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Project acronym:	EcoDaLLi
Project title:	ECOsystem-based governance with Danube-Black Sea 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

EcoDaLLi

Deliverable 3.3

Shared vision on spatial policies for the protection and restoration of freshwater ecosystems and biodiversity in the Danube River basin and its Delta

Grant Agreement No.: 101093908

Funded by the European Union

Deliverable Name	Shared vision on spatial policies for the protection and restoration of freshwater ecosystems and biodiversity in the Danube River basin and its Delta
Deliverable Number	D3.3
Work Package	WP3
Associated Task	T3.4
Due Date	M30 (June 2025)
Completion Date	
Submission Date	
Deliverable Lead Partner	Partner – DDNI

Dissemination Level		
PU	Public	X
SEN	Sensitive	

Change Control | Document History				
Version	**Date**	**Change History**	**Authors**	**Organization**
1.1	26.03.2025	First draft	Dragos Balaican Iulian Nichersu	DDNI
1.2	17.04.2025	Second draft	Dragos Balaican Iulian Nichersu	DDNI
1.3	23.04.2025	Third draft revised	Steffen Büchen	BML-BAW
1.4	03.05.2025	Forth draft revised	Rossana Didonna, Simon Race, Lorea Martin Abad	ICLEI
1.5	26.05.2025	Fifth draft revised	Boryana Stancheva	ADRM
1.6	24.06.2025	Final version	Dragos Balaican	DDNI

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Abbreviations and Acronyms

3R	Restoration, Revitalization, and Regeneration
ABM	Agent-Based Models
CA	Cellular Automata
CAP	Common Agricultural Policy
CSA	Coordination and Support Action
DRBMP	Danube River Basin Management Plan
DSP	Directorate for Public Sanitation
EBA	Ecosystem Based Adaptation
EI	Ecosystem Innovation
EMDS	Ecosystem Management Decision Support System
ER	Ecosystem Restoration
ES	Ecosystem Services
EU	European Union
FLUS	Future Land Use Simulation Model
GIS	Geographic Information System
IA	Innovation Action
ICPDR	International Commission for the Protection of the Danube River
IUCN	International Union for Conservation of Nature
LFA	Logical Framework Analysis
LL	Living Lab
LULUCF	Land Use, Land Use Change, and Forestry
NBS	Nature-based solutions
NGO	Non-governmental Organisation
OECD	Organisation for Economic Co-operation and Development
PCT	Project Core Team
PSS	Planning Support Systems
SD	System Dynamics
SDG	Sustainable Development Goal
TUR	Transformative Urban Recovery
UN	United Nations
UNDAF	United Nations Development Assistance Framework
UNEA	United Nations Environment Assembly
WP	Work Package

Executive Summary

Deliverable D3.3 presents a shared, cross-sectoral vision for spatial policies that support the protection and restoration of freshwater ecosystems and biodiversity in the Danube River Basin and its Delta. Developed under Task 3.4 of the EcoDaLLi project, it translates stakeholder engagement processes into policy-relevant spatial strategies aligned with the EU Mission "Restore our Ocean and Waters by 2030" and the European Green Deal's biodiversity goals.

The deliverable builds on the foundations laid in D3.1 and D3.2, which established the framework for shared vision building by integrating regional stakeholder perspectives. D3.3 takes this further by integrating these insights into spatial development scenarios using a methodology based on Logical Framework Analysis (LFA) and Planning Support Systems (PSS). This combined approach enables evidence-based scenario modeling, dynamic spatial planning, and policy evaluation across diverse geographic and institutional contexts within the Danube Basin.

The modeling framework is structured around the 3R approach—Restoration, Revitalization, and Regeneration—and is supported by participatory validation in real-life contexts, including Living Labs. The scenarios were tested in locations such as the Danube Delta, offering practical insights into ecological planning and adaptation to climate variability.

Key outcomes of this deliverable include:

- A structured methodology for integrating spatial and ecosystem-based planning in freshwater governance;
- Policy recommendations tailored to cross-border regions and urban-rural dynamics;
- Tools to support participatory decision-making and multi-actor collaboration;
- Alignment with broader EU strategies on climate resilience, biodiversity protection, and sustainable land use.

D3.3 is intended for policy-makers, spatial planners, researchers, and regional stakeholders seeking actionable guidance on integrating ecosystem and biodiversity priorities into spatial development. By combining science-based tools with participatory contributions, this deliverable provides a strategic pathway toward resilient, coordinated freshwater governance across the Danube region. This shared vision aims to catalyze long-term alignment of regional policies and foster community empowerment through inclusive governance of freshwater ecosystems.

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1. Introduction

1.1. Project Information

The present deliverable is developed within the framework of the EcoDaLLi Project – ***ECOsystem-based governance with Danube-Black Sea Lighthouse Living Lab for sustainable Innovation processes***. Funded under the Horizon Europe Programme (Grant Agreement No. 101093908), EcoDaLLi is embedded in the EU Mission "Restore our Ocean and Waters by 2030", with a focus on freshwater ecosystems in the Danube River Basin.

As a Coordination and Support Action (CSA) for the Danube-Black Sea Lighthouse, EcoDaLLi is mandated to contribute to the Mission Objective to "Protect and restore marine and freshwater ecosystems and biodiversity, in line with the EU Biodiversity Strategy 2030". The project integrates coordinated, systemic actions to support the European Green Deal's freshwater targets, with an emphasis on ecological restoration, protection, and long-term preservation of the Danube Basin and its Delta.

Main Objective

EcoDaLLi aims to centralise governance structures in the Danube region through innovative and scalable solutions. These are supported by a well-connected Practices Living Lab System and a digital Portal that is fully integrated with the Mission Implementation Platform. The project fosters a stronger innovation ecosystem by facilitating multi-actor collaboration, knowledge sharing, participatory policy development and implementation.

Lighthouse Framework

The EU Mission defines Lighthouses as hubs and platforms that drive the development and implementation of transformative innovations—technological, social, business, and governance-oriented. These innovations accelerate progress towards Mission objectives while delivering societal impact across key river and sea basins. Within this framework, the Danube-Black Sea Lighthouse specifically targets:

- Restoring at least 25,000 km of free-flowing rivers in Europe
- Contributing to EU nature restoration targets

Strategic Alignment

EcoDaLLi aligns with the Danube River Basin Management Plan (DRBMP) (2009, Update 2021), which highlights key restoration priorities such as:

- Re-establishing longitudinal and lateral connectivity
- Enhancing biodiversity and ecosystem functionality

The project also emphasizes social innovation, climate change mitigation, and the reduction of environmental risks and costs through multi-level participatory adaptive governance models. It also fosters synergies across policy levels and sectors by actively engaging stakeholders in Living Labs and cross-border cooperation platforms, strengthening resilience and coherence in spatial planning processes throughout the Danube region.

