



PART OF THE

EU MISSIONS

RESTORE OUR OCEAN & WATERS

Funded by
the European Union



Project acronym:

EcoDaLLi

Project title:

ECOsysteem-based governance with
DAnube lighthouse Living Lab for
sustainable Innovation processes –
EcoDaLLi

Call:

HORIZON-MISS-2021-OCEAN-02-04
– Danube river basin lighthouse –
coordination activities

Programme:

HORIZON EUROPE

Start date of project:

01.01.2023

Duration:

42 Months



Deliverable 6.1

Online interactive portal



Deliverable Name	Online interactive portal
Deliverable Number	D6.1
Work Package	WP6
Associated Task	T6.1
Due Date	M18 (June 2024)
Completion Date	01.07.2024
Submission Date	01.07.2024
Deliverable Lead Partner	UNIZAG FSB

Dissemination Level		
PU	Public	X
SEN	Sensitive	

Change Control Document History				
Version	Date	Change History	Authors	Organization
1.1	27.06.2024	First draft	Filip Jurić	UNIZAG FSB
1.2	30.06.2024	Review	Bernarda Matijevic	Opcina Draz
1.3	30.06.2024	Revision after review	Filip Jurić	UNIZAG FSB
Final Version	01.07.2024	Deliverable submission	Nadja Schlichenmaier	SEZ
2.1	06.10.2024	Deliverable revised on PO request	Filip Jurić	UNIZAG FSB
2.2	07.10.2024	Sent to PO	Nadja Schlichenmaier	SEZ
2.3	09.10.2024	Final formatting and review	Mirjam Zillober & Nadja Schlichenmaier	SEZ
Final Revised Version	09.10.2024	Deliverable resubmission	Nadja Schlichenmaier	SEZ



Disclaimer

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.



Table of Contents

1. Introduction	6
1.1. Document Overview.....	7
1.2. Web Requirements	7
1.2.1. Browser Requirements	8
1.2.2. Accessibility and Responsiveness	8
1.2.3. Efficiency and Expandability	8
1.2.4. Security	8
1.2.5. Maintenance.....	8
1.3. Portal Development Procedure	9
1.4. Content and Structure	9
2. Portal Architecture and Hosting	9
2.1. Hosting	12
2.2. Security Specifications	12
2.3. Permission Levels.....	13
3. Technical Specifications	13
3.1. Technical Requirements	14
3.1.1. Performance Requirements.....	14
3.1.2. Usability Requirements.....	14
3.1.3. Scalability Requirements	14
3.2. Design Principles	14
3.3. Cookies.....	15
3.4. Maintenance and Support	16
3.5. Implementation Plan	16
4. Interactive Features.....	16
4.1. Nature-Based Solutions Content Catalogue.....	17
4.2. Stakeholder Mapping Tool	18
4.3. Filtering Tool	20
4.4. Event Calendar	21
4.5. Section for Practices Living Lab Systems (PLLS).....	22
4.6. Newsletter.....	23
4.7. Localization and Accessibility.....	23
4.8. Connections with Mission Implementation Portal and Digital Twin Ocean Portal.....	24
5. Data Collection and Management.....	25



5.1. Data Categories	25
6. Community Engagement	26
6.2. Expected Impact	26
7. Current Status and Future Work	27

Table of Figures

Figure 1	EcoDaLLi portal pillars	7
Figure 2	Portal registration form	10
Figure 3	Scheme of the portal structure and connection with WPs	11
Figure 4	EcoDaLLi portal header menu in desktop and mobile version	17
Figure 5	WP2 results: NBS catalogue	18
Figure 6	Developed GIS mapping tool	20
Figure 7	Filtering tool developed for WP3 and WP5	21
Figure 8	Event calendar tool with event submitting form	22
Figure 9	Current PLLs tool as pdf document	23
Figure 10	Available languages of EcoDaLLi portal	24
Figure 11	Links to Mission Implementation portal and Digital twin ocean portal	24
Figure 12	EcoDaLLi repository	25



1. Introduction

Deliverable D6.1, titled “Online Interactive Portal,” represents a key milestone in Work Package 6 (WP6) of the EcoDaLLi project, which focuses on enhancing cross-fertilization of achieved results. The primary objective of WP6 is to create a digital platform that facilitates the dissemination and exchange of knowledge, innovative practices, and results generated from various activities within the EcoDaLLi project. The interactive portal aims to support stakeholders by providing a centralized hub for accessing and sharing information related to the protection and restoration of freshwater ecosystems and biodiversity in the Danube River basin. It is designed to integrate contributions from all work packages, including WP2, WP3, WP4, and WP8, ensuring a comprehensive repository of data, tools, and insights. The portal is organized into four main sections (pillars): Governance, Citizens, Business, and Academia. Figure 1 shows scheme of EcoDaLLi pillars that will support the portal. Each section is tailored to the needs and contributions of different stakeholder groups. This structure facilitates targeted information dissemination and interaction among users. The portal content will be accessible through various permission levels, ensuring appropriate access for public users, citizen contributors, stakeholders that have elevated access for enhanced integration and collaboration across various cross-Danube initiatives, and administrative personnel. This hierarchical access model supports both broad public engagement and specialized stakeholder collaboration. Incorporating interactive features such as citizen science applications, newsletters, polls, and questionnaires, the portal is designed to enhance user engagement, foster community participation, and facilitate the exchange of ideas and solutions related to ecosystem preservation and restoration. To bridge language barriers and promote wider community involvement, the portal content is available in both English and local languages of the EcoDaLLi project partners. This localization ensures that information is accessible to a diverse audience across the Danube basin. Connecting with other related projects and initiatives, such as the Mission Ocean, Mission Implementation Support Platform, and Digital Twin Ocean and Water, the portal promotes synergies and comprehensive coverage of innovative actions and solutions across multiple domains. By providing a dynamic and user-friendly platform, D6.1 aims to support the EcoDaLLi project's mission of fostering sustainable development, innovation transfer, and ecosystem resilience in the Danube River basin. The portal will serve as a vital tool for knowledge dissemination, stakeholder engagement, and collaborative problem-solving, contributing significantly to the project's overall impact.



Figure 1 EcoDaLLi portal pillars

Governance pillar focuses on the outputs generated from Work Package 4 (WP4) which are essential for establishing robust governance frameworks and policies to support the EcoDaLLi project. Business encompasses the outcomes derived from Work Package 5 (WP5) which are crucial for integrating business perspectives and ensuring the project's economic viability and sustainability. Academia includes the content produced under Work Packages 2 and 3 (WP2 and WP3) which is fundamental for providing scientific research and educational resources that underpin the project's methodologies and strategies. Citizens is designed to encourage interaction among citizens and stakeholders facilitating rapid information exchange and knowledge transfer and aiming to actively engage the public in the EcoDaLLi project's activities and objectives. The Interactive EcoDaLLi portal aspires to be the central hub for communication knowledge exchange and proactive engagement among all stakeholders involved in the EcoDaLLi project which is pivotal to the preservation and restoration of the Danube basin ecosystem.

1.1. Document Overview

This is a mostly technical document, intended as a guideline for implementation. Firstly, the introduction describes the general approach and the requirements. After that, the architecture is described using a top-down methodology. Each individual component has its own chapter. Finally, the approach taken to integrate the web-based dashboard into the whole EcoDaLLi portal system is described.

1.2. Web Requirements

To initiate the implementation process, it is essential to establish a set of requirements. Rather than specifying every detail of each component separately, a comprehensive framework has been adopted. This framework provides guidelines and establishes boundaries for the development process.

1.2.1. Browser Requirements

The web-based dashboard is accessed through a web browser. The application expects users to use a web browser, but the specific browser should ideally not matter. However, in practice, browser choice significantly impacts development time and user experience. This preliminary implementation targets the latest versions of the following browsers:

- Google Chrome on Desktop
- Google Chrome on Android
- Mozilla Firefox on Desktop
- Mozilla Firefox on Android
- Apple Safari on Desktop
- Apple Safari on iOS
- Microsoft Edge on Desktop

1.2.2. Accessibility and Responsiveness

The EcoDaLLi portal is designed to be a platform for all European citizens, necessitating that the dashboard is accessible to everyone. The dashboard must be designed to accommodate the diversity of EU citizens/stakeholders. Additionally, users will access the dashboard from different devices. While the previous point addressed browser variety, it is also important to support various screen sizes, from mobile phones to large desktop monitors.

