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Grant Proposal

AQUANAVI: Navigating Grand Challenges and their Mitigation using Aquatic Experimental RIs

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Abstract

Water is vital for life on Earth, but aquatic environments worldwide are facing critical challenges that cause severe problems for biodiversity and human well-being. These challenges include, for example, water pollution, habitat degradation, escalating water and air temperatures, salinisation of freshwaters, ocean acidification and invasive species. Since these stressors interact in complex ways, developing predictions and mitigation measures is difficult. Mesocosm experiments, offering controlled, yet realistic settings, are crucial for understanding and mitigating the impact of various stressors and their combinations on aquatic ecosystems. Mesocom facilities are key Research Infrastructures (RI), as they bridge the gap between laboratory experiments and natural systems allowing studies of highly complex environments comparable to natural ecosystems, while still offering controlled and replicated settings not available in natural systems.

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The AQUACOSM-RI consortium, comprising over 60 individual state-of-the-art mesocosm facilities at 28 host institutions across Europe, has therefore been instrumental in advancing aquatic environmental research across climate zones including marine, brackish and freshwater ecosystems. In addition, the EU H2020-INFRAIA projects AQUACOSM (CORDIS No. 731065) and AQUACOSM-plus (CORDIS No. 871081, www.aquacosm.eu) have developed a virtual network beyond Europe of presently > 85 host institutions with > 120 aquatic mesocosm facilities around the world, www.mesocosm.org. However, the rich, yet disconnected resources in aquatic mesocosm-based experimental research and mitigation approaches need to be combined in a modern, visible and accessible way.

The project AQUANAVI (Navigating Grand Challenges and their Mitigation using Aquatic Experimental RIs) aims to enhance existing efforts by creating an interactive atlas of aquatic mesocosm facilities and related mesocosm-based experimental research. Integrating data, publications, reports and information on mesocosm facility capacities generated by the AQUACOSM consortium and other mesocosm facilities in Europe and beyond, AQUANAVI will facilitate fast discovery of resources and unused potentials of available mesocosm facilities in a modern, visible and accessible way that is presently not available. Such a multidimensional tool is expected to enable novel collaborations and a much faster setup and execution of connected and/or distributed experiments and efficient development of environmental mitigation strategies. Built upon the AQUACOSM-RIs and their encompassing data and information repository as well as scientific and technical competence, while also leveraging related infrastructures like AnaEE, EMBRC, JERICO-RI and eLTER, AQUANAVI will provide a comprehensive resource platform to more effectively explore available resources for aquatic experimental research.

AQUANAVI will bridge this wealth of scientific data, expertise and mesocosm facility information through Hi Knowledge, an innovative analysis and visualisation platform that merges Wikidata, Open Knowledge Maps,and Scholia. Hi Knowledge harnesses the semantic capabilities of Wikidata to rapidly construct a FAIR and open corpus for a domain, based on a sophisticated conceptual classification system. Subsequently, Hi Knowledge incorporates visualisation components from Open Knowledge Maps and Scholia, allowing researchers to smoothly navigate information using cutting-edge visualisation techniques, artificial intelligence and knowledge synthesis methods.

Open and collaborative by design, AQUANAVI's architecture will engage a broad range of research communities. By consolidating data and information from diverse RIs, the platform will leverage and enhance the AQUACOSM and related research infrastructures, securing the reusability and interoperability of existing data collections and better exploration of existing RIs in the future. Compliant with FAIR principles and EOSC requirements, AQUANAVI will ensure the long-term sustainability and openness of its resources, enriching both the ENVRI services portfolio and the broader scientific community. In summary, AQUANAVI will empower researchers and stakeholders to implement measures to mitigate the effects of climate change and other Grand Challenges facing aquatic environments, serving as a key resource within and beyond the European research area.

Keywords

aquatic mesocosm facilities, research infrastructures, metadata integration, data discoverability, data visualisation

Contextualisation

This proposal was submitted on 14 May 2024 in response to the 1st Open Call for Open Science Projects and Services by the OSCARS project (O.S.C.A.R.S. - Open Science Clusters' Action for Research and Society, CORDIs No. 101129751). It builds on the earlier EU H2020-INFRAIA projects AQUACOSM (CORDIS No. 731065) and AQUACOSM-plus (CORDIS No. 871081) as well as on the mesocosm.org community and the Hi Knowledge project (Jeschke et al. 2021). Some financial details have been omitted. The applicants were notified of the approval of the proposal on 5 August 2024.