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1.2. Focus of D3.3

This deliverable, D3.3 – ***Shared Vision on Spatial Policies for the Protection and Restoration of Freshwater Ecosystems and Biodiversity in the Danube River Basin and its Delta***, presents the coordinated outputs of stakeholder engagement, spatial scenario development, and ecosystem-based policy modelling carried out under Task 3.4 - *Ecosystem impact assessment for transformations of urban land-uses (integrated spatial policies for river cities & cross-border areas)*, of the EcoDaLLi project.

The purpose of this deliverable is to establish a shared, cross-sectoral vision for spatial policies that support the long-term restoration, protection, and preservation of freshwater ecosystems and biodiversity in the Danube River Basin and its Delta. These efforts contribute to the implementation of EcoDaLLi's ecosystem-based governance approach, reinforcing EU-level commitments on ecological restoration and integrated water management.

D3.3. is the final output of WP3 - Innovative practices in spatial policies for the protection and restoration of freshwater ecosystems and biodiversity. Building upon the work in D3.1 - *Inventory of at least 8 innovative ecosystem-based practices in local, cross-border, transnational spatial policies in the 4 territorial units & at watershed/basin level of Danube River basin,* and D3.2 - *Reports of at least 4 sessions organized by EcoDaLLi as part of established events*, this deliverable translates stakeholder-driven scenarios into policy-relevant spatial development strategies. These scenarios are grounded in scientific evidence, participatory processes, and systems thinking, and are tailored to the Danube's ecological conditions, socio-political contexts, and institutional frameworks, ensuring their relevance and applicability across diverse territorial realities in the basin.

The core objective is to support integrated land and water governance through evidence-based recommendations and adaptive planning tools. The deliverable emphasizes:

- Systemic, cross-border collaboration aligned with the Danube River Basin Management Plan (DRBMP)
- Strategic restoration targets, such as restoring connectivity and enhancing biodiversity
- Support for nature-based solutions and ecosystem services in urban and rural planning

1.3. Structure of D3.3

The structure of the deliverable is organized as follows:

- **Chapter 1 – Project Information** introduces the EcoDaLLi project and explains the focus and context of D3.3 within the larger Mission framework.
- **Chapter 2 – Methodology** outlines the tools, data sources, and modelling approaches used to develop and assess spatial policy scenarios. It includes Logical Framework Analysis (LFA), Planning Support Systems (PSS), and ecosystem impact models.
- **Chapter 3 – Validation of Policy Recommendations and Lessons Learned** presents the shared EcoDaLLi Vision, validated policy scenarios, and key lessons learned from stakeholder engagement and modelling activities.

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- **Chapter 4 – Conclusion** summarizes the main findings and suggests future directions, including implementation through Living Labs and local training on nature-based solutions.

This structure ensures alignment with the broader EcoDaLLi framework, while staying focused on the core goals of Task 3.4—supporting ecosystem-based spatial planning and cross-border cooperation for river basin restoration.

2. Methodology

2.1. General overview

A scenario-based dynamic spatial and temporal modeling approach is proposed within this deliverable to address the project's objectives, enabling a precise alignment of local policy scenarios and targeted development patterns. This method supports practical spatial planning decisions and improves resilience against climate variability and biodiversity loss. The analysis considers multiple sustainable development and adaptation scenarios aimed at achieving neutrality in ecosystem degradation and assessing their potential impacts using the Restoration, Revitalization, and Regeneration (3R) approach.

This planning support approach effectively integrates spatial analysis, simulation modeling, participatory planning, and policy review. Initially, it examines the rules and correlations underpinning the transformation of territorial units driven by human-land interactions, identifying mechanisms that cause shifts in resource use and ecosystem services. Subsequently, diverse simulations are generated using representative case studies, including the Danube Delta, as test sites for validating the practicality and robustness of adaptive solutions. Socioeconomic, ecological, and 3R-specific themes enrich the simulations, offering comprehensive insights into potential landscape transformations. Visualization techniques are employed to interpret simulation outcomes, producing strategic policy recommendations tailored to sustainable land-use practices and ecological management.

Adapting successful ecosystem transformation experiences within the Danube Basin poses significant challenges and cannot rely solely on replicating previous initiatives. Therefore, the deliverable emphasizes the creation of generalizable, model-supported planning frameworks, investigating their broader applicability and scalability across the region.

The overall framework aligns with the Danube-Black Sea Lighthouse initiative, integrating Nature-Based Solutions (NBS), Ecosystem Innovation (EI), and Transformative Urban Recovery (TUR). This multi-stakeholder, integrated strategy targets interconnected local and cross-border challenges. It promotes inclusive collaboration across sectors and governance levels, from community groups to government agencies. Drawing from the experiences of small communities within the Danube Basin, this methodology fosters innovative approaches in spatial and temporal policy-making, addressing urban sustainability, biodiversity conservation, water resources protection, and climate adaptation. Moreover, it aligns with priorities identified in COP27, emphasizing systemic adaptation and sustainable development in response to increasing climate pressures.

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2.1.1. Limitations and considerations

The methodology implementation confronted several challenges that need careful consideration to ensure the robustness and scalability of the approach:

- Limited and fragmentated interoperability of spatial and environmental datasets, stemming from national-level differences in data standards and availability;
- Differences in planning systems, institutional frameworks and governance models across the Danube countries, which affect the alignment of spatial policies;
- Limitations in access to continuous, high-quality environmental monitoring data, especially in cross-border areas;
- Challenges in translating complex simulation outputs into policy-relevant insights that are accessible and actionable for local stakeholders;
- Varied institutional readiness and technical capacity to adopt innovative spatial planning methods and technologies.

To effectively manage these challenges, the approach integrated adaptive modeling techniques, iterative stakeholder feedback, and concerted efforts in cross-border data harmonization. Active engagement through participatory activities such as Living Labs and scenario workshops were instrumental in validating model assumptions, fostering shared understanding, and enhancing the contextual relevance and applicability of the proposed generated policy solutions.

