

**Interreg  
Danube Region**



**Co-funded by  
the European Union**



## **DELIVERABLE 1.3.2**

**Roadmap towards enhanced public and  
cross institutional data availability in the  
Danube river basin**

**June 2026**

**Authors:**

- **Galina Dimova** – Bulgarian Water Association, Bulgaria
- **Ottavia Zoboli** – TU Wien, Austria
- **Adam Kovacs** – International Commission for Protection of the Danube River (ICPDR)
- **Adrienne Clement, Kata Mária Dudás** – Budapest University of Technology and Economics (BME), Hungary
- **Aleksandra Kovacevic** – Public Institution “Vode Srpske”
- **Corina Boscornea, Elvira Marchidan, Constanta Moldovan, Ioana Nedelea** - National Administration Romanian Waters, Romania
- **Danijela Sukovic** - Center for Ecotoxicological Research Podgorica (CETI), Montenegro
- **Darko Barbalić, Jasmina Antolić, Đorđa Medić** – Hrvatske vode, Croatia
- **Jelena Vicanovic** – Public Institution “Vode Srpske”
- **Jelena Vikanovic** - Public Institution “Vode Srpske”, Bosna and Herzegovina
- **Marko Marjanović** – Jaroslav Černi Water Institute, Serbia
- **Michal Kirchner** - Water Research Institute, Slovakia
- **Nataliia Osadcha** - Ukrainian Hydrometeorological Institute, Ukraine
- **Radmila Milačić Ščančar, David Kocman** - Jožef Stefan Institute, Slovenia

## Table of Contents

1	Introduction .....	5
1.1	The challenge of managing hazardous substances in the Danube River Basin.....	5
1.2	Gaps (or lessons learned) from the inventories on priority substances emission, discharges, and losses .....	6
1.3	Pathway-oriented emission modelling – a powerful tool for creating emission inventories and supporting effective policy.....	6
1.4	The FAIR principles for data management .....	7
2	The Tethys survey .....	9
2.1	Methodological approach.....	9
2.2	Key conclusions.....	18
2.2.1	Concerning DC1: Engineering water related infrastructure.....	18
2.2.2	Concerning DC2: Hazardous substances .....	18
2.2.3	Concerning DC3: Hydrometeorological and hydraulic data .....	19
2.2.4	General conclusion .....	20
3	Goals, objectives, and expected results of the roadmap .....	22
4	Proposed actions .....	23
4.1	Goal 1: Improved availability of the priority and the recommendable input data for modelling of hazardous substances emissions .....	23
4.2	Goal 2: Improved public access to data for HSs modelling, their use and re-use. ....	25

## Figures

Figure 1: Methodology for evaluation of data availability and accessibility concerning the modelling of hazardous substances in the Danube River Basin.....	9
Figure 2: Overview of the necessary data for pathway-oriented emission modelling of hazardous substances (based on MoRE) .....	10
Figure 3: Description of the necessary data for pathway-oriented emission modelling of hazardous substances.....	10
Figure 4: Description of the necessary priority input data for pathway-oriented emission modelling of hazardous substances .....	12
Figure 3: Goals and objectives for enhanced data availability and sharing for the purposes of HSs modelling.....	22

## Tables

Table 1: The FAIR principles.....	8
Table 2. DC1: Engineering water related infrastructure. ....	13
Table 3: HS concentration in water and in potential pathways.....	15
Table 4: Hydrometeorological and hydraulic data.....	17

## ***Executive summary***

This document has been developed as an output of Tethys project with the intention to support the further improvement of data availability, accessibility, sharing, and re-use for the purpose of modelling of hazardous substances pollution in the Danube River Basin. It provides an evidence-based assessment of the current situation, identifies key gaps, and challenges, and presents strategic recommendations that may guide future actions, policy discussions, institutional cooperation, and technical improvements. All results are based on information provided by the Tethys project partners, giving an insight into the current national practices on data management and sharing in eleven countries of the Danube River Basin - Austria, Bulgaria, Bosnia and Herzegovina -Republik Srpska, Croatia, Hungary, Montenegro, Romania, Slovenia, Slovakia, Serbia and Ukraine.

The proposed goals, objectives, and actions are therefore intended to serve as a common reference framework for the relevant stakeholders from all the Danube River countries, rather than as a detailed operational plan.

## 1 Introduction

### 1.1 The challenge of managing hazardous substances in the Danube River Basin

In recent decades, the presence and pressure of hazardous substances on water bodies have increased in terms of diversity and quantity and have become a problem of growing concern. Industrial development, especially the chemical industry, agricultural practices, the use of pharmaceutical and cosmetic products have introduced an increasing number of new substances into goods and into our daily lives. On the other hand, advances in analytical methods for their detection, advances in medicine and environmental protection research have raised the alarm about their toxic effects, even at exceptionally low concentrations, both on human health and on aquatic ecosystems.

To address the challenge, the EU has developed a set of directives imposing clear rules on the monitoring and emissions of certain pollutants into water bodies. The most important directives are:

- **The Water Framework Directive (WFD, 2000/60/EEC<sup>1</sup>**, last amended by Directive 2026/805/EU<sup>2</sup>) – it implements a list of priority substances and requires EU member states to report an inventory of emissions, discharges, and losses of priority substances in the RBMPs.
- **The Environment Quality Standards Directive (EQS Directive, 2008/105/EC<sup>3</sup>**, last amended by Directive 2026/805/EU) - sets the list of priority substances to be monitored and the respective admissible concentrations. In April 2026, the EC published the Directive 2026/805/EU which extends the list of priority substances monitored in surface water from 45 to 64. The substances are divided in several groups – nutrients, plant protection products (herbicides, pesticides, insecticides), industrial substances, pharmaceuticals, metals). The Directive also sets a list of 8 priority substances to be monitored in groundwater among which nitrates, certain pesticides and pharmaceutical products<sup>1</sup>. In addition, 6 substances of the former list (*Alachlor, Carbon tetrachloride, Chlorfenvinphos, Simazine, Trichlorobenzenes, Atrazine*) have been moved to the list of river basin specific pollutants.
- **The Urban Wastewater Treatment Directive (UWWTD, Directive 2024/3019<sup>4</sup>)** adopting new, stricter requirements for urban wastewater treatment. The new directive extends the scope of agglomerations subject to its requirements and introduces the mandatory implementation of quaternary treatment for the removal of trace contaminants in WWTPs larger than 150 000 population equivalents (p.e.) and in WWTPs larger than 10 000 p.e. on a risk assessment basis. The directive also set requirement to monitor pollutants from several other directives and regulations

---

<sup>1</sup> <https://eur-lex.europa.eu/legal-content/BG/ALL/?uri=CELEX%3A32000L0060>

<sup>2</sup> <https://eur-lex.europa.eu/eli/dir/2026/805/oj/eng>

<sup>3</sup> <https://eur-lex.europa.eu/eli/dir/2008/105/oj/eng>

<sup>4</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02024L3019-20241212>

(e.g. Directive 2000/60/EC, Directive 2008/105/EC, Directive 2006/118/EC, Directive 2006/118/EC, and others) that are likely to be found in the urban wastewater.

### **1.2 Gaps (or lessons learned) from the inventories on priority substances emission, discharges, and losses.**

A methodology for preparation of inventories is suggested at EU level in the CIS Guidance No. 28 “*Preparation of an Inventory of Emissions, Discharges and Losses of Priority and Priority Hazardous Substances*”. The document recommends a tiered approach for establishing of the inventories consisting of two steps: (1) Assessment of relevance and (2) Approaches for relevant substances. The first step aims at identification of substances of minor concern for the River Basin District (RBD), which shall not be included in the inventory. The second step applies to the rest of the substances, and it requires a more detailed analysis to provide further estimates of emissions, discharges and losses from point and diffuse sources, as well as loads transported in rivers. Three approaches are suggested: riverine load approach; pathway-oriented approach and source-oriented approach. The current practices show that most of the countries follow the simplest riverine load approach. The current lack of application of the pathway-oriented approach (with exception of Germany, Austria, and Hungary) implies that diffuse emissions are estimated as black-box and specific pathways are not identified.

