SWIM

Sustainable **W**ater and **I**ntegrated **M**anagement of Fish Migration and their Habitats in the Danube River Basin and NW Black Sea

D3.1 Requirements for infrastructure

Deliverable nº D3.1

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Glossary and Abbreviations	
API	Application Programming Interface
CZU	Czech University of Life Sciences
CINEA	European Climate Infrastructure and Environment Executive Agency
DX.Y	Deliverable X.Y
DRB	Danube River Basin
EC	European Commission
FTP	File Transfer Protocol
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
MXX	Month XX since the project start
NGO	Non-government organisation
REST API	Representational State Transfer API
RS	Representative Site
TGM WRI	T. G. Masaryk Water Research Institute p. r. i.
TX.Y	Task X.Y
UI	User Interface
UX	User Experience
VR	Virtual Reality

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EXECUTIVE SUMMARY

This *Requirements for infrastructure* report is a formal output of WP3 – T3.1, of the SWIM - *Sustainable Water and Integrated Management of Fish Migration and their Habitats in the Danube River Basin and the North-Western Black Sea project*, financed by the Horizon Europe Programme of the European Commission (Grant Agreement n° **101215230**).

The document is a product of collaborative efforts under the TGM WRI leadership and with close cooperation with CZU and other partners operating SWIM Pilot sites during the first year of the project. It outlines the processes of obtaining and definition of SWIM Platform requirements direction from Pilots. It then defines the functional, non-functional, operational and data requirements that will inform the platform architecture in D3.2 and the detailed data exchange mechanisms, formats and curation procedures in D3.3, together with the principal user roles.

Deliverable D3.1 defines the infrastructure requirements that will guide the design and architecture of the SWIM Platform. Its purpose is not to prescribe a specific software stack, but to translate the needs of pilot sites, project tasks and future end-users into a coherent set of capabilities and constraints. The requirements therefore describe the expected properties of the platform, the categories of data it must accommodate, the ways in which users and external systems are expected to interact with it, and the operational qualities required for a reliable public project service.

The T3.1 identifies three core dimensions of Pilot requirements: data collection, data processing and data display. It also requires the identification and validation of future end-users, their needs and access levels. In addition, the broader objectives of WP3 require a platform architecture that supports interoperability, modelling and integration of data, performance optimisation for short system response times, and future uptake and management after the end of the project. These requirements form the normative basis of the present document.

D3.1 intentionally remains technology-neutral and should be read as the requirements layer of the platform design. Detailed storage and collection mechanisms, API usage and data curation are explicitly assigned to D3.3. Therefore, this deliverable defines, for example, that the platform shall provide authenticated machine-to-machine data ingestion and documented data-access interfaces, but it does not fix endpoint names, protocol profiles, database schemas or specific framework implementations. Likewise, the deliverable defines the need to visualise spatial and time-series data and to integrate hydrological model outputs, but the exact software components used to implement these functions are left to the technical design and implementation stages.

1. INTRODUCTION

1.1. About the SWIM project

SWIM – Sustainable Water and Integrated Management of Fish Migration and their Habitats in the Danube River Basin and Northwestern Black Sea – is a Horizon Europe Innovation Action under the EU Mission Ocean "Restore our Oceans and Waters". It aims on restoration protection and enhancement of habitats of migratory fish species across the Danube River Basin and the NW Black Sea by deploying innovative, sustainable and scalable solution at the SWIM Pilot sites. Through its interlinked activities, SWIM seeks to improve habitat connectivity and restoration, strengthen wild populations of migratory fish and increase the overall state and resilience of freshwater ecosystems. The SWIM Alliance as a key component of the project facilitates structured cooperation among public authorities, research organizations, NGOs, the private sector and local communities to ensure long-term impact.

1.2. Objectives of D3.1

Under WP3 SWIM will develop an integrated digital platform (*SWIM Platform* or simply *Platform*) for processing, integrating and presenting hydrological, ecological and related project data. D3.1 translates the needs of Pilot sites, project tasks and future end-users into platform requirements without prescribing the final technical implementation. The objectives of D3.1 are to:

1. Identify and consolidate Pilot requirements for data collection, processing and display.
2. Define the functional, non-functional, operational and data requirements that will guide the platform design.
3. Identify the main end-user roles, their assumed information needs and appropriate access levels.
4. Define requirements for interoperability, model and data integration, performance and post-project maintainability.
5. Provide a clear requirements baseline for the subsequent technical specifications in D3.2 and D3.3.