2.2. Methodological approach

For the development of the spatial policy scenarios, the Logical Framework Analysis (LFA) was applied to structure development objectives, identify policy gaps, and build causal logic for planning interventions. It involved creating problem trees, stakeholder matrices, and indicator frameworks to define and evaluate pathways to ecosystem restoration. LFA for PSS have described the various methods of integrating computer science and geographic information system (GIS) technology in urban data analysis and graphic visualization models ((Haase & Schwarz, 2009); (Liu, Peng, Clinton , Bai, & Liang, 2020)). System dynamics (SD), cellular automata (CA), and agent-based models (ABM) serve as the primary approaches used to develop these types of models.

The Planning Support System (PSS), first introduced by Harris (Harris, 1989), supports urban planning by integrating science and technology into planning processes. The concept, as the name implies, encompasses (1) planning - serving planning applications, particularly urban planning, design, and management, (2) support - having characteristics that support decision-making but not replacing the urban planner or pursuing intelligent planning solution formation, and (3) system - an interactive tool and interface through which planners can extract useful information and to input and output results that satisfy planning design and analysis. Among the macro goals of PSS development (Brail & Klosterman, 2001) are to support multiple phases of urban planning, including (1) identification of problems, (2) data collection and mining, (3) spatial and temporal analysis, (4) simulation of future scenarios, (5) development of planning schemes and impact assessment, and (6) support for public participation and collaborative decision making. The majority of PSS literature ((Choi & Lee, 2016); (Long & Shen, 2011); (Page, Kalantari, Ferreira, Deal, & Destouni, 2020)) is concerned with how the system approach can continue to be developed and expanded to be applied to spatial planning, urban land use planning, environmental improvement, and policy development.

In dynamic environments, the ability of LFA to establish success metrics and facilitate ongoing evaluation is important for adaptive management. Mostafavi et al. (2020) showed the integration of LFA into health management systems during the COVID-19 pandemic and highlighted its role in integrating mental health and nutritional care with effective management strategies. This is important for the Danube-Black Sea Lighthouse vision, where environmental conditions require a flexible planning approach. In the Danube-Black Sea Lighthouse charter, the application of LFA can also benefit from information from other sectors. For example, the Ecosystem Management Decision Support System (EMDS) shows the importance of integrating logic and decision engines for multi-scale environmental analysis (Reynolds, Hessburg, & Bourgeron, 2014). This can improve Planning Support System (PSS), providing an understanding of ecological and socio-economic factors. In environments such as the Danube, Logical Framework Analysis is an effective tool in terms of the design of support systems. Thus, the structuring of the methodology, the adaptability to changing conditions as well as the focus on stakeholder involvement make LFA a useful tool in terms of the successful implementation of the Danube-Black Sea Lighthouse charter of the Oceans and Inland Waters Mission.

2.2.1. Implementation of LFA & PSS

To integrate dynamic spatial-temporal modeling approaches in the case of sustainable development, LFA was applied, which aims to develop a PSS. The process of developing the methodology, which includes spatial-temporal analysis, simulation scenarios, public debate and also policy evaluation, is structured in six stages:

Stage 1. Conceptual framework. Key approaches such as system dynamics (SD), cellular automata (CA), and agent-based modeling (ABM) were used in this stage. System dynamics (SD) forms causal relationships for decision support in urban development scenarios. This includes problem tree analysis, CLUE modeling, cause-effect modeling, and loop diagramming. CA analyses potential state changes within the landscape by integrating position-based transition rules. Cumulative Impact Balance Analysis and Future Land Use Simulation Model (FLUS) provide a perspective on land use changes. As for ABM, it analyses human-system interactions and their effects on land use and ecological transformation.

Stage 2. Data collection and processing. This stage includes geospatial data (GIS-based mapping, remote sensing), socio-economic (census, policy) and climate and hydrology (precipitation and temperature) data.

Stage 3. Scenario development and simulation. To assess future land use interventions and policies, this study developed different development scenarios, such as the Reference Scenario, Restoration Scenario, and Regeneration Scenario.

Stage 4. Participatory planning and policy review. In this stage, stakeholders are involved in validating the PSS framework. This approach included workshops and expert consultations, public participation, and policy analysis.

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Stage 5. Model validation and policy integration. In this stage, the validation of the PSS framework was carried out through comparative case studies, sensitivity analysis, and impact assessment.

Stage 6. Visualization and decision support. In this stage, data were visualized and decision support was developed. The tools used were GIS techniques, spatial analysis based on artificial intelligence, and the integration of Artificial Neural Networks (Fig. 1).