The project's duration is from 1 December 2024 until 31 May 2026. Additional information on the AQUANAVI project is available through its homepage on the website of the OSCARS project.

Project Description

Water is a fundamental resource for humans and other lifeforms on Earth. In an era of unprecedented environmental change, aquatic environments face a multitude of challenges such as escalating temperatures, extreme weather events, eutrophication, emerging contaminants, light pollution, habitat degradation, ocean acidification, freshwater salinisation, deep-water deoxygenation, invasive species and more — expressions of the impact of human activity upon aquatic ecosystems (Fig. 1). The cumulative effects of these various drivers and stressors and their complex interactions and variability are causing a concerning decline in biodiversity and ecosystem functions and services, underscoring the vast scale and complexity of the Grand Challenges we are facing in the Anthropocene (Fig. 1).

Ecosystem-scale mesocosm experiments are an invaluable tool in disentangling the many convoluted effects of these drivers and stressors on natural highly complex ecosystems across the globe (www.geomar.de/en/discover/ocean-for-climate-protection/carbon-uptake-in-the-ocean/ocean-alkalinity-enhancement) .Fig. 2). This level of analysis is unattainable in laboratory experiments due to their oversimplification and it cannot be derived from field studies because they lack replicated treatments. Moreover, mesocosm experiments, which closely mimic natural ecosystems, often show varying responses to similar stressors depending on factors like ecosystem type, climate zone, trophic state and exposure to anthropogenic impacts. Therefore, mesocosm-based research holds a unique status: it offers the controllability of laboratory studies, while providing the realism of field studies by including multiple trophic levels and communities in near-natural conditions (Fig. 2). They are critical not just for predicting future changes, but also for

testing future scenarios and developing mitigation measures vital to addressing Grand Challenges of aquatic environments in the Athropocene (Figs 1, 2). For example, mesocosm-based research has assisted in elucidating effects of ocean acidification on marine ecosystems and, as a result, large-scale mesocosm experiments are now underway to test different active mitigation measures, including ocean alkalinisation (see, for example,

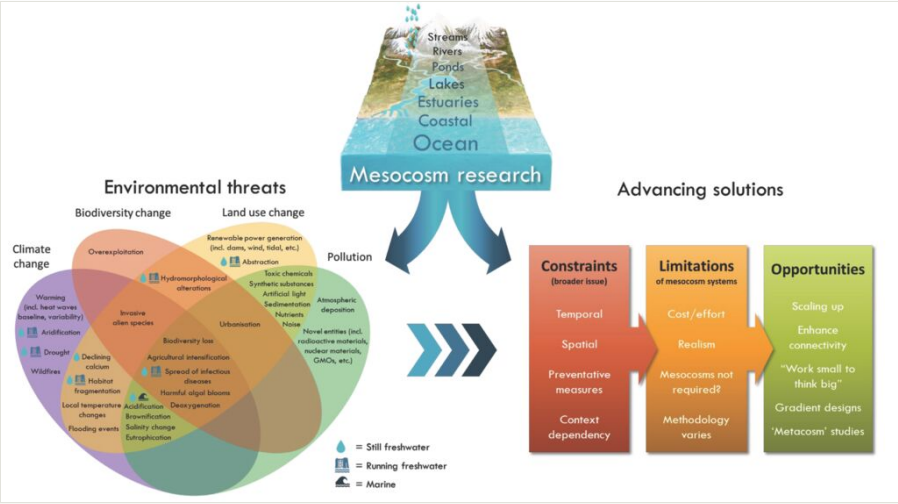

Figure 1. doi

Summarising major global Environmental Threats and the related Grand Challenges (left panel). Mesocosm facilities spanning all aquatic environments from mountains to ocean (middle upper panel) are unique experimental tools to Advance Solutions including Mitigation Approaches (right panel). The figure is derived from the graphical abstract of Macaulay et al. (2025), available under the CC BY 3.0 license.