1.3. Targets of D3.1

The D3.1 primarily targets the partners CZU and TGM WRI responsible for designing, implementing and operating the SWIM Platform and further the Pilot representatives

and stakeholders who will provide data and use its services. It also provides a partial reference for platform-relevant data and outputs, future end-users identified through stakeholder activities, and for partners responsible for data stewardship and long-term operation. Its immediate target is a shared requirements baseline that can be translated into architecture in D3.2 and into concrete data collection, exchange and curation mechanisms in D3.3

1.4. Methodology

The SWIM Pilots represent a broad range of environments, approaches, monitoring systems and equipment, much of which is to be developed, selected or procured during the project. Work under T3.1 sought to homogenize, standardize and catalogue this information as an initial step towards operable SWIM Platform. The document therefore remains technology-neutral, leaving room for the detailed specifications in D3.2 and D3.3.

Individual requirements were collected from information supplied during SWIM Consortium and WP4 meetings and online talks with Pilot representatives scheduled since M9 and undertaken in M10 and M11, held by CZU and TGM WRI. The D3.1 also draws on efforts in WP6 – *Stakeholder engagement, associated regions and results multiplication*, that produced comprehensive list of stakeholders, WP1 – namely D1.1 – *Data management and coordination handbook,* and WP7 - D7.1 – *Communication plan*.

2. REQUIREMENTS

In this document, a requirement is a capability, constraint or operational quality that the SWIM Platform is expected to satisfy. Requirements are grouped into four categories: non-functional, functional, operational and life cycle, and data requirements.

Within Section 2, shall denotes a mandatory baseline requirement, should denotes a preferred requirement that may be departed from with justification, and may denotes an optional capability. Will, is expected to and similar formulations are used only in explanatory text and do not assign a requirement level.

2.1. Non-functional requirements

Non-functional requirements define the usability, accessibility and other perceptive quality attributes of the SWIM Platform, that are not expressed as individual functions.

2.1.1. Visual identity

SWIM project has a unified visual identity developed within the Task 7.1 and described in the section 3.2 of the D7.1. The identity consists of Arial Rounded MT font family, SWIM project logo, palette including Main, Shades and Tints variants and presentation and document templates. The Platform shall apply this identity where the necessary assets can be licensed. Because the selected font family is tied to the Microsoft cloud ecosystem, it may be replaced by a visually similar licensed font. The Platform should also apply the visual identity to derived materials, such as downloadable plot layouts.

2.1.2. Training/Manuals

The Platform shall provide a methodological reference and user guidance online and as a downloadable PDF. The methodological reference shall describe the data collected at individual Pilot sites (see Section 2.4), the expected update frequency, where the data can be found, and which processing or visualisation tools are available.

2.1.3. Updating and life cycle management

Requirements for operation and maintenance beyond the initial development phase are specified in Section 2.3. SWIM Platform is expected to remain useful beyond the initial development phase, and WP3 explicitly aims to prepare for future uptake and management after the project. Operational requirements must therefore be considered from the beginning rather than added only at the end of implementation. The infrastructure should support routine maintenance, controlled upgrades, data recovery, monitoring and clear ownership of critical services.

2.1.4. Identity management

Task T3.1 requires the identification and validation of future end-users, their needs and access levels. The SWIM Platform is expected to serve heterogeneous audiences, including members of the public, researchers, water managers, project partners, Pilot operators and technical administrators. These users differ not only in the level of scientific detail they require, but also in whether they are permitted to contribute, modify, publish or administer data. The Platform shall therefore implement role-based access control with permissions that can be refined without redesigning the application. Roles shall be assigned independently according to responsibility and scope; a user may hold more than one role, but no role shall automatically inherit the permissions of another.

