expressed in MSFD Article 3(1)), specifications and standardised methods for monitoring and assessment.

The "Extreme Events" use case of the WHOW project is focused mainly on floods and drought. The main objective is to gather data that can contribute to improve the risk management resulting from climate change. The data collection starts from the analysis of the European regulatory framework, i.e. the Floods Directive (2007/60/EC) on the assessment and management of flood risks - as a complementary tool to the Water Framework Directive, in the light of the new EU Strategy on Adaptation to Climate Change[1].

The data collection criteria refer to the different types of floods (floods caused by overflowing rivers, flash floods, urban floods and marine floods in coastal areas), and will consider the areas for which there is a significant risk of flooding, and/or meaningful sectors/industries or geographical contexts (agriculture, urban areas).

The new EU climate change adaptation strategy – COM (2021) 82 final - recognizes the importance of the climate-water nexus as many hazards of climate change are related to the hydrological system (sea level rise, intensive rainfall, floods, water scarcity and droughts, melting of glaciers, changes in snow cover and sea ice conditions). The above strategy notes - among other things - that more frequent and extreme weather events such as heat waves, floods, and storms have significant effects on health and quality of life. In addition, it points out the need for integrated cross-sector and cross-border water management that contributes to increased resilience, the promotion of sustainable water use, the protection and conservation of aquatic ecosystems and the improvement of flood risk and water scarcity and drought management strategies, incorporating future floods and drought risk and arranging timely and reliable exchange of data and early warnings.

Floods are natural phenomena/natural catastrophes that cannot be prevented. However, some human activities - such as increasing human settlements and economic assets in floodplains and the reduction of the natural water retention due to improper land use - and climate change (rapid glacier melting and heavy rainfalls) contribute to an increase in the likelihood and adverse impacts of flood events.

Floods are a threat to human health, cultural heritage, the economy and the environment. Decision 2001/792/EC, EURATOM of the Council of 23/10/2001, establishing a Community mechanism to facilitate reinforced cooperation in civil protection assistance interventions, mobilizes support and assistance from Member States in the event of major emergencies, including floods. Civil protection can provide adequate responses to affected populations and improve their preparedness and ability to cope with such disasters.

In recent years, hundreds of floods have hit Europe, including devastating floods along the Danube and Elda rivers, which have caused many casualties, the evacuation of thousands of people and huge economic losses, estimated at many billions of Euros. The worst floods were those recorded in 2002, 2006, 2009, 2010, 2013 and 2014. As a consequence of what occurred in 2002, the EU Council of Ministers launched an initiative to propose a directive on flood risk management.

The focus of European countries then shifted from protection to actual flood risk management. Moreover, the main watercourses in Europe are shared by more than one State, and therefore coordinated action at Community level proved to be the most effective.

[1] https://ec.europa.eu/commission/presscorner/detail/en/ip_21_663

The reference regulatory framework aimed at flood risk prevention and planning in the Member States was therefore reflected in the so-called Floods Directive (Directive 2007/60/EC) on the assessment and management of flood risks. This directive works in synergy with the Water Framework Directive and can be seen as its supplementary tool, since the latter, although envisaging the principle of cross-border coordination within river basin districts in order to achieve a good ecological and chemical status of water, had not set any objective related to flood risk management, nor had taken into account the flood risks resulting from climate change.

A Guidance Document[2] on Adaptation to Climate Change in Water Management was drafted in 2009, the document outlines adaptation measures related to the Water Framework Directive.

3 Use Cases

Water interacts with human health in several ways. Humans need water to survive (for drinking purposes) but since most of the human activities involve the water cycle, the protection and maintenance of the water resource at an acceptable level from a physical, chemical and biological point of view is fundamental for human health. Examples are activities such as agriculture, manufacturing and energy related processes, transport, fishing, tourism, which require water as a vector, resource or necessity.

Finally, there are situations in which water can be dangerous for humans. This is evident in case of significant events which, through large quantities of water, or prolonged scarcity of the resource, generate an imminent hazard to the exposed population.

In the framework of the WHOW project, Use Cases have been gradually developed and fine tuned using a dual approach: 1) Top-down: starting from legislative and policy requirements at the EU and Italian level in the water and health domains; 2) Bottom-up: gathering requirements through a co-creation program where interested stakeholders and users have been involved from the initial phases of the project.

The following three Use Cases have been identified:

1) Contaminants in marine waters: Linking data on bioaccumulation and human exposure to chemicals and biological contaminants in marine waters; ingestion of contaminated fish products; and airborne exposure (e.g. Ostreopsis Ovata).

2) Water for human consumption: Linking data on drinking water quality, measured by compliance with new EU microbiological, chemical and physical parameters, with data on water-related diseases and pathogens.

3) Extreme events: Linking data on floods, sea storms, storm surges, coastal floods and drought to human health, alteration of the hydrological cycle, and agriculture and fisheries industries.

In the following sections, the three use cases are described in detail, addressing regulatory aspects, the anthropic pressures on the water resource, and the impacts on human health and the environment.

For each use case, other relevant aspects have been identified and possible data sources necessary to provide a complete overview have been listed.

[2] https://ec.europa.eu/environment/water/adaptation/index_en.htm

3.1 Use Case 1 - Human exposure to chemical and biological pollutants in marine waters

All animals, including humans, can be exposed to and absorb natural and chemical pollutants in their natural surroundings by eating, breathing, and drinking. These pollutants are substances which are not easily broken down in the environment. Some persistent organic pollutants occur naturally, but others are man-made, such as the chemicals used in pharmaceutical, pesticide, industrial, and solvent manufacturing. Additionally, some anthropogenic activities are responsible for releasing heavy metals and toxins into the seawater. One of the reasons that these pollutants cannot be degraded in the environment is that plants and animals have not yet been exposed to them for a long period of time. This means they have not had enough time to evolve the appropriate biological methods for detoxification and elimination.

When substances, such as chemicals or heavy metals, concentrate within the internal organs and tissues of living beings biomagnification can occur. Biomagnification refers to the condition where the chemical concentration in an organism exceeds the concentration of its food when the major exposure route occurs from the organism's diet.

There are several biomagnification processes, including: bioaccumulation, biodilution, and bioconcentration. Bioaccumulation occurs within a specific level of the food chain, or trophic level. It involves the concentration of toxins in specific organs within a particular species. Bioconcentration occurs when the toxin comes only from a source of water. Biodilution is similar to both bioaccumulation and bioconcentration in that it occurs across a specific level of the food chain and only affects species living in water bodies. Additionally, biodilution is the opposite of biomagnification, meaning that the concentration of toxins becomes diluted as it moves to higher levels of the food chain.

Because humans are at the top of the food chain, biomagnification is of serious concern. The toxins responsible for health problems include: mercury, lead, chromium, cobalt, cadmium and natural toxins. Humans who are affected by biomagnification tend to have a higher risk of developing certain cancers, liver failure, birth defects, brain damage, and heart disease. Natural toxins in food can cause both acute and chronic health effects with a range of clinical symptoms. Acute symptoms range from mild gastrointestinal upset, neurological symptoms, respiratory paralysis to fatality. This is more likely among the susceptible groups of the population such as children and the elderly. Within hours if not shorter, acute symptoms are seen following ingestion of various marine toxins in shellfish and other seafood. Poisoning from ingested marine toxins is an underrecognized hazard for travellers, particularly in the tropics and subtropics.

Furthermore, the risk is increasing because of climate change, coral reef damage, and spread of toxic algal blooms. The occurrence of harmful algal blooms in surface waters is often accompanied by the production of a variety of algal toxins (Figure 2). These toxins are designed to target in humans and animals' specific organs on which they act: epatotoxins (liver), neurotoxins (nervous system), cytotoxic alkaloids, and dermatotoxins (skin), but they often have important side effects too. For example among neurotoxins the natural palytoxin (PLTX), produced by Ostreopsis ovata in tropical regions, can induce lethal cases following the ingestion of contaminated fish products.

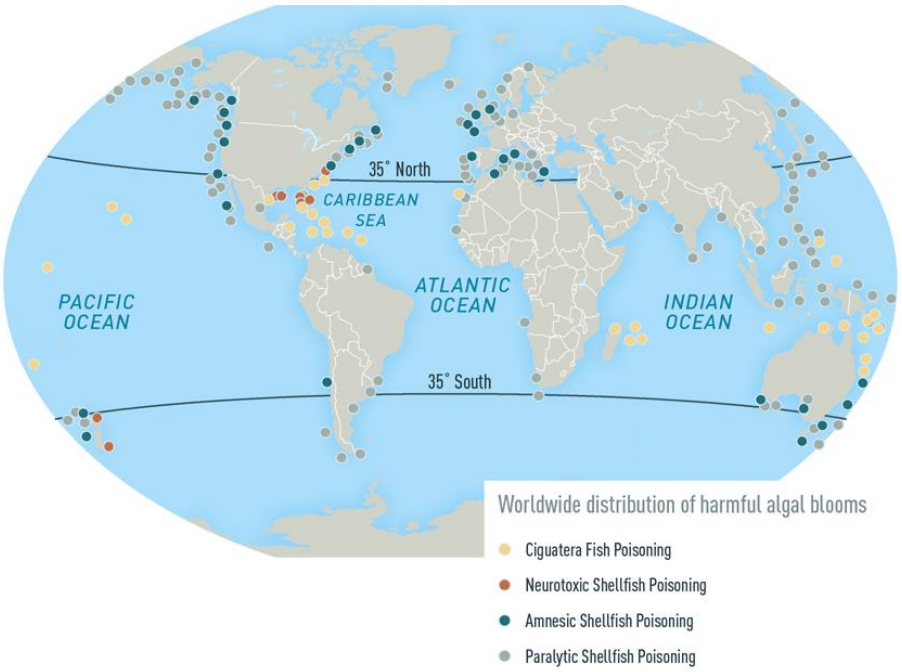

Figure 2 - Areas reporting harmful algal blooms[3]

3.1.1 Biomagnification and Bioaccumulation

Bioaccumulation is a process that occurs when a chemical substance is accumulated in the tissues of an organism through any possible pathways of absorption.

This storage is not balanced by any losing process and it is quantified by the bioaccumulation factor, defined as the ratio between the concentration of the chemical element in the organism and the concentration in the surrounding environment. The bioaccumulation of pollutants can occur directly from the environment in which the organism lives, through the respiratory surfaces and /or the skin. For aquatic organisms, the bioconcentration factor is typically referred to the absorption of the pollutant from water and can be easily estimated by numerical models using pollutant concentrations as input.

Human health could be affected by bioaccumulation in case of direct contact with contaminated water resources or by biomagnification. Biomagnification occurs when larger organisms (as predators or humans) feed upon the already contaminated organism lives and in turn absorb elements into their own tissues at a higher concentration. The more contaminants are eaten, the more pollutants will be present in the new organism. Because the amounts of contaminants become more and more concentrated at each trophic level, apex predators (and also humans) could risk having fatal levels of accumulation in their bodies. As a result, the main effects on human health regards the interaction between chemical substances and tissues, from gastrointestinal or respiratory disease, poisoning, tumors. But there are also secondary effects related to the inability to use the fishery resource for human consumption in case of a high level of contamination.

A large number of chemical substances can activate a bioaccumulation process, from industrial waste, to pesticides, from plastics in water to drugs or antibiotics for human or animal consumption.

[3] Harmful algal bloom data from Woods Hole Oceanographic Institution, Woods Hole, MA: 2015 (Accessed August 28, 2018). Source: http://www.whoi.edu/redtide/regions/world-distribution

Required datasets

ReqID	Theme	Dataset	Description	Critical issues
UC1.1	Water	Chemical substances	Chemical monitoring requested by EU Directives (MSFD, WFD)	Monitoring managed by regional agencies and collected at European level in EIONET network (Member States can restrict access to databases)
UC1.2	Water	Distribution of aquaculture sites	Positioning and dimensions of aquaculture sites	Not exhaustive dataset
UC1.3	Water	Numbers of litter fragments	Marine Litter monitoring requested by EU Directives (MSFD - Descriptor 10)	Irregular and scattered data
UC1.4	Health	Epidemiological data	Data on Chemical and biological food contaminants for consumption	Open Data to be found

Table 1 - Use Case 1 - Biomagnification - Required datasets

3.1.2 Ostreopsis ovata

Ostreopsis ovata is a microalgae belonging to the dinoflagellate group, hailing from tropical and subtropical regions and found in recent years also in temperate zones and in many Mediterranean countries, in particular in areas characterized by poor hydrodynamic conditions and shallow waters (eg closed bays). In optimal environmental conditions and with a high value of sea temperature, the number of cells can rapidly increase until giving origin to blooms.

The toxic microalga Ostreopsis ovata has been detected for the first time in Italian waters in 1994 along the Tyrrhenian coast of Lazio, while in previous years it was observed in other Mediterranean locations such as France, Lebanon, Spain, since 1979. Two potentially toxic species of Ostreopsis are known to be present in the Mediterranean Sea: O. ovata and O. fattorussoi. Another non-toxic species is O. siamensis.

Along the Italian coast, intense and recurrent blooms of O. ovata occurred in several locations of the Tyrrhenian Sea (Sicily, Lazio, Tuscany, Liguria), Ionian Sea and Adriatic Sea (Puglia, Marche, Gulf of Trieste) with toxic effects on humans and benthic organisms such as limpets, mussels, olothurians, sea urchins (suffering or mortality).