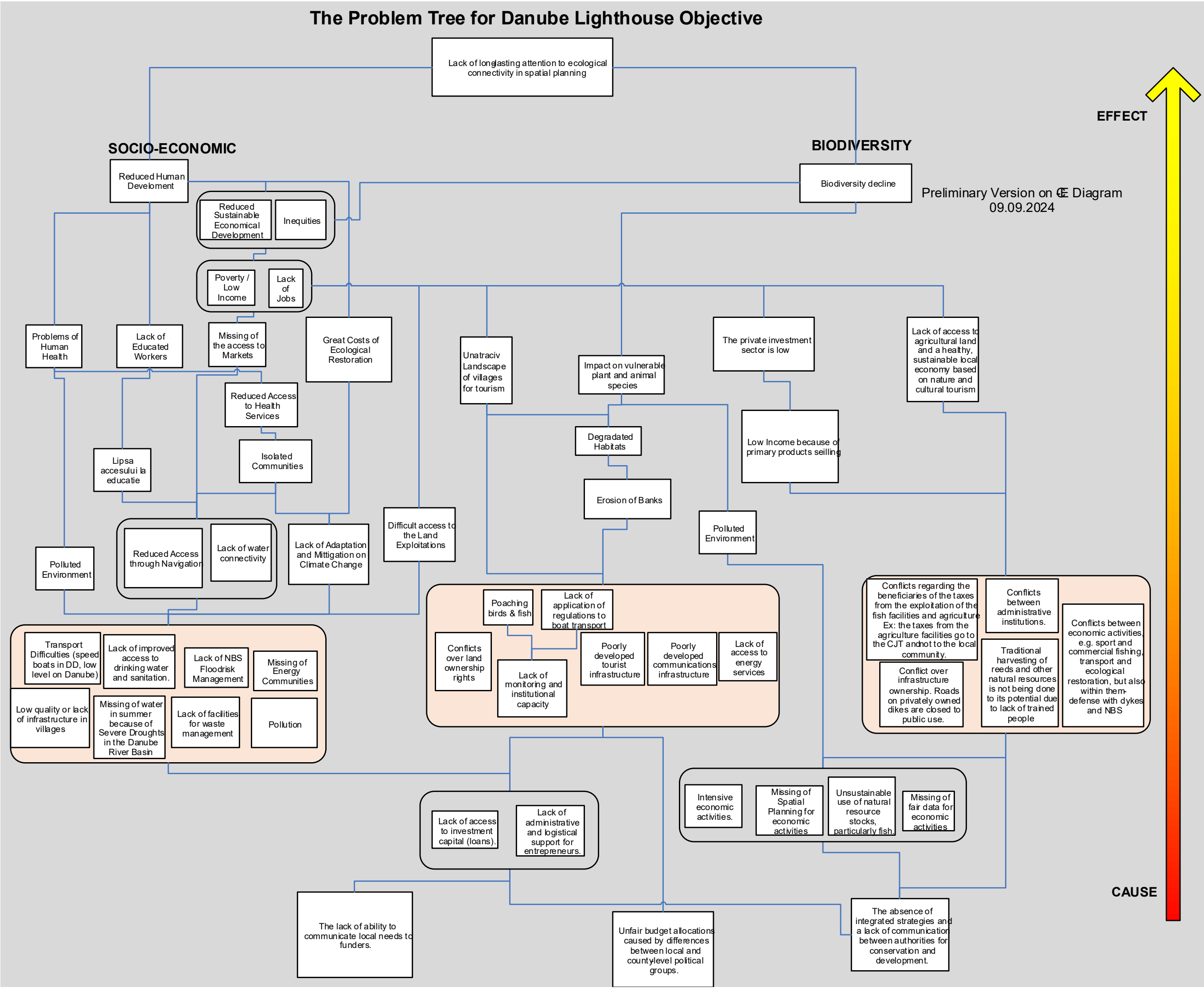

Fig. 1 The Problem Tree for Danube and Black Sea Lighthouse Objectives developed using LFA and PSS methodology

3. Validation of Policy Recommendations and Lessons Learned

3.1. EcoDaLLi Living Lab

EcoDaLLi supports the development of innovative solutions based on the MISSION OCEAN Innovation Action (IA) projects. The purpose of this project is to test, demonstrate, develop and implement the mission activities. It engages a wide range of local stakeholders, including public authorities, service providers, civil society, and citizens such as: Prefecture, ENEL Distribution, AQUASERV, DSVSA, DSP, Local Council, County Council, Energoterm, ARBDD, ADI APA CANAL, APM, LIDAS, MIADMAR, EUROPOLIS, SNIF, Fishing Village, Agromarkets, Deltalact, citizens, farmers.

Living Labs are open innovation ecosystems operating in real-life environments. They emphasize iterative feedback process throughout the life cycle of an innovation and aim to generate a sustainable impact, emphasizing co-creation, rapid prototyping, testing and scaling up solutions and businesses. Through these living labs, shared value is created for all actors involved. In this context, the Danube & Black Sea Lighthouse acts as an intermediary/orchestrator between citizens, research organizations, companies and agencies/government levels for the EU Mission "Restore our Ocean and Waters" which aims to protect and to restore the health of our ocean and waters through research and innovation, citizen engagement and investment in the blue economy. The Living Lab system used is presented in detail in Deliverable D1.2 - *EcoDaLLi Wiki- Scoping paper on concept, definitions and thematical scope of EcoDaLLi*

The development and implementation of EcoDaLLi Living Lab included the following stages:

3.1.1. Concept of EcoDaLLi Living Lab

This concept includes foundation, development, and results.

- **Foundation** is based on "Contingency theory and scientific resource-based view" and "Over 30 years of practical experience in ER/NBS" (Ecosystem Restoration/Nature based Solutions).
- **Development** focuses on "Open Network Innovation" and various projects (Danube4ALL, DALIA, DAWETREST, RESTORE4LIFE), plus "ECODALLI Research Design".
- **Results** focus on "Perspectives of the Network, the User and Stakeholder roles, and the outcomes in Living Labs".

3.1.2. Participation and context of innovation

Within research and innovation processes, the relationship between the degree of participation and the orientation towards knowledge shows how certain contexts (e.g. controlled, stable, emerging and complex) influence the nature of participation and how knowledge is generated.

Firstly, there are situations in which participation is low, being based only on observation. In this case, the projects carried out aim to test solutions in well-controlled environments or to apply innovations in emerging contexts. Stakeholders are not directly and

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actively involved. A typical example of a project in which participation is low is an individual pilot, which is carried out in simple and controlled contexts (ER/NBS). Similarly, some innovation-oriented projects, carried out in complex environments, but mainly focused on developing ecological solutions, capacity building and elaborating strategies and policy recommendations at the European level.

Conversely, there are situations in which participation is high, being based both on observation and co-creation. In such situations, the integral part of the knowledge generation process is represented by actors. In controlled environments, such as Living Labs or future scenarios applied in ER/NBS, researchers have an essential role in shaping the results. In complex environments—where transformation pathways must be negotiated among diverse interests—active and continuous stakeholder participation becomes essential. An example in this sense is the initiatives within EcoDaLLi/the Danube & Black Sea Lighthouse or other platforms that address sustainable transitions.

Ultimately, to ensure the adaptability and success of innovative solutions, the need for interactive collaboration increases as the context becomes more dynamic and complex. In contrast, in stable and controlled environments, one can choose punctual testing with a low degree of participation, or participatory design processes that capitalize on collective creativity (Fig. 2).

