seacure

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Strategic Orientation Analyses. Integrated result of the quantified SWOT analyses of the regional innovation ecosystems within the basins/territorial units

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D.1.2 – Strategic Orientation Analyses. Integrated result of the quantified SWOT analyses of the regional innovation ecosystems within the basins/territorial units

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22	ACR+	Association of Cities and Regions for Sustainable Resources Management	BEN
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24	Proman	Proman Management GMBH	BEN
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Summary

The SEACURE project has the overall ambition of addressing nutrient pollution in the Mediterranean basin, considering the landscape-river-sea continuum in an integrated view.

The project aims at implementing holistic strategies to prevent, reduce and remediate nutrient excess and pollution in soil and aquatic ecosystems, integrating technological, social and governance innovations, and focusing on engagement, empowerment, commitment and capacity building with key actors, targeting six specific territorial units in three Mediterranean countries (Greece, Italy, and Spain).

To support these efforts, multiple strategies will be deployed. Task 1.2 focuses in performing a strategic orientation analysis, with the aim of finding the main and recurring problems of the six regions partaking in the project, having a holistic view analysing ecological, socioeconomic, technical and regulatory strong and weak points of the innovation ecosystem of the regions and its environment following a SWOT-framework approach (Strengths, Weaknesses, Opportunities, Threats), taking into account stakeholder perspective from scratch, to guide the regions and analyse the unique opportunities and complications of each region, and the general setbacks.

The analysis stand out some of the more recurring challenges and potential activities to overcome them considering the capacities of the regional innovation ecosystems dealing with nutrient pollution and management in the regions and the project, this being the following: the lack of knowledge transfer, replication of old or punctual initiatives that have shown strong potential, technology uptake (the slow uptake of the new technology by end users and municipalities), and lastly, upscaling (as several technologies or practices have been tested with demos, but there are still barriers in the implementation: social-economic, administrative, etc.).

Despite these challenges, the regions exhibit significant potential and present the tools for implementing, regulating, and educating to prevent, reduce and remediate nutrient pollution.

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List of Abbreviations

S3	*Smart Specialisation Strategies*
N, P	*nitrogen (N) and phosphorus (P),*
EU	*European Union*
WFD	*Water Framework Directive*
RIS	*Regional innovation systems*
QH	*Quadruple Helix*
SUR	*Sustainable use of pesticides*
RIE	*Regional Innovation Ecosystem*
RIS3	*Research & Innovation Policy*

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[1] Introduction

[1.1] Motivation

The SEACURE project has the overall ambition of addressing nutrient pollution in the Mediterranean basin considering the landscape-river-sea continuum in an integrated view. The project aims at implementing holistic strategies to prevent, reduce and remediate nutrient excess and pollution in soil and aquatic ecosystems, approaching the problem from a multidisciplinary and integrated perspective. It targets six specific territorial units in three Mediterranean countries, integrating technological, social and governance innovations. The project places particular emphasis on engagement, empowerment, commitment and capacity building among key stakeholders.

The purpose of this deliverable is to analyse the regional innovation ecosystems of the six selected territorial units, aiming at providing a strategic understanding of the innovation landscape, focusing on key factors that can influence the development and implementation of nutrient pollution management solutions in the six regions.

The analysis identifies, through a SWOT exercise, the intrinsic strengths and capabilities of each region (research expertise, technological infrastructure, policy support, and stakeholder engagement), the existing weaknesses (regulatory barriers, funding limitations, technological and knowledge gaps, among others), external opportunities (emerging technologies, policy incentives, market demands, collaborative networks) and potential threats (environmental risks, regulatory uncertainties, economic constraints), which can drive innovation or hinder the progress of nutrient pollution management. This analysis also integrates the separated analyses in an integrated SWOT to compare the common challenges, strengths, opportunities, and threats across the six regions, while also identifying their unique specificities. This exercise will serve as the basis for defining joint action points where collaboration is beneficial and region-specific strategies where tailored approaches are needed.

This SWOT analysis, together with the stakeholder engagement activities under Task 1.1, the review of past implemented solutions (T1.3) and the regional vision papers (T1.4), will provide essential insights to guide the demonstration activities (WP2), the regional-level upscaling efforts (WP4), and the development of Regional Upscaling Plans (WP6). These elements are further elaborated at the end of this document, as a Strategic Orientation Analysis for helping in the alignment of these activities, and hence supporting the co-creation of effective, resilient, and sustainable solutions to mitigate nutrient pollution in the Mediterranean basin.