The blooms have been associated with phenomena of human intoxication whose symptoms (cough, irritation of the upper airways, muscle or joint pain, conjunctivitis, rhinorrhea, fever due to the production of ovatoxins - OVTXs) could disappear spontaneously in the following 24-72 hours.

In tropical regions, lethal cases following the ingestion of contaminated fish products have been registered to the production of palytoxin (PLTX). In the Summer 2005 along the Ligurian coast, hundreds of people required medical attention because of respiratory problems and fever which apparently was caused by the exposure to the algal toxins through the marine aerosol.

Required datasets

ReqID	Theme	Dataset	Description	Critical issues
UC1.5	Water	Concentration of microalgae	Regional monitoring for Ostreopsis ovata and Cyanobacteria	Irregular and scattered data in Europe
UC1.6	Health	Bathing prohibition	Number of bathing bans	Few dataset available at municipal and ministerial level
UC1.7	Health	Epidemiological data	Access to the emergency room for single pathology	Open data to be found
UC1.8	Health	Epidemiological data	Data on Chemical and biological food contaminants for consumption	Open data to be found

Table 2 - Use Case 1 - Ostreopsis ovata - Required datasets

Legal framework

A set of recent European directives looks to the water and in particular to the sea with a holistic approach. In this sense, the water bodies are not separately evaluated by chemical, biological and physical aspects.

The European Directive 2000/60/CE (Water Framework Directive, WFD) defines waters as “not a commercial product like any other but, rather, a heritage which must be protected, defended and treated as such”. The main objectives of the Water Framework Directive are to protect all high status waters, prevent further deterioration of all waters and to restore degraded surface and ground waters to good status, according to the new concepts of Good ecological status and Good chemical status, by establishing the environmental quality standards for a set of chemical, biological, hydromorphological elements. In this sense, the Water Framework Directive is complementary to other EU regulations such as the REACH regulation on chemical elements, the directive on industrial emissions and regulations on pesticides.

According to the European Directive 2008/56/CE (Marine Strategy Framework Directive, MSFD) “the marine environment is a precious heritage that must be protected, preserved and, where practicable, restored with the ultimate aim of maintaining biodiversity and providing diverse and dynamic oceans and seas which are clean, healthy and productive”.

This Directive defines eleven qualitative descriptors which describe what the environment will look like when the Good Environmental Status has been achieved and to do this, each Member State must implement a marine strategy for its marine waters, in cooperation with other Member States sharing the same marine region.

Furthermore, the Bathing Water Directive (2006/7/CE) considers the surveillance of algae bloom in the “Bathing water profiles”. Also the mentioned Water Framework Directive and Marine Strategy Framework Directive consider the surveillance of harmful algae blooms. In particular, the Marine Strategy takes into account the algae blooms in descriptors 2 and 5 (Non-indigenous species, Eutrophication).

Monitoring activities

Following the above-mentioned directives, each EU Member State carries out a monitoring program in relevant points of each water body to observe the concentration of identified and alternative substances. National and European data portals collect these data usually every year.

In Italy, Regional Agencies provide these data that are collected by ISPRA and forwarded to the European dedicated portal (such as EIONET).

Some research institutions are involved in the observation of the presence of chemical substances in the tissues of fishes.

In Italy, the microalgae surveillance has been active since 2007 (Toxic Algae Program Directive of the Minister of the Environment no. GAB / 2006/6741 / B01). The monitoring activities are carried out by the Regional Agencies (ARPA) along the coasts of the 15 coastal regions, generally from June to September / October. Each Agency reports the concentration in terms of cells per litre and/or macroalgae cells per gr on the bottom and in the water column in a number of monitoring points. The observing activities are carried out during the summer season every two weeks or monthly. There is a threshold value for the protection of human health. According to the results of these monitoring activities, authorities could restrict permissions for the use of some locations.

Opportunities

The application of this use case could provide several opportunities. First of all, it could push for the opening of some useful datasets, in particular data on substances concentration in organisms and the number of infection/diseases due to bioaccumulation (in terms of cases, access to medical care, health expenditure). Many are the opportunities for stakeholders.

Citizens can have clear information about the environmental status of sea areas and bathing waters and related risks for human health, while the business world related to fishery and tourism can have data to identify areas for aquaculture or for human leisure. Public authorities can better monitor critical status and can promptly adopt appropriate measures to ensure the safety of citizens, while researchers can define accurate models for the transmission mechanism between water and organisms, for the prediction of the localization of the blooms and for clinical studies.

3.2 Use Case 2 - Water for human consumption

Drinking water is one of the most important resources for the survival of living beings and is indispensable for many anthropogenic activities. Moreover, the continuous increase of the population has led to a greater demand for drinking water and a required improvement in its quality. Thus, the availability of water has become the parameter for evaluating the living conditions of a population.

Recently, due to the pandemic, there has been a growing interest in health issues: among these the quality of drinking water, the quantity of chemicals and pathogenic microorganisms present and the repercussions on human health in case of consumption of contaminated water.

This proposed case study's objective enables an evaluation of any correlations between the quality of water for human consumption and health.

The concept of this use case derives from the observation of a series of evidences depicting the correlation between the use of contaminated water and negative health effects that have been documented recently in the Lombardy Region: the latest case in 2018 is San Felice del Benaco, a well-known tourist resort of Garda Brescia, when the aqueduct manager found the presence of Norovirus type II in three sampling points; the episode took place nine years after the pandemic of June 2009, with three thousand people intoxicated [4].

This use case is therefore born on a regional scale starting from the data available by Lombardy Region, but has the aim of being extended to other Italian regions and possibly also to the European context.

The co-creation program concretely encourages this extension with the active participation of the Regions of Umbria, Sicily and Friuli-Venezia Giulia.

Furthermore, the proposed program contributes to the development of this use case and widens the scope of investigation both with regard to water, including monitoring of groundwaters as an element with a relevant impact on the quality of water for human consumption, both in regards to impacts on health but also towards the consumption of health services.

3.2.1 Water for human consumption

Definition

As defined in EU Directive 98/83/EC and in Legislative Decree 31/2001, water intended for human consumption refers to all treated or untreated water, intended for drinking, cooking or for the preparation of food or other domestic uses both public and private premises, regardless of their origin, whether they are supplied through a distribution network, supplied by means of tanks or in bottles or containers, including spring water.

All waters used in food businesses for the manufacture, treatment, storage or placing on the market of products or substances intended for human consumption also belong to the category.

This legislation does not apply to natural mineral waters recognized as such by the responsible authorities, pursuant to Directive 2009/54 / EC, and to waters considered medicinal according to Directive 2001/83 / EC.

Legal framework

The regulatory framework governing the quality of water intended for human consumption is very complex and complete. The objectives of the regulations, both at European and national level, are the protection of

[4] https://brescia.corriere.it/notizie/cronaca/18_giugno_28/san-felice-virus-nell-acquedotto-vietato-consumare-l-acqua-4fb45ee2-7afb-11e8-80d9-0ec4c8d0e802.shtml

human health from the negative effects deriving from the contamination of water intended for human consumption, ensuring its healthiness and cleanliness, as well as improving access to water intended for human consumption [5].

In the European Union, the main and recent updated regulatory reference is the EU Directive of 16 December 2020, no. 2184, which concluded the revision process of the EU Directive 98/83 / EC. The Directive introduced the following changes [6]:

- Updating the water quality standards with the new knowledge (more stringent than) updated WHO recommendations.
- Tackling emerging pollutants, such as endocrine disruptors and PFAS, as well as microplastics.
- Preventive approach favouring actions to reduce pollution at source by introducing the "risk based approach". This is based on an in-depth analysis of the whole water cycle, from source to distribution.
- Measures to ensure better access to water, particularly for vulnerable and marginalized groups.
- Measures to promote tap water, including in public spaces and restaurants, to reduce (plastic) bottle consumption.
- Harmonization of the quality standards for materials and products in contact with water, including a reinforcement of the limit values for lead. This will be regulated at EU level with the support of the European Chemicals Agency (ECHA).
- Measures to reduce water leakages and to increase transparency of the sector.
- Transparency and communication.

At the individual country level, the steps to adopt the new directive are underway. In Italy, the main regulatory reference currently in force is Legislative Decree 2 February 2001, n. 31, which implements Directive 98/83 / EC, subsequently amended and integrated by Legislative Decree 2 February 2002, n. 27. The following general obligations are established in this decree, from which an extract is reported [7]:

1. Water intended for human consumption must be healthy and clean.

2. For the purpose referred to in paragraph 1, water intended for human consumption:

a) they must not contain microorganisms and parasites, or other substances, in quantities or concentrations such as to represent a potential danger to human health;

b) without prejudice to the provisions of articles 13 and 16, they must meet the minimum requirements set out in parts A and B of annex I;

c) must comply with the provisions of the provisions adopted pursuant to article 14, paragraph 1.

With regard to radioactivity, Legislative Decree 28/2016 provides the acceptability requirements for water intended for human consumption in relation to radioactive substances. In particular, it establishes the principles and regulates the methods of controlling radioactive substances by means of indicator parameters, as well as the related parameter values.

At the regional level, in Lombardy the regulatory reference is represented by the Circular 16/3/2004 n.15 D.G. Health (15 / SAN / 2004). It provides the guidelines for the application of Legislative Decree 31/2001. Furthermore, it establishes the quality requirements of water intended for human consumption, defines the

[5] Art. 2 della Direttiva EU 2020/2184

[6] L. Lucentini, "Directive (EU) 2020/2184 on the quality of water intended for human consumption"

[7] Art. 4 del D.Lgs 31/2001

responsibilities and competences of the water suppliers of the control bodies, regulates controls, exceptions, provisions and sanctions.

Health risks covered by the legislation

In countries with advanced economies, the chemical risks associated with the consumption of water are systematically controlled through prevention strategies and adequately planned and controlled treatment processes. The EU Directive 2184/2020 introduced a new generalized approach regarding water safety based on the concept of risk [8], from which an extract is reported:

Member States shall ensure that the supply, treatment, and distribution of water intended for human consumption is based on a risk-based approach, covering the entire supply chain, from the river basin to extraction, treatment, storage and to the distribution of water, up to the point where the values must be respected, as specified in Article 6.

This risk-based approach should involve three elements. I) the identification of the hazards associated with river basins for extraction points, in accordance with the guidelines and the OMS Water Safety Management Plan Manual. II) the possibility for the water supplier to adapt the monitoring to the main risks and take the necessary measures to manage the risks identified in the supply chain deriving from the extraction, treatment, storage and distribution of water. III) an assessment of the potential risks (for example, Legionella or lead) connected to domestic distribution systems, paying particular attention to priority room[9].

Although systematic checks are carried out through prevention strategies and adequate treatment processes, numerous chemical contaminants can be found in the water at the user's tap. This is the case of PFAS contamination, which have the characteristic of being very persistent, bio-accumulative and toxic. In fact, their potential for bioaccumulation is a function of the level of exposure and can hardly be traced back to a single BAF (bio-accumulation factor) value not related to the breakdown in the tissue lipid fraction and adipose tissue, but with rapid oral absorption. This results in significant protein binding in plasma and liver, no biotransformation reaction and slow elimination with renal reabsorption [10].

OMS notes that, in the EU, of all the pathogens present in water, Legionella bacteria cause the greatest burden from a health point of view. With respect to microbiological hazards, there is the potential for regrowth of microorganisms with Legionella and other opportunistic pathogens, such as Pseudomonas aeruginosa, of concern to health. Legionella is a problem as a consequence of inhalation of droplets carrying the organisms, leading to serious lung infections, and Pseudomonas aeruginosa is a potential problem for vulnerable persons, particularly in hospitals or other institutions via contact with or inhalation of water (droplets) where it can cause a range of serious infections that can be difficult to treat because of their resistance to antibiotics [11].

Safe water intended for human consumption means not only the absence of harmful microorganisms and substances, but also the presence of certain amounts of natural minerals and essential elements, taking into consideration that long-term consumption of demineralized water or water very low in essential elements such as calcium and magnesium can compromise human health. A certain amount of such minerals is also vital in order to ensure that water intended for human consumption is neither aggressive nor corrosive and to improve the taste of such water. Minimum concentrations of such minerals in softened or demineralized water could be considered in accordance with local conditions.

[8] Art. 7 Directive EU 2020/2184

[9] Art. 8, comma 6 Directive EU 2020/2184

[10] https://www.europarl.europa.eu/doceo/document/E-8-2016-003878_EN.html

[11] https://ec.europa.eu/environment/water/water-drink/pdf/WHO_parameter_report.pdf

Monitoring activities

At the national level, the Legislative Decree 31/2001 and its subsequent amendments in the Legislative Decree 2 February 2002, n. 27 provide guidelines relating to the sampling frequency of water intended for human consumption and the parameters to be monitored.

Annex I of Legislative Decree 31/01 provides restrictions on 53 parameters, divided as follows:

• Part A: 2 microbiological parameters (5 for water sold in containers or in bottles);

• Part B: 28 chemical parameters, unwanted and toxic elements, for which restrictive limits of concentration in water are indicated;

• Part C: 21 physical parameters, for which recommended values are mentioned which should not be exceeded;

• 2 radioactivity parameters.

• Information on any ancillary controls, concerning algae, bacteriophages against E.coli, helminths, pathogenic enterobacteria, enteroviruses, fungi, protozoa, Pseudomonas aeruginosa, pathogenic staphylococci.