1.2.3. Efficiency and Expandability

Efficiency is crucial for user experience users. The web-based dashboard must be highly responsive, minimizing unnecessary wait times. If waiting is unavoidable, the dashboard should provide feedback and remain usable. Efficiency and scalability are often linked. As the number of users increases, the system load grows, potentially slowing response times and degrading user experience. Architectural choices should aim to decouple efficiency from scalability, ensuring the system can seamlessly expand to support thousands of users, as EcoDaLLi intends to serve all European citizens/stakeholders interested in Danube lighthouse and ecosystem.

1.2.4. Security

EcoDaLLi is a platform where users manage their personal information, which is inherently sensitive. Security is a foundational aspect of the EcoDaLLi project. A defense-in-depth approach is essential to protect users' personal information. Every component of the web-based dashboard must be designed with security as a priority, and no component should be trusted implicitly. Effective security requires separation of concerns, ensuring that each component performs its function securely. Adherence to standard security practices for web applications is mandatory. This includes the use of modern, strict SSL encryption for communication between the user agent and the application. HTTP version 2 should be used, and no third-party requests are allowed (e.g., no CDN, trackers, ads, or in-line JavaScript). These rules enable the strict use of HTTP strict transport security, HTTP content security policy, HTTP frame options, and HTTP XSS protection. In summary, all information processed by the web-based dashboard must remain confidential under all circumstances.

1.2.5. Maintenance

As a consortium project, EcoDaLLi requires high-quality code that fosters collaboration. The application code must be clean, with a well-defined architecture and thorough documentation.

This includes code comments, API documentation, and documentation on design decisions, development practices, and deployment guidelines.

Tests are equally important for maintaining software quality. Tests provide stability and serve as a form of documentation. They should cover and describe actual business logic. While test coverage metrics are not the main focus, ensuring that logic is fully represented in test scenarios is crucial. Reviewing the tests should give developers a clear understanding of the software's objectives.

1.3. Portal Development Procedure

Designing and implementing a system like the web-based portal involves starting with the user interface design, based on known requirements, and then working down to the implementation. This approach offers several advantages. Firstly, presenting a user interface design early invites detailed user feedback. Any feedback can be quickly incorporated into the design without impacting technical decisions or requiring significant changes to the underlying back-end code. This creates a fast, reactive, and interactive feedback loop, encouraging close collaboration with end-users on the final design. Secondly, this process uncovers previously unknown requirements by prompting users to think about the actual application usage. Lastly, it sets user expectations early, reducing the likelihood of unexpected issues later in the process. Once the design is finalized, use cases and technical requirements can be derived from it, forming the basis for the technical implementation. During implementation, development can proceed from the front-end, informed by finalized designs and use cases, while the back-end is developed to support front-end features. This allows for rapid prototyping and early feedback, ultimately saving time. This front-to-back approach requires early definition of abstractions, particularly the API contract between the front-end and back-end. Unlike traditional approaches where the back-end dictates the API contract, this method involves a collaborative effort to limit surprises and enhance early collaboration and feedback.

1.4. Content and Structure

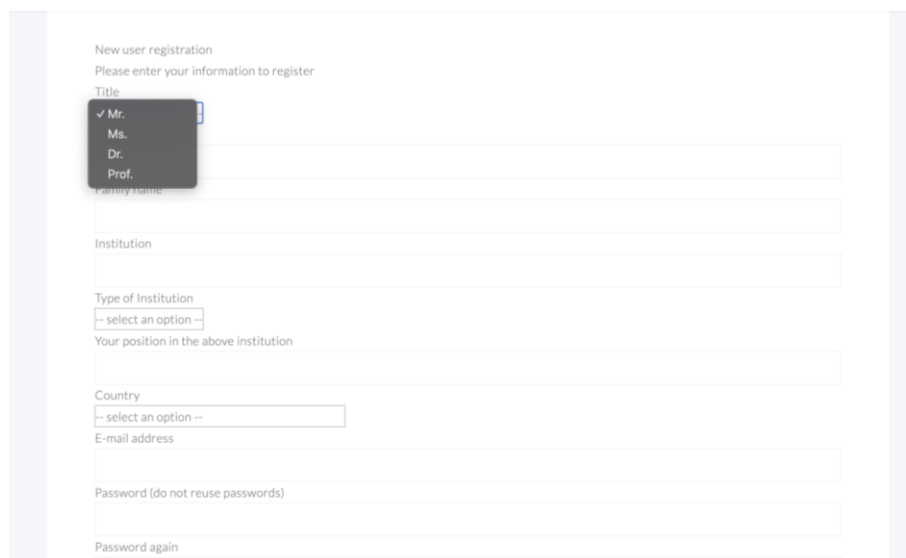
The portal will be divided into parts for WP2, WP3, WP4, and WP8, with additional connections to the Mission Implementation Portal and the Digital Twin Ocean. The data will include methodologies from WP2 regarding Nature-Based Solutions (NBS) and social challenges, stakeholder mapping tools, best practices for the public from WP3, information about Living Labs (LLs) and the concept of Practice Living Labs (PLLs) from WP4, and mapping of innovations with filtering tools from WP5. Dissemination tools from WP8 will also be used, incorporating all relevant content as outlined in the Grant Agreement.

2. Portal Architecture and Hosting

Considering all requirements, the overall architecture must be devised to be as straightforward as possible while fulfilling all security and efficiency needs. To achieve this, the web-based portal has been divided into several smaller services, either developed in-house or sourced from existing open-source software. Each service focuses on a specific function, following a microservice architecture. All external communication over the internet occurs through a single-entry point: the reverse proxy. Both users and administrators interact with this

component using HTTPS (HTTP plus SSL). The reverse proxy has three main roles. Firstly, it enforces HTTPS, allowing no unencrypted traffic except for the HTTPS redirect between the user and the reverse proxy. This component manages all HTTPS functionality, relieving individual services of this task. Secondly, the reverse proxy directs traffic to the appropriate service (whether authentication provider, front-end, or back-end) based on the incoming Uniform Resource Identifier (URI). Lastly, it load-balances traffic between multiple instances of the services as needed. This single-entry point approach offers several advantages. It reduces the exposed surface of the platform to the internet, ensuring no core components are directly exposed. Additionally, it simplifies monitoring for security and performance issues through a single entry point.

EcoDaLLi requires users to authenticate using registered accounts before accessing the web-based portal. This approach ensures that users can create and manage their own accounts within the EcoDaLLi system. To facilitate this, a secure and straightforward account registration and authentication process will be implemented. Figure 2 show registration form that user has to fill in, where special focus is given on type of institution (citizen, academia, business, governance, NGO), which will lead to specific user content. This method does not rely on external national login providers, allowing for a more streamlined and consistent user experience. The web-based dashboard support a flexible authentication system that can integrate various authentication providers as needed. To enhance security and simplify future integrations, the authentication functionality is managed as a separate service. Initially, Google will be used as a test provider due to its well-documented and accessible authentication methods, although it will not be used in the implemented environment. This setup will allow for initial development and testing while ensuring that the final solution is robust and secure for all users.



The screenshot shows a web form titled "New user registration" with the instruction "Please enter your information to register". The form includes the following fields and elements:

- Title:** A dropdown menu with options: Mr. (selected), Ms., Dr., and Prof.
- Family Name:** A text input field.
- Institution:** A text input field.
- Type of Institution:** A dropdown menu with the option "-- select an option --".
- Your position in the above institution:** A text input field.
- Country:** A dropdown menu with the option "-- select an option --".
- E-mail address:** A text input field.
- Password (do not reuse passwords):** A text input field.
- Password again:** A text input field.

Figure 2 Portal registration form

The front-end of the web-based dashboard includes everything sent to the browser to display the user interface and interact with the back-end API. This includes HTML, CSS, JavaScript, fonts, images, and other assets.

Modern front-end development involves assembling these assets into static files, which are then served from the filesystem by a webserver. Most business logic of the web-based dashboard resides in the back-end, which defines an API for the front-end to use. The back-end performs several functions. It consolidates the functionalities provided by other components through the Blockchain API, Data Processor API, Personal Data Analyzer, and Risk Management Module into a single API. Additionally, it secures access to the APIs by continuously validating and authenticating each user request before forwarding it to the respective services. The back-end uses Redis (Remote Dictionary Server - an open-source, in-memory data structure store that is widely used as a database, cache, and message broker) to temporarily cache data from the message bus for users not currently logged in, preventing the message bus from filling up. In the future, Redis can also be used to share state between back-end instances if necessary. Each service behind the reverse proxy can be scaled horizontally by adding more instances, with the reverse proxy handling load-balancing among instances.