[1.2] Methodology

The SWOT methodology (Strengths, Weaknesses, Opportunities, and Threats) has been applied to analyse nutrient-related challenges across six regions, with the objective of assessing the readiness of each regional innovation ecosystems to tackle current and future challenges derived from the nutrient pollution.

The analysis has been developed in four steps:

1. Stakeholder-driven perspective: The analysis was primarily based on the insights and opinions of key actors involved in the nutrient pollution management in each region. This ensured that

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the findings reflect the realities of the regional contexts and incorporate the perspectives of those directly engaged in the field.

2. Complementary desk research: To support and validate the findings from stakeholders, additional desk research has been conducted, including several sources and key documents. This included:

   i. Mapping the regional innovation ecosystems to identify key actors and ongoing initiatives.

   ii. Reviewing existing data and references related to environmental context water management initiatives, existing initiatives at different levels, nutrient management information, regulatory updates, innovation performance in each region, etc.

   iii. Analysing the Smart Specialisation Strategies (S3) in each region to include broader regional innovation and policy priorities.

   iv. Reviewing Basin Management Plans to integrate the regulatory and environmental context. Last, but not least, incorporating other relevant sources of information to provide a well-rounded analysis.

3. Validation through interviews with demo leaders: A final round of interviews with the demonstration sites leaders has been conducted to validate and refine the findings and fill in any identified gap.

4. Integrated cross-regional analysis: After completing the individual SWOT analysis for each region, a comparative analysis has been performed aiming at identifying common challenges, strengths, opportunities, and threats across the six regions, as well as highlighting region-specific aspects that may require tailored strategies.

[2] Context

[2.1] Nutrient pollution in Europe

Nutrient pollution represents a significant environmental challenge across Europe, affecting both surface and groundwater quality, with profound implications for ecosystems, public health, and economic activities. Excessive concentrations of nutrients, primarily nitrogen (N) and phosphorus (P), originate from various anthropogenic sources, including agriculture, wastewater discharge, and industrial activities. These nutrients, when present in excessive amounts, contribute to eutrophication, soil quality degradation, loss of biodiversity, and ultimately the deterioration of water quality.

Key Sources and Drivers

Agriculture continues to be the primary contributor to nutrient pollution in Europe, with the excessive use of fertilizers and manure application leading to runoff into rivers, lakes, and coastal waters. Urban wastewater treatment plants, while improving in efficiency due to European Union (EU) directives, still contribute significant nutrient loads, particularly where outdated infrastructure or insufficient treatment capacities exist.

Regulatory Framework and Policy Initiatives

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The EU has established a robust regulatory framework to address nutrient pollution, with key directives such as the Water Framework Directive (WFD), the Zero Pollution Action Plan, the Nitrates Directive, and the Urban Wastewater Treatment Directive, setting stringent targets for nutrient reduction. These policies aim to mitigate pollution at the source, promote sustainable agricultural practices, and enhance wastewater treatment efficiency. Furthermore, the European Green Deal and its related strategies, including the Farm to Fork and Biodiversity Strategies, emphasize the need for a more circular and sustainable approach to nutrient management. This regulatory scenario supports the advancement in the implementation of strategies for diminishing nutrient pollution, despite some temporary deceleration on certain regulations, such as the regulation for the sustainable use of pesticides (SUR), in the current geopolitical context.

[2.3] Identified Challenges

Despite progress, nutrient pollution remains a persistent issue due to factors such as climate change, which influences precipitation patterns and runoff dynamics, and increasing agricultural intensification. Moreover, the legacy effects of historical nutrient accumulation in soils and sediments continue to impact water bodies. Addressing these challenges requires innovative solutions, including precision agriculture, enhanced wastewater treatment technologies, and the development of nutrient recovery and recycling systems to close the loop on nutrient use and promote circularity.