During the development of the third River Basin Management Plans, all EU member states reported their inventories of emissions, discharges, and losses of harmful substances. In the Report of the Commission to the Council and EP on the implementation of the WFD and the Flood Directive<sup>5</sup> it is mentioned that there are significant differences among and within the countries in both the relevant toxic substances considered and the completeness of the data reported. The top 10 substances for which emission inventories have been most set up in the member states are: mercury, benzo(a)pyrene, fluoranthene, benzo(g,h,i) perylene (PAHs), nickel, lead, cadmium, nonylphenol, PFOS and tributyltin-cation.

The costly monitoring of hazardous substance and scarce or even missing monitoring data concerning the potential emitters and pathways as well as the inefficient exchange of data among the stakeholders can be regarded as the major obstacles for still unsatisfactory management of hazardous substances.

### **1.3 Pathway-oriented emission modelling – a powerful tool for creating emission inventories and supporting effective policy.**

A powerful tool to address the above-mentioned challenges is the creation of simulation models that can quantify, at the river basin level, the emission loads of hazardous substances reaching surface waters through different pathways. Running different model scenarios and analysing the results can significantly facilitate the decision-making process regarding monitoring programs, management and prevention measures for hazardous substances pollution and their impact on river basin ecosystems.

---

<sup>5</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52025DC0002&qid=1773505479573>

MoRE (Modelling of Regionalized Emissions) is an open-source software that is widely used in some countries (e.g. Germany, Austria) to model annual emissions of nutrients, heavy metals, and certain priority substances<sup>6</sup>. The model is based on a pathway-oriented approach, and the results are validated with observed loads at river water gauging stations. MoRE provides flexible modelling capabilities, can consider different input data options and quantification approaches to improve the assessment of the quality of different input data, the reliability of the results and the effect of different, potential, and actual measures to reduce emissions of harmful substances.

An important pre-condition for the successful application of MoRE and similar emission models is the availability, comprehensiveness, and reliability of considerable number of various data concerning land use, statistical data, hydrology, topography, and data for soil characterisation, as well as concentrations of hazardous substances in multiple environmental compartments. The diversity of data often managed by different national and international institutions, the various methodologies for monitoring and analytical measurements, the different data formats, often not allowing digital processing, are considered as major obstacles for broader application of models at river basin scale.

Finally, the terms for using or reusing various data sets are too restrictive or unclear, which creates additional difficulties when using them in models.

#### **1.4 The FAIR principles for data management**

In 2016 was published the article “[FAIR Guiding Principles for scientific data management and stewardship](#)”<sup>7</sup> which proposes guidelines for improving the **Findability**, **Accessibility**, **Interoperability**, and **Reuse** of digital data assets ensuring they can be found, understood, and reused by humans and machines (Table 1).

These principles aim to maximize the value of research data by requiring persistent identifiers, rich metadata, and clear licenses for use. Although these principles were proposed and conceived with research data in mind, they could also be applied to data and metadata generated within monitoring programs, in national statistics, etc.

The FAIR principles are also implemented in Directive (EU) 2019/1024 of the European Parliament and of the Council<sup>8</sup>. It sets out the minimum requirements on open data and the re-use of publicly funded research data and information collected by the public-sector bodies or the public undertakings (such as geographical, land registry, statistical or legal information).

---

<sup>6</sup> Fuchs, S.; Kaiser, M.; Kiemle, L.; Kittlaus, S.; Rothvoß, S.; Toshovski, S.; Wagner, A.; Wander, R.; Weber, T.; Ziegler, S. Modeling of Regionalized Emissions (MoRE) into Water Bodies: An Open-Source River Basin Management System. *Water* 2017, 9, 239. <https://doi.org/10.3390/w9040239>

<sup>7</sup> Wilkinson, M., Dumontier, M., Aalbersberg, I. *et al.* The FAIR Guiding Principles for scientific data management and stewardship. *Sci Data* 3, 160018 (2016). <https://doi.org/10.1038/sdata.2016.18>

<sup>8</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019L1024&qid=1698415759959>

**Table 1: The FAIR principles**

Findability	Accessibility	Interoperability	Reuse
<p><b>F1:</b> (Meta) data are assigned globally unique and persistent identifiers.</p> <p><b>F2:</b> Data are described with rich metadata.</p> <p><b>F3:</b> Metadata clearly and explicitly include the identifier of the data they describe.</p> <p><b>F4:</b> (Meta)data are registered or indexed in a searchable resource</p>	<p><b>A1:</b> (Meta)data are retrievable by their identifier using a standardised communication protocol.</p> <ul style="list-style-type: none"> <li>• The protocol is open, free, and universally implementable.</li> <li>• The protocol allows for an authentication and authorisation procedure where necessary.</li> </ul> <p><b>A2:</b> Metadata should be accessible even when the data is no longer available</p>	<p><b>I1:</b> (Meta)data use a formal, accessible, shared, and universally applicable language for knowledge representation.</p> <p><b>I2:</b> (Meta)data use vocabularies that follow the FAIR principles.</p> <p><b>I3:</b> (Meta)data include qualified references to other (meta)data</p>	<p><b>R1:</b> (Meta)data are richly described with a plurality of accurate and relevant attributes.</p> <ul style="list-style-type: none"> <li>• (Meta)data are released with a clear and accessible data usage license.</li> <li>• (Meta)data are associated with detailed provenance.</li> <li>• (Meta)data meet domain-relevant community standards</li> </ul>

The Directive aims at increasing the added value of that kind of information by making it more easily available for different entities, by enabling the supply and publicity of datasets with a particularly high economic impact, and by promoting competition and transparency in the information market. However, the Directive allows for a derogation from the rules on public access to information which may contain "sensitive data" or information with commercial characteristics (e.g. data concerning the protection of national security, statistical or commercial confidentiality). This could be the case for data relating to water engineering infrastructure, or data concerning plant protection products or the application or use of pharmaceutical products in any region.

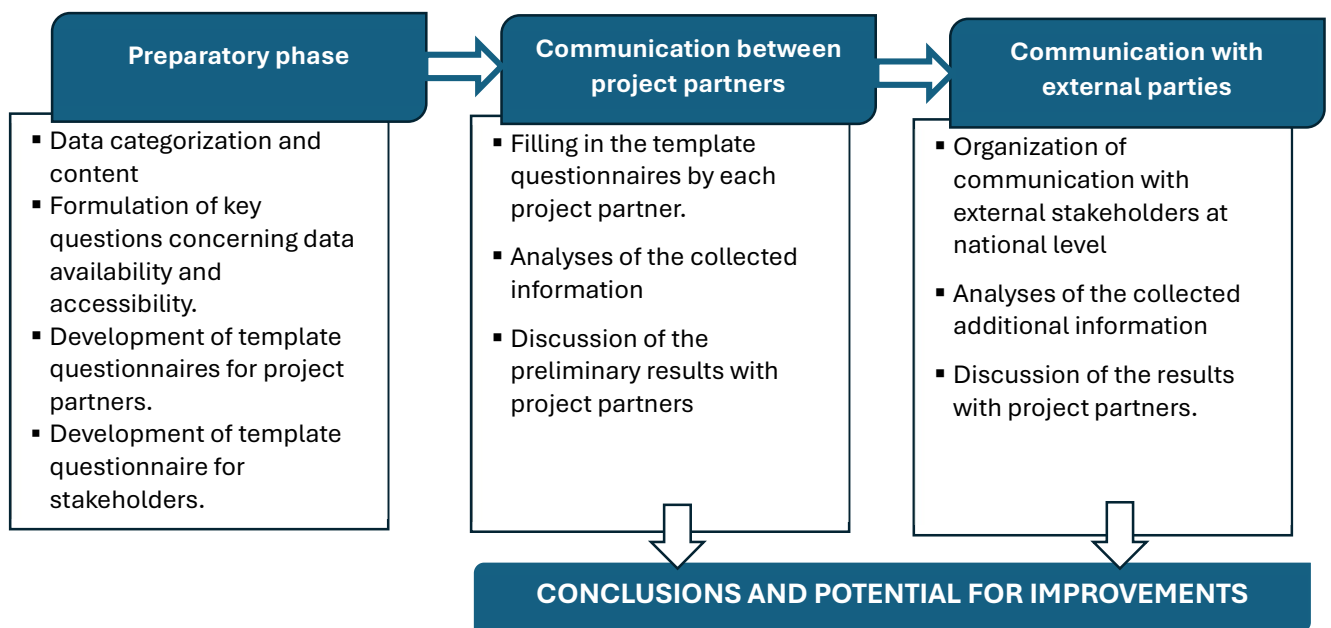
The re-use of data falling within the scope of Directive 2019/1024 should be subject to standard licencing (e.g. <https://creativecommons.org>) and free of charge, but the Directive allows also exemption from the rule, i.e. charging for data receiving, e.g., in case of *“public sector bodies that are required to generate revenue to cover a substantial part of their costs relating to the performance of their public tasks”* (Article 6, item 2).