Annex II of Legislative Decree 31/01 governs the control phase. A distinction is made between so-called routine checks and verification checks and the minimum sampling frequency is defined:

• The *routine control* aims to provide information at regular intervals on the organoleptic and microbiological quality of the water supplied for human consumption as well as information on the effectiveness of any drinking water treatments (in particular disinfection), to ascertain whether the water intended for human consumption meet or not the relevant parameter values set by the decree.

• The *verification check* aims to provide the information necessary to ascertain whether all the parameter values contained in the decree are respected. All the parameters set are subject to verification control, unless the local health unit responsible for the control determines that, for a given period, it is unlikely that a parameter is in a given water supply in concentrations such as to predict the risk of a marked compliance with the relative parameter value. This clause does not apply to parameters for radioactivity.

• The *minimum frequency* of sampling and analysis for water intended for human consumption provided by a distribution network, by tanks, or used in food businesses. Samples must be taken at the points identified pursuant to Article 6, in order to ensure that the water intended for human consumption meets the requirements of this decree.

The specifications for the analysis of the parameters are provided in Annex III. In particular, the methods of analysis for microbiological parameters and the performance characteristics of the chemical methods are defined.

• *Parameters for which methods of analysis* are specified: the following methods of analysis relating to biological parameters are provided for reference, whenever a CEN / ISO method is available, or for guidance, pending their possible future adoption, in accordance with the referred to in Article 12 of Directive 98/83 / EC, further CEN / ISO international definitions of methods for these parameters.

• *Parameters for which the performance characteristics* are specified: by specified performance characteristics it is meant that the analysis method used must be able, at a minimum, to measure concentrations equal to the parameter value with an accuracy, precision and limit specified detection. These methods, if dissimilar from the reference methods referred to in article 11, paragraph 1, letter d), must be

sent in advance to the Higher Institute of Health which reserves the right to verify them as indicated in the decree approving the reference methods. Regardless of the sensitivity of the analysis method used, the result must be expressed by indicating the same number of decimals used for the parameter value referred to in Annex 1, parts B and C.

At the local level, the regions and autonomous provinces, making use of local health authorities, ensure controls in water intended for human consumption. Withdrawals are made in points of the public water network representative of the water that reaches the homes of citizens, aimed at verifying and respecting the parameter values listed above. At the same time, each region, through the ARPA / APPA, monitors the quality of the hydrographic basins, with the aim of preventing and protecting the environment, through chemical, physical and microbiological surveys on rivers, lakes and seas.

In this case of use, each region, based on the data of its ARPA / APPA and ASL, will be able to participate in making its data available. Currently, monitoring data are almost always published in the form of a dataset, but not always open and downloadable.

As regards the Lombardy Region, the Territorial Agencies for Health (ATS) carry out the monitoring and implementation of the national directive with the aim of prevention and protection of health. The monitoring data are then transmitted to the Lombardy Region, which stores them in the Company information system, where the results of the quality controls carried out with respect to the microbiological, chemical and physical macro-parameters of the ancillary controls (algae, bacteriophages anti E.coli, helminths, pathogenic enterobacteria, enteroviruses, fungi, protozoa, Pseudomonas aeruginosa, pathogenic staphylococci). In the context of the WHOW project and the specific use case, a process of opening up water monitoring data for human consumption was initiated.

The data relating to the monitoring carried out by ARPA Lombardia, on radioactivity and on chemical and physical parameters are available in xlsx format on the portal of the institution (Arpa -Lombardia).

Required datasets

ReqID	Theme	Dataset	Description	Critical issues
UC2.1	Water	Human consumption Water monitoring	Parameter values on water withdrawals (98/83 /EC) for the Lombardy Region and participating Regions (from ATS, ASL, ARPA). To be integrated with the monitoring data of the water plant managers	RL dataset at the beginning, data from other regions and managers are lacking
UC2.2	Water	Radioactivity	Parameter values of radioactivity on human consumption water (Legislative Decree 28/2016)	

Table 3 - Use Case 2 - Water - Required datasets

3.2.2 Groundwater

Definition

To assess the correlation between water quality and the effects on human health, it is essential to consider the checks carried out on groundwater.

As defined in Legislative Decree 152/2006, by groundwater we mean all the waters that are under the surface of the soil in the saturation zone and in direct contact with the soil or subsoil. In the same decree reference is made to groundwater bodies, defining them as a distinct volume of groundwater contained by one or more aquifers.

Legal framework

The regulatory reference at European level is the EU Directive 80 of 20 June 2014, which amends Annex II of Directive 2006/118 / EC of the European Parliament and of the Council on the protection of groundwater from pollution and deterioration.

At the national level, the two main regulatory references are Legislative Decree 152/2006 Environmental regulations. Rules on soil protection and the fight against desertification, protection of water from pollution and management of water resources "and the Ministerial Decree of 6 July 2016 Ministry of the Environment and Protection of the Territory and the Sea in transposition of the directive 80/2014/EU. The latter replaces the Legislative Decree of 16 March 2009, no. 30, which defines specific measures to prevent and control pollution and groundwater depletion, such as [12]:

a) criteria for the identification and characterization of groundwater bodies;

b) quality standards for some parameters and threshold values for other parameters necessary for the evaluation of the good chemical status of groundwater;

c) criteria for identifying and reversing significant and lasting trends in the increase in pollution and for determining the starting points for such reversals;

d) criteria for the classification of the quantitative status;

e) methods for defining the qualitative and quantitative monitoring programs.

Health risks covered by the legislation

Following complex natural phenomena, groundwater, due to the exchanges that take place in the different geological compartments, are enriched with minerals, micro and macronutrients, which have essential biological functions in the human body. In the presence of particular rocks, soils or sediments, the waters can be enriched with significant concentrations of toxic elements such as arsenic, fluorine, boron or uranium.

Groundwater bodies are exposed to anthropogenic contamination which can be particularly significant in areas with high agricultural and / or industrial pressure, human settlements lacking adequate wastewater treatment, pollutant spills, extreme weather events or other accidental phenomena nature [13].

It is necessary to carry out control and monitoring activities to ensure the quality and healthiness of the groundwater.

[12] Art.1 del D. Lgs 30/2006

[13] https://www.salute.gov.it/portale/temi/p2_6.jsp?lingua=italiano&id=4263&area=acque_potabili&menu=acque

Monitoring activities

As part of the chemical monitoring, a surveillance monitoring network and an operational monitoring network are provided. Groundwater monitoring programs are necessary to provide a complete and correct cognitive picture of the state of the waters within each river basin, to detect the presence of upward trends in the long-term increase in pollutant concentrations caused by the impact of anthropogenic activities and ensure compliance with the objectives of the protected areas. Based on the characterization and impact assessment carried out in accordance with Annex 1 of Legislative Decree 30/2009, the regions define a surveillance monitoring program for each period to which a river basin management plan is applied. The results of the surveillance monitoring program are used to develop an operational monitoring program to be applied for the remainder of the period covered by the plan.

Surveillance monitoring, to be conducted during each river basin management cycle, should be carried out in both at-risk and non-risk water bodies or groups of water bodies. Regions must compulsorily monitor the following basic parameters [14]:

• Oxygen content (OD), if there is an interaction with surface waters;

• pH;

• Electrical conductivity (CE);

• Nitrates;

• Ammonium ion.

In addition to the basic parameters, the regions, on the basis of a detailed analysis of the pressures, select from the substances listed below those potentially released into the groundwater body. In the absence of this analysis, all the substances listed below must be monitored:

• Pollutants of natural origin: Arsenic, Cadmium, Lead, Mercury, Chlorides, Sulphates.

• Synthetic pollutants: Trichlorethylene, Tetrachlorethylene.

Table 3 of Legislative Decree 30/2009 lists the threshold values for the good chemical status of groundwater. Exceeding these values at any monitoring point is indicative of the risk that one or more conditions relating to the good chemical status of the groundwater are not met [15].

Required datasets

ReqID	Theme	Dataset	Description	Critical issues
UC2.3	Water	Groundwater monitoring	Regional data (ARPA)	

Table 4 - Use Case 2 - Underground Water - Required datasets

[14] Allegato 4 del D. Lgs 30/2009

[15] Allegato 2 del D. Lgs 30/2006

3.2.3 Infectious diseases

Definition

As introduced at the beginning of the paragraph, water is such a fundamental resource for the life and sustenance of living beings that it can have a direct or indirect impact on their health.

As defined by the ISS, an infectious disease is a disease caused by microbial agents that come into contact with an individual, reproduce and cause a functional alteration: the disease is therefore the result of the complex interaction between the immune system and the organism stranger. The germs that cause infectious diseases can belong to different categories and mainly viruses, bacteria or fungi[16].

Contagious infectious diseases are caused by pathogens which, directly or indirectly, are transmitted to other receptive subjects. In non-contagious infectious diseases, however, transmission requires the intervention of special vectors or particular circumstances.

To contract an infectious disease, the individual must be exposed to the germ and be in a state of susceptibility, that is, when he has no defences (natural or acquired) against the specific infectious agent. To prevent an infectious disease, one can act on contact or on susceptibility: the removal of one of the two causes makes the other unable to cause the disease. The risk of contagion by contact is eliminated by reducing the body's exposure to the germ, while the reduction of susceptibility can be done through vaccination or prophylaxis.

The time that elapses between contact between a microbe and the human body until symptoms appear is called the "incubation period", which differs according to the infectious disease and depends on the relationships established between the germ and the host. During the incubation period there is also talk of "infection", or the presence of microbial agents that reproduce within the body. The infection can proceed without symptoms and in that case we speak of "asymptomatic infection". If, on the other hand, symptoms appear, a "disease" is established. The clinical characteristics of the infections can therefore vary from asymptomatic to very severe pictures that can even lead to the death of the patient.

Less serious infectious diseases can resolve on their own while in other cases they may require hospitalization, in any case the most suitable therapy depends on the pathogen responsible for the disease.

Legal Framework

The need to protect the health of the population and in particular to prevent the spread of infectious diseases, already emerges from the Consolidated Health Laws in force since 08/24/1934.

The text provides that the health personnel in charge immediately report, when they become aware of them, cases of infectious and diffusive diseases or even only the suspicion in a context dangerous to public health.

The Ministerial Decree of 15 December 1990: "Information system of infectious and diffusive diseases", published in the Official Gazette, 8 January 1991, n. 6 provides for the division into 5 classes, based on importance and impact, which cover the same, in public health. The data is received by the Directorate General for Prevention, as indicated by the Ministerial Decree 1990 and the reporting of these diseases is mandatory.

The five notification classes respond to criteria of epidemiological relevance and to differentiated prophylaxis needs. Moreover, according to the notification class, they change: the times, the notification methods and the flows of the disease itself:

[16] https://www.epicentro.iss.it/infettive/

CLASS ONE: diseases for which immediate reporting is required or because they are subject to the International Health Regulations or because they are of particular interest.

These diseases (such as, for example, botulism, rabies, trichinosis) can cause serious implications in public health, nationally and internationally, both in terms of the adoption of counter-measures, to deal with any epidemics, and for the severity the clinical pictures, caused by the various pathogens, both in terms of communication in Europe of possible events, related to them, which may represent a cross-border threat;

SECOND CLASS: significant diseases because of high frequency and / or subject to control interventions;

THIRD CLASS: diseases for which special documentation is required;

CLASS FOUR: diseases for which the reporting of the individual case by the doctor must be followed by the reporting of the local health unit only when epidemic outbreaks occur;

CLASS FIVE: infectious and diffusive diseases notified to the local health unit and not included in the previous classes, zoonoses indicated by the veterinary police regulations referred to in the decree of the President of the Republic February 8, 1954, n. 320.

It is important to remember that the national information system for the detection of infectious diseases, subject to mandatory notification, is affected by the various regional organizational realities.

In the context of the Lombardy Region, the D.g.r. February 26, 2015 - n. X / 3190 “Review and update of the surveillance, prevention, prophylaxis and control interventions of infectious diseases with optimization of the reading of the« Signals »in view of Expo 2015” defines the rules on the surveillance and prevention of infectious diseases.

The decree aims to strengthen and make more efficient the use of the telematic system for reporting Infectious Diseases (MAINF) as a regional prevention and control tool in Lombardy.

Health risks covered by the legislation

The regional process, in conjunction with national directives, aims at the prevention and management of the risk of spreading the following infectious diseases [17]:

AIDS, HIV Infections, Amebiasis, Anthrax, Blenorrhagia, Botulism, Brucellosis, Cholera, Dermatophytosis, Infectious Diarrhea, Diphtheria, Tick-borne Encephalitis, Creutzfeldt Jacob's Encephalopathy, Hepatitis A-B-C-D-E, Hepatitis Non-A and Non-B, Hepatitis Unspecified, Hemorrhagic Fever, Yellow Fever, Recurrent Epidemic Fever, Typhoid Fever, Filariasis, Giardiasis, Influenza, Infections, Toxinfections, Food poisoning, Leprosy, Legionellosis, Cutaneous and Visceral Leishmaniasis, Leptospirosis, Listeriosis, Malaria, Lyme disease, Invasive pneumococcal disease, invasive meningococcal disease , Invasive haemophilic disease, Chikungunya disease, Bacterial meningitis, Meningo viral encephalitis-west nile disease, Nontuberculous microbacteriosis, Mononucleosis, Measles, Parasitosis, Epidemic parotitis, Pediculosis, Pertussis, Plague, Poliomyelitis, Rabies, Rickettsiosis, Rubella, Nontyphoid salmonellosis, Scabies, Scarlet fever, Shigellosis, Syphilis, Tetanus, Toxoplasmosis, Typhoid exanthema, Trichinosis, Tuberculosis, Tularemia, Varicella.