The project AQUANAVI (**Navi**gating Grand Challenges and their Mitigation using **Aqua**tic Experimental RIs) seeks to accelerate our response to the challenges faced by aquatic environments by combining the rich yet disconnected resources in aquatic mesocosm-based research. AQUANAVI will bring together experimental data, publications, reports and information on mesocosm facilities. In this way, it will make a large amount of mostly isolated scientific expertise, technical competence and know-how, as well as information on unused potentials in a worldwide network of aquatic mesocosm facilities easily findable, accessible and usable. This interactive atlas of experimental opportunities will enable researchers to more effectively set up and conduct coordinated mesocosm experiments across climate zones, aquatic ecosystem types and trophic levels in marine, brackish and freshwater ecosystems. This will enable both more effective testing of hypotheses to better predict future scenarios and facilitate the discovery of adequate active mitigation methods for the pressures placed on aquatic ecosystems. AQUANAVI will allow researchers not only to quickly become familiar with the expertise available in aquatic mesocosm-based research around the world, but also identify mesocosm facilities that allow full scenario testing and obtain contact information of personnel with

the respective expertise. As a first-of-its-kind tool supporting studies for prediction and mitigation, AQUANAVI will support researchers, policy-makers and practitioners in tackling the Grand Challenges of aquatic environments in the Anthropocene.

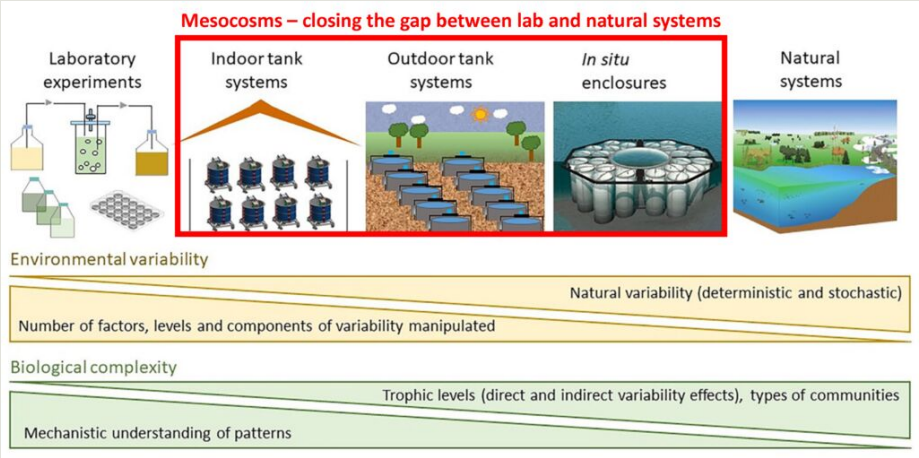

Figure 2. doi

Experimental studies in mesocosms (red frame) are crucial tools to test effects of stressors, as well as mitigation approaches by combining ecological realism in environmental and biological complexity, while allowing replicated experimentation, thus closing the gap between controlled laboratory experiments (left) and natural environments (right). The figure is modified from Gerhard et al. (2022), where it is available under a CC BY 4.0 license. AQUANAVI participants Stella A. Berger and Jens C. Nejstgaard were senior authors of that paper and leading the AQUACOSM-plus network hosting the workshop that gathered a large number of international mesocosm experts to capture an updated summary of the present knowledge in this field.

AQUANAVI will build on the extensive mesocosm-based data offered by AQUACOSM and related Research Infrastructures (RI). Amongst aquatic European Research Infrastructures, the distributed AQUACOSM-RI, together with the previous marine FP7 MESOAQUA project (No. 228224), has provided access to > 60 individual mesocosm facilities for many hundreds of visiting researchers (ca. 23,000 person-days of access). These visiting researchers have been supported by an even greater number of local staff and scientists at each mesocosm host location (i.e. the project consortium members across Europe) over almost two decades. With support of research and development work by using mesocosm facilities, the AQUACOSM-RI has fostered inter- and cross-disciplinary collaborations between a broad range of research fields and industry representatives, enhanced standardisation and harmonisation between formerly rather separated research fields, specifically science in marine and freshwaters and contributed to the production of many open digital resources including publications and reports, datasets and metadata and a mesocosm-focused Wiki knowledge base and Standard Operating Procedures (SOP).