## 2 The Tethys survey

### 2.1 Methodological approach

A study was conducted within the Tethys project on the availability and publicly accessibility of data needed for modelling hazardous substances (HS) at a river basin scale. The methodology consisted of three steps (

Figure 1). Eleven Danube River Basin countries took part (Austria, Bulgaria, Bosnia and Herzegovina -Republik Srpska, Croatia, Hungary, Montenegro, Romania, Slovenia, Slovakia, Serbia, and Ukraine), as the Tethys project partners and some key stakeholders in the relevant countries have actively participated in collecting the necessary information.



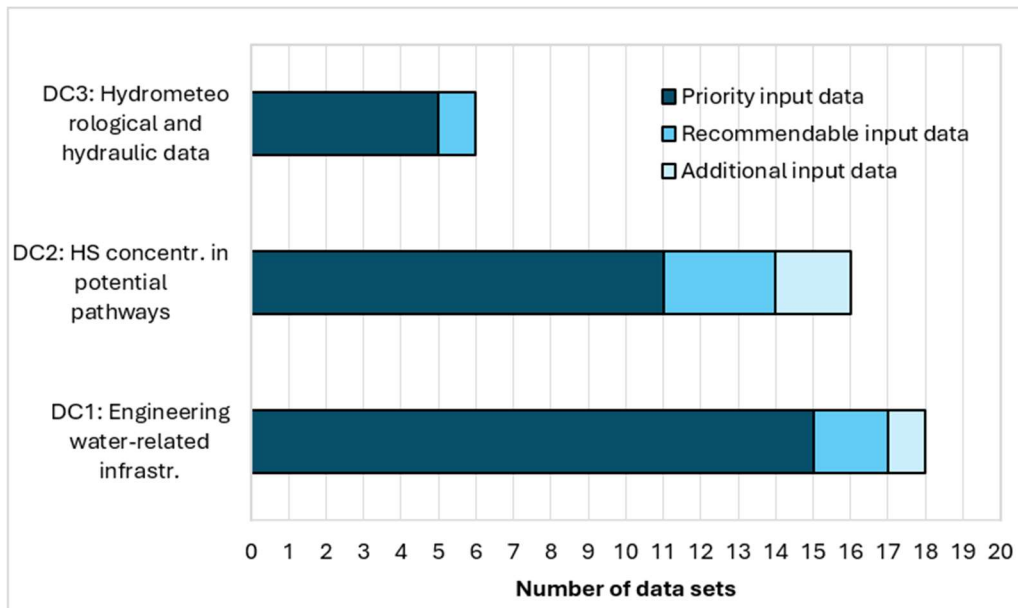
**Figure 1: Methodology for evaluation of data availability and accessibility concerning the modelling of hazardous substances in the Danube River Basin**

The requirements for a pathway-oriented emission modelling, using MoRE as the reference implementation input data, were used within the survey. The model necessitates in total 35 different input data sets. Within the Tethys survey, they have been divided into three general data categories (DC) based on the key characteristics of the information (Figure 3).

The data were further assessed concerning their importance for modelling, e.g.:

- *Priority input data sets* - input data without which modelling cannot be done.
- *Recommendable data sets* – information that will help the model to provide sufficiently reliable results.
- *Additional input data sets* – data that will enhance the quality and plausibility of the results.

A more detailed description of the necessary data sets for MoRE is presented on the figure below.



**Figure 2: Overview of the necessary data for pathway-oriented emission modelling of hazardous substances (based on MoRE)**

Data Category 1 Engineering water-related infrastructure	Data Category 2 HS concentration in water and in potential pathways	Data Category 3 Hydrometeorological and hydraulic data
<p><b>Priority input data</b></p> <ul style="list-style-type: none"> <li>▪ Number of inhabitants <sup>1</sup></li> <li>▪ Water consumption <sup>1</sup></li> <li>▪ Connection rate to sewer network <sup>1</sup></li> <li>▪ Connection rate to WWTP <sup>1</sup></li> <li>▪ Rate not connected inhabitants <sup>1</sup>.</li> <li>▪ Rate septic tanks load to WWTP load <sup>1</sup></li> <li>▪ Length storm water sewers <sup>1</sup></li> <li>▪ Length sewage sewers <sup>1</sup></li> <li>▪ Length combined sewers <sup>1</sup></li> <li>▪ WWTPs load</li> <li>▪ WWTP capacity</li> <li>▪ WWTP treatment stages</li> <li>▪ Tile drained areas <sup>2</sup></li> <li>▪ Inhabitants connected to sewer network and WWTP</li> <li>▪ Industrial discharges</li> </ul> <p><b>Recommendable data sets</b></p> <ul style="list-style-type: none"> <li>▪ Volume of sedimentation tanks</li> <li>▪ Volume of stormwater overflow tanks</li> </ul> <p><b>Additional input data</b></p> <ul style="list-style-type: none"> <li>▪ Commercial wastewater runoff</li> </ul>	<p><b>Priority input data</b></p> <ul style="list-style-type: none"> <li>▪ Conc. in topsoil on arable land <sup>3</sup></li> <li>▪ Conc. in topsoil of grassland <sup>3</sup></li> <li>▪ Conc. in topsoil of naturally covered areas <sup>3</sup></li> <li>▪ Conc. in groundwater</li> <li>▪ Conc. in surface water</li> <li>▪ Conc. in WWTP effluent (≥ 2000 p.e.)</li> <li>▪ Conc. in WWTP effluent (&lt; 2000 p.e.)</li> <li>▪ Conc. in untreated sewage discharges</li> <li>▪ Conc. in industrial direct dischargers</li> </ul> <p><i>Atmospheric deposition data</i></p> <ul style="list-style-type: none"> <li>▪ Area-specific rates of HS deposition or conc. in atmospheric deposition</li> </ul> <p><i>Other pathways</i></p> <ul style="list-style-type: none"> <li>▪ Conc. in runoff from abandoned mining sites <sup>4</sup></li> </ul> <p><b>Recommendable data sets</b></p> <ul style="list-style-type: none"> <li>▪ Concentration in combined sewer overflows</li> <li>▪ Conc. in storm drains runoff</li> <li>▪ Concentration in runoff from roads</li> </ul> <p><b>Additional input data</b></p> <ul style="list-style-type: none"> <li>▪ Conc. in water from septic tanks</li> <li>▪ Conc. in commercial areas runoff</li> </ul>	<p><b>Priority input data</b></p> <p><i>Hydrometeorological data</i></p> <ul style="list-style-type: none"> <li>▪ Evapotranspiration <sup>5</sup></li> <li>▪ Precipitation <sup>5</sup></li> <li>▪ Discharge at monitoring river gauges</li> </ul> <p><b>Hydraulic data</b></p> <ul style="list-style-type: none"> <li>▪ Discharge from wastewater treatment plants</li> <li>▪ Runoff from abandoned mines</li> </ul> <p><b>Recommendable data sets</b></p> <ul style="list-style-type: none"> <li>▪ Runoff from streets</li> </ul>