Figure 3 the simplified architecture of the portal, highlighting the access permissions categorized into three distinct levels. The first level is designed for public access, where general users can view content without any accreditation or special permissions. The second level is dedicated to project partners and citizen stakeholders, granting them rights to contribute to specific data creation activities, such as adding new initiatives or participating in questionnaires related to WP2, WP3, and WP8. The highest level of access is reserved for the administrative team responsible for portal development, allowing them comprehensive oversight of all data and the ability to perform database management and maintenance tasks.

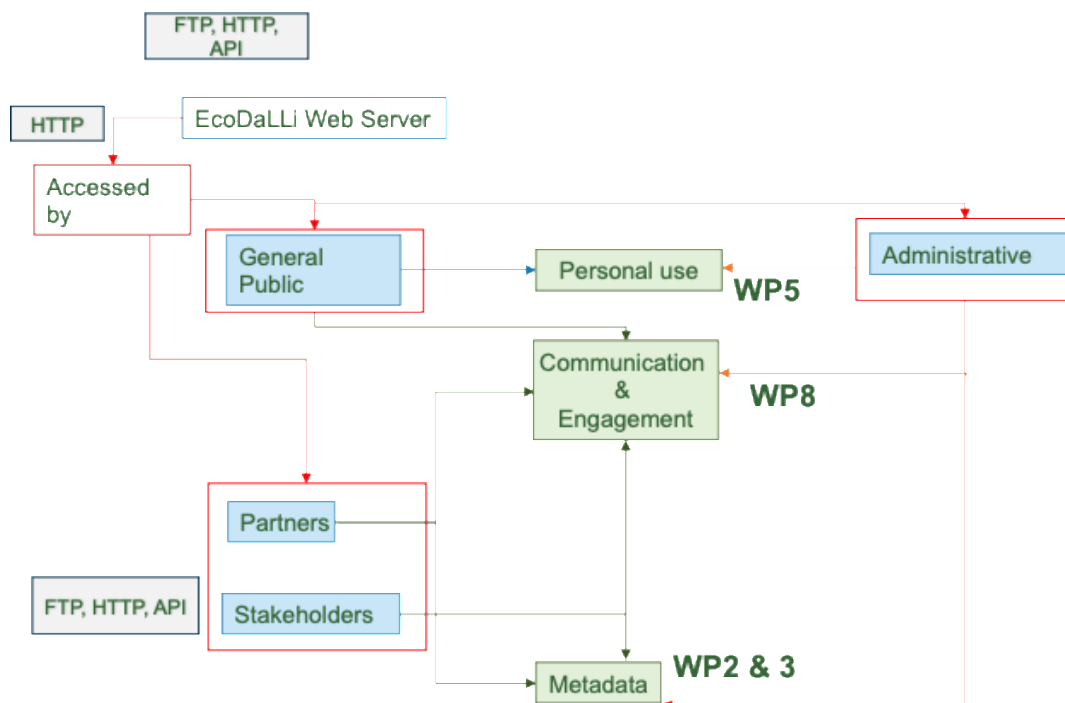


Figure 3 Scheme of the portal structure and connection with WPs

2.1. Hosting

The EcoDaLLi portal, hosted on the domain portal.ecodalli.eu, is provided by Plus Hosting server and developed and managed by UZ-FSB. This portal is designed to facilitate data storage, project connections, and citizen interaction, with inputs from various project partners. The hosting is managed by DHH S.p.A., a technology group renowned for offering cloud computing and internet access products across Southern Europe, particularly around the Adriatic Sea. DHH adheres to stringent security and management standards, holding certifications such as ISO 27001 and ISO 22301, which ensure robust data protection and business continuity. Their data centers, which power the EcoDaLLi portal, utilize renewable energies, are monitored 24/7, and comply with top certifications, underscoring DHH's commitment to security and sustainability.

2.2. Security Specifications

The EcoDaLLi portal employs robust security measures to ensure the protection of sensitive information and maintain the integrity of data. Key security features include data encryption, access control, and data integrity mechanisms.

Data Encryption: To protect sensitive information during transmission, the portal utilizes SSL certificates from Let's Encrypt (<https://letsencrypt.org/>). These certificates establish an encrypted link between the web server and the browser, ensuring that all data passed between them remains private and secure. The SSL protocols ensure that the server's identity is verified through the SSL handshake process, which initiates encryption for all subsequent data transmissions. This approach safeguards user information from interception and tampering, providing a secure user experience. Let's Encrypt's automated, simple, and free SSL certificates also ensure that our certificates are always up to date, mitigating the risk of expired certificates and potential security vulnerabilities.

Access Control: The portal implements stringent access control mechanisms to manage different levels of access for internal partners, stakeholders, and the public. User authentication and authorization methods are employed to verify user identities and control access to resources, ensuring that only authorized individuals can access sensitive information. Each registered partner is required to complete an email-based authorization process, wherein the system sends a verification link to the partner's registered email address. This step is mandatory to confirm the authenticity of the partner and to grant them access to specific sections of the portal. Only after successful verification can partners contribute to data creation and access project-specific content, adding an additional layer of security to the portal's access management. Access to the EcoDaLLi portal's databases will be strictly controlled using cPanel's IP Access Control feature, allowing connections only from IP addresses explicitly approved by WP leaders at UZ-FSB. This setup ensures that only designated stakeholders can interact with the databases, preventing unauthorized access. WP leaders will be responsible for updating and maintaining the list of allowed IP addresses, thereby enforcing a high level of security and access management for the portal's critical data and resources.

Data Integrity: The portal utilizes SHA-256 bit encryption for hashing sensitive data, such as passwords and other critical information. SHA-256 is a cryptographic hash function that processes input data and produces a fixed-size, 256-bit hash value, serving as a digital

fingerprint of the original data. This hash value ensures the integrity and confidentiality of the data, making it computationally infeasible to derive the original input from the hash value. This cryptographic technique is crucial for securing sensitive information during both transmission and storage, preventing unauthorized access and tampering.

SHA-256 Bit Encryption: SHA-256 is a widely-used cryptographic hash function chosen for its resistance to cryptographic attacks. It ensures that sensitive information is protected by producing a unique hash value that acts as a digital fingerprint. This prevents unauthorized access and ensures data integrity, as it is computationally infeasible to reverse-engineer the original data from the hash value.

By incorporating these advanced security measures, the EcoDaLLi portal ensures a secure, reliable, and trustworthy environment for data storage, project connections, and citizen interaction.

2.3. Permission Levels

As already mentioned in describing the structure of the portal, access to the EcoDaLLi portal content will be structured into distinct permission levels to ensure appropriate access and engagement for various user groups. Public Access will provide general data, information, and community services accessible to all users. Citizen/stakeholder contributors will have enhanced interaction capabilities with stakeholders and participation in citizen science activities, fostering greater public involvement.

Stakeholders and partners that have elevated access to the cross-Danube initiatives will facilitate the inclusion and connection of various regional initiatives, promoting collaboration and shared objectives. The administrative level will grant full access to administrative users for comprehensive management and operational purposes. The portal's four foundational pillars: Governance, Citizens, Business, and Academia is supported by content derived from various work packages. This structure ensures a comprehensive and collaborative approach to the preservation and restoration of the Danube basin ecosystem.

3. Technical Specifications

With the UX design established, the technology stack for the front-end of the EcoDaLLi web-based dashboard can be selected. The goals for this stack align with the overall objectives: accessibility, responsiveness, performance, scalability, security, and maintainability. To ensure maintainability of the front-end business logic, using a framework is essential. A well-known framework also enhances the transferability of the code to other engineers by enforcing a structured project organization. For the EcoDaLLi web-based dashboard, React.js has been chosen. React.js is one of the most popular front-end JavaScript frameworks, providing extensive documentation and support from a large developer community. This popularity ensures that the software can be easily supported and maintained by developers other than the original authors. In addition to React, React Router is used for declarative routing. Since much of the business logic can be managed as a state machine, Redux is utilized to facilitate the development and management of these state machines. For testing, Jest is used for unit

tests, while Cypress is employed for integration tests. The Data Processors screen (which may be renamed for user-friendliness) lists all connected data processors, allowing users to search through the list. This list prioritizes the data processors with which the data subject is involved. Summary information for each data processor can be added to the list, depending on technical capabilities. Each data processor entry can be expanded to display detailed information about the data shared and/or requested, the data exchanged with other data processors, and controls to update information and/or permissions.