AQUANAVI also aims to leverage relevant information from mesocosm Research Infrastructures and repositories within the global aquatic research community. For this,

we will use the presently most complete overview of available aquatic mesocosm facilities in the world, our www.mesocosm.org virtual network. By engaging all these partners to contribute data, metadata, publications, reports, expertise and experimental abilities related to their respective mesocosm facilities, this project aims to include key data also from all European aquatic mesocosm facilities. This effort significantly extends the number of available facilities beyond the ones that could be included in the EU-projects MESOAQUA,AQUACOSM and AQUACOSM-plus, due to budgetary restraints on maximum numbers of partners in such projects. AQUANAVI will, therefore, also serve to further develop the collaborative ties to other European RIs, such as AnaEE and EMBRC and observatory data collecting RIs, such as JERICO and eLTER.

AQUANAVI will bridge this wealth of scientific data through Hi Knowledge (Jeschke et al. 2021), an innovative analysis and visualisation platform that merges Wikidata (Vrandečić et al. 2023), Open Knowledge Maps (Kraker et al. 2019) and Scholia (Nielsen et al. 2017). Hi Knowledge harnesses the semantic capabilities of Wikidata to rapidly construct a FAIR and open corpus for a domain, based on a sophisticated conceptual classification system. Subsequently, Hi Knowledge incorporates visualisation components from Open Knowledge Maps and Scholia, allowing researchers to effortlessly navigate information using cutting-edge visualisation techniques, artificial intelligence and novel methods for knowledge synthesis. This approach has proven successful in the enKORE project within the Hi Knowledge initiative, creating an interactive knowledge atlas for invasion science. In AQUANAVI, by applying and extending the capabilities of Hi Knowledge, users will be able to tap into an international network of mesocosm-based research, exploiting the knowledge and expertise easily accessible and available at one platform and opening up new avenues for well-informed future experiments to addressing environmental change and focus on mitigation.

Open and collaborative by design, AQUANAVI's architecture will engage a broad range of research communities. By consolidating data from diverse RIs, the platform will leverage and enhance existing mesocosm infrastructures, securing the reusability and interoperability of existing data collections. Compliance with FAIR principles and EOSC requirements on data storage, interoperability and accessibility will ensure that AQUANAVI remains a long-term resource supporting collaborative and data-driven experimental research initiatives. This openness and sustainability will enrich both the ENVRI services portfolio and the broader science clusters and EOSC community. As a dynamic and inclusive platform designed to facilitate collaborative research and innovation, AQUANAVI will empower researchers and stakeholders to address the Grand Challenges in aquatic ecology by connecting them to suitable mesocosm facilities and their data, metadata and knowledge base. AQUANAVI will serve as a key resource for the scientific community within and beyond the European Research Area.

Scientific impacts

The Grand Challenges demand highly complex research to allow an adequate understanding of the interaction of multiple environmental stressors and their impact on

aquatic ecosystem functioning and services, including biodiversity (Fig. 1). Adequate information on the infrastructures for testing hypotheses experimentally and the knowledge that would be needed for performing such complex research are, to a large extent, existing, but not all readily findable and are far from coordinated. In AQUANAVI, we therefore propose to develop a tool that would substantially facilitate findability and coordination of RI capacities between different research institutions, between countries and even between continents. The information needed to effectively coordinate future experiments and data usage is presently mainly available to experts with personal networks. The AQUANAVI tool would make this information available to the broader scientific community and to developers, decision-makers, practitioners and other stakeholders.

The general scientific knowledge in the field of aquatic ecology is available in extensive numbers of mostly open access publications on mesocosm research, general research on aquatic ecology and, specifically, research on the Grand Challenges. These publications are deposited digitally and are findable via well-known web services. With raised standards of open data availability, also the numbers of FAIR datasets in the field are increasing rapidly in large repositories like ZENODO or PANGAEA. Further, an open international virtual network of mesocosm facilities containing basic information on the technical specifications of these facilities in marine and freshwater systems, as well as their geographical locations is available online on the website mesocosm.org. However, this information has not yet been organised in an easily searchable data format and is presently far from exhaustive. AQUANAVI proposes to ameliorate this deficiency, while at the same time connect the related publications and other data to the respective facilities. Finally, the expertise of performing mesocosm experiments, considering ecological, technical and even managerial aspects, has been accumulated in generations of researchers, but has only marginally been published. AQUANAVI aims to integrate such data in the process of making information on existing resources FAIR.