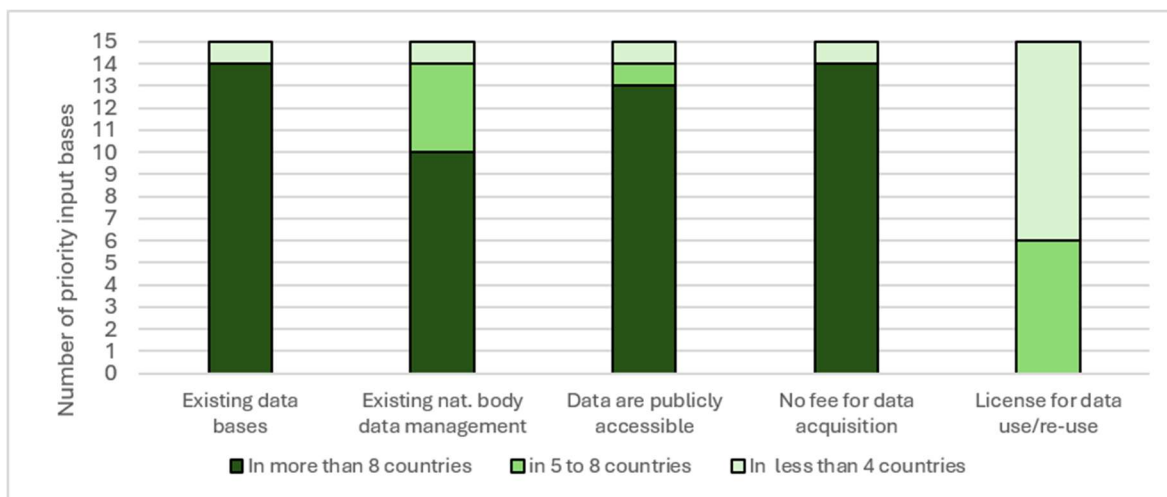
**Figure 3: Description of the necessary data for pathway-oriented emission modelling of hazardous substances**

NOTES to Figure 3: 1. These data are priority input data in case specific information on WWTP capacity and loads and /or on sewer system characteristics (e.g. connection rate) is not available.  
2. These data are important in case of extensive agricultural areas  
3. If the hazardous substance is not accumulated in soils, these data are not priority  
4. These data are priority input data in regions where abandoned mining is significant  
5. Evapotranspiration data are necessary in case there are no data from water balance modelling available

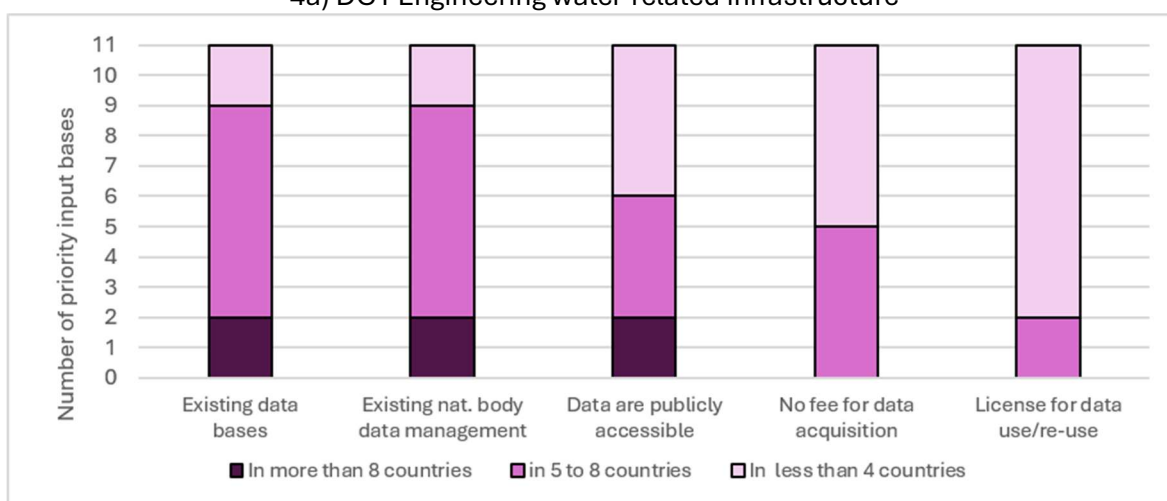
Several key questions were asked to clarify the data availability and ownership, their public accessibility, the mechanism of data acquisition and the conditions (licensing) for data use / re-use by external parties (e.g. different from the data owner or data hosting institution).

- 1) Who is the data owner?
- 2) Is there a national/ regional institution for data management?
- 3) How often the data base is updated?
- 4) Are the data public available?
- 5) Is there a fee for data acquisition?
- 6) Is there clear license given for the data use?
  - a) What kind of license is issued?
  - b) What are the conditions of the license?

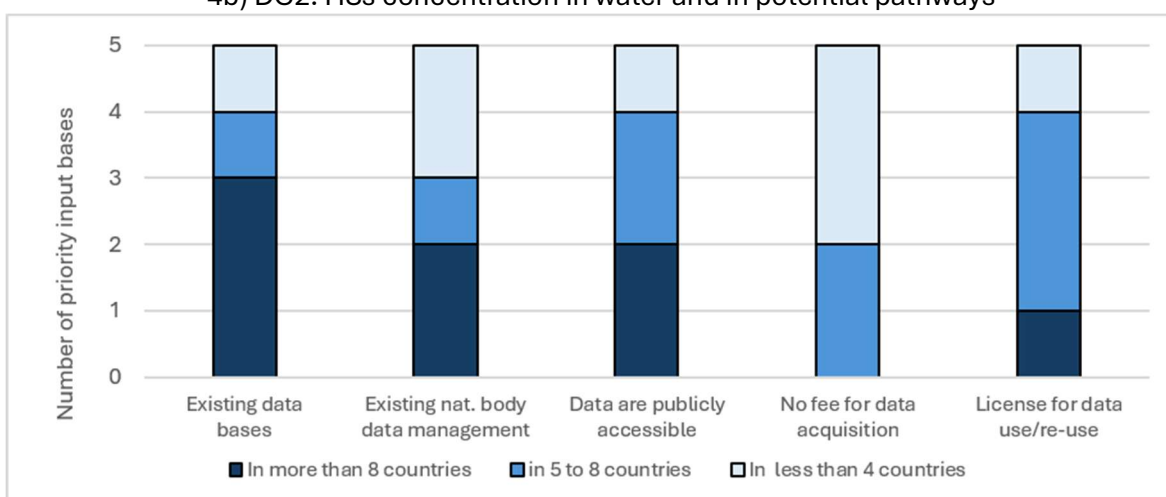
Based on the analyses of the collected information some key conclusions have been drawn concerning status-quo of the necessary input data sets. The key results from the Tethys survey for the priority input data for each main data category are summarized on Figure 4, while Table 2, Table 3, and Table 4 present more detailed analysis on data availability and accessibility.