1. *Public users* require a low-barrier interface with clear explanations, intuitive navigation and visually accessible results. No registration is required in order to access all public parts of the platform including the ability to view, analyse, compare and partially export selected data.

2. *Registred users*, such as experts and stakeholders require additional detail such as full metadata, measurement units, downloadable time series, extended filters and statistics, and the ability to compare data sources or scenarios or retain selected analytical outputs. Registration shall not by itself grant permission to contribute, curate or publish data.

3. *Data providers* require clear templates, standards, validation feedback and predictable submission procedures. The role shall be assigned to authenticated users or machine clients and shall permit submission and management of data only within an explicitly assigned Pilot or dataset scope. Some pilot sites will contribute data manually and only periodically; hence the interaction should not assume frequent use or technical expertise.

4. *Data curators* require the ability to review submissions, change publication status, manage controlled vocabularies, resolve metadata issues. Responsibility for approving a dataset for public release should be explicitly assigned in the governance model developed alongside the platform.

5. *Platform administrators* shall perform operational and maintenance services. This tier shall only be restricted to designated TGM WRI and CZU personnel and shall not automatically grant scientific data editing or publication rights.

The roles are summarised in Table 1. They are not hierarchical and may be combined only through explicit assignment. For example, a registered user may also be a data provider or data curator within a defined scope, while a platform administrator need not hold either role.

Authentication, *authorisation* and *data visibility* shall be treated as separate concepts. Authentication establishes who the user is. Authorisation defines which operations the user can perform. Data visibility defines which datasets or dataset states the user is permitted to see. This distinction is required because a SWIM partner may be authorised to upload data while some of those data remain internal until validation, and because administrative privileges should not automatically imply unrestricted scientific editing rights.

TABLE 1 - DEFINED PLATFORM USER TIERS AND THEIR ROLE AND ACCESS LEVEL

User group	Primary needs	Access level
Public user	View project outputs, explore maps and indicators, display public time series, read metadata and download public products.	Unauthenticarted read-only access to published content and public data.

Registered expert/stakeholder	Perform more detailed exploration, use extended filters, save or request selected analytical outputs where relevant.	Authenticated access to approved extrended and published content and functions.
Data provider	Upload datasets and metadata and retain status.	Authenticated write access to assigned datasets/Pilot scope.
Data curator	Review submitted data, resolve validation issues, harmonise metadata, approve publication and manage dataset versions.	Elevated data-management rights across assigned domains.
Platform administrator	Manage accounts and roles, services, configuration, monitoring, logs and audit trail level access.	Administrative access (without scientific data editing or publication rights).

2.1.5.Stakeholders

T3.1 requires the identification and validation of future end-users, their needs and access levels. This has been done through the T6.2 *Stakeholder identification tool*. It contains roughly 300 stakeholder records spanning local, regional, national and transnational actors. The classification is dominated by entries labelled Institution (~40%) and NGO (~21%), followed by Company (~9%), Local Authority (~7%), Network (~7%) and Regional Authority (~4%), with the remaining records distributed among national and federal authorities, research bodies, civil-society groups, universities and individuals.

For platform design, the most important consideration is the function that an organisation or individual is likely to perform. For example, ministries, river-basin authorities, universities, protected-area administrations and museums may have very different information needs. The stakeholder list has therefore been reorganised into platform-relevant groups and mapped to the roles defined in Section 2.1.4 (Annex 1).

A public or community user may primarily need a map, a short explanation and a small number of interpretable indicators. Water managers and environmental authorities need the same information with spatial and temporal filters, metadata, scenario comparison and downloadable evidence. Researchers require the most detailed data, methods, automated access. Data providers and platform operators additionally need contribution, validation, publication and administration functions. The stakeholder screening also supports a strong

demand for multilingual design. Many stakeholders are local or regional actors whose interest is likely to be limited to a specific reach, municipality, protected area or pilot site, while international organisations and networks need comparable information across borders.