Thus, while all of these resources exist, they are presently not FAIR, as some of them are not findable or not accessible/interoperable/reusable. What is currently clearly missing is a searchable FAIR resource centred around the experimentation in mesocosms, interconnecting existing mesocosm infrastructures, what these experimental facilities can do technically and scientifically, what has been done, how it is done methodologically and where the expertise and opportunity for collaboration lies. The currently widely scattered information will be centralised and more findable, searchable and comparable through visualisation and filter functionalities in the AQUANAVI platform, thereby utilising previous investments of creating these resources and enabling interdisciplinary collaborations for tackling the Grand Challenges that aquatic environments are presently facing.

The development of an interactive atlas of experiential opportunities and previous scientific outputs from mesocosm-based research at RIs for addressing aquatic Grand Challenges, as envisioned by AQUANAVI, therefore holds significant scientific promise in advancing our understanding of aquatic ecosystems, applying mitigation approaches and informing environmental management. Specifically, AQUANAVI will allow to make

full use of: (a) the full portfolio of existing mesocosm infrastructures and their features and characteristics, also in a comparative way; (b) a large range of information currently lacking a DOI, like documents on standards, protocols and instructions for constructing low-cost mesocosms; and (c) publicly available scientific publications and datasets. The platform will also support a holistic approach to global research questions, as it can assist both, the (meta-)analysis of aquatic ecology studies and the future implementation of coordinated investigations spanning diverse climate zones, types of aquatic habitats and species communities.

Using AQUANAVI, researchers will, thus, be able to leverage the mesocosm facilities, as well as the related knowledge for designing the best possible experiments in a much more efficient way than currently feasible. It will be possible to follow a workflow that is ideal from a scientific and societal point of view, but has been unrealistic in the past. Asking a question related to one of the Grand Challenges - designing the ideal experiment related to understanding or mitigating this Grand Challenge - and finding the matching (combination of) mesocosm facilities will be made straightforward using AQUANAVI.

During the building phase of the AQUANAVI platform, we will invite the incorporation of data also from other European RIs that work with mesocosms like EMBRC and AnaEE. The latter will serve as an important complement to the larger dataset from the AQUACOSM-plus network by including more European facilities that could not even be included in the AQUACOSM-plus consortium due to practical and economic limitations. As this project focuses on gathering data and offers increased exposure of the participating facilities, there is no such limitation for this proposal. The combined use of services from several RIs/ESFRI RIs, including observatory and long-term data (e.g. JERICO, eLTER) and the use of mesocosms as research tools for hypothesis testing and modelling ecosystem processes, can create the highest impact and strongest synergies between ESFRI-RI services for discovery, as well as developing mitigations and solutions for aquatic environmental challenges. This will be greatly facilitated by the AQUANAVI platform, which will enable stakeholders to find the best-suited facility and information for their specific purposes. The integration into the EOSC and the science clusters, furthermore, will not only provide more exposure to this knowledge, but will also enable a long-lasting re-usability.

With the creation of a co-location graph of mesocosm facilities and the European ESFRI RIs, we will facilitate quick searches for sites where predictions, based on long-term observational data, can be directly tested using local or close to local, mesocosm facilities.

AQUANAVI will be open for everyone to use and also open for curated contributions from all over the world. With mesocosms being a key research tool, they inherently bear the capacity for investigating a wide range of research questions in numerous fields and research communities including limnology, oceanography, ecology, biogeochemistry, climate change biology, ecotoxicology, but also applied and industrial fields for aquaculture, sensor development, remote sensing, as well as testing the effect on these

ecosystems when adapting the related mitigation measures, such as, for example, carbon dioxide removal strategies. This plethora of fields additionally invites interdisciplinary and cross-domain collaboration in a single mesocosm experiment.

We plan to use the AQUACOSM communication network including industry partners, as well as the inter-RI communication channels in the environmental science cluster to disseminate results and reach a wide range of communities.