#### 4a) DC1 Engineering water-related infrastructure



#### 4b) DC2: HSs concentration in water and in potential pathways



#### 4c) DC 3: Hydrometeorological and hydraulic data

**Figure 4: Description of the necessary priority input data for pathway-oriented emission modelling of hazardous substances**

**Table 2. DC1: Engineering water related infrastructure.**

**Status of data availability, publicly accessibility and national regulations for data re-use across the DRB countries**

<b>Criterion</b>	<b>In more than 8 investigated countries</b>	<b>In 5 to 8 investigated countries</b>	<b>In less than 5 investigated countries</b>
<b>Data availability</b>	<p><b><u>Priority input data</u></b></p> <ul style="list-style-type: none"> <li>▪ Number of inhabitants</li> <li>▪ Water consumption</li> <li>▪ Connection rate to sewer network</li> <li>▪ Connection rate to WWTP</li> <li>▪ Rate not connected inhabitants.</li> <li>▪ Rate septic tanks load to WWTP load.</li> <li>▪ Length storm water sewers</li> <li>▪ Length sewage sewers</li> <li>▪ Length combined sewers</li> <li>▪ WWTPs load</li> <li>▪ WWTP capacity</li> <li>▪ WWTP treatment stages</li> <li>▪ Inhabitants connected to sewer system</li> <li>▪ Industrial discharges</li> </ul> <p><b><u>Recommendable data sets</u></b></p> <ul style="list-style-type: none"> <li>▪ Volume of sed. Tanks</li> </ul>	<p><b><u>Recommendable data sets</u></b></p> <ul style="list-style-type: none"> <li>▪ Volume of storm water overflow tanks</li> </ul> <p><b><u>Additional input data</u></b></p> <ul style="list-style-type: none"> <li>▪ Commercial wastewater runoff</li> </ul>	<p><b><u>Priority input data</u></b></p> <ul style="list-style-type: none"> <li>▪ Tile drained areas.</li> </ul> <p><b><u>Recommendable data sets</u></b></p> <p>Not applicable</p> <p><b><u>Additional input data</u></b></p> <p>Not applicable</p>
<b>Existing national body for data management</b>	<p><b><u>Priority input data</u></b></p> <ul style="list-style-type: none"> <li>▪ Number of inhabitants</li> <li>▪ Connection rate to sewer network</li> <li>▪ Connection rate to WWTP</li> <li>▪ Length sewage sewers</li> <li>▪ Length combined sewers</li> <li>▪ WWTPs load</li> <li>▪ WWTP capacity</li> <li>▪ WWTP treatment stages</li> <li>▪ Inhabitants connected to sewer system</li> <li>▪ Industrial discharges</li> </ul>	<p><b><u>Priority input data</u></b></p> <ul style="list-style-type: none"> <li>▪ Water consumption</li> <li>▪ Rate not connected inhabitants.</li> <li>▪ Rate septic tanks load to WWTP load.</li> <li>▪ Length stormwater sewers</li> </ul> <p><b><u>Additional input data</u></b></p> <ul style="list-style-type: none"> <li>▪ Commercial wastewater runoff</li> </ul>	<p><b><u>Priority input data</u></b></p> <ul style="list-style-type: none"> <li>▪ Tile drained areas.</li> </ul> <p><b><u>Recommendable data sets</u></b></p> <ul style="list-style-type: none"> <li>▪ Volume of sed. Tanks</li> <li>▪ Volume of storm water overflow tanks</li> </ul>
<b>Publicly accessibility</b>	<p><b><u>Priority input data</u></b></p> <ul style="list-style-type: none"> <li>▪ Number of inhabitants</li> <li>▪ Water consumption</li> <li>▪ Connection rate to sewer network</li> <li>▪ Connection rate to WWTP</li> <li>▪ Rate not connected inhabitants <b>(CoA)</b></li> <li>▪ Length storm water sewers <b>(CoA)</b></li> <li>▪ Length sewage sewers <b>(CoA)</b></li> <li>▪ Length combined sewers <b>(CoA)</b></li> <li>▪ WWTPs load</li> </ul>	<p><b><u>Priority input data</u></b></p> <ul style="list-style-type: none"> <li>▪ Rate septic tanks load to WWTP load <b>(CoA)</b></li> </ul> <p><b><u>Recommendable data sets</u></b></p> <ul style="list-style-type: none"> <li>▪ Volume of storm water overflow tanks <b>(CoA)</b></li> <li>▪ Volume of sed. Tanks <b>(CoA)</b></li> </ul>	<p><b><u>Priority input data</u></b></p> <ul style="list-style-type: none"> <li>▪ Tile drained areas.</li> </ul> <p><b><u>Additional input data</u></b></p>

Criterion	In more than 8 investigated countries	In 5 to 8 investigated countries	In less than 5 investigated countries
	<ul style="list-style-type: none"> <li>▪ WWTP capacity</li> <li>▪ WWTP treatment stages</li> <li>▪ Inhabitants connected to sewer system</li> <li>▪ Industrial discharges</li> </ul>		<ul style="list-style-type: none"> <li>▪ Commercial wastewater runoff (<b>CoA</b>)</li> </ul>
Existing license for data re-use	Not applicable	<p><b><u>Priority input data</u></b></p> <ul style="list-style-type: none"> <li>▪ Number of inhabitants</li> <li>▪ Connection rate to WWTP</li> <li>▪ WWTPs load</li> <li>▪ WWTP capacity</li> <li>▪ WWTP treatment stages</li> <li>▪ Inhabitants connected to sewer system</li> </ul>	<p><b><u>Priority input data</u></b></p> <ul style="list-style-type: none"> <li>▪ Water consumption</li> <li>▪ Connection rate to sewer network</li> <li>▪ Rate not connected inhabitants.</li> <li>▪ Rate septic tanks load to WWTP load.</li> <li>▪ Length storm water sewers</li> <li>▪ Length sewage sewers</li> <li>▪ Length combined sewers</li> <li>▪ Tile drained areas.</li> <li>▪ Industrial discharges</li> </ul> <p><b><u>Recommendable data sets</u></b></p> <ul style="list-style-type: none"> <li>▪ Volume of storm water overflow tanks</li> <li>▪ Volume of sed. Tanks</li> </ul> <p><b><u>Additional input data</u></b></p> <ul style="list-style-type: none"> <li>▪ Commercial wastewater runoff</li> </ul>

**Table 3: HS concentration in water and in potential pathways**

**Status of data availability, publicly accessibility and national regulations for data re-use across the DRB countries**