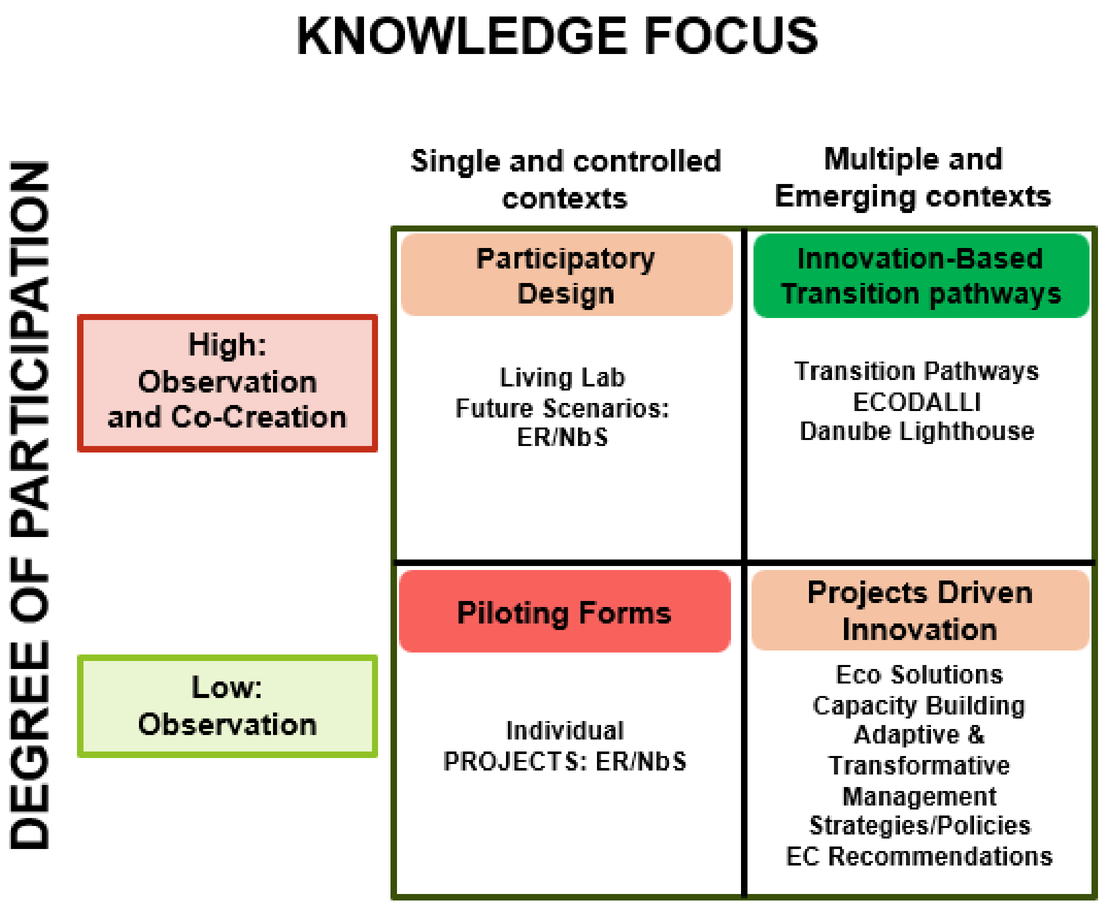

Fig. 2 Participatory Framework for Innovation and Sustainable Transition *(adapted from https://www.researchgate.net/publication/283538558_Living_Labs_as_Open_Innovation_Networks_-_Networks_Roles_and_Innovation_Outcomes*)

3.1.3. EcoDaLLi Living Lab Structure

The integrated innovation process within EcoDaLLi Living Lab – Danube & Black Sea Lighthouse follows a circular dynamic, highlighting its iterative and flexible nature. Within this process, an important stage is represented by the definition and exchange of knowledge between the actors involved. This emphasizes social innovation and the integration of various perspectives. At the same time, the importance of carrying out activities in a real-life context is highlighted. This ensures the relevance and applicability of the proposed solutions.

Another stage is the translation of knowledge into applicable ecological innovations. This stage analyzes the orientation towards environmentally sustainable solutions. The next step is the generation and exploration of ideas. Thus, once the ideas are clarified, solutions are analyzed and co-created. In this phase, collaboration involves several interested actors. Depending on the real needs and the Danube context specifics, solutions' validation and adaptation are ensured. At the same time, a collaboration network is created between the participants. This collaborative network shows the importance of constant exchange of information, creates a framework of mutual support and supports the implementation of solutions. As such, the process within the EcoDaLLi Living Lab is driven by the interaction between the specific perspectives of the Danube area and the requirement that the solutions be tested in real conditions. This indicates the robustness and applicability of the solutions developed within the Living Lab (Fig. 3).