3.1. Technical Requirements

3.1.1. Performance Requirements

The portal is designed to efficiently handle large volumes of data from multiple sources, including real-time sensor data and remote sensing inputs. This ensures that the system remains responsive and reliable even under heavy data loads. Data visualization and analysis tools are optimized for responsive performance, providing users with timely insights crucial for effective decision-making and engagement with the data. High system availability is essential to guarantee uninterrupted access to portal services, with the infrastructure designed to provide reliable uptime, minimizing disruptions and ensuring continuous access for all users.

3.1.2. Usability Requirements

The portal features a user-friendly interface that enables intuitive navigation and seamless interaction with data visualization tools and citizen science applications. This design ensures that users can easily find and use the portal's features. Robust accessibility features are incorporated to ensure the portal is usable by a diverse audience, including support for assistive technologies. Comprehensive user documentation and training resources are provided to assist stakeholders in effectively utilizing the portal's functionalities, helping users make the most of the portal's capabilities and enhancing their overall experience.

3.1.3. Scalability Requirements

The portal is designed to scale resources, such as server capacity and storage, to accommodate increasing data volumes and user traffic as the project progresses. This scalability ensures that the portal can handle growing demands without compromising performance. Supporting integration with external systems and data sources is a key feature, allowing for the seamless incorporation of external data and enhancing the portal's functionality and reach. Regular performance testing and optimization are conducted to maintain the portal's responsiveness and reliability, ensuring the system remains efficient and effective and providing a high-quality user experience.

3.2. Design Principles

The design of the EcoDaLLi portal is based on core principles that shape its architecture and operational functions. These principles are crucial for ensuring the portal's efficiency, adaptability, and sustainability over the long term. By following these guidelines, the portal effectively supports the EcoDaLLi project's goals of biodiversity monitoring, climate adaptation, and water management, promoting agility and collaboration throughout its lifecycle.

- **Modularity:** The portal is organized into modular components that can be independently developed, updated, and maintained. This modular structure enhances flexibility and facilitates the easy integration of new features and technologies.

- **Interoperability:** A strong focus on interoperability allows seamless communication and data exchange with external systems and datasets. This fosters collaboration with other projects and initiatives, optimizing the use of shared resources and knowledge.
- **Scalability:** The architecture is built to efficiently scale, handling increasing data volumes, user traffic, and evolving project needs. Scalability ensures the portal can grow its capabilities without sacrificing performance or user experience.
- **Maintainability:** Maintenance processes are streamlined to keep the portal operational and efficient over time. This involves regular updates, monitoring, and optimization of system performance and security measures.

3.3. Cookies

The cookie is the critical piece of data in an HTTP request that differentiates an authenticated request from an unauthenticated one, granting access to a user's private information. There are several methods for authenticating API requests, with cookies being one of the most established. The web-based dashboard of EcoDaLLi consists of two main components: the front-end and the back-end. The front-end directs the user's browser to send requests to the back-end based on user interactions. Both components are hosted on the same domain behind a reverse proxy. To authenticate a user, a token must be included with every API request to the back-end. This can be achieved using an API field, an HTTP header like "Authorization," or a cookie. Cookies are the most traditional and widely used method for this purpose. They are well-understood and extensively researched within the browser context, unlike local session storage or JavaScript objects, which are less mature in terms of security. Since the token must accompany every request and all communication occurs within the same domain, cookies are the most straightforward solution. The cookie must contain key information for the back-end: the authentication provider used, the authentication timestamp, and the unique identifier of the user. This unique identifier is personally identifiable information (PII) and must be protected from third parties. Although the cookie value can be as secure as the web page content, a defense-in-depth strategy suggests encrypting the cookie value for added protection. Given that cookies persist longer on the user's device than web page content, they are prime targets for malware, making encryption essential. Cookies cannot be valid indefinitely. If an attacker captures a cookie, they gain access to the user's information. Limiting the cookie's validity period reduces this risk significantly. After the validity period expires, the cookie is invalidated, and the user must log in again. A short validity period, such as one hour, is recommended. To ensure the cookie's validity, it must be cryptographically signed by a trusted provider. For EcoDaLLi, this is the registered accounts authentication provider. The cookie value should be encrypted to protect the PII it contains. Moreover, there must be a way to serialize these pieces of information into a single payload. While JSON Web Token (JWT) is a common choice for this purpose, it has limitations that make it unsuitable for EcoDaLLi. JWT does not encrypt the payload by default, is complex, and has faced criticism from security researchers. Instead, EcoDaLLi relies on Let's Encrypt for all its encryption needs. This approach is straightforward and secure, providing a reliable solution. Cookies are encrypted and signed using SSL certificates from Let's Encrypt, ensuring secure transmission of data. Both the authentication provider service and the dashboard's back-end use these certificates to validate and decrypt the cookie.

The encrypted data is then base64 encoded and stored in the cookie. When validating the cookie, the process is reversed: it is first base64 decoded, then verified and decrypted using the Let's Encrypt certificates. The timestamp's validity is checked, and if everything is correct, the user is authenticated. To simplify implementation, the authentication token processing is integrated into a common library used by both the back-end and the authentication provider service.

3.4. Maintenance and Support

Backup procedures will follow the best practices for cPanel (<https://cpanel.net/>), ensuring data integrity and availability. The backup process for the EcoDaLLi portal will be implemented using cPanel's backup interface, ensuring comprehensive data protection. Full account backups will be scheduled regularly and stored either on the server or remotely via FTP/SCP, depending on the configuration. The backup files will include all relevant website files, databases, and email data. Additionally, automated notifications will be configured to inform administrators upon the completion of each backup process, ensuring that all critical data is consistently safeguarded and available for restoration if needed. For more details, refer to cPanel Backup Documentation (<https://docs.cpanel.net/cpanel/files/backup-for-cpanel/>).

3.5. Implementation Plan

The portal will be updated according to the needs of the project, with support from UZ-FSB available via email during the project period. The portal is in continuous development, evolving with the data from various work packages and according to the needs of WP leaders. Additionally, task T6.1.2 On-going Portal Content Update (LP: UZ-FSB; Part: All Partners) will focus on regular content updates and the implementation of additional features on the EcoDaLLi portal throughout the project's duration. Special attention will be given to enhancing the Governance pillar to promote awareness and emphasize the importance of sound policy decisions for the sustainable use of river resources. These updates and new functionalities will support project activities and improve the portal's effectiveness as a resource for stakeholders.

4. Interactive Features

In this section, the focus will be given on the implemented EcoDaLLi portal tools, and those that are developed, but not fully online operate due to not yet prepared or implemented content. Portal homepage is structured that all features are available from header menu, as shown in Figure 4.



Figure 4 EcoDaLLi portal header menu in desktop and mobile version

4.1. Nature-Based Solutions Content Catalogue

The EcoDaLLi project is dedicated to enhancing the protection and restoration of freshwater ecosystems and biodiversity within the Danube River basin. A key component of this initiative is the development and online publication of a comprehensive Nature-Based Solutions (NBS) catalogue, accompanied by a robust NBS assessment methodology. This effort is encapsulated within Work Package 2 (WP2), which outlines a structured approach to identifying, assessing, and promoting best practices in biodiversity conservation and restoration. The process began with Task 2.1, which focused on creating a methodology for NBS assessment. This task was led by FTN, with contributions from GeoEcoMar, INCDDD, ICLEI EURO, ADRM, UZ-FSB, BOKU, WWF Hungary, and SMS. Over the first eight months (M1 – M8), the team leveraged existing knowledge to establish a comprehensive methodology designed to identify best practices in biodiversity conservation and restoration along the Danube River basin, including its delta. The outcome of this task was documented in Deliverable D2.1, providing a foundational framework for subsequent assessments. The NBS methodology and the comprehensive catalogue of NBS initiatives have been made available online through the EcoDaLLi portal. This digital resource serves as a vital tool for stakeholders, providing access to detailed information on best practices, methodologies, and policy recommendations for biodiversity conservation and restoration. By facilitating easy access to these resources, the portal supports the broader goal of fostering sustainable development and ecosystem resilience within the Danube River basin. Figure 5 shows developed framework that will be presented at the portal for different NBSs.