Data category	In more than 8 investigated countries	In 5 to 8 investigated countries	In less than 5 investigated countries
<b>Data availability</b>	<p><b><u>Priority input data</u></b></p> <ul style="list-style-type: none"> <li>▪ Conc. in groundwater</li> <li>▪ Conc. in surface water</li> </ul>	<p><b><u>Priority input data</u></b></p> <ul style="list-style-type: none"> <li>▪ Conc. in topsoil on arable land <sup>3</sup></li> <li>▪ Conc. in topsoil of grassland <sup>3</sup></li> <li>▪ Conc. in topsoil of naturally covered areas<sup>3</sup></li> <li>▪ Conc. in WWTP effluent (≥ 2000 p.e.)</li> <li>▪ Conc. in WWTP effluent (&lt; 2000 p.e.)</li> <li>▪ Conc. in untreated sewage discharges</li> <li>▪ Conc. in industrial direct dischargers</li> </ul>	<p><b><u>Priority input data</u></b></p> <ul style="list-style-type: none"> <li>▪ Area-specific rates of HS deposition or conc. in atmospheric deposition</li> <li>▪ Conc. in runoff from abandoned mining sites</li> </ul> <p><b><u>Recommendable data sets *</u></b></p> <ul style="list-style-type: none"> <li>▪ Concentration in combined sewer overflows</li> <li>▪ Conc. in storm drains runoff.</li> </ul> <p><b><u>Additional input data</u></b></p> <ul style="list-style-type: none"> <li>▪ Conc. in water from septic tanks</li> <li>▪ Conc. in commercial areas runoff</li> </ul>
<b>Existing national body for data management</b>	<p><b><u>Priority input data</u></b></p> <ul style="list-style-type: none"> <li>▪ Conc. in groundwater</li> <li>▪ Conc. in surface water</li> </ul>	<p><b><u>Priority input data</u></b></p> <ul style="list-style-type: none"> <li>▪ Conc. in topsoil on arable land <sup>3</sup></li> <li>▪ Conc. in topsoil of grassland <sup>3</sup></li> <li>▪ Conc. in topsoil of naturally covered areas<sup>3</sup></li> <li>▪ Conc. in WWTP effluent (≥ 2000 p.e.)</li> <li>▪ Conc. in WWTP effluent (&lt; 2000 p.e.)</li> <li>▪ Conc. in untreated sewage discharges</li> <li>▪ Conc. in industrial direct dischargers</li> </ul>	<p><b><u>Priority input data</u></b></p> <ul style="list-style-type: none"> <li>▪ Area-specific rates of HS deposition or conc. in atmospheric deposition</li> <li>▪ Conc. in runoff from abandoned mining sites</li> </ul> <p><b><u>Recommendable data sets *</u></b></p> <ul style="list-style-type: none"> <li>▪ Concentration in combined sewer overflows</li> <li>▪ Conc. in storm drains runoff.</li> </ul> <p><b><u>Additional input data</u></b></p> <ul style="list-style-type: none"> <li>▪ Conc. in water from septic tanks</li> <li>▪ Conc. in commercial areas runoff</li> </ul>
<b>Publicly accessibility</b>	<p><b><u>Priority input data</u></b></p> <ul style="list-style-type: none"> <li>▪ Conc. in groundwater</li> <li>▪ Conc. in surface water</li> </ul>	<p><b><u>Priority input data</u></b></p> <ul style="list-style-type: none"> <li>▪ Conc. in WWTP effluent (≥ 2000 p.e.) (CoA)</li> <li>▪ Conc. in WWTP effluent (&lt; 2000 p.e.) (CoA)</li> <li>▪ Conc. in untreated sewage discharges (CoA)</li> <li>▪ Conc. in industrial direct dischargers (CoA)</li> </ul> <p>Note: CoA means conditional assessment</p>	<p><b><u>Priority input data</u></b></p> <ul style="list-style-type: none"> <li>▪ Conc. in topsoil on arable land</li> <li>▪ Conc. in topsoil of grassland</li> <li>▪ Conc. in topsoil of naturally covered areas</li> <li>▪ Area-specific rates of HS deposition or conc. in atmospheric deposition</li> <li>▪ Conc. in runoff from abandoned mining sites</li> </ul> <p><b><u>Recommendable data sets *</u></b></p> <ul style="list-style-type: none"> <li>▪ Conc. in comb. sewer overflows</li> <li>▪ Conc. in storm drains runoff (CoA)</li> </ul> <p><b><u>Additional input data</u></b></p> <ul style="list-style-type: none"> <li>▪ Conc. in water from septic tanks</li> <li>▪ Conc. in commercial areas runoff (CoA)</li> </ul>

Data category	In more than 8 investigated countries	In 5 to 8 investigated countries	In less than 5 investigated countries
Existing license for data re-use	<p><b>Priority input data</b></p> <p>Not applicable</p>	<p><b>Priority input data</b></p> <ul style="list-style-type: none"> <li>▪ Conc. in groundwater</li> <li>▪ Conc. in surface water</li> </ul>	<p><b>Priority input data</b></p> <ul style="list-style-type: none"> <li>▪ Conc. in topsoil on arable land</li> <li>▪ Conc. in topsoil of grassland</li> <li>▪ Conc. in topsoil of naturally covered areas</li> <li>▪ Conc. in WWTP effluent (&lt; 2000 p.e.)</li> <li>▪ Conc. in WWTP effluent (&lt; 2000 p.e.)</li> <li>▪ Conc. in untreated sewage discharges</li> <li>▪ Conc. in industrial direct dischargers</li> <li>▪ Atmospheric deposition</li> <li>▪ Area-specific rates of HS deposition or conc. in atmospheric deposition</li> <li>▪ Conc. in runoff from abandoned mining sites</li> </ul> <p><b>Recommendable data sets *</b></p> <ul style="list-style-type: none"> <li>▪ Conc. in comb. sewer overflows</li> <li>▪ Conc. in storm drains runoff.</li> </ul> <p><b>Additional input data</b></p> <ul style="list-style-type: none"> <li>▪ Conc. in water from septic tanks</li> <li>▪ Conc. in commercial areas runoff</li> </ul>

*Note: There are no data sets at national level for concentration of HS in the run-off from roads at national level. Only Austria has reported about existence of some data, based on projects.*

**Table 4: Hydrometeorological and hydraulic data**

**Status of data availability, publicly accessibility and national regulations for data re-use across the DRB countries**

Data category	In more than 8 investigated countries	In 5 to 8 investigated countries	In less than 5 investigated countries
Data availability	<b><u>Priority input data</u></b> * <ul style="list-style-type: none"> <li>▪ Precipitation</li> <li>▪ Discharge at monitoring river gauges</li> </ul>	<b><u>Priority input data</u></b> <ul style="list-style-type: none"> <li>▪ Evapotranspiration</li> </ul>	<b><u>Priority input data</u></b> <ul style="list-style-type: none"> <li>▪ Discharge from WWTPs</li> </ul>
Existing national institution for data management	<b><u>Priority input data</u></b> * <ul style="list-style-type: none"> <li>▪ Precipitation</li> <li>▪ Discharge at monitoring river gauges</li> </ul>	<b><u>Priority input data</u></b> <ul style="list-style-type: none"> <li>▪ Evapotranspiration</li> </ul>	<b><u>Priority input data</u></b> <ul style="list-style-type: none"> <li>▪ Discharge from WWTPs</li> </ul>
Publicly accessibility	<b><u>Priority input data</u></b> * <ul style="list-style-type: none"> <li>▪ Precipitation</li> <li>▪ Discharge at monitoring river gauges</li> </ul>	<b><u>Priority input data</u></b> <ul style="list-style-type: none"> <li>▪ Evapotranspiration</li> <li>▪ Discharge from WWTPs (CoA)</li> </ul>	Not applicable
Existing license for data re-use	<b><u>Priority input data</u></b> * <ul style="list-style-type: none"> <li>▪ Precipitation</li> </ul>	<b><u>Priority input data</u></b> <ul style="list-style-type: none"> <li>▪ Evapotranspiration</li> <li>▪ Discharge at monitoring river gauges</li> <li>▪ Discharge from WWTPs</li> </ul>	Not applicable

*Note: There are no data sets at national level for the runoff from abandoned mines and the runoff from streets*

## 2.2 Key conclusions

### 2.2.1 Concerning DC1: Engineering water related infrastructure.

- Most priority input data, except for the tiled drained areas, are existing in many DRB countries, there are also national institutions that manage the data collection. In the general case the data are publicly available and there is no fee for data acquisition. The requirements of the Urban Wastewater Treatment Directive<sup>9</sup> concerning existence of sewer network and wastewater treatment plants in urban areas and the need for regular reporting have a significant positive effect on the availability and publicly accessibility of these data.
- Some specific parameters however like the type of the sewer network or the recommendable data sets (e.g. volume of sedimentation tanks, volume of stormwater overflows) are existing, but mostly at the data owner, i.e. they should be required by the data owners (e.g. the Sewer System operator) and it's up to the will of the owner to provide these data. In this case it is considered that the data are "conditionally accessible."
- Information concerning tile drained areas seems to be least available among the DRB countries and there should be put efforts to update the existing registers or establish registers especially in the countries with predominantly agricultural activities.
- The conditions for data use/re-use seem not to be well arranged in most of the countries. For majority of the input data sets there is either no clear licence, or the contacted partners could not provide information. In the cases where such licences exist, they are based on the Creative Commons Licenses definitions (<https://creativecommons.org/>). The predominant type of licencing is CC 0 or CC BY 4.0, followed by CC BY-SA 4.0 and CC BY-NC-ND.