Monitoring activities in Lombardy Region [18]

The main subjects in charge of the reporting process are:

[17] Allegato 1 del D.g.r. 26 febbraio 2015 - n. X/3190

[18] https://www.ats-brianza.it/images/pdf/documentistudirelazioni/Come%20effettuare%20segnalazione%20di%20malattia%20infettiva%20ad%20ATS%20Brianza(1).pdf

- General Practitioners;
- Free Choice Pediatricians;
- Hospital Doctors;
- Continuity Care Doctors;
- Doctors of the Social-Healthcare Structures;
- Competent Doctor.

The reporting of an infectious disease is aimed at:

• identify the risk factors and the source of the infection;

• search for contacts;

• organize interventions or actions to prevent further cases of disease linked to the exposure risk;

• evaluate existing strategies or implement new ones in order to prevent further episodes.

With the report in MAINF a file is opened, connected to a patient, placed temporally and territorially to the symptoms of the infection and which reports different information sheets according to the pathology such as:

- Contagion Sheet- source/mode/type of exposure, country visited, travel departure date;
- Diagnosis Sheet- family/species of etiologic agent, clinical picture, serotype/phenotype, type of isolation diagnosis;
- Risk Factors Sheet- pathologies, hospitalizations/treatments, ongoing therapies, behaviors,l habits;
- Prophylaxis Sheet, Outcomes/Criteria Sheet, Investigated Contacts Sheet, Surveillance Sheet, Therapy Sheets, and Disease-Specific Sheets.

Required datasets

ReqID	Theme	Dataset	Description	Critical issues
UC2.4	Health	Infection diseases	Report and aggregate data by Lombardy Region	Granular closed data - data from other regions is not available

Table 5 - Use Case 2 - Infection diseases - Required datasets

3.2.4 Other health impacts

During the co-creation meetings, at the suggestion of the Umbria region, it was decided to integrate the data on health impacts with the datasets concerning consumption and health services.

The information debt, in the health sector, is a set of data relating to services provided to patients that are requested and used at national level for the definition of the needs of the sector and therefore, in the end, for the quantification of the funds to be allocated. The regional information debt towards the Ministry of Health is satisfied through the collection of regional information flows. The health information system finds its legal basis in article 87 of the law 23 December 2000, n. 388 - "Provisions for the preparation of the annual

and multi-year budget of the State (2001 Finance Law)" and is implemented through the Framework Agreement between the State, the Regions and the Autonomous Provinces of Trento and Bolzano of 22 February 2001. Healthcare companies regularly produce mobility flows to the regions for health compensation in relation to:

• Flow of hospitalizations for relative diagnoses;

• Flow of specialist services for examinations / analyses relating to pathologies;

• Pharmaceutical Flow for Prescribed Drugs.

The flows relating to acute hospitalizations, rehabilitation and long-term hospitalizations are very detailed monthly data and present the main and secondary diagnosis, the main and secondary interventions according to the ICD-9-CM coding, and the homogeneous groupings of diagnoses or DRGs (Diagnosis Related Groups).

The flow of specialist services is a quarterly data relating to outpatient specialist and diagnostic services, including first aid services if not followed by hospitalization and contains the service code according to the National or Regional Tariff Nomenclature.

For the pharmaceutical sector, we have the quarterly data of prescriptions and, on the basis of drugs administered for specific pathologies, we could trace the volumes of prescriptions by pathology. In fact, the path contains the drug code, the drug code distributed according to the Ministerial code MINSAN10 or similar.

Required datasets

ReqID	Theme	Dataset	Description	Critical issues
UC2.5	Health	Consumption data (Hospitalization, Specialist services, Pharmaceuticals)	Report and aggregate data by Lombardy Region	Granular closed data - data from other regions is not available
UC2.6	Health	ER	Reports and aggregate data on access to the ER	Closed data. Only the Lazio Region publishes them, without specifying disease.

Table 6 - Use Case 2 - Health - Required datasets

3.3 Use Case 3 - Extreme events

The Extreme Events use case gathers hydro-meteorological and tidal data that provide the knowledge base for analyses related to the impacts of extreme events, more specifically floods and droughts, on the environment and human health.

3.3.1 Floods

Definition

Floods are natural phenomena which cannot be prevented. Floods have the potential to cause fatalities, displacement of people and damage to the environment, to severely compromise economic development and to undermine the economic activities of communities. However, the increase in the likelihood of their

occurrence and the aggravation of their impact are determined by certain human activities (such as increasing human settlements and economic activities in floodplains and the reduction of the natural water retention by land use) and by climate change (rapid melting of glaciers, precipitation variability and intensification).

Legal framework

The legal framework for data collection on flood events is set by the Water Framework Directive (2000/60/EC) and the Floods Directive (2007/60/EC). The Water Framework Directive, which aims at achieving "good status" for all waters, requires - among other things - a summary of significant pressures and impact of human activity on the status of surface water and groundwater, and will help mitigate the effects of flooding related to human pressures.

The Directive provides for enhanced resource planning within formally identified River Basin Districts. The River Basin Management Plans established by competent authorities identify landfills, contaminated or abandoned industrial sites, plants covered by the European Directive on industrial emissions (2010/75/EC) and others, urban waste water discharges and storm water overflows as point source water pollution. Nonpoint source water pollution derives from sources such as mining activities, uncollected discharges, other categories of contaminated or abandoned industrial sites, transport, agriculture and urban runoff.

Indications in the River Basin Management Plans show that agriculture and urban development are the main sources of adverse effects on surface water bodies and exert significant pressure on groundwater bodies, too, although groundwater bodies are more affected by industrial activities. Water abstraction and diversion mainly for fish farms, hydropower, industrial, agricultural and civil uses for drinking water abstraction also have an impact. The abstraction of water exceeding its natural renewal capacity puts significant pressure on surface and groundwater. In particular, agricultural use places the greatest burden on both groundwater and surface water bodies, and the latter are impacted by abstractions for hydropower use.

The Floods Directive is the first directive to specifically address the issue of *flood*, it works in synergy with the Water Framework Directive and can be seen as its complementary instrument. The purpose of the Floods Directive is to establish a framework for the assessment and management of *flood risks* aiming at reducing the adverse consequences for human health, the environment, cultural heritage and economic activity associated with floods in the community.

The Directive specifies that *measures*[19] to reduce flood risks should, as far as possible, be coordinated through a *river basin*, if they are to be effective.

Flood risk

The Directive foresees three steps for flood risk management: preliminary flood risk assessment, flood hazard and risk maps and flood risk management plans.

The first step in the flood risk management process is for Member States to produce a preliminary flood risk assessment for each river basin district or unit of management (Article 4), which allows Member States to identify areas where they determine that a potential significant flood risk exists or is likely to occur (Article 5).

The preliminary flood risk assessment is to be prepared on the basis of:

[19] The natural management of floods takes into account the hydrologic processes within the catchment area of a river basin to establish where measures need to be implemented, with a focus on increasing natural water retention (e.g. streamflow restoration by realigning coastal areas, water streams reconfiguration, and wetlands restoration to help slow the *slow of floods*)

(a) available or readily derivable information, such as records and studies on long-term developments, including the consequences of climate change;

(b) maps including the borders of the river basins, sub-basins and, where existing, coastal areas, showing topography and land use

(c) historical records of floods which have occurred in the past, which have adversely affected human health, the environment, cultural heritage and economic activity, and for which the likelihood of similar future events is still relevant, including their flood extent and conveyance routes and an assessment of the adverse impacts they have entailed.

In addition, depending on the specific needs of Member States, the preliminary flood risk assessment shall include an assessment of the potential adverse consequences of future floods for human health, the environment, cultural heritage and economic activity, taking into account, as far as possible, elements such as topography, the position of watercourses and their general hydrological and geomorphological characteristics, including floodplains as natural retention areas, the effectiveness of existing man-made flood-defense infrastructures, the position of populated areas, areas of economic activity, and long-term developments including the impacts of climate change on the occurrence of floods.

The second step in the flood risk management process is for Member States to prepare flood hazard maps and flood risk maps.

Pursuant to Article 6, the directive obliges Member States to prepare, at the level of the River Basin District or Management Unit, flood hazard maps and flood risk maps at the most appropriate scale for the areas identified under Article 5. The maps shall include the perimeter of the geographical areas for the three flood scenarios: low probability of floods or extreme event scenarios, medium probability of floods, high probability of floods, indicating for each scenario the flood extent, the water depth or the water level, the flow velocity or the relevant water flow.

Moreover, within the scenarios described above, the maps should show the potential adverse consequences resulting from floods, such as the indicative number of inhabitants potentially affected, the type of economic activities existing in the area, the facilities on integrated pollution prevention and control and the protected areas potentially affected. Additional information, such as the indication of the areas where floods with a high content of transported sediments and debris floods can occur, information on other significant sources of pollution, etc. should also to be included in the maps. In order to avoid or reduce the adverse impacts of floods in affected areas, flood risk management plans should be prepared, and that is the third step.

Monitoring activities

In Italy, the Floods Directive (2007/69/CE) was transposed by Legislative Decree no. 49/2010. Such Decree works in synergy with Legislative Decree n. 152/06, which transposed the Water Framework Directive, and with the Prime Ministerial Decree of 29 September 1998.

The preparatory activities for preliminary risk assessments, the elaboration of hazard and risk maps and the drafting of management plans are carried out by the District Basin Authorities, as identified by the Legislative Decree 152/2006, together and in accordance with the preparatory activities for the Hydrogeological Structure Plans already carried out. The District Basin Authorities are the Primary Competent Authorities and they are flanked by other institutions according to their functions for the fulfilment of the Framework Directives on Water and Floods: i.e. the Regions and Autonomous Provinces, the Environmental Ministry (MITE), ISPRA and the Civil Protection Department. The Regions and Autonomous Provinces, in coordination with each other and with the Civil Protection Department, are responsible for preparing the part of the River

Basin Management Plans relating to the national and regional warning system for hydraulic risk and civil protection purposes.

The Floods Directive considers risk maps as maps of risk elements - one for each of the three probability scenarios. The Legislative Decree no. 49/2010, in compliance with the criteria defined in the Prime Ministerial Decree of 29 September 1998, establishes that risk mapping provides a representation of risk classes (R1 - moderate, R2 - medium, R3 - high, R4 - very high), able to express synthetically, through a single map, the way in which the hazard and the potential damage are combined within the floodable areas.

The reference territorial units, defined at national level for the purposes of implementing the Floods Directive, i.e. the Units of Management (UoM), derive, for Italy, from the basins of regional, interregional and national importance, as identified by Law 183/89. As to EU fulfilments, in the first cycle of flood risk management, Italy made use of the so-called transitional measures (art. 13 FD). The preliminary flood risk assessment (art. 4 FD), concluded in July 2019, was carried out for the first time by Italy for the reference period 2012-2018. The next deadline for the revision of flood risk management plans and related knowledge tools is 22/12/2021.

The monitoring activities carried out by the Authorities responsible for flood risk planning and management in the two management cycles provide information on the actual extent of the floodable areas for the different event probability scenarios and on the elements actually exposed in the specific situations by type of element - *population, cultural heritage* (cultural and landscape assets), *economic activities and infrastructures* (private property - including dwellings – infrastructures, rural land use, agricultural activities, forestry, mining and fishing), *environment* (water bodies, protected areas, point and nonpoint sources of pollution). A 'Report on flood hazard conditions in Italy and associated risk indicators' - report no. 353/2021[20] - was recently drawn up by ISPRA and SNPA.

As part of the update and revision activities of the Flood Risk Management Plan, the District Basin Authorities have addressed studies for the assessment of flood risks (i.e. damages). For example, according to the advanced report stemming from the flood damage assessment project of the Po River Basin District Authority (AdBPo), launched on 05/03/2020 and edited by the working group constituted by a consortium of Italian universities, the damages consequent to the hazard scenario are assessed according to the methodology indicated in the project and for the categories: residential, agriculture, roads and railways. The definition of the analysis methodology for other categories of exposed elements is still under study.

Potential adverse consequences for human health

Floods can cause fatalities and the evacuation of people. The most important floods that have affected Italy, and which have taken a heavy toll in terms of both casualties and damage, were those of the Po river in the Polesine area (1951), the Arno river (1966) and the Po river in northern Italy (1994 and 2000).

According to studies conducted by the WHO-European Centre for Environment and Health (2002), in terms of the recurrence of health effects, these can be grouped into: a) effects occurring during or immediately following the event; b) effects developing in the days or weeks following the event; c) long-term effects that could occur and/or last for months or years after a flood.

All these categories can be defined as direct or indirect health effects.

20 https://www.isprambiente.gov.it/files2021/pubblicazioni/rapporti/rapporto_alluvioni_ispra_353_16_11_2021_rev2.pdf

Direct effects occur during the flood due to the overflow of water (trauma resulting from flooding, contact with water or polluted water) and include:

mortality from drowning, heart attack and injuries. The number of deaths associated with floods is closely linked to the catastrophic nature of the floods (rapid rise of water, heavy flooding, objects carried by the rush of flows) and the behaviour of the victims. In the 1998 flood in Sarno, Italy, 147 deaths were caused by a river of water and mud that rapidly destroyed an urban area; in 1996, 86 people died in a flood in Biescas, Spain, due to a torrent of water and mud that flooded a campsite located near a river that had been channelled;

injuries (e.g. sprains/strains, lacerations, contusions, etc.) especially in the phase following the flood, when people return to their homes to clean up the rubble and quantify the damage caused.