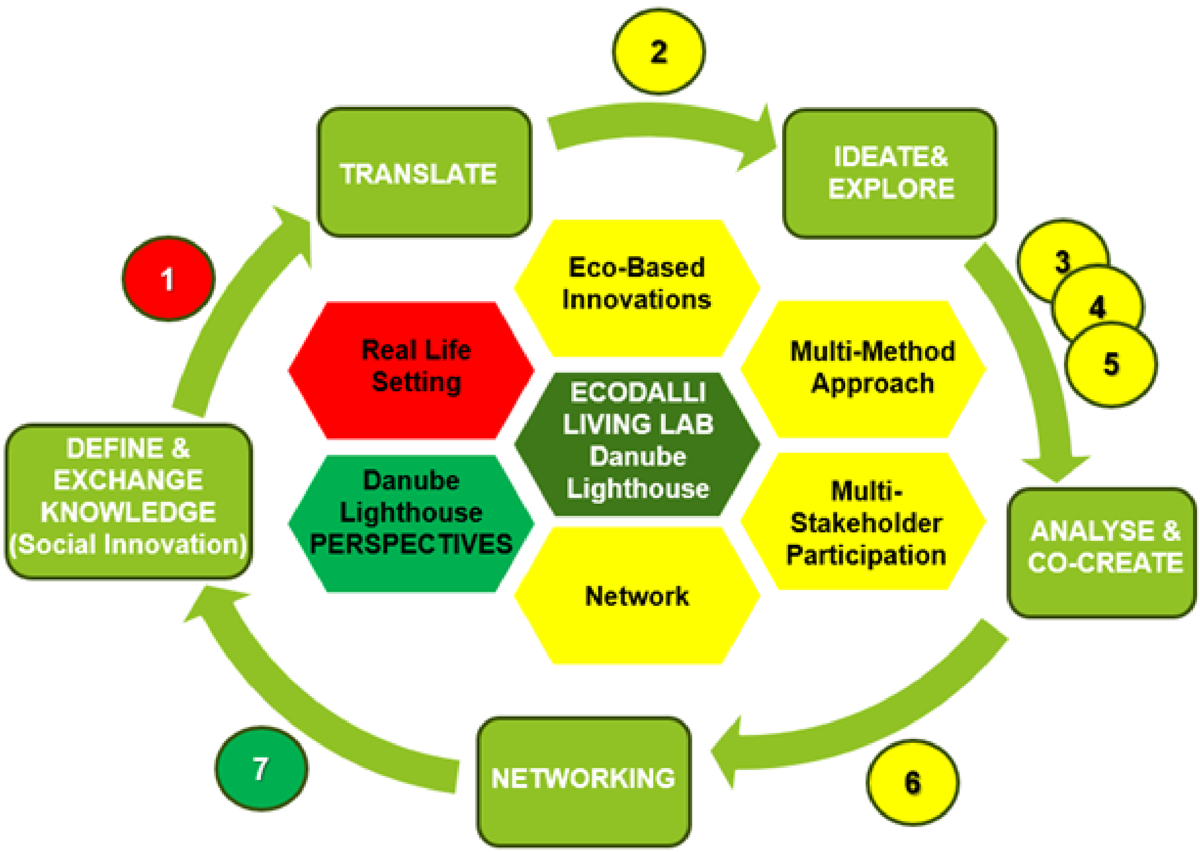

Fig. 3 EcoDaLLi Living Lab Structure

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3.1.4. Water, Biodiversity, Climate Change

In the Danube Delta the Living Lab was organized by the Ministry of Environment, Waters and Forests of Romania (MEWF) in collaboration with Tulcea County Prefecture and the Danube Delta National Institute (DDNI). The Danube Delta represents a critical case for applying a Nexus approach to ecological restoration, where the interlinkages between water systems, biodiversity, and climate change underscore the systemic nature of local socio-ecological processes. Water plays a foundational role, with key concerns including the Water Balance and Underground Balance, both essential for maintaining hydrological integrity in support of ecosystem functions. Yet, water-related problems persist, particularly in ensuring sufficient and sustained water flows for ecological purposes. These challenges are addressed by a constellation of institutional actors, including the City Council, County Council, ANAR (National Administration "Romanian Waters"), ARBDD (Administration of the Danube Delta Biosphere Reserve), and Aquaserv, whose coordinated action is vital to effective water management. In parallel, biodiversity in the Delta is under increasing pressure due to habitat fragmentation, biodiversity loss, and the erosion of ecological connectivity. Addressing these issues requires the implementation of NBS to restore linkages across habitats and sustain ecosystem services. The socio-economic fabric is also deeply intertwined, involving local citizens, small producers, and market stakeholders whose resilience is affected by limited infrastructure and competition with large retail chains. The lack of greenhouses further constrains local production capacity. Climate change acts as a cross-cutting driver, exacerbating existing pressures through land-use and land-use change, forestry dynamics, and the operation of outdated energy infrastructure. Financial constraints—such as those related to maintaining lake water levels—illustrate the systemic costs of adaptation. Ultimately, ecosystem restoration in the Danube Delta depends on integrated water management, biodiversity conservation, and climate adaptation, all underpinned by institutional collaboration and support for local socio-economic actors.

In the context of ecological restoration, the linkages between water, biodiversity, and climate change (Fig. 4) and the actors involved are complex. This is a “Nexus” approach that indicates the interdependence of socio-economic processes and natural resources within local ecosystems.

Water. Water is a critical element to consider for ecological restoration. However, two key issues have been identified: Water Balance and Underground Balance, both of which highlight the hydrological balance necessary for ecosystem restoration; as well as Water problems for ecological restoration which show difficulties in water management in terms of supporting ecosystems. Several institutional actors are involved in water management, including the: City Council, County Council, ANAR, ARBDD, and Aquaserv.

Biodiversity. Biodiversity plays a significant role in restoring ecosystems. However, biodiversity is currently facing various challenges, such as biodiversity loss and a lack of ecological connectivity. The latter factor highlights the need for NBS to enhance connectivity between habitats in terms of maintaining biodiversity. Also, a socio-economic network is involved in biodiversity conservation, such as:

- **Citizens** – beneficiaries and local actors;
- **Local producers** – dependent on ecosystems;

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- **Local stores** and **Large Chain Stores** – economic connections between producers and consumers;
- **Directorate for Sanitary Protection (DSP)** and **Agromarkets** – factors influencing the distribution and competitiveness of agri-food products.

One of the biggest economic problems is that local producers are unable to keep up with the prices and quality provided by large retail chains. These producers are also limited by the lack of greenhouses, which limits production capacity.

Climate Change. Climate change has a significant impact on both ecological restoration and the use of natural resources. Thus, Land Use, Land-Use Change, and Forestry (LULUCF) affect biodiversity. In this context, it is necessary to adopt measures to protect local communities and ecosystems. Specific problems in the region are represented by old power plants that contribute to environmental pressures, as well as the cost of maintaining the water level in the lake, which indicates financial challenges associated with maintaining aquatic ecosystems. As such, water management, biodiversity protection, and climate change adaptation contribute to the restoration of ecosystems. Restoration is closely linked to institutional cooperation, support for local producers, and the adoption of adaptive solutions in the face of climate change.