### 2.2.2 Concerning DC2: Hazardous substances

- Only data for the concentration of HSs in ground water and in surface water are available in almost all the countries. There are national authorities that manage the data collection, and the information is publicly available. In most of the countries these data are without fee for acquisition, but there are also countries (e.g. Montenegro, Romania, Slovakia) that apply fees.
- Priority data sets concerning HSs in atmospheric deposition and in run-off from abandoned mining seem to be least available. Only Austria, Hungary and Slovakia report about existing data sets concerning atmospheric deposition and Hungary, and Slovakia report about existing monitoring of the quality of run-off from abandoned

---

<sup>9</sup> <https://eur-lex.europa.eu/eli/dir/2024/3019/oj/eng>

mines. It should be noted also that in some countries (e.g. Croatia) there are no mining activities, i.e. such information is not necessary for the modelling.

- The existence of the rest of the priority input data sets is varying in the different countries, resulting also in various publicly data accessibility and charging for data acquisition. Data related to concentration of HSs in urban run-offs (e.g. storm drains run-off, run-off from commercial areas) are subject to conditional access from the data owner.
- The conditions for data use/re-use seem not to be well arranged in most of the countries. For majority of the input data sets there is either no clear licence, or the contacted partners could not provide information. For instance, concerning the concentration of HSs in surface water from the 11 countries that have reported monitoring, 7 countries have reported that they apply licence, while the rest 4 have reported “no license”. The lack of clear rules for data use/re-use however impedes the efficient data utilisation for strategic planning or research purposes.

In the cases where such licences exist, they are based on the Creative Commons Licenses definitions (<https://creativecommons.org/>). The predominant type of licencing is CC BY 4.0, followed by CC BY-SA 4.0. There are countries also, which apply “tailor made” licencing.

### 2.2.3 Concerning DC3: Hydrometeorological and hydraulic data

- Data for precipitation and monitoring of water flows are available in all the countries; there are national institution concerning data management and the data are public available. Only Montenegro has reported that data concerning river flows are not publicly available. In the predominant case however, there is a fee for data acquisition.
- Monitoring of WWTP discharges is practiced also in all the countries except for Bosnia and Herzegovina - Republic Srpska. In the predominant case there is no fee, but these data are available at the WWTPs operator, and their acquisition may be subject to negotiation. Only Austria and Slovakia report that there are national/federal institutions that manage the data at national level.
- There are no data sets at national level in any of the countries concerning run-off from abandoned mines and run-off from streets.
- The conditions for use/re-use of the existing data sets seem to exist in many countries, although only for the precipitation data exist licencing in almost all the countries (i.e. in 9 countries out of 11). Many countries have also licence for the rest of the hydrometeorological and hydraulic data. The predominant type of licencing is CC BY 4.0, followed by CC BY-NC-ND.

#### 2.2.4 General conclusion

Based on the results from the Tethys survey the following general conclusions could be made:

1. Data that are subject to normative regulation, e.g. data collected within the requirements of the Water Framework Directive or within the Urban Wastewater Treatment Directive are available in all the EU countries. There are national/regional administrative bodies that manage the data collection and maintenance, the format of reporting is unified for all the EU countries. These data are also publicly available and often with no fee for data acquisition, i.e. their availability for modelling is well arranged.

The non-EU countries (Bosna & Herzegovina – Republic Srpska, Montenegro, Serbia, and Ukraine) have also data sets concerning key parameters for WWTPs, as well as well-developed or partially developed monitoring for the water quality status of surface waters. There is also existing but limited national monitoring concerning ground water in Montenegro and Serbia but no such in BA-Rep. Srpska and Ukraine. In all these countries (except for BA – Rep. Srpska) the existing data for the mentioned above parameters are publicly available and there is no fee for data acquisition. However, the data sets are typically not available in open data digital formats but in pdf format for example (within the annual reports). Such a format is not suitable for machine processing.

It is expected that the ongoing development of the EU environmental legislation will have further positive effects on enhancing the monitoring, data management and publicly accessibility.

It is worth mentioning the stricter rules of the new Urban Wastewater Directive for urban wastewater management in agglomerations (over 1000 p.e.), also concerning the quality of combined sewer overflows and discharges from WWTPs, especially regarding hazardous substances. Article 21 (3) also requires monitoring of urban wastewater for microplastics and pollutants specified in other directives (e.g. in Annexes VIII and X to Directive 2000/60/EC, Annex I to Directive 2008/105/EC, Annex I to Directive 2006/118/EC and Part B of Annex II to Directive 2006/118/EC, Annex to Decision 2455/2001/EC, Annex II to Regulation (EC) No 166/2006, Annexes I and II to Directive 86/278/EEC; parameters listed in Part B of Annex III to Directive (EU) 2020/2184 and parameters listed in Annex I to Directive 2006/7/EC). No doubt this enhanced monitoring of various substances will augment the data bases necessary and will support the emission inventory and modelling.

In November 2025, EU Directive 2025/2360<sup>10</sup> on soil monitoring and resilience entered into force, aiming at achieving healthy and resilient soils by 2050. Soil contamination, in terms of heavy metals and selected organic compounds are part of the monitoring requirements. The first reporting deadline on the Directive implementation and soil health assessment is by December 2031.

---

<sup>10</sup> <https://eur-lex.europa.eu/eli/dir/2025/2360/oj/eng>

2. Data which are not subject to EU regulation (e.g. volume of sedimentation tanks, length of combined or storm water sewers, water consumption, etc.), although existing are often scattered among different data owners, the data format varies from owner to owner, sometimes not favouring digital processing. In general, the data are not publicly available and their acquisition and rights for data sharing and re-use is subject to negotiation with the data owners.

Although the information subject to UWWTD regulation compensates to greater extent the necessity of other information concerning sewer system, the latter is of special importance for areas where small agglomerations (i.e. less than 2000 p.e.) are predominant. The lack of data managing body at national level complicates the data acquisition and sharing. There are however good examples in Austria, Croatia, Montenegro, and Slovakia where there is a national body that manages the data collection.

3. The information concerning non-point sources needs to be enhanced in all the DRB countries. There seems not to exist sustainable monitoring, respectively data sets at national level for e.g. the concentration of hazardous substances from the run-off from roads (also in terms of quantity). Few are countries (Austria, Hungary, Slovakia) that have data sets concerning tile drained areas or atmospheric deposition.
- Licensing for data sharing and re-use is also a critical issue that needs to be substantially improved. For many data there are no clear rules, although there are good examples of using the standard licences of the Creative commons (<https://creativecommons.org/>) - CC 0, CC BY 4.0, CC BY-SA 4.0 and CC BY-NC-ND.

### 3 Goals, objectives, and expected results of the roadmap

Based on the Tethys survey, the several goals and objectives are defined which shall be fulfilled for improving the data management, the cross institutional data exchange, and data management.