By providing researchers with a comprehensive platform for finding and leveraging aquatic mesocosm facilities and discovering their valuable information and research databases, AQUANAVI aims to facilitate interdisciplinary research collaborations and foster innovation in aquatic science. It will enable the exploitation of already existing, but scattered scientific information and the implementation of complex experimental designs for understanding and mitigating aquatic Grand Challenges. Moreover, AQUANAVI will provide access to scientific knowledge and full technical potential of different facilities, also for approaches that may still not have been tried in one facility, but in other similarly configured facilities. This type of information is currently very hard to find, especially in a centralised format connecting previous outcomes of mesocosm-based research with future possibilities, including presently unexplored ones. In addition to reaching out to the scientific community, the new platform can assist policy-makers, practitioners, educators and the general public as a search tool more compact than otherwise available and more powerful in clustering and filtering information for specific Grand Challenges. Ultimately, AQUANAVI seeks to catalyse scientific discoveries and solutions to address pressing challenges faced by aquatic ecosystems worldwide.

Digital resources

The success of AQUANAVI relies on the seamless integration of multiple research infrastructures. It will build on the extensive mesocosm-based data repository offered by the AQUACOSM RI and will leverage information from further RIs and repositories, such as AnaEE and EMBRC, JERICO and eLTER. AQUANAVI will bridge this wealth of scientific data with Hi Knowledge, an innovative analysis and visualisation platform that merges Wikidata, Open Knowledge Maps and Scholia. Through the consolidation of data from diverse sources and the provision of intuitive tools for analysis and visualisation, based on the Hi Knowledge approach, AQUANAVI will build a FAIR atlas of experimentally derived aquatic ecology research data, thus fostering cross-disciplinary collaboration and innovation within the aquatic research community. AQUANAVI's outputs will feed back into the EOSC and Science Clusters resources, enriching the digital research ecosystem.

In particular, the project will leverage the following resources of these Research Infrastructures:

AQUACOSM-RI:

- **AQUACOSM website** provides comprehensive information on mesocosm facility descriptions within AQUACOSM-RI, knowledge base, publications and reports, videos and includes specific data information as follows:

- The **AQUACOSM metadata catalogue** embedded in the AQUACOSM website currently holds more than 300 datasets describing the metadata of previously conducted and AQUACOSM-RI funded mesocosm experiments, including information on experiment locations, measured parameters, contact information and more. It is accessible through a targeted API;

- **AQUACOSM Project Tracker** is a web-based IT tool containing tabular information on AQUACOSM-plus funded mesocosm projects/experiments within the Transnational Access (TA) programme with the option to filter & sort according to types of information (e.g. hosting facility, keywords). The Project Tracker is connected to the expert contributor module which provides bidirectional contact information for external experts and TA users;

- A dedicated mesocosmWIKI is harbouring standard experimental protocols used in mesocosm and aquatic research, as well as instructions to build low-cost mesocosm variants, open to extension and to editing of WIKI articles through the community;

- The FVB-IGB maintains a growing **repository of currently > 120 mesocosm research facilities** spanning the globe, accessible through https://mesocosm.org/ . It includes contact information of facilities, their physical parameters, technical capabilities and equipment, scientific specialist areas and information on related publications. AQUANAVI will mine these data and expand the repository, for example, by including contact persons.

Open Knowledge Maps:

- **Open Knowledge Maps** operates the world's largest AI-based search engine for research. The open research infrastructure enables users inside and outside of academia to create visual overviews of research topics, based on more than 400 million scientific documents. The platform has become a popular discovery service with a million users per year and over 5 million knowledge maps created to date;

- The OKMaps Custom Services are a cloud-based platform enabling the integration of Open Knowledge Maps components into 3rd party services. Via several APIs, the Custom Services offer extensive customisation options, including the ability to restrict the knowledge maps to specific data sources;

- The software infrastructure for all Open Knowledge Maps services is open source via the powerful knowledge mapping and visualisation framework Head Start.

Wikidata:

- **Wikidata** (https://wikidata.org/) is a public-domain database of general reference information across all knowledge domains. FAIR and multilingual from the start, it currently covers over 100 million items described with machine-readable statements chosen from over 10-k properties. The knowledge graph is curated by a global community of about 25 k monthly contributors. The Wikidata software is free and open source and the data can be accessed by way of several Automated Programming Interfaces (APIs), including the Wikidata Query Service, a SPARQL endpoint;

- **Scholia** (https://scholia.toolforge.org/) is an open-source tool that provides Wikidata-based scholarly profiles. It currently receives about 200,000 daily page views. About 30 different types of profiles are available, from topic to author and protein. Each profile type contains a set of panels that address some common questions about the respective entity type. The panels are fed by SPARQL queries to Wikidata and parametrised by the identifier of the specific entity to be profiled.