Type 1 NBS	Type 2 NBS	EcoDaLLi NBS CATALOGUE	
Monitoring Regular monitoring of physical, chemical or biological indicators	Sustainable management protocols Creation and preservation of habitats and shelters to support biodiversity	 	
Country Hungary	Project summary: Project site is at Szőlőiget, 30 km north of Budapest along the Danube Bend. Work here will focus on the re-dynamization of the river section through ecological groyne optimization - the first implementation in the field in Hungary. River regulations resulted in loss of habitats and loss of side arms all along the Danube river. Danube has a channel character in many sections with low structural diversity. One of the typical situation is located at the 1675 Rkm. Two groynes have been built in the Danube right side littoral zone as a river regulation infrastructure. Between the groynes sedimentation and siltation have been found. Gravel littoral zone turned into slow flowing or standing water with mud. The dynamic character of the river has been totally lost in this 600 m long habitat. Nevertheless, it is well known that navigation has a negative impact on ecology. The main impact is wave stress for aquatic species. Navigation impacts are significantly higher in channelized sections.		
River, water body Danube	Replication and scalability Lots of old water regulation structures are along the Hungarian Danube stretch which could be revised and reshaped thus protecting siltation and riverbed narrowing and juvenile fish and macroinvertebrates from waves caused by heavy ship traffic.		
Societal Challenges 	Participation process DANUBE4all will closely cooperate with the local communities, inhabitants, SMEs, and stakeholders to optimise the final design, strengthening participation before, during and after implementation of the measures e.g., by involving Citizen Science in monitoring programs		
Other:	Best practices and references 1. Increasing biodiversity of the area (app. 50 ha) following by the increased structural diversity; 2. 10-20 cm/s velocity in littoral zone (nursery for reophilous species) even at low water level; 3. The island will provide a safe habitat against wave stress; 4. The island will be sustainable in the long term. 5. The restoration is compatible with both navigation and flood protection interests.		
Stage ME Size B	Lessons learnt Project is ongoing, these can be concluded in a later stage.		
Geotype N IS yes	Environmental, socio-cultural, economic impacts Richness of biodiversity and habitats increases while the section will be suitable as fish spawning area. Also it helps to maintain the fairway conditions. This provides also more opportunities for anglers and less invasive species will be present. It will be a good example to be replicated representing an NBS for navigation and biodiversity as well. And the richer is the biodiversity the better it can mitigate also climate change effects.		
Project WEBSITE https://www.danube4allproject.eu/middle-danube			
			

Figure 5 WP2 results: NBS catalogue

4.2. Stakeholder Mapping Tool

The EcoDaLLi project is dedicated to enhancing the protection and restoration of freshwater ecosystems in the Danube River basin through the development of a comprehensive tool for stakeholder mapping, which will be available on the project portal. This tool is designed to facilitate the identification, categorization, and engagement of stakeholders involved in city-river interactions and ecosystem-based practices across the basin. The first phase involves creating an inventory of innovative solutions for city-river interactions and conducting detailed stakeholder mapping. Partners will map local and cross-border stakeholders essential for the Comprehensive Spatial Assessment (CSA). This mapping covers technical aspects related to biodiversity, water systems, and climate change areas, including relevant actors involved with ports and fleets, protected natural areas, utilities, environmental protection regimes, land-use regimes, tourism, and other sectors. The process ensures representation from academia, governance, business, and citizens, and covers the spatial dimensions of the SCA Lighthouse: Upper Danube, Middle Danube, Lower Danube, and the Delta. The mapping exercise is led by ADRM and ICLEI, who develop guidelines. Using the methodology established in WP2, the team maps innovative ecosystem-based practices in local, cross-border, and transnational spatial policies within the four territorial units and at the watershed/basin level of the Danube River basin. This includes tailored stakeholder groups and considers the temporal dimension, with results presented in Deliverable D3.1. Subsequently, ICLEI leads the initiative to foster knowledge co-creation and stakeholder engagement, with support from various partners. This includes peer-to-peer and expert meetings within established events, such as ICLEI's and

EEA's European Urban Resilience Forum. Additionally, a roundtable with local actors will facilitate knowledge exchange, co-creation, and citizen involvement in policies, strategies, socio-economic paths, and ecosystem-based approaches and solutions at river-city, cross-border, and transnational policy levels. The outputs will feed into the activities in WP4 - Living Labs and will be documented in Deliverable D3.2.

To further enhance stakeholder engagement, the project aims to establish the EcoDaLLi local panel. This involves defining recommendations from workshops and organizing an expert meeting to draft a proposal for the panel, including a charter, sub-panels, and a program. The panel will enable the integration of policies, strategies, approaches, and solutions at local, cross-border, and transnational levels across the four Danube River basin territorial units. Additionally, recommendations for training programs will be developed to enhance the innovation potential of local stakeholders and promote citizen engagement techniques. Finally, an ecosystem impact assessment focused on urban land-use transformations and integrated spatial policies for river cities and cross-border areas will be conducted. The framework developed will address interconnected local and trans-border challenges in the Danube Region by fostering inclusion and collaboration across all sectors and levels, from community groups to government agencies. Rooted in the experiences of small communities in the Danube Basin, the framework will promote innovation in spatial and temporal policies for sustainable urban economies, biodiversity and water resource protection, climate change adaptation, and globalization. This shared vision for change will engage stakeholders critical to sustainable adaptation and respond to priorities for COP27. The stakeholder mapping tool developed through these efforts will be integrated into the EcoDaLLi portal. This tool will provide a dynamic platform for identifying, categorizing, and engaging stakeholders across various sectors and regions of the Danube River basin. It will support the dissemination of innovative solutions, facilitate knowledge exchange, and promote collaborative efforts for ecosystem preservation and restoration. By providing stakeholders with access to this comprehensive mapping tool, the portal will enhance the overall effectiveness and reach of the EcoDaLLi project.

For mapping tools, open-source tools Leaflet.js (<https://leafletjs.com/examples/layers-control/>) and uMap (<https://umap.openstreetmap.fr/en/>) will be utilized, both of which are based on Open Street Map (<https://www.openstreetmap.org/>). These tools provide an interactive and robust platform for data visualization and stakeholder engagement. Primary stakeholders of the portal include the project partners involved in the EcoDaLLi project. Secondary stakeholders encompass all entities interested in Danube-related topics, innovation action projects in the Danube region, workshops, best practices, and those seeking financial support. By leveraging these advanced mapping tools and engaging a wide range of stakeholders, the EcoDaLLi portal will significantly enhance its role as a vital resource for ecosystem management and innovation in the Danube River basin.