Indirect effects can result from damage to infrastructure and property. Such effects include:

infectious diseases (gastrointestinal diseases, dermatitis, conjunctivitis) and rare cases of vector-borne or rodent-borne diseases. Infectious diseases are uncommon and are usually confined to endemic diseases in the flooded area, while the risk of introducing new ones, such as vector-borne, is negligible. However, rates of diseases that existed before a flood may rise due to poor sanitation or crowding of homeless people. In the Czech Republic, there was an outbreak of leptospirosis after the 1997 flood; 13 outbreaks of water-borne infections, totaling about 7,300 cases, were reported in Finland between 1998-1999, due to non disinfected standing water in the areas most affected by the flood;

poisoning caused by ruptured underground pipes, toxic waste overflowing, and the release of chemicals stored in the soil. The pollution of the Danube in January 2000 was caused by the breakage of an embankment at the Baia Mare gold mine in Romania, which spilled cyanide compounds into the river. This caused an environmental disaster, for which no health effects have been reported so far;

post-traumatic disorder (PTSD), including anxiety, depression, psychosocial disorders and suicide. Apart from the trauma of being a flood victim itself, many mental disorders stem from displacement, damage to homes, loss of family assets and often lack of insurance coverage. These disorders may continue for months or even years after the event. A survey conducted six months after the floods in the South-East of England in October 2000 found that while the physical effects were small, the psychological effects - anxiety and depression - were significant and persistent. Suicides could also occur. American data collected 36 months before and 48 months after a disaster show a statistically significant increase from 12.1 to 13.8 per 100,000 people in suicide rates following floods. Finally, the study shows that the effects of floods can be particularly devastating when they affect already vulnerable groups such as children, the elderly, the disabled, ethnic minorities and the poor who, because of their social, political and economic constraints, have special health needs.

Potential adverse consequences for the environment

Human activities increase the likelihood of flooding and exacerbate its adverse consequences. The dangers to the environment are manifold and concern water and other environmental resources. The progressive and significant consumption of land takes away spaces for natural flood expansion and reduces the drainage capacity of surfaces. The occupation and exploitation of flood plains, for example, for the construction of housing, industrial and commercial structures, infrastructures to meet social and economic needs, or for agricultural purposes, have imposed the need to defend these areas in a logic of protection of the existing and further expansion, confining the waterways in increasingly restricted areas.

Looking at the basin scale, i.e. the area that receives rainwater and drains it, land consumption, i.e. the replacement of originally agricultural, natural or semi-natural areas with artificial cover, affects the way in which water concentrates and flows, is then collected by the hydrographic network and spread in the form of flood waves. A major problem is large sealed areas with consequent modification of soil/subsurface water

absorption conditions. These areas are typically related to large car parks, logistics activities, large commercial and industrial estates, airport runways.

The potential impacts on the environment, exacerbated during flooding events, are related to the rainwater drainage into surface waters - exceeding natural quantities - or storm water runoff from large yards - also dispersed in the subsoil - which may contain significant quantities of pollutants, essentially related to the running and parking of vehicles or periodic weeding.

Forest fires cause degradation of the plant cover, increase the speed of streamflows and make surfaces more unstable due to the erosive action of water. They also produce large quantities of solid material which increase the destructive power of floods and can cause a partial or complete shut-off of the river outflow sections, especially at crossing points

Potential adverse consequences for the cultural heritage

From the cognitive activities carried out by competent authorities between 2012 and 2018, it results that Veneto (21.2%) and Liguria (18.6%) have the highest percentage of cultural and landscape assets exposed to flood risk for the high hazard scenario, compared to the total number of cultural and landscape assets in the related regional territories. In Veneto, the province of Venice is the one with the highest percentage of cultural assets exposed to flood risk for all probability scenarios (with a minimum of more than 60% for the high probability scenario and a maximum of about 80% for the low probability scenario). In Liguria, the province of Savona has the highest percentage of cultural assets exposed for all hazard scenarios.

Potential adverse consequences for economic activities

Analysis methods to quantify the risk (i.e. damage) resulting from the hazard scenario are currently being studied for the following categories: *residential*, *agriculture*, *roads and railways* and other categories of exposed elements.

Required datasets

ReqID	Theme	Dataset	Description	Critical issues
UC3.1	Water	Hydrological and meteorological data	Precipitation, hydrometric level, flow characteristics, air temperature and pressure, humidity.	Observed data from monitoring activity managed by several regional agencies are not published in a unique dataset.
UC3.2	Water	Physical properties of seawater	Waves, tides, currents, temperatures	Non-homogeneous observed time series. Huge spatial dataset
UC3.3	Water	Water cycle management and water works	Data from water treatment plant - flow rate from drainage and overflow channels, water quality and quantity out of water waste treatment plants, location of supply and discharge points. Mitigation activities against floods and landslides	Private operators, sensitive information

UC3.4	Water	Extreme events census	Identification of extreme events (storm surges, coastal floods, floods, in urban or rural areas)	Data aggregated at national or regional level
UC3.5	Water	Short-term pollution events	Microbiological contamination (quality and quantity) in bathing waters generated by meteorological extreme events	Data available in form of bulletin or decree (pdf)
UC3.6	Water	Chemical status of water bodies	Monitoring activities established from european directives (MSFD, WFD)	Data from several actors. Different portals and licences.
UC3.7	Water	Biological status of water bodies	Bacteria concentration for bathing waters (Escherichia Coli ed Enterococchi Intestinali)	Data from several actors. Different portals and licences.
UC3.8	Water Environment	Soil Use	Soil use, chemical concentration (i.e. pesticides), contaminated sites in coastal areas and nearby water courses.	Heterogeneous and aggregated data. Several lists of hazardous substances. Needs for geographical queries
UC3.9	Water Health	Bathing water status	Classification of monitoring points based on the risk of contracting infections due to the presence of bacteria	Data available from different national and european portals. Data are not homogeneous
UC3.10	Health	ER	Data on access to the ER or medical cares divided by diseases and areas (municipalities)	Closed data. Only some aggregated data is open.
UC3.11	Health	Exposed elements and risk maps for population	Lists of elements and zones exposed to hydro-meteo risks	Non homogeneous data. In some cases, useless formats (image, pdf, non exportable maps)

Table 7 - Use Case 3 - Floods - Required Datasets

3.3.2 Drought

Definition

Drought is a natural phenomenon. It is a temporary, negative and severe deviation along a significant time period and over a large region from average precipitation values (a rainfall deficit), which might lead to meteorological, agricultural, hydrological and socioeconomic drought, depending on its severity and duration (Schmidt et al., 2012). There is, however, no single definition of drought, as it is necessary to specify the range of phenomena to which it refers, whether natural, social or economic. We speak of meteorological drought

when there is a relative decrease in precipitation; of hydrological drought when there is a relatively low water quantity in the soil, stream or aquifers; of agricultural drought when there is a deficit in soil water content leading to stressful crop growth; and of socioeconomic drought when it refers to overall land consumption (World Meteorological Organization, 2006).

The New Climate Change Adaptation Strategy defines drought as: “Drought is an unusual and temporary deficit in water availability - whether atmospheric, surface water or groundwater”. UNWater defines water scarcity in three different ways: 'Water scarcity can mean scarcity in availability due to physical shortage, or scarcity in access due to the failure of institutions to ensure a regular supply or due to a lack of adequate infrastructure'. In the 'AQUASTAT Glossary, FAO, 2020' the definition of drought is given: "A period in which the actual rainfall is significantly less than the average for that locale. A drought is characterized by decreased river bank heights, river volume, and/or groundwater levels - Remark: Decreased water resources due to over abstraction is not a drought'. Linked to the notion of scarcity is the notion of water stress. UNWater defines water stress as: 'Level of water stress: freshwater withdrawal as a proportion of available freshwater resources'.

For water management purposes, it is important to consider that water scarcity conditions are to be linked to a sharp reduction in water body levels together with water abstraction from those same water bodies. At the same time, it is important to consider the need to meet water demand for various uses. In other words, the above conditions generally occur as a result of the combination of climate factors (drought) and anthropogenic factors (surface and groundwater pressures).

It is therefore necessary to have real-time monitoring data of the main hydrological magnitudes, such as precipitation, temperatures, flow rates of watercourses and springs, groundwater levels, and those relating to the uses of water resources, i.e. abstractions from watercourses, aquifers and springs, including also the water requirements necessary to protect ecosystem services (Article 70, point f) of Law 221/2015).

Legal framework

The framework for drought data collection are the Water Framework Directive and the new EU Strategy on Climate Change Adaptation as far as water scarcity is concerned.

The new EU Climate Change Adaptation Strategy reports that due to the change in climate recorded over the last two decades, many European regions are already facing more frequent, severe and longer lasting droughts, including devastating droughts in the Mediterranean region. The new strategy highlights those droughts can have cascading effects: for example, they reduce water levels in rivers and groundwater, stunt tree and crop growth, increase pest attacks and fuel wildfires.

Potential adverse consequences for the environment

The impact on the environment is connected to persisting drought conditions. A prolonged drought (6-12 months) will affect the streamflow, while a longer drought (one or two years) will affect water availability in aquifers. Other climate-related factors (e.g. high temperatures, strong winds and low relative humidity) can further aggravate the severity of this phenomenon. In general, water scarcity and draught events are associated with a reduction in water availability (natural water resources) leading to the inability to meet long-term average demand, or when the delivered flow rate cannot meet instantaneous demand in spring-fed water systems that do not have storage reservoirs.

A water scarcity assessment must also take into account those cases where demand is extremely variable throughout the year. This is the case, for example, of multiple-use reservoirs where the quantity of water used for irrigation purposes is particularly high or, conversely, of single-use reservoirs where water demand is particularly high during the tourist season. Moreover, the assessment of water scarcity must also take into

account that the quantity of water available varies from year to year, depending on the reservoir's annual storage. Water availability problems are frequent in areas affected by characterized by to low rainfall, but also in those areas characterized by high population density and/or intense irrigation farming and industrial activity. The quantity of available water is influenced by water quality - a reduction in water availability can occur as a result of a deterioration in its quality.

In Europe, most of the losses caused by drought - around EUR 9 billion per year - affect agriculture, the energy sector and the public water supply. Extreme droughts in Western and Central Europe in 2018, 2019 and 2020 caused significant damage. In 2018 alone, agricultural damages amounted to some EUR 2 billion in France, EUR 1.4 billion in the Netherlands and EUR 770 million in Germany.

The new Strategy also states that Europe can already respond to droughts with short-term emergency measures under the Union Civil Protection Mechanism and with existing EU-wide early warning systems, while Member States are implementing integrated river basin management through the Water Framework Directive, and some have adopted Drought Management Plans for vulnerable river basins.

Finally, given that in the longer term almost all river basins could be exposed to this risk, the new Strategy states that technical and organizational adaptation solutions are required in all sectors. This includes, in agriculture, the sustainable reuse of water, soil management and vegetation cover, drought-resistant crops, vertical farming or even land use planning and restoration of damaged areas. In energy and transport, this includes preparing for disruptions on particular waterways with freight transport, hydropower and cooling for power plants. For drinking water, this includes promoting residential water saving or additional supply and storage infrastructure.

Monitoring activities

As far as hydrological activities are concerned (i.e. hydrological magnitudes and meteo-hydrological monitoring networks), in 2013, ISPRA promoted, under its coordination, the establishment of a Permanent Working Group on Operational Hydrology Services, in order to rebuild a cohesive and coordinated system to ensure a consistent level of quality and functionality throughout the country.

As to water use data, there are several problems: the monitoring of water abstractions – for example - is not always carried out and abstraction data are not always easy to access. ISTAT (the Italian Institute of Statistics) derives data on water use from water demand estimates. Coordinated, continuous and detailed information on water consumption is currently lacking.

In 2016, in Italy, the Ministry for Environment (MATTM) (now Ministry for Ecological Transition-MITE) promoted and subsequently established permanent Observatories for water uses for each Hydrographic District. District Authorities, the MITE, Ministry of Agricultural, Food and Forestry Policies (MiPAAF), and MT, DPC, ISPRA, ISTAT, CREA, Regions, ANBI, lake consortia and hydropower companies play an active role in the Observatories.

An Observatory is a permanent, subsidiary unit working to support integrated water management. It collects, updates and disseminates data on the availability and use of water resources in an Hydrographic District in the event of droughts and/or water scarcity and it does so in compliance with the Hydrographic District Management Plan and with the water balance. The National Strategy for Adaptation to Climate Change (SNACC) is also taken into due account by the Observatories.

A central role is also played by the National Technical Coordination Committee, established in 2016, and headquartered at MITE, with the specific task of promoting the harmonization of national criteria to determine the severity of water scarcity phenomena, to identify the reference parameters (hydrological,

hydraulic, agronomic, drought environmental and economic impact) required to monitor and define data transmission and validation procedures.

3.3.3 Heatwaves

Definition

During droughty seasons, another phenomenon involving water in a gaseous state (as vapor) can strongly affect human health, the heatwave. A heatwave happens when a combination of hot temperature and high humidity appear for several consecutive days. In climatology, the occurrence of at least three consecutive hot days is defined as a heatwave. The definition is not rigorous, because it depends also on the average meteorological conditions of the region, the orography of the territory, the urban development of the area.