Nutrient pollution presents complex and interrelated challenges across different dimensions, impacting environmental, technical, socioeconomic, and regulatory aspects:

1. **Environmental threats:** Excessive nutrients lead to eutrophication, causing algal blooms, hypoxia, and the loss of aquatic biodiversity. These changes disrupt ecosystems, reduce water quality, and contribute to long-term degradation of freshwater and marine habitats. The impacts of climate change further intensify these conditions by altering precipitation and runoff patterns, further intensifying nutrient loading.
2. **Technical challenges:** The implementation of advanced treatment technologies is often constrained by high investment and operational costs. Additionally, existing wastewater treatment plants may require significant upgrades to meet stringent nutrient removal standards. Monitoring and modelling nutrient flows at different scales also remain complex due to variations in land use, hydrology, and pollution sources.
3. **Socioeconomic challenges:** Nutrient pollution negatively affects fisheries, tourism, and drinking water supplies, causing economic losses and public health risks. The financial burden of implementing nutrient management measures, particularly in agriculture, can burden farmers and industries, requiring incentives and support to adopt sustainable practices. Furthermore, uneven implementation of policies across regions creates disparities in pollution mitigation efforts.
4. **Regulatory constraints:** While EU directives provide a strong framework, enforcement and compliance vary across member states. Regulatory gaps, lack of coordination between sectors, and delays in policy implementation hinder effective nutrient management. Additionally, balancing economic growth with stringent environmental requirements poses challenges for industries and policymakers alike.

This context serves as a foundation for the subsequent SWOT analysis, which aims to evaluate the strengths, weaknesses, opportunities, and threats related to the nutrient pollution management innovation ecosystems in the six regions of the SEACURE project. By understanding the current

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landscape and technological advancements, this deliverable aims at identifying strategic actions to enhance water quality, foster sustainable development, and ensure compliance with evolving regulatory frameworks. The findings from this analysis will contribute to shaping actions within and after the project targeting policies and technologies that support the sustainable management of nutrients in the Strategic Orientation Analysis developed based on the results of the integrated SWOT analysis.

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[3] SWOT analysis of the regional innovation ecosystems of the demonstration regions

[3.1.] Introduction to Regional Innovation Systems and Ecosystems

Regional Innovation Systems

Regional innovation systems (RIS) emphasize the importance of regions as key drivers of innovation (Asheim et al., 2011, Roman et al, 2020)[1,2], being innovation understood as the result of the interaction among a diverse range of actors spread across various institutions and locations. Traditionally, these interactions have been framed within the Triple Helix Model, which emphasizes the roles of government, industry, and academia as primary innovation drivers, later expanded to the Quadruple Helix (QH) model, incorporating civil society and fostering the transition from purely technical innovations to social innovations, ensuring that growth and advancements occur in a sustainable and inclusive manner. The QH model is an integral element in the design of smart specialization strategies as fostering knowledge creation and exchange by bringing together firms, research centres, independent inventors and lead users (Carayannis and Grigoroudis 2016)[3].

Additionally, the innovation performance of the European regions is assessed by analysing a set of innovation indicators that evaluate framework conditions (i.e. population with tertiary education, scientific publications, overall digital skills, ...), investments (i.e. R&D expenditure, innovation expenditure, ...), innovation activities (i.e. SMEs introducing product innovations, public-private patent applications, ...) and impacts (i.e. employment in knowledge-intensive activities, innovation sales, development of environment-related technologies, ...) (Table 1) [4,5]. This performance provides interesting insights on the capabilities of the regions involved for tackling the diverse nutrient-related challenges.

Europe's regions are grouped into four innovation performance groups according to their innovation indicators with respect to the EU baseline:

- **Innovation Leaders**: more than 125% above the EU average.
- **Strong Innovators**: between 100% and 125% of the EU average.
- **Moderate Innovators**: between 70% and 100% of the EU average.
- **Emerging Innovators**: below 70% of the EU average.

Regional Innovation Ecosystems

Within this framework, the concept of Regional Innovation Ecosystem (RIE) refers to the network of interconnected stakeholders, institutions, policies, and infrastructures within a specific geographic area that work together to drive innovation, economic development, and sustainability around a specific challenge, area or topic. It is an open, dynamic system where different actors collaborate, compete, and evolve to generate and implement new knowledge, technologies, and solutions.