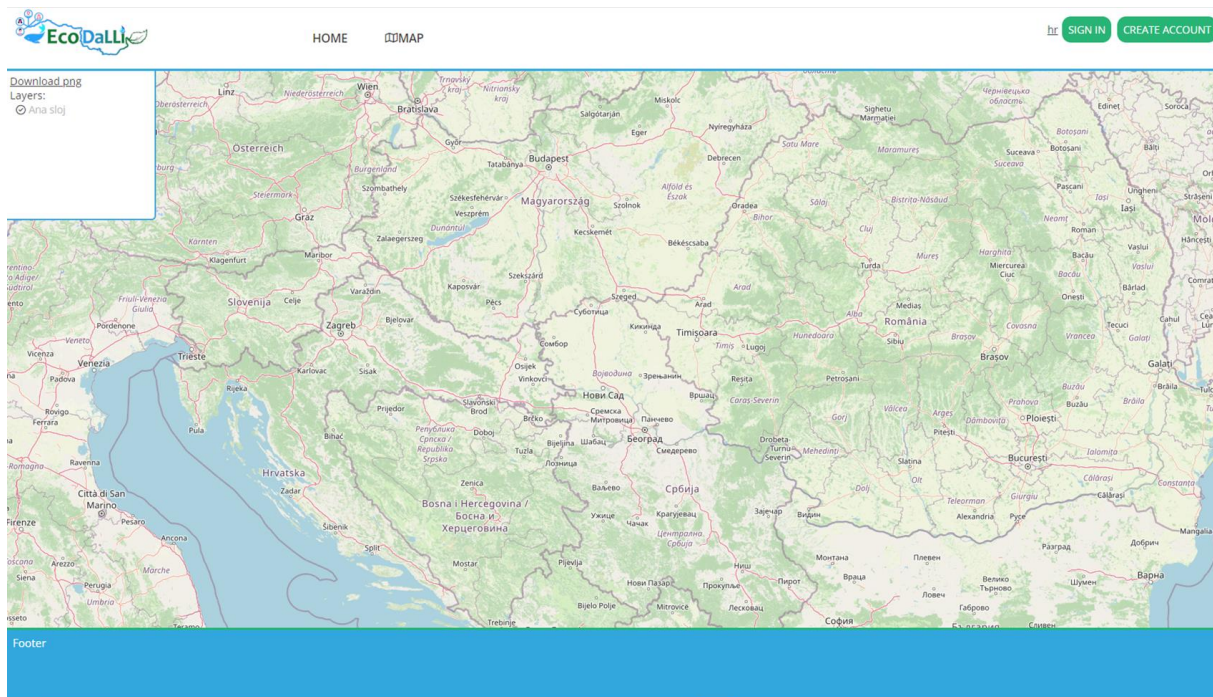


Figure 6 Developed GIS mapping tool

4.3. Filtering Tool

The EcoDaLLi project places significant emphasis on mapping innovation services within the Danube River basin through Work Package 5 (WP5). This initiative is designed to identify, categorize, and disseminate innovative services that contribute to the protection and restoration of freshwater ecosystems. The same comprehensive mapping tool developed in WP3 for stakeholder mapping will be utilized to capture the results of WP5. This integrated approach ensures consistency and leverages the robust capabilities of the tool to map both stakeholders and innovative services effectively. In the initial phase, partners will undertake a detailed mapping of innovative services, focusing on technical solutions, governance models, business strategies, and other relevant practices that support ecosystem-based management. This mapping will cover local, cross-border, and transnational levels, ensuring a comprehensive overview of the services available across the entire Danube River basin. The process involves engaging stakeholders from various sectors, including academia, governance, business, and civil society, to gather diverse insights and ensure that the mapping reflects the full spectrum of innovative practices, such as those documented in Deliverable D3.1 on ecosystem-based practices. The project will develop a robust methodology for the mapping exercise, building on existing frameworks and incorporating new insights gained from stakeholder interactions. This methodology will guide the identification and categorization of innovative services, ensuring that the mapping is systematic and comprehensive. The results of this exercise will be documented in Deliverable D5.1, which will provide a detailed overview of the innovative services identified. Additionally, the mapping tool will feature an enhanced filtering tool that allows users to filter innovations based on specific parameters:

- Country
- Actor providing funding
- Actor providing innovation services

Following the initial mapping, the project will focus on refining and validating the results through a series of workshops and stakeholder engagements. These activities will provide an opportunity to gather feedback on the mapped services, identify any gaps or areas for improvement, and ensure that the mapping is accurate and up-to-date. The feedback gathered during these engagements will be used to refine the methodology and update the mapping as needed. The final phase involves integrating the mapping of innovation services into the EcoDaLLi portal. This will create a dynamic platform where stakeholders can access detailed information about innovative services, explore best practices, and connect with service providers. The portal will facilitate knowledge exchange and promote the adoption of innovative services across the Danube River basin. By making this information readily available, the portal will support stakeholders in identifying and implementing effective solutions for ecosystem management. Overall, the mapping of innovation services within WP5 will play a crucial role in enhancing the EcoDaLLi project's impact. By providing a comprehensive and accessible overview of available services, the mapping will help stakeholders make informed decisions, foster collaboration, and drive the adoption of innovative practices for the preservation and restoration of the Danube River basin's ecosystems. The integration of the WP3 mapping tool and the additional filtering capabilities will significantly enhance the functionality and usability of the portal, making it an indispensable resource for all stakeholders involved.

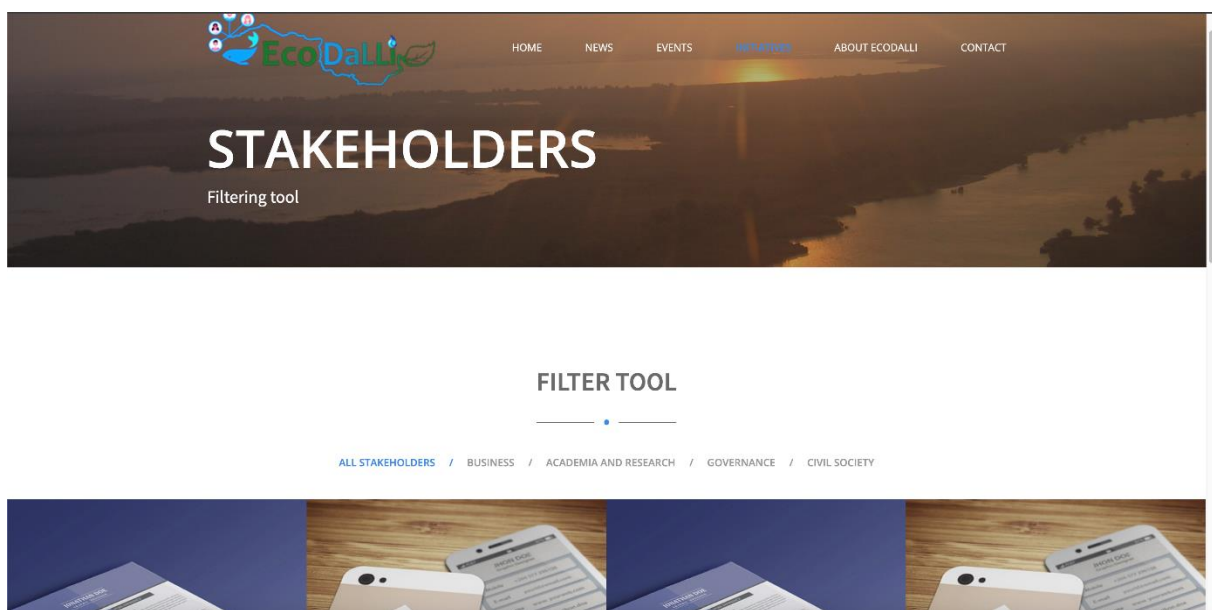
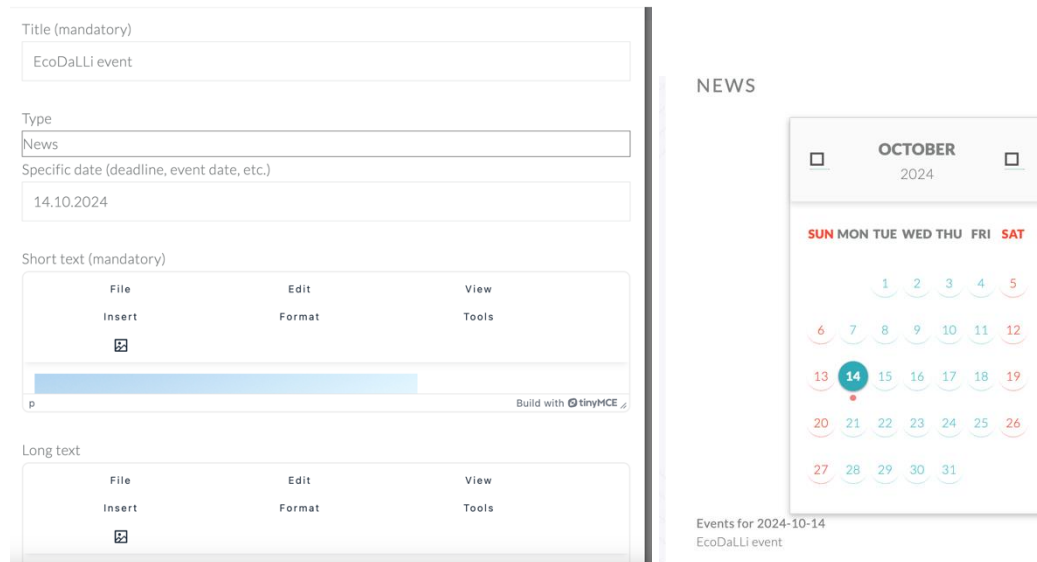


Figure 7 Filtering tool developed for WP3 and WP5

4.4. Event Calendar

The EcoDaLLi portal will include an event calendar that showcases all relevant events for the Danube Lighthouse and associated Innovation Action projects. Only users with the appropriate permissions, primarily project partners, will be able to directly add events. Other users can submit events for review, which will be published upon approval. The calendar is built using TinyMCE and PIGNOSE open-source packages. TinyMCE provides a rich-text editor for

adding event descriptions, while PIGNOSE offers a highly customizable and visually appealing calendar with features like multiple date selection, scheduling options, and support for various themes and languages. Figure 8 shows event calendar tool based on PIGNOSE, and event editor form based on TinyMCE that is available from profile dashboard.



The figure displays two components of the event management tool. On the left is the 'Event submitting form' which includes fields for 'Title (mandatory)' (containing 'EcoDaLLi event'), 'Type' (set to 'News'), and 'Specific date (deadline, event date, etc.)' (set to '14.10.2024'). Below these are two 'TinyMCE' rich text editors for 'Short text (mandatory)' and 'Long text', each with a toolbar and a 'Build with tinyMCE' link. On the right is the 'NEWS' section featuring a calendar for 'OCTOBER 2024'. The calendar shows dates from 1 to 31, with the 14th highlighted. Below the calendar, it states 'Events for 2024-10-14 EcoDaLLi event'.