In a simple way, the monitoring activities of heatwaves is carried out by considering the number of consecutive days with a mean or maximum daily temperature above a fixed threshold, or evaluating particular indexes mainly based on air temperature (i.e. the Heat Wave Magnitude Index daily HWMId). Recent studies take into account also humidity because the estimation of heatwave magnitude based only on temperature may underestimate the severity. In fact, high humidity during consecutive hot days can amplify the effect of extreme heat waves in particular interfering with the human body's ability to regulate internal temperature through sweating. As a result, new indexes have been proposed in order to monitor the occurrence of heatwaves, such as the Apparent Heat Wave Index (AHWI)

Impact on human health

Heatwaves can strongly affect human health, in particular increasing the mortality rates. The relationship between heatwaves and mortality or morbidity in a specific area is affected by local population demographics, economic wellbeing, underlying disease risk, the presence of vulnerable subpopulations, weather variability, physiologic acclimatization, and locally available adaptations.

Exposure to heat causes severe symptoms, such as heat exhaustion and heat stroke, which causes faintness, as well as dry, warm skin, due to the inability of the body to control high temperatures. Other symptoms include swelling in the lower limbs, heat rash on the neck, cramps, headache, irritability, lethargy and weakness. Heat can cause severe dehydration, acute cerebrovascular accidents and contribute to thrombogenesis (blood clots).

The United Nations Office for Disaster Risk Reduction (UNDRR) estimates that from 1998-2017, more than 166 000 people died due to heatwaves, including more than 70 000 who died during the 2003 heatwave in Europe [21]. The World Meteorological Organization (WMO) foresees additional 250 000 deaths each year from climate-sensitive diseases (among which heatwave is a fundamental component) from 2030 onward.

Increased mortality during heat waves has been attributed mainly to cardiovascular illness (13–90%) and diseases of the cerebrovascular (6–52%) and respiratory systems (up to 14%), especially among the elderly. Heat stress can rapidly become life threatening, especially among those with limited access to immediate medical attention. Severe heat stroke symptoms can be observed in older and children, but also in younger adults, especially among adults engaging in outdoor activities involving exertion.

Required datasets

[21] "Economic Losses, Poverty and Disasters 1998-2017" – UNISDR CRED (October 2018)

ReqID	Theme	Dataset	Description	Critical issues
UC3.12	Water	Hydrological and meteorological data	Precipitation, hydrometric level, flow characteristics, air temperature and pressure, humidity.	Observed data from monitoring activity managed by several regional agencies are not published in a unique dataset.
UC3.13	Water	Water cycle management	Data from water treatment plant - flow rate from springs and supply points, water quality	Private operators, sensitive information
UC3.14	Water	Extreme events census	Identification of extreme events (minimal runoff, water supply crisis, Saltwater intrusion)	Data aggregate at national or regional (basin) level
UC3.15	Water	Chemical status of water bodies	Monitoring activities established from european directives (MSFD, WFD)	Data from several actors. Different portals and licences.
UC3.16	Water	Biological status of water bodies	Bacteria concentration for bathing waters (Escherichia Coli ed Enterococchi Intestinali)	Data from several actors. Different portals and licences.
UC3.17	Water Environment	Water needs	Sanitary, drinking, agricultural, leisure needs for human activities related to waters.	Heterogeneous and aggregated data.
UC3.18	Health	ER	Data on access to the ER or medical cares divided by diseases and areas (municipalities)	Closed data. Only some aggregated data is open.

Table 8 - Use Case 3 - Drought - Required datasets

4 Data

This section includes the datasets currently published, or being published, which potentially meet the requirements of each of the three WHOW Use Cases.

The datasets have been selected on the basis of the following criteria:

- relevance with respect to the requirements of each use case;
- data licence: closed datasets are discarded and fully interoperable datasets are privileged. Also non completely open datasets are reported, if considered necessary for the implementation of the use case;
- requirement of national and international legislation: the datasets deriving from the application of EU directives are preferred;

- detailed and well documented metadata;
- specific requests raised during the co-creation meetings.

The following lists are not intended to be exhaustive. While, on the one hand, the investigation of useful datasets will continue, on the other hand, it will certainly be necessary to fine tune the lists due to technological or data policy issues that will not allow their transformation into linked open data.

For each topic (water and health) the minimum information for each dataset is shown below:

- Name of the dataset and / or short description;
- Rights holder: institute, agency, organism that holds the rights of the data because it is the responsible party for the monitoring or the dissemination activity;
- Access URL: location of the resource (as of December 31, 2021);
- Use Case: reference to the appropriate requirement identifiers.

4.1 Water

Dataset	**Rights holder**	**Access URL**	**Use Case**	**ReqID**
PFAS data (perfluoroalkyl substances) surface waters - Year 2018	Arpa Lombardia	https://www.arpalombardia.it/sites/DocumentCenter/Documents/PFAS/Allegato_1_DATI_PFAS_2018_ACQUE_SUP.xlsx	Human consumption waters	UC2.1
PFAS data (perfluoroalkyl substances) groundwater - Year 2018	Arpa Lombardia	https://www.arpalombardia.it/sites/DocumentCenter/Documents/PFAS/Allegato_2_DATI_PFAS_2018_ACQUE_SOT.xlsx	Human consumption waters	UC2.1
Analytical data of river water bodies	Arpa Lombardia	https://www.arpalombardia.it/Pages/Dati/2019/Acque/Dati-analitici-corpi-idrici-fluviali-2019.aspx?tipodati=1&tema=Acque&sottotema=Sottotema%20Ambientale&ordine=1	Human consumption waters	UC2.1
Analytical data of lake water bodies	Arpa Lombardia	https://www.arpalombardia.it/Pages/Dati/2019/Acque/Dati-analitici-corpi-idrici-lacustri-2019.aspx?tipodati=1&tema=Acque&sottotema=Sottotema%20Ambientale&ordine=1	Human consumption waters	UC2.1

Analytical data of groundwater	Arpa Lombardia	https://www.arpalombardia.it/Pages/Dati/2019/Acque/Valori-analitici-Sotterranee-2019.aspx?tipodati=1&tema=Acque&sottotema=Sottotema%20Ambientale&ordine=1	Human consumption waters	UC2.3
Surface Waters (lakes) - LTLECO - LTLeco is a descriptor that integrates the values of 3 parameters detected on the lake: total phosphorus, transparency and hypolymnic oxygen. Reference year: 2013	Arpa Lombardia	https://www.arpalombardia.it/Pages/Dati/2019/Acque/LTLECO-AS-2019.aspx?tipodati=1&tema=Acque&sottotema=Sottotema%20Ambientale&ordine=1	Human consumption waters	UC2.1
Surface Waters (water courses) - LIMECO - LIMeco: descriptor that integrates the values of 4 parameters measured on a watercourse: ammonia nitrogen, nitric nitrogen, total phosphorus and dissolved oxygen (100 -% saturation). Reference year: 2013	Arpa Lombardia	https://www.arpalombardia.it/Pages/Dati/2019/Acque/LIMECO-AS-2019.aspx?tipodati=1&tema=Acque&sottotema=Sottotema%20Ambientale&ordine=1	Human consumption waters	UC2.1
Chemical status of groundwater	Arpa Lombardia	https://www.arpalombardia.it/Pages/Dati/2019/Acque/Stato-chimico-Sotterranee-2019.aspx?tipodati=1&tema=Acque&sottotema=Sottotema%20Ambientale&ordine=1	Human consumption waters	UC2.3
Environmental Radioactivity Monitoring Network	Arpa Lombardia	https://www.arpalombardia.it/Pages/Dati/2019/Radiazioni%20Ionizzanti/Rete-Monitoraggio-Radioattivita-Dati-2019.aspx?tipodati=0&tema=Radiazioni%20%20ionizzanti%20%28IR%29&sottotema=Sott	Human consumption waters	UC2.2

		otema%20Ambientale&ordine=1		
Flow rate (or hydrometric height) data relating to the watercourse monitoring network	Arpa Lombardia	https://www.dati.lombardia.it/Ambiente/Dato-di-portata-o-altezza-idrometrica-relativo-all/9zzw-tkky	Extreme events	UC3.1 UC3.12
Weekly inflows per basin	Arpa Lombardia	https://www.arpalombardia.it/Pages/Dati/2018/Idrometeorologia/Afflussi-settimanali-bacino-2018.aspx?tipodati=1&tema=Tema%20Ambientale&sottotema=Sottotema%20Ambientale&ordine=1	Extreme events	UC3.1 UC3.12
Weekly outflows per basin	Arpa Lombardia	https://www.arpalombardia.it/Pages/Dati/2018/Idrometeorologia/Deflussi-settimanali-bacino-2018.aspx?tipodati=1&tema=Tema%20Ambientale&sottotema=Sottotema%20Ambientale&ordine=1	Extreme events	UC3.1 UC3.12
Monthly inflows per basin	Arpa Lombardia	https://www.arpalombardia.it/Pages/Dati/2018/Idrometeorologia/Afflussi-mensili-bacino-2018.aspx?tipodati=1&tema=Idrometeorologia&sottotema=Sottotema%20Ambientale&ordine=1	Extreme events	UC3.1 UC3.12
Monthly outflows per basin	Arpa Lombardia	https://www.arpalombardia.it/Pages/Dati/2018/Idrometeorologia/Deflussi-mensili-bacino-2018.aspx?tipodati=1&tema=Idrometeorologia&sottotema=	Extreme events	UC3.1 UC3.12

		Sottotema%20Ambientale&ordine=1		
Height of the lakes	Arpa Lombardia	https://www.arpalombardia.it/Pages/Dati/2018/Idrometeorologia/Altezza-laghi-2018.aspx?tipodati=1&tema=Idrometeorologia&sottotema=Sottotema%20Ambientale&ordine=1	Extreme events	UC3.12
Interpolation of hourly precipitation observations - Spatial interpolation of hourly precipitation observations of the regional meteorological survey network on regular Gauss Boaga grid, pitch 1,5km x 1,5km, by means of an optimal interpolation algorithm without background. The time stamp is in UTC + 1 and refers to the end of the integration time. The data is in millimeters. The data is in geoascii format, one file for each hour, with date and time label in the file name.	Arpa Lombardia	https://www.dati.lombardia.it/browse?limitTo=blob&q=Interpolazione+osservazioni+orarie+precipitazioni&sortBy=relevance	Extreme events	UC3.1 UC3.12
Soil defense works - Census of soil defense works carried out in Regione Lombardia. The works are represented with polygonal, linear or punctual geometry and divided into the following categories: Monitoring / Investigations, Rock defense works, Avalanche defense works, Drainage works, Support works, Surface stabilization works, Hydraulic works,	Regione Lombardia	https://www.geoportale.regione.lombardia.it/metadati?p_p_id=detailSheetMetadata_WAR_gptmetadataportlet&p_p_lifecycle=0&p_p_state=normal&p_p_mode=view&_detailSheetMetadata_WAR_gptmetadataportlet_uuid=%7BCB3A8777-BB92-420C-9C3F-48A0106516B2%7D	Extreme events	UC3.8

Special works. For each work, the type (e.g. embankment, rockfall barrier, bridle, etc.), the material (steel, concrete, timber, stones, etc.), the location, the Law / Financing Program and the Type of intervention (extension / adaptation, construction, demolition, maintenance, etc.). As of 31 August 2019, the database contains 5756 polygonal works, 40,693 linear works and 13,982 specific works.				
Large dams - the dataset contains the information layer of the large dams, or the barrage works greater than 15 m in height, or which determine a reservoir volume greater than 1 million cubic meters (CIRC. M.LL.PP. April 19 1995, n. Us / 482), under state jurisdiction. They fall within the Lombard territory and are supervised by the Italian Dams Register, a non-economic public body of high technical specialization established in 2003, which performs all the tasks assigned by the legislation in force to the National Dam Service and over which the current Minister exercises supervision. of Infrastructure and Transport. Visible at a scale of 1: 150,000 or more detailed.	Regione Lombardia	https://www.geoportale.regione.lombardia.it/metadati?p_p_id=detailSheetMetadata_WAR_gptmetadataportlet&p_p_lifecycle=0&p_p_state=normal&p_p_mode=view&_detailSheetMetadata_WAR_gptmetadataportlet_uuid=%7BBC8DEB07-FD3F-4651-888E-E03232960D5F%7D	Extreme events	UC3.3