The technological innovation potential of AQUANAVI lies in its capacity to harness a collective array of digital resources. Central is the development of a conceptual classification system in which all aquatic mesocosm-based research can be integrated. This classification scheme will be exposed as linked data and serve as the basis for the knowledge graph of aquatic environmental sciences built in Wikidata. The resulting AQUANAVI corpus will be made available via a query API endpoint (using the SPARQL query language) and a bibliographic metadata API endpoint (using the OAI-PMH protocol) for widespread reuse. This pipeline forms the basis for the development of AI-based data-driven visualisation components by Open Knowledge Maps, which will be exposed via the Custom Services APIs. The resulting backbone of the AQUANAVI platform will enable efficient data organisation, retrieval and analysis for users worldwide.

In terms of computing resources, AQUANAVI will build on robust infrastructure provided to the project in-kind by the participating RIs. Wikidata, Scholia and Open Knowledge Maps are all hosted on extensive networks of servers optimised for scalability and reliability. Additional server capacity for running data pipelines and the AQUANAVI platform itself will be provided by the FVB-IGB.

Project Implementation and Final Deliverables

The project is structured in seven distinct tasks, executed during the 18 months of the project (Fig. 3). Deliverables are classified according to Horizon Europe typology.

T1 Management and dissemination (M1-18, lead: FVB-IGB, involved: OKMaps)

This task aims at overseeing project progress, resource allocation, stakeholder communication and dissemination. FVB-IGB will be in charge of project management,

assuring regular online meetings, continuous flow of information amongst all project partners and the timely fulfilment of tasks.

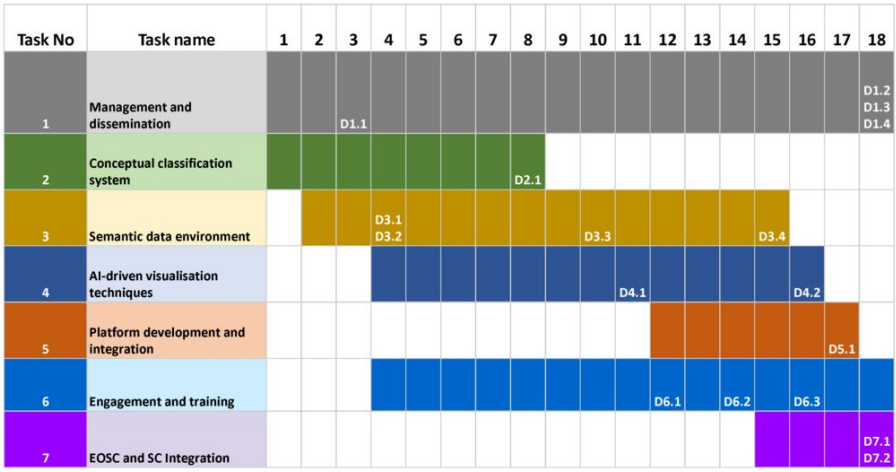

Figure 3. doi

GANTT chart showing the scheduling of tasks and deliverables during the 18 months of the project. For details on the deliverables D1.1 to D7.2, see text.

Subtasks:

- T1.1 Opening of a “Project collection” in the open access journal *RIO - Research Ideas and Outcomes*, where documentation will be added over the project’s course (M3, DEC);
- D1.2 Journal article summarising the main project results and methodology (M18, R);
- D1.3 Final project summary (M18, R);
- D1.4 Presentation at the OSCARS final event (M18, DEC).

T2 Conceptual classification system (M1-8, lead: FVB-IGB)

In T2, the focus is on developing a robust conceptual classification system tailored to aquatic mesocosm-based research. This system will serve for organising and structuring diverse types of mesocosm facilities, datasets and publications as well as accompanying information (knowledge base, SOPs, videos, projects) in a FAIR and open manner. Building on previous efforts in the Hi Knowledge initiative, Grand Challenges, overarching research questions and major hypotheses will be part of the classification system, making it possible to develop respective search and filtering options (T3 and 4).

Deliverable:

- D2.1 Conceptual classification system (M8, OTHER).