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Table 1. Indicators included in the European Innovation Scoreboard and the Regional Innovation Scoreboard

	EIS 2023	RIS 2023
FRAMEWORK CONDITIONS		
HUMAN RESOURCES	*Doctorate graduates per 1000 population aged 25-34*	*No regional data*
	Percentage of population aged 25-34 having completed tertiary education	Identical
	Lifelong learning, the share of population aged 25-64 enrolled in education or training aimed at improving knowledge, skills and competences	Identical
ATTRACTIVE RESEARCH SYSTEMS	International scientific co-publications per million population	Identical
	Scientific publications among the top-10% most cited publications worldwide as percentage of total scientific publications of the country	Identical
	Foreign doctorate students as percentage of all doctorate students	*No regional data*
DIGITALISATION	*Broadband penetration (Share of enterprises with a maximum contracted download speed of the fastest fixed internet connection of at least 100 Mb/s)*	*No regional data*
	Individuals who have above basic overall digital skills	Own estimates using Households with broadband access
INVESTMENTS		
FINANCE AND SUPPORT	R&D expenditure in the public sector as percentage of GDP	Identical
	Venture capital expenditure as percentage of GDP	*No regional data*
	Direct government funding and government tax support for business R&D	*No regional data*
FIRM INVESTMENTS	R&D expenditure in the business sector as percentage of GDP	Identical
	Non-R&D innovation expenditures as percentage of total turnover	Data for SMEs
	Innovation expenditures per person employed in innovation-active enterprises	Data for SMEs
USE OF INFORMATION TECHNOLOGIES	Enterprises providing training to develop or upgrade ICT skills of their personnel	No regional data
	Employed ICT specialists	Estimates using Employment in information and communication
INNOVATION ACTIVITIES		
INNOVATORS	SMEs introducing product innovations as percentage of SMEs	Identical
	SMEs introducing business process innovations as percentage of SMEs	Identical
LINKAGES	Innovative SMEs collaborating with others as percentage of SMEs	Identical

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	Public-private co-publications per million population	Identical
	Job-to-job mobility of Human Resources in Science & Technology	*No regional data*
INTELLECTUAL ASSETS	PCT patent applications per billion GDP (in Purchasing Power standards)	Identical
	Trademark applications per billion GDP (in Purchasing Power standards)	Identical
	Individual design applications per billion GDP (in Purchasing Power standards)	Design applications
IMPACTS		
EMPLOYMENT IMPACTS	Employment in knowledge-intensive activities as percentage of total employment	Employment in medium-high and high-tech manufacturing and knowledge-intensive services
	Employment in innovative enterprises	Data for SMEs
SALES IMPACTS	*Medium and high-tech product exports as percentage of total product exports*	*No regional data*
	Knowledge-intensive services exports as percentage of total service exports	*No regional data*
	Sales of new-to-market and new-to-enterprise innovations as percentage of total turnover	Data for SMEs
ENVIRONMENTAL SUSTAINABILITY	*Resource productivity*	*No regional data*
	Air emissions in fine particulates (PM2.5) in Industry	Exposure to fine particulates (PM2.5)
	Development of environment-related technologies	*No regional data*

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The key components of a Regional Innovation Ecosystem typically are (1) actors & stakeholders, (2) infrastructure and resources, (3) regulatory and policy frameworks and (4) innovation instruments and mechanisms, all these sensitive to (5) market and demand forces.

1. **Actors & stakeholders:**

Actors potentially involved in a RIE are defined in terms of the QH scheme, being the **public sector** formed by governmental agencies, regulatory bodies and policy-makers that set the legal and financial framework; the **private sector,** representing companies, startups, and industries, who potentially can develop and commercialize innovations; **academia & research institutions,** such as universities, research and technological centres, devoted to knowledge and technical development and transfer; **civil society, NGOs** and in general **potential end-users**, that can include consumer organizations, environmental groups, community associations, in the orbit of influencing social acceptance and implementation.

In the specific case of RIE around nutrient pollution, this group is made of farmers and agricultural companies, researchers, policymakers, technology providers, urban water cycle companies, but also citizens and end-user industries.

2. **Infrastructure and resources:**

Infrastructure and resources involved in a RIE refer to **physical assets**, such as research facilities, incubator initiatives or industrial facilities, as well as **digital infrastructures** as for example installed monitoring systems, data platforms available for the different users, etc. **Resources** refer also to **financial resources** available, either in the form of grants, investments, or other types of economic incentives that may foster innovation, as well as private and public funding sources, or a combination of both.