List of reclaimed sites in Lombardy - Year 2020	Regione Lombardia	https://hub.dati.lombardia.it/Ambiente/Elenco-dei-siti-bonificati-sul-territorio-lombardo/cp5f-hfya	Human consumption waters	UC2.1
List of contaminated sites in Lombardy - Year 2020	Regione Lombardia	https://hub.dati.lombardia.it/Ambiente/Elenco-dei-siti-contaminati-sul-territorio-lombard/xw6a-pk6u	Human consumption waters	UC2.1
Homogeneous zones for hydro-weather risk - List of Municipalities	Regione Lombardia	https://www.dati.lombardia.it/Protezione-Civile/Zone-omogenee-per-rischio-Idro-Meteo-Elenco-Comuni/ebfb-p3bd	Extreme Events	UC3.11
Homogeneous zones for hydro-weather risk - Centroids	Regione Lombardia	https://www.dati.lombardia.it/Protezione-Civile/Zone-omogenee-per-rischio-Idro-Meteo-Centroidi/n9f9-gc7k	Extreme Events	UC3.11
Weather sensor data	Arpa Lombardia	https://www.dati.lombardia.it/Ambiente/Dati-sensori-meteo/647i-nhxk	Extreme Events	UC3.1 UC3.12
Unified regional hydrographic network - The map represents the hydrographic network, created according to the procedure described below. It was decided to use the hydrographic network of the 1: 10 thousand vector CT10 Regional Technical Map as a starting point, both because it is a continuous data throughout the region and because in recent projects (2006-2008) it has been updated by checking the connection of the arches of the lattice and the orientation	Regione Lombardia	https://www.geoportale.regione.lombardia.it/metadati?p_p_id=detailSheetMetadata_WAR_gptmetadataportlet&p_p_lifecycle=0&p_p_state=normal&p_p_mode=view&_detailSheetMetadata_WAR_gptmetadataportlet_uuid=%7B279640CD-39AD-4437-8B6C-65E2A915096B%7D	Extreme Events	UC3.1 UC3.12

of the arcs. The CT10 hydrographic network has a limitation: it is not very suitable for the identification of the artificial hydrographic network. For the artificial hydrographic network, it was decided to refer to the Sibiter, which however only concerns the Lombardy plain territory. Having identified the hydrographic base from which to start, a procedure was created, in the ArcGis 9.3.1 desktop environment, capable of projecting the hydrographic networks of SIBA, RIP, Water Management Plan on the aforementioned base.				
Meteorological Stations - available data: • Hydrometric level (cm) • Snow height (cm) • Precipitation (mm) • Temperature (° C) • Relative humidity (%) • Global Radiation (W / m2) • Wind speed and direction (m / s and degrees). • Wind speed and direction (m / s and degrees N) gust NB: data are rapresented in solar time and refers to the observations obtained up to the indicated time"	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/nf78-nj6b	Extreme Events	UC3.1 UC3.12

Ostreopsis ovata	ISPRA	https://annuario.isprambiente.it/sys_ind/search	Human exposure to chemical and biological pollutants	UC1.5
Ostreopsis ovata	ISPRA	https://sinacloud.isprambiente.it/portal/apps/Cascade/index.html?appid=9ba106bedb744828b810a53025112ac4	Human exposure to chemical and biological pollutants	UC1.5
Bathing waters class	ISPRA	https://sinacloud.isprambiente.it/portal/apps/Cascade/index.html?appid=9ba106bedb744828b810a53025112ac4	Human exposure to chemical and biological pollutants	UC1.4 UC1.6 UC1.8 UC3.9
Chemical pollutant - Sistema Informativo Centralizzato Strategia Marina (nazionale)	ISPRA	www.db-strategiamarina.isprambiente.it/app/#/	Human exposure to chemical and biological pollutants	UC1.1 UC1.4 UC1.8
Chemical pollutants - EMODnet Strategia Marina (europeo)	EMODnet	https://www.emodnet-chemistry.eu/data	Human exposure to chemical and biological pollutants	UC1.1 UC1.4 UC1.8
Chemical pollutants - CDR Eionet	EIONET/EEA	https://cdr.eionet.europa.eu	Human exposure to chemical and biological pollutants	UC1.1 UC1.4 UC1.8

Chemical pollutants - Waterbase EEA	EEA	https://www.eea.europa.eu/data-and-maps/data/waterbase-water-quality-icm-1	Human exposure to chemical and biological pollutants	UC1.1 UC1.4 UC1.8
Chemical pollutants -WISE	EEA/WISE	https://water.europa.eu/marine	Human exposure to chemical and biological pollutants	UC1.1 UC1.4 UC1.8
Bathing waters quality	EEA	https://www.eea.europa.eu/tems/water/europes-seas-and-coasts/assessments/state-of-bathing-water	Human exposure to chemical and biological pollutants	UC1.4 UC1.6 UC1.8 UC3.9
Chemical pollutants-Nutrients-Copernicus	Copernicus	https://resources.marine.copernicus.eu/product-detail/MEDSEA_MULTIYEAR_BGC_006_008/INFORMATION	Human exposure to chemical and biological pollutants	UC1.1 UC1.4 UC1.8
Chemical pollutants	ISPRA	https://sinacloud.isprambiente.it/portal/apps/webappviewer/index.html?id=a38bab6b0aae4464ade50d6cbe2e3bbc	Human exposure to chemical and biological pollutants	UC1.1 UC1.4 UC1.8
Italian Wave Network (wave and meteo observations)	ISPRA	http://dati.isprambiente.it/id/ron	Extreme Events	UC3.2
Italian Tide Gauge Network (tide and meteo observations)	ISPRA	http://dati.isprambiente.it/id/rmn	Extreme Events	UC3.2

Pesticides in waters (concentration of chemical substances in inland and ground waters)	ISPRA		Extreme Events	UC3.6 UC3.8 UC3.15
RENDIS - Repertory of mitigation measures for National Soil Protection (collection of mitigation measures against floods and landslides)	ISPRA	http://dati.isprambiente.it/id/rendis	Extreme Events	UC3.3 UC3.13
Soil consumption indicators	ISPRA	http://dati.isprambiente.it/id/consumoSuolo	Extreme Events	UC3.8
Waterbase-UWWTD	Directorate-General for Environment (DG ENV) European Environment Agency (EEA)	https://www.eea.europa.eu/data-and-maps/data/waterbase-uwwtd-urban-waste-water-treatment-directive-7	Extreme Events	UC3.3 UC3.13
Annali Nivologici (snow annals)	ARPAV	https://www.arpa.veneto.it/temi-ambientali/neve/dati/stazioni-automatiche	Extreme Events	UC3.1 UC3.12
Dati meteorologici ultimi anni (Meteorological data - last years)	ARPAV	https://www.arpa.veneto.it/bollettini/storico/	Extreme Events	UC3.1 UC3.12

Dati meteorologici ultimi 60gg (Meteorological data - last days)	ARPAV	https://www.arpa.veneto.it/bollettini/meteo60gg	Extreme Events	UC3.1 UC3.12
Dati meteorologici in tempo reale (Meteorological data - real time)	ARPAV	https://www.arpa.veneto.it/bollettini/meteo/h24/	Extreme Events	UC3.1 UC3.12
Portate, Livelli Idrometrici, livelli dei laghi (River flows, hydrometric levels, lake levels)	ARPAV	https://www.arpa.veneto.it/temi-ambientali/idrologia/file-e-allegati/rapporti-e-documenti/idrologia-regionale/idrologia-regionale-la-rete-idrometrica	Extreme Events	UC3.1 UC3.12
Livelli idrometrici e precipitazioni in tempo reale (hydrometric levels and precipitations in real time)	ARPAV	https://www.arpa.veneto.it/temi-ambientali/acqua/datiacqua/dati_idrometeo.php	Extreme Events	UC3.1 UC3.12
Balneazione - Classificazione 2020 (Bathing waters 2020)	ARPAV	http://geomap.arpa.veneto.it/layers/geonode%3Abalneazione_classi2021_gbo	Extreme Events	UC3.5 UC3.7 UC3.9
Balneazione - Classificazione 2019 (Bathing waters 2019)	ARPAV	http://geomap.arpa.veneto.it/layers/geonode%3Abalneazione_classi2020_gbo	Extreme Events	UC3.5 UC3.7 UC3.9
Balneazione - Classificazione 2018 (Bathing waters 2018)	ARPAV	http://geomap.arpa.veneto.it/layers/geonode%3Abalneazione_classi2019_gbo	Extreme Events	UC3.5 UC3.7 UC3.9
Balneazione - Classificazione 2017 (Bathing waters 2017)	ARPAV	http://geomap.arpa.veneto.it/layers/geonode%3Abalneazione_classi2018_gbo	Extreme Events	UC3.5 UC3.7

				UC3.9
Balneazione - Classificazione 2016 (Bathing waters 2016)	ARPAV	http://geomap.arpa.veneto.it/layers/geonode%3Abalneazione_classi2017_gbo	Extreme Events	UC3.5 UC3.7 UC3.9
Balneazione - Classificazione 2015 (Bathing waters 2015)	ARPAV	http://geomap.arpa.veneto.it/layers/geonode%3Abalneazione_classi2016_gbo	Extreme Events	UC3.5 UC3.7 UC3.9
Specchi d'acqua (Water bodies)	ARPAV	http://geomap.arpa.veneto.it/layers/geonode%3Av_specchi_acqua	Extreme Events	UC3.1 UC3.12
Stato chimico delle foci a delta (2014-2016) (Chemical status for river delta)	ARPAV	http://geomap.arpa.veneto.it/layers/geonode%3Alagune_st_chi_rami_2014_2016#more	Extreme Events	UC3.6 UC3.15
Depuratori pubblici (public water treatment plants)	ARPAV	http://geomap.arpa.veneto.it/layers/geonode%3Av_depuratori	Extreme Events	UC3.3 UC3.7 UC3.13 UC3.16
Bacini Idrografici Senza Ruscellamento Uscente (Hydrographic basins without overflows)	ARPAV	http://geomap.arpa.veneto.it/layers/geonode%3ABISRU	Extreme Events	UC3.1 UC3.12
Mare - Stato chimico 2014-2016 (Chemical status of the sea)	ARPAV	http://geomap.arpa.veneto.it/layers/geonode%3Amare_chimico_2014_2016	Extreme Events	UC3.6 UC3.15

Significato Campi_Stato chimico fiumi 2014-2016	ARPAV	http://geomap.arpa.veneto.it/documents/234	Extreme Events	UC3.6 UC3.15
Stato chimico fiumi 2014-2016 (Chemical status of the rivers)	ARPAV	http://geomap.arpa.veneto.it/layers/geonode%3Astato_chimico_fiumi_2014_2016	Extreme Events	UC3.6 UC3.15
Stato chimico laghi 2014-2016 (Chemical status of the lakes)	ARPAV	http://geomap.arpa.veneto.it/layers/geonode%3Astato_chimico_laghi_2014_2016	Extreme Events	UC3.6 UC3.15
Livello di Inquinamento da Macrodescrittori, anno 2019 (LIM, D.Lgs. 152/1999) (Pollution level from macro descriptors)	ARPAV	http://geomap.arpa.veneto.it/layers/geonode%3Alim_2019	Extreme Events	UC3.6 UC3.7 UC3.15 UC3.16
Stato chimico delle altre lagune 2014-2016 (Chemical status of the lagoons)	ARPAV	http://geomap.arpa.veneto.it/layers/geonode%3Alagune_st_chi_altre_2014_2016	Extreme Events	UC3.6 UC3.15
Siti Potenzialmente Contaminati (Potential contaminated sites)	ARPAV	http://geomap.arpa.veneto.it/layers/geonode%3Asiticontaminati_pti	Extreme Events	UC3.8 UC3.11
Aziende a rischio di incidente rilevante (Companies at risk of a major accident)	ARPAV	http://geomap.arpa.veneto.it/layers/geonode%3AaziendeRIR2019	Extreme Events	UC3.8 UC3.11
Pozzi e piezometri (wells and piezometers)	ARPAV	http://geomap.arpa.veneto.it/layers/geonode%3Av_approv_idrico	Extreme Events	UC3.8 UC3.11 UC3.12

Localizzazione discariche (dumps)	ARPAV	http://geomap.arpa.veneto.it/layers/geonode%3Av_siti_discariche	Extreme Events	UC3.8 UC3.11
Discariche (dumps)	ARPAV	http://geomap.arpa.veneto.it/layers/geonode%3Av_discariche	Extreme Events	UC3.8 UC3.11
Carta del consumo di suolo del Veneto 2019 (Soil consumption map in Veneto)	ARPAV	http://geomap.arpa.veneto.it/layers/geonode%3ASC_R05_2019	Extreme Events	UC3.8
Corpi idrici fluviali (Progetti di Piano, 2020) - Rivers	ARPAV	http://geomap.arpa.veneto.it/layers/geonode%3Acorpi_idrici_fluviali	Extreme Events	UC3.1 UC3.12

Table 9 - Available dataset - Water

4.2 Health

Dataset	**Rights holder**	**Access URL**	**Use Case**	**ReqID**
Drinking Water Sampling - the dataset will contain the detections carried out by the ATS on the water samples in different types of sampling points (network points, water houses). For each point are indicated: detection date, address, geographic coordinates, sample id, measured parameter, value and unit of measurement	Regione Lombardia		Human consumption waters	UC2.1
Consumption of drugs in Regione Lombardia for level I ATC	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/2mr3-henm	Human consumption waters	UC2.5

Indicative dataset ESAC consumption of antibiotics	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/2rgc-zpff	Human consumption waters	UC2.5
Dataset Hospital Assistance for ACC and ATS	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/3rtw-8p48	Human consumption waters	UC2.5
Dataset Health conditions by municipality, age and gender	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/3zx9-b2zj	Human consumption waters	UC2.5
Dataset Medium Inpatient And Medium Access For ACC and ATS	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/4de2-n9qf	Human consumption waters	UC2.5
Dataset Average Hospitalization And Average Accesses By Type DRG and ATS	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/7raw-ua8y	Human consumption waters	UC2.5
Dataset Medium Inpatient And Medium Access For DRG And Structure	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/7vbr-ss62	Human consumption waters	UC2.5
Health conditions dataset by province, gender and cause	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/8adf-7566	Human consumption waters	UC2.5
Antibiotic consumption dataset in terms of DDD for level III and IV	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/a92t-4duz	Human consumption waters	UC2.5
Delivery of drugs in Regione Lombardia for the first 10 second-level ATCs	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/bxvn-na8g	Human consumption waters	UC2.5