2.2. Functional requirements

2.2.1. Hydrological and hydraulic models

The selected basin-scale hydrological model, mesoscale hydrologic model (mHM), is a core hydrological and analytical component of SWIM. The platform shall therefore be able to catalogue, store or reference, process and visualise model inputs and outputs together with necessary forcing datasets. Model results shall not be treated as isolated downloadable files; rather they shall be exposed through the spatio-temporal concepts like statistics, time series, graphs and maps so that users can compare modelled and measured conditions and explore scenario results.

- The platform shall register model runs with information on model version, parameterisation or configuration, input datasets, simulation period and scenario.
- Model outputs shall be viewable as maps, time series or summary indicators according to their dimensionality.
- The platform shall support comparison between observed data and model outputs where appropriate as well as multi-model or climate scenario comparison.
- Climate-change and other scenarios shall be distinguishable from baseline or historical runs and shall retain clear scenario metadata.
- The exposition through the platform shall not block the interactive web interface; If possible, requests and results should be handled as managed jobs with status information.

The exact scope of remote model execution will depend on the later architecture and on the computational environment available and defined in the following D3.2. D3.1 therefore outlines support for model integration and result handling, while leaving the implementation of job orchestration, computational backends and high-performance computing interfaces to later technical specifications.

2.2.2. Derived indicators and calculations

The platform shall support selected derived indicators that can be calculated from available observations or model outputs. Pilot discussions identified a new water-quality index as an example and additional indicators may include threshold exceedance, low-flow or drought metrics, flood-related indicators, habitat-related summaries and combinations of environmental variables. Such calculations should be reproducible, documented and clearly separated from the original measurements.

Each derived indicator shall have a documented definition, required input variables, units and method available in the user documentation. The user interface will allow interactive selection of input data or, if applicable, sample data and parameters for lightweight calculations when this can be performed within an acceptable response time. More computationally demanding processing is not expected, but if occur it shall be executed outside the immediate browser interaction and returned as a managed result, for example through a result URL.

2.2.3. Basic platform components

The design and architecture of SWIM Platform will be fully described in D3.2 – *Infrastructure design document* as well as the data format will be the core of D3.3 – *Data collection requirements and collection mechanisms*. However, several components and basic functionality requirements were delineated during T3.1. They are summarised in Table 2 and remain subject to refinement in the subsequent deliverables.

TABLE 2 – REQUIRED PLATFORM COMPONENTS

Platform Component	Functionality
Map window	Dynamic map window with annotations, layer/feature selection interlinked with tabular and plotting and computational components. It shall support interoperable spatial-data access and reuse; specific service interfaces will be determined in D3.2 and D3.3.
Tabular component	The Platform shall provide tabular views with selection and filtering mechanisms.
Graphical (plotting) component	Plotting component is required at least in the form of backend mechanism for uploaded data.
Computational component	Some features applicable outside the SWIM project spatial scope, like autoregressive temperature modelling or water quality index computation described in Section 2.2.2 shall be exposed to the Platform users via calculation tools, given they produce custom data in predefined structure.
Data management component	The Platform shall provide functions for data providers and data curators to check data validity and consistency and manage the submission workflow.
Identity management component	The Platform shall provide or integrate mechanisms for registration, authentication and role management consistent with Section 2.1.4.

2.2.4. Virtual reality

Stakeholders will be involved in a knowledge and technology transfer participatory process using virtual reality (VR) and foresight scenarios. To better integrate stakeholders' knowledge into the SWIM Platform, the SWIM Alliance (WP6) will use VR technology as transfer method to provide realistic and tangible simulations that enhance understanding of current state and potential future scenarios, after the implementation of pilots. The SWIM Platform shall support VR component at least through a hyperlink.

2.3. Operational and life cycle requirements

SWIM platform is expected to remain functional and useful beyond the development phase (after the WP3 end in M48). Operational requirements shall therefore be considered from the beginning.

The infrastructure must support maintenance and controlled upgrade plan, data recovery with backup plan, monitoring and clear ownership of services among involved partners. Operational responsibility is expected to be shared primarily by CZU and TGM WRI, while Pilot representatives may retain responsibility for their data. The requirements are summarised in Table 3.