In the context of this work, the existence of infrastructure and resources can support the development and implementation of new technologies like smart monitoring systems, precision agriculture, novel water treatment technologies, nature-based solutions, among others.

3. **Regulatory and policy frameworks:**

This component includes all the regulation, at local, regional, national and EU level that supports innovation in the general sense and, in the scope of SEACURE project, specifically sustainability and environmental policies. Of course, and linked with the point 2. above, the policy support to dedicated funding programs, economic incentives such as subsidies or tax exemptions or regulations, etc. can also encourage innovation.

In the case of nutrient pollution, dedicated regulations and EU strategies and directives such as the EU Green Deal, the Water Framework Directive and the Zero Pollution Action Plan, the Nitrates Directive and the Urban Wastewater Treatment Directive, are of primary importance, as well as all national and the regional legislation corpus derived from them.

4. **Innovation instruments and mechanisms**

For strengthening the innovation ecosystems, it is crucial to put in place mechanisms and tools specifically designed to support innovation, such as technology transfer initiatives (from research to market), collaboration platforms, open innovation mechanisms and entrepreneurial support initiatives (e.g., incubators, accelerators, or venture capital).

In the SEACURE context, cross-sectoral collaboration initiatives must be considered, as well as cross-regional knowledge transfer. Technology licensing, industry partnerships, and public-private collaborations are valuable tools to bring technology to market. Addressing nutrient pollution requires

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knowledge-sharing across sectors, and needs to integrate expertise from agriculture, water management, environmental sciences, and technology development. Initiatives facilitating collaboration among actors are highly beneficial, as well as joint initiatives to codevelop and test new solutions.

5. **Market and demand forces**

This group includes both economic and industrial needs, as well as societal challenges that shape priorities and innovation policies. It may also include societal behavioural trends that force the market evolving in one or another direction, and consequently the innovation system also evolves (i.e. sustainability consumption patterns).

In this project, climate change and environmental concerns, as well as societal awareness regarding the challenges posed by pollution and their consequences, are key market drivers to be considered.

Smart Specialisation Strategies (S3)

Last, but not least, Smart Specialization Strategies (S3) are a core component of the European Union's Cohesion Policy and Research & Innovation Policy (RIS3) that promote place-based, evidence-driven innovation strategies that focus on regional strengths and competitive advantages. While RIE provide the ecosystem where these strengths can be leveraged and mobilized, S3 aims to identify and build on regional innovation capabilities, aligning with the sectoral expertise and unique assets of each territory. For this reason, we have taken S3 into consideration while analysing the Regional Innovation Ecosystems of the six demonstrative regions.

[3.2] Description of each regional innovation ecosystem

The demonstrator regions of the SEACURE project present a general positive tendency in their innovation indicators for the last years, as shown in

Figure 1.

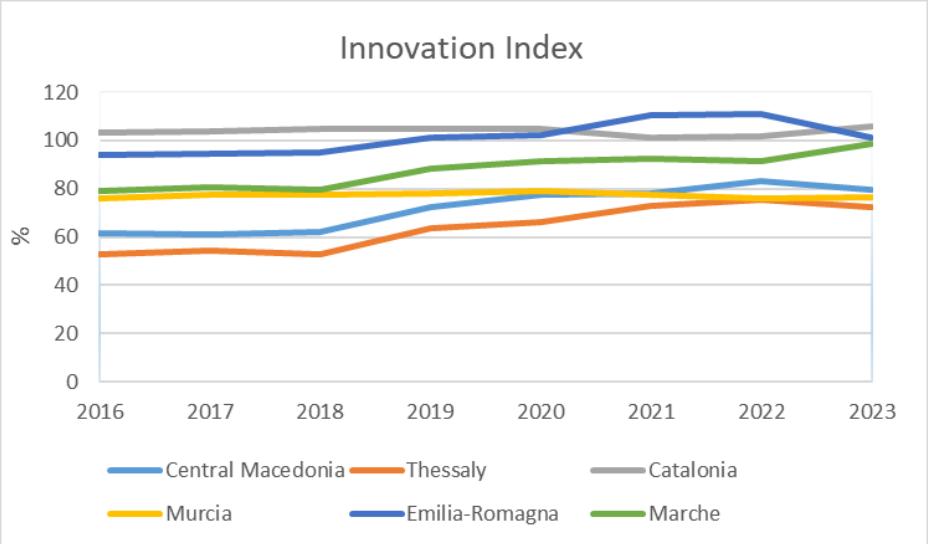

Figure 1. Regional innovation indicators evolution for the six demonstrator regions of SEACURE from 2016 to 2023 [4]

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A deeper view of the main innovation indicators of the six demo regions shows that, in terms of framework conditions, Catalonia and Murcia are leaders in digital skills, whereas Catalonia and Central Macedonia are the regions with more population with tertiary education (Figure 2).