Figure 8 Event calendar tool with event submitting form

4.5. Section for Practices Living Lab Systems (PLLS)

The tool will be implemented based on the developed manual for Practices Living Lab Systems (PLLS). This manual provides a comprehensive framework to ensure the effective setup and coordination of PLLS, focusing on fostering collaboration, stakeholder engagement, and the dissemination of best practices. The implementation will adhere to the methodologies and strategies detailed in the manual, facilitating structured communication and co-creation processes across the project's sites and ensuring consistent and impactful outcomes aligned with the EcoDaLLi project's goals. Currently, the manual exists only as a PDF document, and further development is planned to integrate it into a more interactive format.

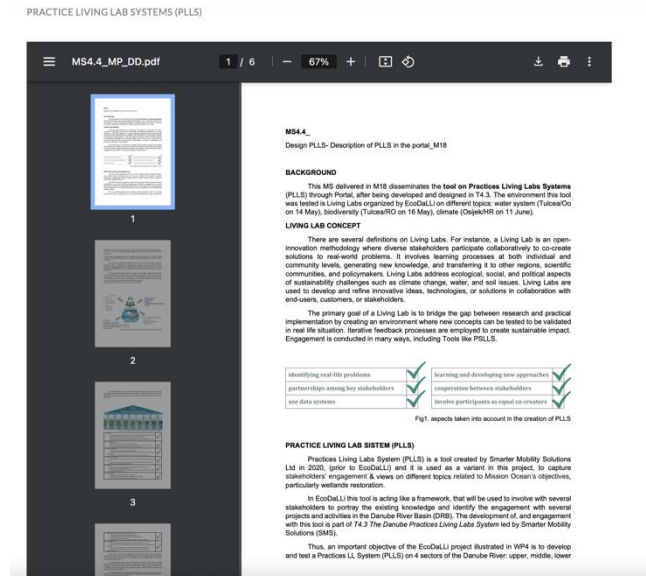


Figure 9 Current PLLs tool as pdf document

4.6. Newsletter

Newsletters are created for all Danube Lighthouse projects using Mailchimp, and polls will be created using Microsoft Forms, which will be integrated with the project Teams folder owned by Steinbeis Europa Zentrum GmbH. Generating new data applications and technologies through citizen science projects will yield valuable datasets to inform policy decisions, improve environmental monitoring, and drive technological innovations.

4.7. Localization and Accessibility

Localization will ensure that some features are translated into the languages of all project partners, using a digital dictionary filled by project partners. The portal is developed to be available in 10 languages (shown in Figure 10):

- English
- German
- French
- Romanian
- Hungarian
- Serbian
- Croatian
- Bulgarian
- Greek
- Georgian

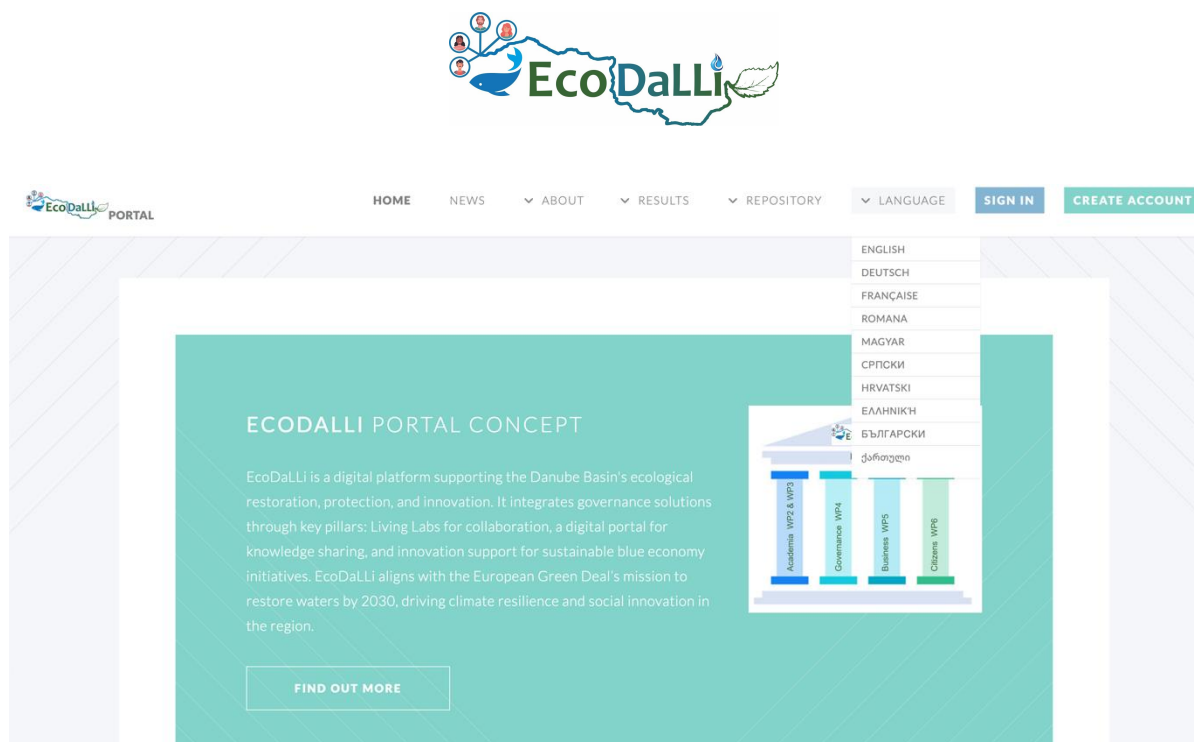


Figure 10 Available languages of EcoDaLLi portal

4.8. Connections with Mission Implementation Portal and Digital Twin Ocean Portal

The EcoDaLLi portal is currently developed with direct links to the Digital Twin Ocean and Mission Implementation Support Platform. The EcoDaLLi portal development team actively participates in Help Desk Development meetings alongside other Lighthouse projects and the Prep4Blue project to harmonize data and improve inter-portal connections. In future content updates, these links will be further enhanced to align with agreements made under the Mission Ocean Help Desk Development framework, ensuring a more integrated and cohesive support system across the participating initiatives.

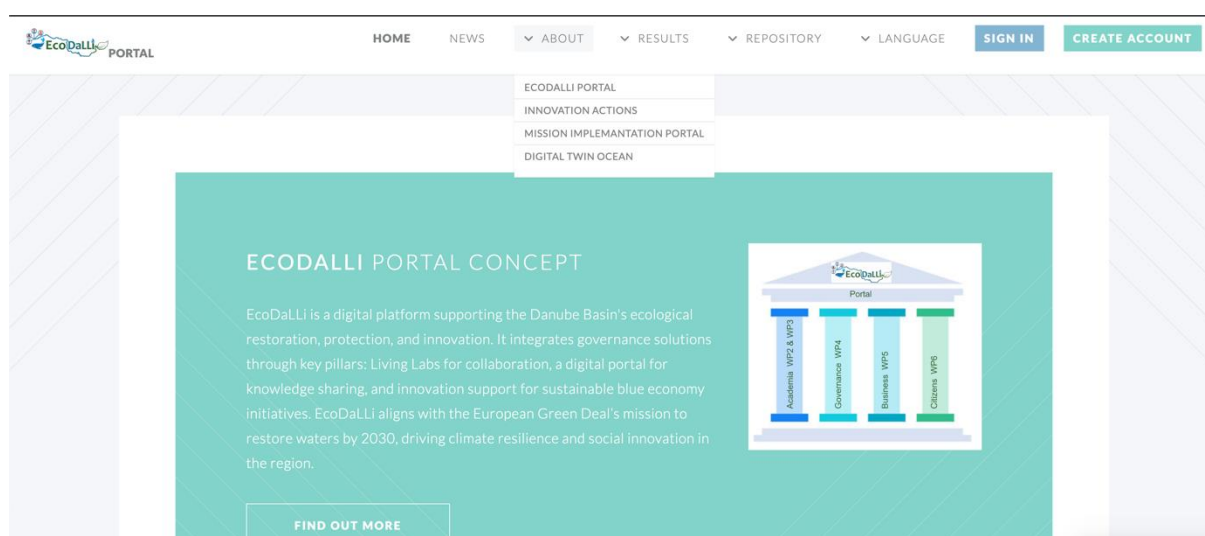


Figure 11 Links to Mission Implementation portal and Digital twin ocean portal

5. Data Collection and Management

This section addresses the primary focus of Deliverable D1.4 - Data Management Plan within the EcoDaLLi project. Detailed and comprehensive information regarding data collection methodologies, management strategies, and protection protocols can be found in D1.4. This condensed overview provides essential insights into the project's approach to gathering, organizing, and securing data to support its objectives effectively.