TABLE 3 – SPECIFIED OPERATIONAL AND LIFE CYCLE REQUIREMENTS

Requirement	Solution
Monitoring	Containers and services shall run under supervision. Errors like storage problems, failed ingestion jobs and unavailable services shall be visible to administrators
Logs	All critical processes shall be logged. Third-party components shall provide adequate logging, and developed components shall implement logging for data input/output and other critical operations.
Deployment, regular and irregular updates	Update and upgrade procedures shall minimise disruption to access and shall provide a rollback or recovery path.
Documentation	The Platform shall maintain technical and user documentation. The technical documentation will be private and shall define ownership, responsibilities, data stewardship.
Regular backup	A full-system backup shall be performed at least monthly. Detailed retention and recovery procedures shall be defined during implementation.
Software	Platform administrators shall regularly review software compatibility and available updates.

2.4. Data requirements

2.4.1. Pilot data and context

The Pilot material demonstrates a high level of heterogeneity in both the origin and structure. Some SWIM Pilots rely primarily on public monitoring datasets and monitoring field surveys, while others generate new measurements through sensors, laboratory analyses, telemetry, bathymetric surveys, modelling or habitat mapping.

Several datasets will require manual processing before they can be submitted to the Platform, for example field notes and Excel spreadsheets, whereas other data sources may be suitable for periodic automated transfer. This heterogeneity is a central infrastructure requirement: the platform must support a common project data environment without assuming that all partners have identical monitoring systems or the capacity to develop automated interfaces.

The Pilot screening also indicates that temporal resolution varies substantially. Surveys and measurement may consist of individual campaigns before and after restoration measures or may be repeated only every few years. Mobile telemetry may be conducted several times per year, while fixed receivers generate continuous observations that are downloaded periodically. Water-quality sampling may occur few times per year, whereas automatic stations produce daily or more frequent measurements. Historical public datasets may contain hourly to annual records. The infrastructure must therefore preserve the native temporal resolution of source data while enabling consistent filtering, aggregation and comparison in the presentation layer.

Fish-related information is expected to range from relatively simple species occurrence records to telemetry-based movement data. The infrastructure shall support the relationship between biological observations and environmental context. A tagged-fish position, for example, is meaningful only when linked to time, location, species or individual identifier, telemetry method and potentially concurrent hydrological or water-quality conditions. Similarly, a fish survey should retain information on sampling method, survey reach, effort and date so that comparisons between campaigns remain scientifically interpretable.

The Platform shall also support habitat descriptors relevant to migratory species, including depth, flow, substrate composition, connectivity, temperature and oxygen conditions. Some pilot sites emphasise the effect of low water levels, sedimentation and side-channel connectivity, while the sterlet pilot highlights deep fast-flowing reaches with gravel substrate and temperature-sensitive behaviour. These examples imply that the platform shall allow biological, hydrological, water-quality and spatial datasets to be combined during analysis without requiring all information to originate from the same source.

2.4.2. Data format and shape

D3.1 does not prescribe final file formats or schemas because these are part of D3.3 and some data sources remain subject to ongoing procurement. At the requirement level, however, the Platform shall accommodate the principal data shapes identified by the Pilots: tabular and time-series observations, point, line and polygon spatial data, raster or gridded data, model inputs and outputs and supporting metadata or documents. Data structures shall retain the information needed for scientific interpretation, including units, timestamps, spatial reference, provenance, quality or status information, and identifiers linking related observations.

Where practical, exchange should use open or widely supported machine-readable formats and documented structures. The Platform shall support both manual file-based submission and authenticated machine-to-machine transfer. Exact accepted formats, validation rules, metadata templates, API definitions and curation workflows will be specified in D3.3.

For data intended for external reuse, D3.3 shall define suitable metadata, licensing, persistent-identification and interoperability provisions, taking account of relevant domain and geospatial standards and any justified access restrictions. This high-level requirement does not prescribe a particular service protocol in D3.1.

3. CONCLUSION

D3.1 consolidates requirements derived from discussions with SWIM Pilot representatives, relevant project tasks and the initial stakeholder screening into a common baseline for the SWIM Platform. It captures requirements expressed by Pilot representatives and other project partners while recognising that several data sources and workflows are still being specified.