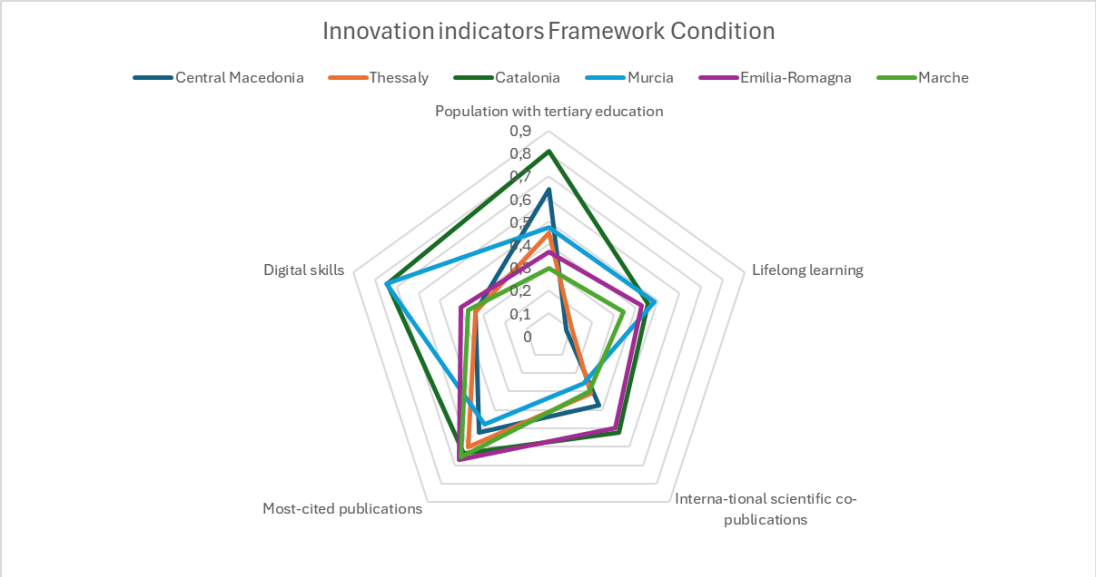

Figure 2. Regional Innovation Scoreboard indicators on framework conditions for the six demo regions, 2023 [4]

Regarding investment indicators, Thessaly and Central Macedonia have the highest R&D expenditures in the public sector, while Catalonia and Emilia-Romagna have the highest R&D expenditures in the business sector, Thessaly has the highest investment in non-innovation, whereas Marche has the highest ratio of innovation expenditures per employee. Catalonia leads in the number of ICT specialists.