T3 Semantic data environment (M2-15, lead: FVB-IGB, involved: OKMaps)

T3 includes the development of semantic data structures and knowledge graphs in Wikidata dedicated to aquatic mesocosm research. The classification system (T2) will be used as a conceptual basis. Meta-data on mesocosm facilities and related publications and datasets describing methods and experiments will be made machine-actionable. By establishing persistent identifiers and implementing automated identification mechanisms, we will create a FAIR and open knowledge repository. This resulting AQUANAVI corpus will be made available via several endpoints for retrieval and ingested in the search engine BASE for use within Open Knowledge Maps. This environment will serve as the backbone of the AQUANAVI platform, enabling efficient data organisation, retrieval and analysis for users worldwide.

Deliverables:

- D3.1 SPARQL endpoint (M4, OTHER);
- D3.2 OAI-PMH endpoint (M4, OTHER);
- D3.3 AQUANAVI registry (M10, DEC);
- D3.4 Knowledge graph of aquatic mesocosm-based research (M15, OTHER).

T4 AI-driven visualisation techniques (M4-16, lead: OKMaps, involved: FVB-IGB)

In T4, the focus is on developing AI-driven visualisation techniques to enable intuitive exploration and discovery of aquatic mesocosm facilities and related documents. By integrating machine learning and natural language processing with semantic data structures, we will create dynamic, interactive visualisations that facilitate the planning of complex mesocosm experiments making the most of existing RIs and related existing knowledge. Through rigorous testing and refinement, based on user feedback, we strive to deliver user-friendly and impactful mapping components.

Deliverables:

- D4.1 Knowledge visualisation and mapping components - iteration 1 (M11, OTHER);
- D4.2 Knowledge visualisation and mapping components - iteration 2 (M16, OTHER).

T5 Platform development and integration (M12-17, lead: FVB-IGB, involved: OKMaps)

Building upon T2-4, T5 will integrate the services developed to enable efficient search and filtering on the AQUANAVI platform. The platform will allow users to explore the rich

AQUANAVI knowledge graph using dynamic, interactive visualisations. The development of mapping and filtering options, based on attribution to specific Grand Challenges, research questions or hypotheses, taxonomic groups and more, will further enhance the AQUANAVI platform's analysis and synthesis capabilities for researchers in the aquatic ecology community.

Deliverables:

- D5.1 AQUANAVI platform fully functional (M17, DEM).

T6 Engagement and training (M4-18, lead: FVB-IGB, involved: OKMaps)

By embracing a co-design approach, we aim to cultivate a vibrant community of users and contributors dedicated to advancing aquatic research and conservation efforts. Respective workshops will be complemented by dissemination campaigns and training with target audiences across the different disciplines and European RIs involved in aquatic ecology. Broad dissemination of project results will be accomplished by utilising the networks of all involved partners, including the AQUACOSM-RI communication channels (Twitter/X, established AQUACOSM newsletter, contacts to other RIs and their newsletters) for reaching the global mesocosm community and the European RI communities.

Deliverables:

- D6.1 Online workshop (M12, OTHER);
- D6.2 Social media posts and newsletter contributions in existing dissemination channels (M14, DEC);
- D6.3 Conference workshop (M16, OTHER).

T7 EOSC and SC Integration (M15-18, lead: FVB-IGB, involved: OKMaps)

Through this task, we will ensure compliance with EOSC requirements for data storage, interoperability and accessibility, laying the foundation for enhanced collaboration and data-driven research initiatives. FVB-IGB and Wikidata are involved in the National Research Data Infrastructure (NFDI) initiative, which strengthens research data infrastructures within disciplines, makes them interoperable across disciplines and integrates them with international efforts like EOSC and the Research Data Alliance.

Deliverables:

- D7.1 AQUANAVI registered in the ENVRI Catalogue of Services and the ENVRIHub (M18, OTHER);
- D7.2 AQUANAVI registered with the EOSC EU Node (M18, OTHER).

Domain

Life sciences, Earth and environmental sciences

Type of challenge/s

Open science project, open science service, cross-domain/cross-RI

Funding program

OSCARS 1st Open Call for Open Science Projects and Services

Grant title

AQUANAVI: Navigating Grand Challenges and their Mitigation using Aquatic Experimental RIs

Conflicts of interest

The authors have declared that no competing interests exist.
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