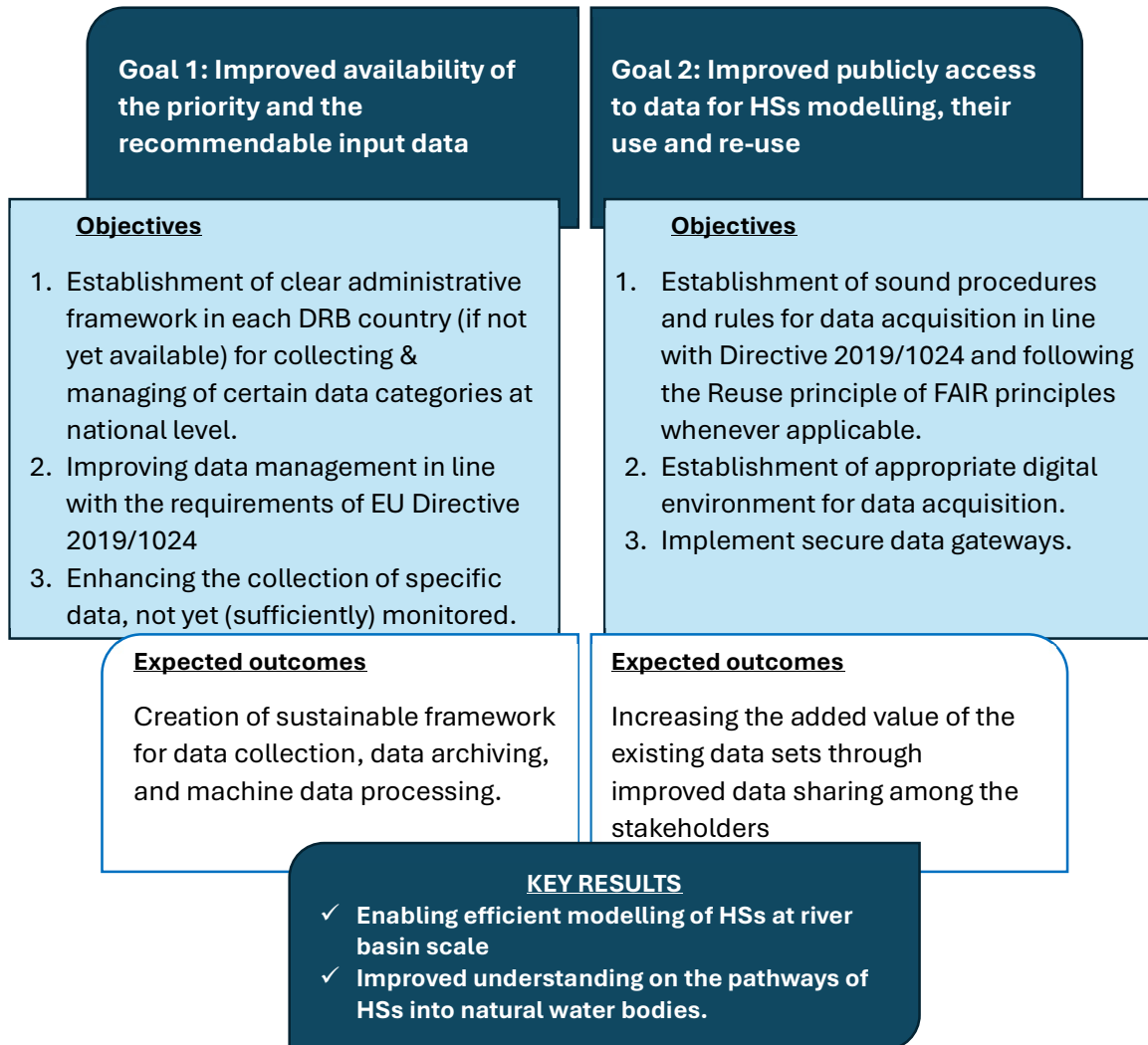


Figure 5: Goals and objectives for enhanced data availability and sharing for the purposes of HSs modelling

## 4 Proposed actions

The tables below provide recommendations for the proposed key actions to be taken at national and Danube Basin level to improve the availability and accessibility of data for modelling purposes. A prioritization of actions in terms of timescales is also suggested, i.e. short-term actions – up to 3 years implementation, midterm actions – up to 5 years and long-term actions – up to 7 years implementation.

### 4.1 Goal 1: Improved availability of the priority and the recommendable input data for modelling of hazardous substances emissions

#### Objective 1. Establishment of clear administrative framework in each DRB country for collecting & managing of certain data categories at national level<sup>11</sup>

##### Short term actions

- ❖ Review at national level of the administrative units engaged in priority input data collecting and management (see Fig.2).
- ❖ Establish a national/regional unit to manage the monitoring/collection of certain recommended or additional input data (see Fig. 2) that are not yet collected at national level.

##### Midterm actions

- ❖ Establishment of a specialized unit (e.g. in the River Basin Directorates) to manage the process of interinstitutional data exchange.
- ❖ Optimisation of the exchange of information among the different administrative bodies at national level, e.g.:
  - ✓ rules for interinstitutional exchange of data.
  - ✓ level of aggregation of the data exchange.
  - ✓ appropriate digital environment for informational exchange.

#### Objective 2: Improving data management in line with the requirements of EU Directive 2019/1024 on open data and the re-use of public sector information

##### Short term actions

- ❖ Review of the content and template of the existing national data sets and revising it, if necessary, allowing machine searching and data processing.
- ❖ Review of the existing metadata considering the FAIR principles (*Findability, Accessibility, and Interoperability*) and undertaking measures for enhancing the content of metadata and/or establishment of metadata (if not yet existing).

---

<sup>11</sup> Based on the data requirements of pathway-oriented emission modelling, using MoRE as the reference implementation

### Midterm actions

- ❖ Exchange of information with ICPDR on the available national data/metadata and discussion on the possibilities for development of a unified content of certain databases.
- ❖ Establishment of digital environment (e.g. cloud) with public access to the existing metadata of all the DRB countries.

## **Objective 3: Enhancing the collection of specific data not yet (sufficiently) monitored**

### Short term actions

- ❖ Review at national level of the status of monitoring for e.g.:
  - Tile drained areas.
  - Volume of storm water overflow tanks
  - Concentration of HSs in WWTP effluents, untreated sewage discharges, combined sewer overflows and in storm drains run-off.
  - Concentration of HSs in commercial wastewater run-off
  - Concentration of HSs in industrial direct discharges
  - Concentration of HSs in diverse types of topsoil
  - Area-specific rates of HS deposition or conc. in atmospheric deposition
- ❖ Assessing the bottlenecks for monitoring at national scale and at DRB scale.

### Midterm actions

- ❖ Developing a national/international program for enhancing the monitoring.
- ❖ Establishment of procedures in line with Objective 2 for appropriate data management.

### Longterm actions

- ❖ Execution of the monitoring program at national/international level
- ❖ Regular update of the monitoring program based on the current results and the relevant EU policy.

## 4.2 Goal 2: Improved public access to data for HSs modelling, their use and re-use.

### Objective 1. Establishment of sound procedures for data acquisition and data use/re-use in line with Directive (EU) 2019/1024 and following the Reuse principle of FAIR principles whenever applicable

#### Short term actions

- ❖ For each existing set of data should be established
  - The level of data aggregation that is publicly available (e.g., monthly, annual values).
  - The format of data set to be published. The format should allow machine processing.
  - The procedures for data acquisition (e.g. upon request or free access).
  - The fee for data acquisition - if applicable and following the requirements of Directive 2019/1024.
  - The type of license for data use and/or reuse – it is recommendable to use standard licences.

### Objective 2. Establishment of appropriate digital environment for data acquisition

#### Midterm actions

- ❖ Establishment of user-friendly formats for data visualisation (e.g. using GIS) and data downloads.
- ❖ Possibilities for communicating the data with the existing ICPDR systems (TNMN and Danube GIS)

### Objective 3. Implement secure data gateways

#### Midterm term actions

- ❖ Build a centralized/federal Application Programming Interfaces (API) -driven network that allows update of the metadata, data sets and registers the external users' downloads.
- ❖ Applying the NIS2 Directive (Directive (EU) 2022/2555<sup>12</sup> principles on measures for a high common level of cybersecurity across the Union

---

<sup>12</sup> <https://eur-lex.europa.eu/eli/dir/2022/2555/oj/eng>