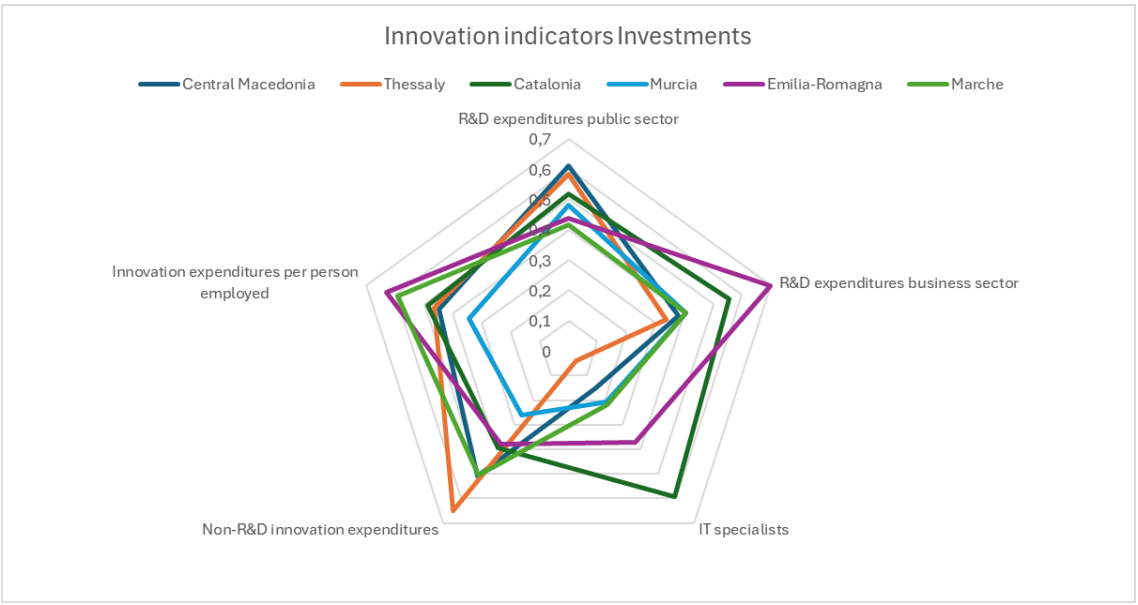

Figure 3. Regional Innovation Scoreboard indicators on investments in the six demo regions, 2023 [4]

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Regarding innovation activities, central Macedonia, Thessaly and Marche lead in product and business process innovations, and SMEs collaboration, while Marche and Emilia-Romagna lead in design applications, Catalonia and Murcia being stronger in trademark applications, as shown in Figure 4.

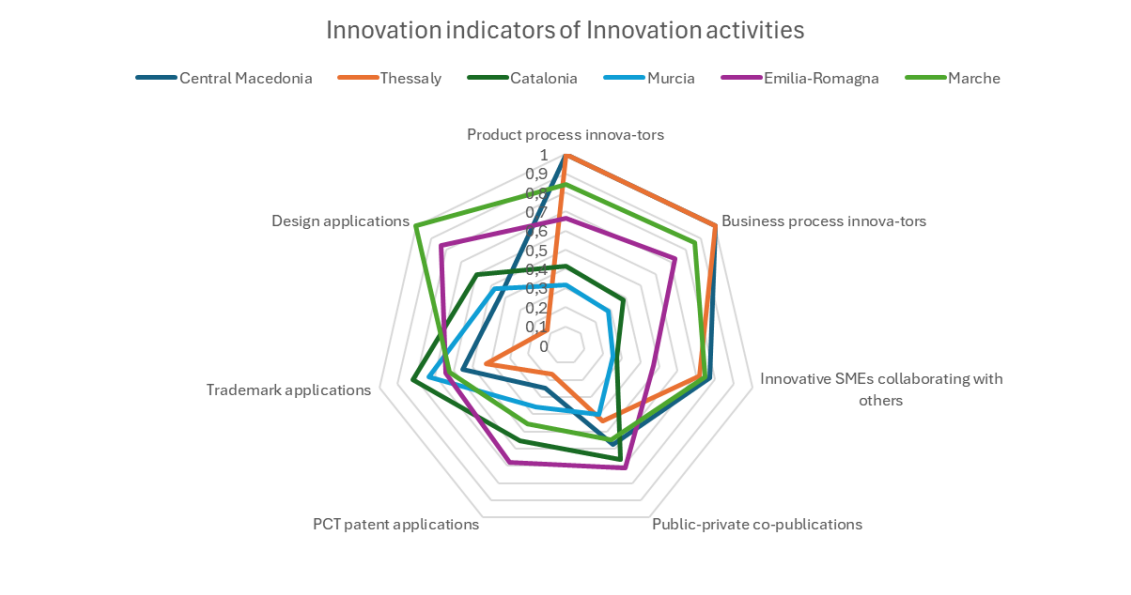

Figure 4. Regional Innovation Scoreboard indicators on innovation activities in the six demo regions, 2023 [4]

The next sections include a summary description of the regional innovation ecosystems in each of the six regions.

[3.2.1] Axios River delta

Key Stakeholders:

Table 2. Regional innovation ecosystem actors related to nutrient pollution and management in Central Macedonia. Characterization and roles.