The Platform's maintenance requirements are listed within the timeframe of its lifetime including references to visual design and data management, described in Deliverables D1.1 and D1.2. The report builds upon compiled individual interviews with SWIM participants, SWIM pilot leaders in particular.

The document deliberately remains technology neutral. It defines required capabilities and operational constraints rather than final software components, protocols or database schemas. It also remains consistent with related project provisions, including the visual identity described in D7.1 and data-management principles addressed in D1.1. Detailed architecture and infrastructure choices are reserved for D3.2, while D3.3 will specify collection and storage mechanisms, API usage, formats, schemas and data curation.

A limitation of D3.1 is that several Pilot datasets, monitoring systems and workflows are still being specified or procured. In addition, the stakeholder register provides a strong basis for identifying user categories, but detailed needs and access preferences assigned to those categories remain assumptions until they are validated through subsequent engagement, prototyping and testing. This is consistent with the intended role of D3.1 as a stable requirements document rather than a final implementation specification. For each pilot site, the next consolidation step should capture a minimum dataset profile: responsible provider, expected variables, temporal frequency, spatial representation, source format, approximate size, planned transfer mechanism, metadata availability, access/publication status and expected update period. The same exercise should be performed for mHM forcing and outputs and for the data produced within Tasks T2.2 and T2.4. It is expected that these profiles will manifest the high-level requirements in D3.1 into architecture schemas, data exchange templates and interfaces without changing the overall Platform delineation.

ANNEXES

Annex 1: Stakeholder groups and corresponding platform roles.

Nature-conservation authorities, protected-area managers	Nature-conservation agencies, county nature-protection institutions, biosphere/natural-park administrations and environmental agencies.	Habitat and migration-route maps; ecological status and pressure indicators; hydrology/water-quality overlays; species-sensitive layers and thresholds; metadata and provenance; controls for sensitive species/location information.	Registered expert; selected organisations may contribute or curate data.
Universities and scientific institutes	Universities, faculties, hydrological/biological institutes, museums, academies and research centres.	Detailed observations and harmonised datasets; complete metadata and methods; data download and readable API; model runs and calibration/validation performance; QA flags, citation and reproducibility.	Public or registered expert; some may contribute data.
Fisheries	Sports-fishing associations, angling associations, fisheries bodies, hunting associations and fishers.	Maps and summaries of fish, habitat and water conditions; migration barriers and connectivity information; seasonal low-flow and temperature/oxygen information; accessible explanations; downloadable summaries; possible structured contribution of local observations.	Public or registered stakeholder; write access only when formally contributing data.
Environmental NGOs and civil-society organisations	Ecological organisations and societies, river networks, conservation groups and local associations.	Communication-ready maps and charts; trends in habitat quality, fish migration, pressures and climate impacts; transparent	Public or registered stakeholder; some may contribute data.

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		evidence and source metadata; multilingual explanations; export functions and downloads.	
Municipalities, counties and local administration	Cities, municipalities, county administrations, district offices and planning bodies.	Dashboard and map-based communication; local territory scope; concise status and trend indicators; restoration/flood/drought relevance; scenario summaries and downloadable outputs.	Public or registered expert; some may contribute data.
Commercial, infrastructure and water-dependent operators	Fisheries companies, port/landing operators, tourism businesses, water-management companies and other operational actors.	Operationally relevant hydrology, water quality and habitat constraints; spatial planning context; clear conditions and trends; access to authoritative datasets and indicators; machine exchange where monitoring or operational systems are connected.	Public or registered expert; some may contribute data.
Cross-border networks, international organisations and related projects	Networks like ICPDR; European and international water and river networks, Mission projects and sister initiatives.	Cross-pilot and cross-border comparability; indicators and harmonized vocabularies; metadata exploration; downloads and APIs; reuse and citation information.	Public or registered expert; machine-readable reuse is important.
SWIM project partners, pilot data providers and platform operators	SWIM Partners	Authenticated upload and API ingestion; templates; validation feedback; staging/QA status; metadata editing; versioning; publication workflow; job status; logs, monitoring, user/role administration and technical documentation.	Data provider, curator or platform administrator depending on responsibility and involvement.