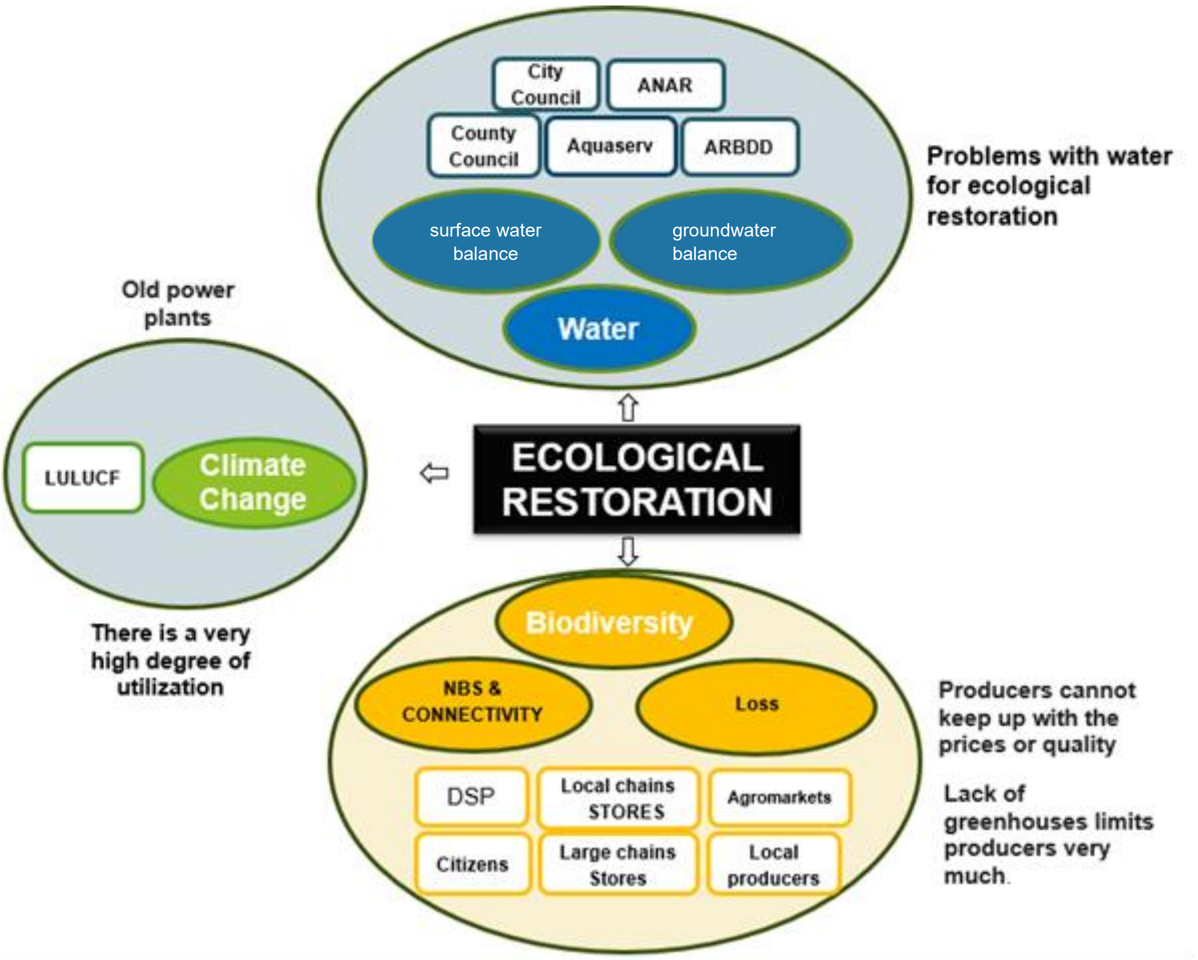

Fig. 4 Factors and challenges in ecological restoration

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3.1.5. Pillars: Biodiversity – Social – Economy

The three pillars, namely biodiversity, social and economy, indicate the association of biodiversity with other European initiatives. This highlights the major objectives of transforming and restoring ecosystems in the EU. The implementation of European strategies functions within the Living Lab as a nucleus of collaboration and experimentation. Various connections regarding strategic initiatives of the European Union are generated from the Living Lab (Fig. 5).

These initiatives include:

- EU Biodiversity Strategy for 2030, focused on protecting and restoring ecosystems;
- The CC Paris Agreement on climate change;
- The 2030 Agenda for Sustainable Development and the Sustainable Development Goals;
- European Green Deal an initiative to reduce environmental impact and achieve climate neutrality;
- European Climate Law establishing the legal framework for achieving climate objectives;
- CAP (Common Agricultural Policy) aiming at the sustainability of agriculture;
- Circular Economy Action Plan oriented towards reducing waste and using resources efficiently;
- EU strategy on adaptation to climate change;
- “From Farm to Consumer” Strategy for a sustainable food system;
- Strategy in the field of bioeconomy promoting the use of biological resources in the economy;
- EU forestry strategy for 2030 for protecting forests;
- EU soil strategy for protecting soil;
- The strategy for sustainable and intelligent mobility.

The objectives of the EU Biodiversity Strategy for 2030 are the following:

- Transforming at least 30% of Europe's land and seas into effectively managed protected areas.
- Restoring degraded ecosystems throughout the EU in a precarious state, as well as reducing pressure on biodiversity.
- Promoting transformative change: NBS , EBA (Ecosystem-Based Adaptation), and Towards a Scenario-based Spatial Dynamic Modeling for Predicting Land Use Change

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These initiatives depend on integrated collaboration and implementation. Thus, innovative solutions on biodiversity, climate change adaptation and sustainable development can be tested and applied in platforms such as Living Labs (LL).