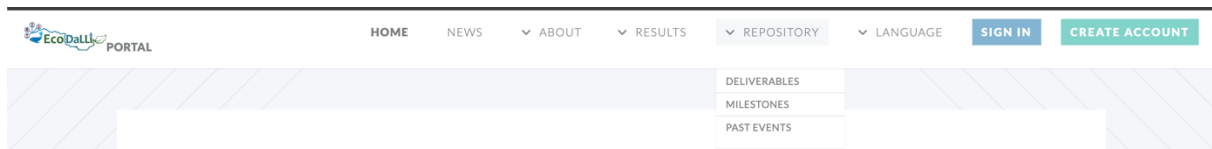


Figure 12 EcoDaLLi repository

5.1. Data Categories

The EcoDaLLi project organizes data into structured layers, categorizing information based on type and relevance to project objectives. This systematic approach ensures efficient data management and retrieval, facilitating comprehensive analyses and informed decision-making processes throughout the project lifecycle. The structured organization allows for streamlined data flow and supports the project's diverse analytical needs.

Processing Layer: Advanced methodologies are applied within the processing layer to refine and enhance data quality. This includes AI-based data preparation techniques to improve data integrity, harmonization of datasets to ensure consistency, and the integration of sophisticated analytics capabilities to derive actionable insights. These processes transform raw data into valuable information, ready for analysis and decision-making.

Storage Layer: Secure and scalable data storage mechanisms are implemented to maintain the integrity and accessibility of project data. Robust storage solutions include backup and recovery capabilities, compliance with data protection regulations such as ISO 27001 and ISO 22301, and adherence to best practices in data management. These measures protect against data loss and unauthorized access, ensuring the project's data assets are secure and reliable.

User Interface Layer: User-friendly interfaces and APIs are developed to provide intuitive data retrieval and interaction for end-users. These interfaces offer seamless access to integrated datasets, visualization tools for data exploration, and features for generating reports and conducting analyses. This layer empowers stakeholders to effectively utilize the project's data assets, enhancing user engagement and facilitating the extraction of meaningful insights.

Front-End Technology Stack

With a UX design provided, the technology stack for the front-end of the web-based dashboard focuses on accessibility, responsiveness, performance, scalability, security, and maintainability. Redux is implemented to simplify the development and management of state machines, which are essential for handling business logic within the dashboard. To ensure

robust and reliable code quality, Jest and Cypress are used for unit and integration testing, respectively. The Data Processors screen, potentially renamed for better user-friendliness, lists all connected data processors, allowing users to search and prioritize those they are involved with. Summary information for each data processor can be included, depending on technical feasibility. Each entry can be expanded to show detailed data sharing and requesting information, as well as data exchanged with other processors. Additionally, controls for updating information and permissions are provided, ensuring users have comprehensive and actionable insights into their data interactions. The integration with secure authentication protocols, such as encrypted cookies, and the use of Let's Encrypt for SSL certificates further bolster the security and reliability of the EcoDaLLi portal, ensuring a safe and trustworthy environment for all users.

6. Community Engagement

The EcoDaLLi project's online interactive portal is designed to engage targeted groups from each of its four pillars: Governance, Citizens, Business, and Academia. By promoting proactive participation in ecosystem restoration, the portal aims to encourage stakeholders to become actively involved in the preservation and enhancement of the Danube River basin's ecosystems. It will propose effective solutions tailored to the specific needs and challenges identified within the region, ensuring that stakeholders have access to practical and actionable strategies for ecosystem management. A key feature of the portal is its role as a comprehensive database and collection of catalogues on good practices. This repository will serve as a valuable resource for stakeholders, offering insights into successful ecosystem-based practices and enabling the sharing of knowledge and experiences. By facilitating active communication among stakeholders about Danube basin ecosystem preservation and restoration, the portal will foster a collaborative environment where ideas, solutions, and concerns can be openly communicated and addressed. The portal is committed to ensuring broad engagement of the community, reaching out to diverse groups and encouraging their participation in the project's initiatives. This inclusive approach will help to build a strong network of stakeholders who are invested in the health and sustainability of the Danube River basin. By providing a platform for stakeholders to communicate their ideas, solutions, or concerns, the portal will enhance the collective capacity to address environmental challenges and implement effective restoration strategies.

6.2. Expected Impact

The expected impact of the portal is significant, as it aims to support the EcoDaLLi project's mission by fostering sustainable development, innovation transfer, and ecosystem resilience in the Danube River basin. By serving as a vital tool for knowledge dissemination, the portal will enhance stakeholder engagement and facilitate collaborative problem-solving, contributing substantially to the project's overall impact. The portal's dynamic and user-friendly platform will ensure broad engagement and effective communication among stakeholders, facilitating the successful implementation of innovative solutions and practices across the Danube River basin. This will be achieved through a well-structured and accessible interface that caters to

the needs of different user groups, promoting active participation and continuous interaction. Key Performance Indicators (KPIs) for the portal, along with other metrics, will be detailed in the Grant Agreement. These KPIs will provide a framework for measuring the portal's success

in achieving its objectives, ensuring that it remains focused on delivering tangible benefits to the ecosystem and its stakeholders. Through this comprehensive approach, the D6.1 deliverable will play a crucial role in advancing the EcoDaLLi project's goals and fostering a sustainable future for the Danube River basin.

7. Current Status and Future Work

While the EcoDaLLi portal is currently in its initial operational phase and serves as a repository for EcoDaLLi's Deliverables and Results it does unfortunately not yet deliver on all planned features. It has made significant progress in its development: The main structure of the portal has been established, organized into four primary sections: Governance, Citizens, Business, and Academia, the portal's architecture and hosting have been set up, including robust security measures such as data encryption and access control mechanisms and it has been designed to support multiple languages and integrate contributions from various work packages. However, additional work will be required to make sure that the portal fully delivers on the expected outcomes and successfully supports the EcoDaLLi projects implementation.

The portal will be updated to serve as a centralized hub for stakeholders to access and share information related to the protection and restoration of freshwater ecosystems in the Danube River basin. It will integrate data and insights from various work packages, providing a comprehensive repository of methodologies, stakeholder mapping tools, and information about Living Labs and Practices Living Lab Systems. The portal currently includes links to the Digital Twin Ocean and the Mission Implementation Support Platform and will continue to expand its interactive features such as data visualization, newsletters, and polls, all designed to enhance user engagement and facilitate the exchange of ideas and solutions among stakeholders. These features will be online and fully operable until end of November 2024.

The development of the EcoDaLLi portal will continue to evolve through to M42 (June 2026), incorporating inputs and outcomes from ongoing and upcoming work packages. The content for the four main pillars: Governance, Citizens, Business, and Academia will be further refined, ensuring that it meets the evolving needs of stakeholders. The municipalities of Draž and Tulcea will actively implement and test the developed solutions in their local areas to validate the applicability of these tools and methodologies. Feedback and insights gathered from these implementations will be used to further refine and optimize the solutions, ensuring their effectiveness and scalability across different regions of the Danube River basin. In addition to serving as a repository of methodologies and tools, the portal will evolve to include a catalogue of technical services, toolboxes, governance, and business models that support the deployment of solutions produced under the associated Innovation Action projects. It will also be developed as a gathering point for various stakeholders, facilitating the transfer of knowledge and the exchange of best practices and innovative ideas. This effort will culminate in a digital guide that consolidates lessons learned from implemented solutions and good-practice examples for ecosystem restoration.



As the EcoDaLLi portal progresses, it will establish further synergies with other initiatives and platforms under the Mission Ocean and related projects to provide a comprehensive overview of innovative actions and solutions. The development team actively participates in Help Desk Development meetings together with other Lighthouse projects and the Prep4Blue project to harmonize data and improve connections between platforms. Future content updates will further align these connections with agreements established under the Mission Ocean “Help Desk Development” framework.

Additionally, the tools and functionalities stemming from WP2, WP3, and WP4 results will be finalized and integrated into the portal by the end of November 2024. These updates will further enhance the portal’s capability to serve as a comprehensive and dynamic platform for knowledge dissemination and stakeholder interaction.

The involvement of the Governance sector will be a key focus in future development phases, as this sector plays a pivotal role in overcoming barriers related to the preservation and restoration of the Danube River. By actively engaging governance stakeholders in content creation and the implementation of project results, the portal aims to empower these stakeholders to take ownership of the resources and utilize them effectively for sustainable ecosystem management. This part for Citizen-Governance interaction will be developed during the project duration.