Dataset Amoxicillin Consumption versus AMOXIC CLAV	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/cr7g-57r7	Human consumption waters	UC2.5
Dataset Average Hospitalization And Average Accesses By Type Of Assistance And Structure	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/eth3-mt87	Human consumption waters	UC2.5
Infectious diseases Regione Lombardia rates by sex and age	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/fvk5-jiuq	Human consumption waters	UC2.4
Number of drugs dispensed in Regione Lombardia of the first 10 active ingredients	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/gigt-rjms	Human consumption waters	UC2.5
Volumes Outpatient Specialist Services in Regione Lombardia	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/hdbq-kes5	Human consumption waters	UC2.5
Hospital Assistance for DRG and ATS	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/hgji-mdrs	Human consumption waters	UC2.5
Dataset Average Hospitalization And Average Accesses By Type Of Assistance and ATS	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/j8cg-z22v	Human consumption waters	UC2.5
Regione Lombardia SDO dataset	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/jv9t-c6q6	Human consumption waters	UC2.5
Dataset Average Hospitalization And Average Accesses By Discipline Discipline And ATS	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/jxj6-c2bw	Human consumption waters	UC2.5

Dataset Hospital Assistance for MDC and ATS	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/k92a-zk3k	Human consumption waters	UC2.5
Regione Lombardia Performance Rate Dataset by Gender and Age Group	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/ku85-2444	Human consumption waters	UC2.5
Regione Lombardia Performance Rate Dataset For Branca	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/mf2p-q7py	Human consumption waters	UC2.5
Dataset Hospital Assistance for Discipline Discipline and ATS	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/p48x-gife	Human consumption waters	UC2.5
Dataset Medium Inpatient And Medium Access For MDC And Facility	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/qnzb-fd54	Human consumption waters	UC2.5
Dataset Average Hospitalization And Average Accesses By Discipline Discipline And Structure	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/r24g-ddwh	Human consumption waters	UC2.5
Health Conditions For Rates	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/rgwy-ci7d	Human consumption waters	UC2.5
Dataset Medium Inpatient And Medium Access For ACC And Facility	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/rzni-6n8h	Human consumption waters	UC2.5
Number of drug packs dispensed in Regione Lombardia	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/t5s2-djkh	Human consumption waters	UC2.5

Hospital assistance for DRG and ATS type	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/u6fv-esyj	Human consumption waters	UC2.5
Dataset Medium Inpatient And Medium Access For DRG AND ATS	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/u7nv-yypg	Human consumption waters	UC2.5
Health conditions dataset by province	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/vsrf-pmc7	Human consumption waters	UC2.5
Dataset Hospital Assistance For ATS	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/w492-h6wu	Human consumption waters	UC2.5
Dataset Average Hospitalization And Average Accesses By DRG Type and Structure	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/w5br-7g3i	Human consumption waters	UC2.5
Health conditions dataset by province, gender and age group	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/xqrj-c9pb	Human consumption waters	UC2.5
Dataset Medium Inpatient And Medium Access For MDC And ATS	Osservatorio epidemiologico	https://www.dati.lombardia.it/d/ygqr-wrkx	Human consumption waters	UC2.5
Food consumpion data/OpenEFSAportal	EFSA	https://www.efsa.europa.eu/en/data-report/chemical-hazards-database-openfoodtox	Human exposure to chemical and biological pollutants	UC1.4 UC1.8

Chemical contaminants and biological Hazards EFSA portal	EFSA	https://www.efsa.europa.eu/en/aboutefsa	Human exposure to chemical and biological pollutants	UC1.4 UC1.8
Chemical substances ISS	ISS	https://www.reach.gov.it/banche-dati-delliss	Human exposure to chemical and biological pollutants	UC1.4 UC1.8
Chemical pollutants MiTE	MiTE	https://bancasostanze.minambiente.it/ricerca-sostanze	Human exposure to chemical and biological pollutants	UC1.4 UC1.8
Chemical pollutants-EEA	European Chemicals Agency; American Chemical Society; Verisk Europe APS	https://echa.europa.eu/it/advanced-search-for-chemicals?p_p_id=dissadvancedsearch_WAR_disssearchportlet&p_p_lifecycle=0&p_p_col_id=column-1&p_p_col_count=2	Human exposure to chemical and biological pollutants	UC1.4 UC1.8
Luoghi della cultura (Italian cultural heritage)	MIBACT	https://dati.beniculturali.it/lodview/resource/datasetLuoghiDellaCultura.html	Extreme Events	UC3.11
Mappa rischi (Hydrological risks and demographic indicators)	ISTAT	https://www.istat.it/it/mappa-rischi/indicatori	Extreme Events	UC3.11
Incidenti da valanga	AINEVA	https://aineva.it/incidenti/	Extreme Events	UC3.10

European Avalanche Warning Services - Fatalities	EAWS	https://www.avalanches.org/fatalities/	Extreme Events	UC3.10

Table 10 - Available dataset – Health

5 Legal and quality analysis

In order to consolidate the list of candidate datasets for use cases implementation, a set of checklists have been prepared for a legal, privacy and data quality assessment.

This chapter reports evaluation criteria and checklists that will then be applied. Dataset deliverable will report all evidence.

5.1 Checklist for legal analysis of the datasets

In order to assess the different potential datasets that have been initially identified, a set of criteria guided our choice for each identified use case. The criteria are list in the following table

Criterion	Definition
Relevance for the project	This criterion aims at detecting all those data sources that show a particular relevance for the objectives of WHOW
Social impact	This criterion aims at evaluating the datasets according to the social impact of their openness. The criterion takes then into account the demand of possible external users (e.g., citizens, enterprises, etc).. Also fall into this criterion all those datasets that are to be opened according to priority lists at the national and European level (i.e., Open Data Directive - High Value Datasets)
Availability	This criterion aims at assessing the sustainability of the openness of the datasets. It is intended for instance as the availability of the data providers of opening datasets, potentially still close, during the lifespan of the project
Technical - Interoperability with other data sources	This criterion is more technical; its scope is to evaluate whether specific datasets can be ready to be interoperable with other data sources (e.g., already available as linked open data, structured with a clear semantics, easily linkable with other datasets, etc.)
Privacy	This criterion aims at evaluating the datasets under the privacy aspects, taking into account the GDPR regulation.
Legal accessibility	This criterion evaluates the identified datasets in terms of legal constraints, coming from national regulations that can limit their openness.

Table 11 – List of adopted criteria

For each criterion above, a set of questions are proposed for the evaluation of every single dataset identified in WHOW. The following table lists these questions.

Criterion	**Question**	**Answer**
Relevance for the project	Is the dataset particularly relevant for sustaining specific use cases of WHOW?	Yes No Not applicable
	Is it necessary to open the dataset in order to support the achievements of the main results of the project?	Yes No Not applicable
Social Impact	Has the dataset been required by external users in order to support specific use cases coming from them?	Yes No Not applicable
	Is the dataset included in priority lists at the national level?	Yes No Not applicable
	Did you conduct a survey among stakeholders, also including enterprises that do not belong to the domain sectors of the project, in order to understand the interests in opening specific datasets?	Yes No Not applicable
	Is the dataset related to some high value datasets as defined in the context of the European Directive on Open Data (Directive (EU) 2019/1024)?	Yes No Not applicable
Availability	Were the internal stakeholders willing to open the dataset of their responsibility?	Yes No Not full convinced Not applicable
	Is the dataset, also possibly required by external users, already available for the open data process?	Yes No Not applicable
	In case of a negative answer to the previous question, did you foresee the collection and publication process within the project for the dataset?	Yes No Not applicable
	Does the process of the previous answer guarantee sustainability of it over time?	Yes No Not applicable

Technical interoperability with other data sources	Does the dataset include elements that may facilitate the interconnection with other datasets (e.g. shared classifications, common (geo) identifiers, same temporal coverage, etc.).	Yes No Not applicable
	If yes to the previous question, specify which are the elements.	Free text
	Is the dataset already available under the Linked (Open) Data paradigm?	Yes No Not applicable
	If yes to the previous question, which are the elements that can facilitate the interconnection with other available linked open datasets (e.g., time, geo identifiers, etc.)?	Free text
	If the dataset is not in linked open data, does it specify and publish a clear semantics of its elements in the form of detailed description of its data schema?	Yes No Not applicable
Privacy	Does the dataset contain personal data that can directly or indirectly identify a natural person? A personal data is any information that regards an identified or identifiable natural person (companies and public bodies are excluded). An identifiable natural person is a person that can be identified directly or indirectly via i) an identifier such as a name or a number; ii) data regarding his/her location; iii) an online identifier; iv) one or more identifying elements such as genetic, economic, social, cultural or physical characteristics.	Yes No Not applicable
	If yes to the previous question, is the information authorized by law?	Yes No Not applicable
	Does the dataset contain indirect information that can be used to identify a person?	Yes No Not applicable
	If yes to the previous question, is the information authorized by law?	Yes No Not applicable
	Does the dataset contain specific categories of data (e.g., sensitive data) connected to a person?	Yes No Not applicable

	If yes to the previous question, is the sensitive data properly anonymized so that re-identification is not possible?	Yes No Not applicable
	In case personal data is included, is the data collected adequate, relevant and limited to what is necessary in relation to the purposes for which they are processed ('data minimisation')?	Yes No Not applicable
Legal accessibility	The dataset that you wish to use is accompanied with a closed license (e.g., no commercial re-use, no derivatives)?	Yes No Not applicable
	Are you sure there are no law limitations in the open process for the dataset?	Yes No Not applicable
	Is the dataset subject to temporal restrictions for its publication?	Yes No Not applicable
	Is the data subject to specific legal or jurisprudential prohibitions that prevent its indexing by search engines?	Yes No Not applicable

Table 12 – Dataset evaluation criteria

5.2 Data quality framework

In order to evaluate the quality of the datasets that will be part of WHOW's knowledge graph, WHOW will adhere to the FAIR Data Maturity Model. The Model is a comprehensive framework that aims at evaluating the different FAIR (Findable, Accessible, Interoperable, Reusable) principles with a set of indicators that have been defined for this purpose.

We introduce in the following part of this section the indicators of the FAIR Data Maturity Model that allows us to evaluate both the original quality of the datasets being used in WHOW, and the quality to be guaranteed as a result of the project activities to be carried out .

In addition to the subset of indicators of the FAIR model, the data quality framework will take into account the characteristics of quality as defined in the ISO/IEC 25012 and 25024 standards.

ID Identifier	**Description**	**Evaluation**	**Priority**
RDA-F1-01M	Metadata is identified by a persistent identifier	Yes No	Essential
RDA-F1-01D	Data is identified by a persistent identifier	Yes No	Essential
RDA-F2-01M	Rich metadata is provided to allow discovery	Yes No	Essential

RDA-F4-01M	Metadata is offered in such a way that it can be harvested and indexed	Yes No	Essential
RDA-A1-01M	Metadata contains information to enable the user to get access to the data	Yes No	Important
RDA-A1-04M	Metadata is accessed through standardised protocol	Yes No	Essential
RDA-A1-04D	Data is accessible through standardised protocol	Yes No	Essential
RDA-A1-05D	Data can be accessed automatically (i.e. by a computer program)	Yes No	Important
RDA-A1.2-01D	Data is accessible through an access protocol that supports authentication and authorisation	Yes No	Useful
RDA-I1-01M	Metadata uses knowledge representation expressed in standardised format	Yes No	Important
RDA-I1-01D	Data uses knowledge representation expressed in standardised format	Yes No	Important
RDA-I2-01M	Metadata uses FAIR-compliant vocabularies	Yes No	Important
RDA-I2-01D	Data uses FAIR-compliant vocabularies	Yes No	Useful
RDA-I3-01D	Data includes references to other data	Yes No	Useful
RDA-I3-02M	Metadata includes references to other data	Yes No	Useful
RDA-R1.1-02M	Metadata includes information about the licence under which the data can be reuse	Yes No	Essential
RDA-R1.3-01M	Metadata complies with a community standard	Yes No	Essential
RDA-R1.3-01D	Data complies with a community standard	Yes No	Essential
RDA-R1.3-02D	Data is expressed in compliance with a machine-understandable community standard	Yes No	Important
WHOW-DQA-M	Metadata is accurate with respect to a shared standard	Yes No	Important
WHOW-DQA-D	Data is accurate	Yes No	Essential

WHOW-DQT-M	Metadata is up-to-date with respect to current time	Yes No (also if it is unclear)	Important
WHOW-DQT-D	Data is up-to-date with respect to its update frequency	Yes No (also if it is unclear)	Essential
WHOW-DQC-M	Metadata is complete	Yes No	Useful
WHOW-DQC-D	Data is complete	Yes No	Important

Table 13 - Checklist of quality evaluation

Based on these indicators the data quality model can then compute the following data quality levels:

- Insufficient level → none of indicators are satisfied
- Sufficient level → only half of the essential indicators are satisfied
- Good level → all the essential indicators are satisfied
- Very Good level → all the essential and important indicators are satisfied
- Excellent level → all indicators are satisfied

This will allow to show over time the evolution of the quality of the datasets, thus demonstrating the advantages of the WHOW's approach.