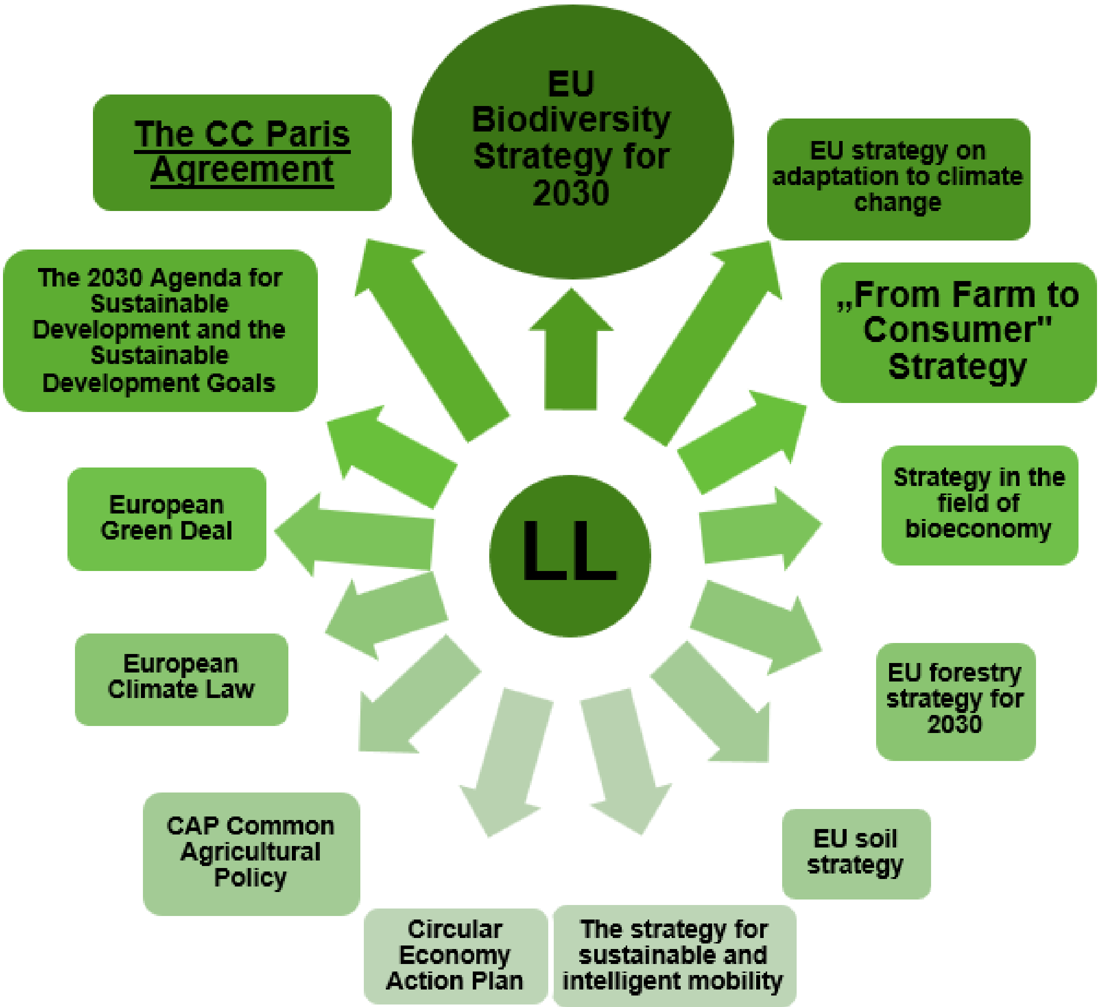

Fig. 5 Living Labs in the context of Biodiversity and Circular Economy

Regarding the economy, the goals for 2030 include:

- **Intensification**. The idea that "economic growth takes priority over ecological conservation" has been replaced by an integrated vision in which economy and ecology are put on an equal footing. This vision is known as "Ecology First" and argues that economic policies should align with biodiversity conservation objectives. Moreover, the link between finance, government and the private sector is important in achieving transitions to sustainable development models. From a carbon and environmentally friendly perspective, these transitions are neutral.
- **Differentiation.** In terms of traditional policy instruments, a clear separation has been found between economically developed countries and countries in the developing world. Thus, countries in the developing world have relied on public financing and

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government sector financing, while economically developed countries use the private sector market.

- **Pluralization**. Nature has complex and multidimensional value, and in this context, governments need to use various economic instruments to achieve biodiversity conservation objectives. It is important to implement economic measures regarding livelihoods and community well-being, climate resilience and natural resource management as freshwater ecosystems also provide cultural and landscape value, which should be integrated into planning instruments to reinforce societal connection to nature.
- **Marketing.** An effective solution to the lack of public funds and the inconsistencies between the financial and fiscal systems is to integrate market mechanisms into ecological conservation strategies. Thus, without such a solution, economic problems such as unclear property rights, market failure, high transaction costs, overuse of natural assets, and supply-demand asymmetry arise.

The **Social Pillar** within the EcoDaLLi Living Lab framework emphasizes inclusive governance, active stakeholder engagement, and community-oriented innovation processes. As implemented across the Danube River basin, the LLs serve not only as experimentation platforms, but also as vehicles for fostering participatory dynamics that align ecological restoration efforts with societal needs. This pillar reflects the foundational role of local actors—citizens, educators, NGOs, producers, and municipal institutions—in shaping adaptive governance and sustainable territorial transformation.

Through the **Practice Living Lab System (PLLS)** and iterative feedback mechanisms, the LLs assess and strengthen key dimensions of social participation, including human capital, governance interaction, soft system elements, and knowledge co-creation. Communities along the Danube River basin—especially those in vulnerable or ecologically significant regions such as the Danube Delta—are encouraged to contribute to scenario development, spatial visioning, and policy innovation in real-life settings. This participatory process builds trust and ownership over long-term goals, enhancing both the **resilience** and **contextual relevance** of ecological interventions.

The social pillar also supports the co-design of solutions addressing **social equity**, **public health**, **access to services**, and **local economic vitality**, particularly for areas experiencing marginalization or lack of infrastructure. In this respect, the LLs help identify social gaps and needs while promoting locally grounded innovation, including education and awareness-raising initiatives. By anchoring social innovation in territorial context, the EcoDaLLi LLs contribute to broader European strategies such as the **EU Biodiversity Strategy**, the **European Pillar of Social Rights**, and the **Sustainable Development Goals (SDGs)**.

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4. Conclusion

The approach presented in this study uses various scenarios regarding the evaluation of local policies and sustainable development models. In this case, through a Restoration, Revitalization and Regeneration (3R) strategy, adaptation to climate change is pursued.
To understand the connection between people and the environment, Logical Framework Analysis includes spatial analysis, simulation modeling, policy review and participatory planning. In this way, territorial transformations and resource use can be analyzed.
On different representative sites, such as the Danube Delta, several sustainable development scenarios were tested in terms of feasibility and applicability of the proposed models.

The “Danube & Black Sea Lighthouse” includes ecosystem innovation and transformative urban recovery, involving local communities and governments. Planning Support Systems (PSS) help the decision-making process regarding urban and territorial planning, but do not replace the human factor. This system includes problem identification, spatial and temporal analysis, scenario simulation and impact assessment. Advanced modeling methods include System Dynamics, Cellular Automata and models for international policies. The framework proposed in this study integrates scenario-based spatial modelling, participatory governance mechanisms, and ecosystem-based planning tools to support resilient and inclusive territorial development. It responds to the priorities developed by COP27, aligning with international initiatives on climate change adaptation and sustainable ecosystem management. By coupling Logical Framework Analysis (LFA) with PSS, the approach enables evidence-based decision-making, multi-stakeholder collaboration, and the practical application of restoration models across diverse ecological and institutional contexts in the Danube River basin. The presented shared vision and modeling framework lay the groundwork for coordinated, science-informed action. To this end, the EcoDaLLi Portal, co-creation workshops, and the broader Living Lab system offer essential platforms for knowledge exchange, mutual learning, and capacity building—facilitating continued collaboration across the Danube River basin and beyond.

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