Entity/ies	Category	Sub-category	Knowledge	Technology provider	End user	Policymaker, regulation	Local administration	Market actor	Capital, support, mentoring	Network and community
Aristotle University of Thessaloniki (AUTH)	R&D	University	■							
CERTH/ ELGO-DEMETER	R&D	Technological centre	■							
Thessaloniki Technology Park (TTP)	R&D	Technology Park	■	■						■

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Region of Central Macedonia, and the municipalities of the region	Public	Local administration				■	■			
Ministry of Rural Development and Food	Public	National policymaker				■				
Ministry of the Environment and Energy	Public	National policymaker				■				
Axios-Loudias-Aliakmonas Delta National Park	Public	Natural Park					■			■
Wastewater Treatment Plant of Thessaloniki	Public	Water management company						■		
WATER SUPPLY AND SEWERAGE COMPANY OF THESSALONIKI S.A. (EYATH)	Public	Water managment company						■		
Water Supply and Sewerage Municipal Enterprise of Larissa (DEYSL)	Private	Water management company						■		
1st agricultural cooperative of rice producers of chalastra	Private	Agrifood industry						■		
2nd agricultural cooperative of rice producers of chalastra	Private	Agrifood industry						■		
EcoResources	Private	SME, enterprise		■				■		
Agromatrix	Private	SME, enterprise		■				■		
Agronomist	Private	SME, enterprise		■				■		
The Agricultural Cooperative B of Chalastra	Private	Agrifood industry			■			■		
The Association of Imathia's Agricultural Cooperatives	Private	Agrifood industry			■			■		
The Agronutritional Cooperation of the Region of Central Macedoni	Civil society	Farmers and farmers association			■					■
Ecological Movement of Thessaloniki	Civil society	Environmental NGO's	■							■
The Hellenic Society for the Protection of Nature (HSPN)	Civil society	Environmental NGO's	■							■

Region Innovation Performance:

Central Macedonia is a **Moderate Innovator**. Innovation performance has increased since 2016 (24.8%). The strengths of the region are in the field of **innovation activities**: SMEs introducing either product or business processes innovations, collaboration among SMEs, and public-private publications are above the EU average. This also impacts on employment and sales, being the employment of innovative enterprises and sales of innovative products above the EU average. On the contrary, the weaknesses of the region are related to **digitalisation and intensive knowledge**, being

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lifelong learning indicators, ICT specialists and knowledge-intensive employment, and patent applications below the EU average (Figure 5).

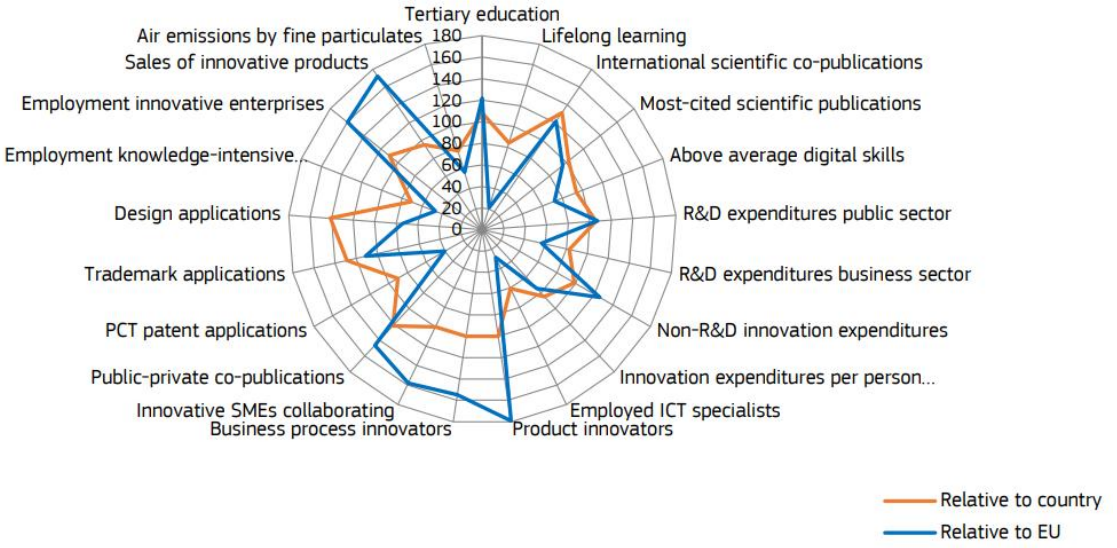

Figure 5. Radar graph of innovation performance of Central Macedonia, showing relative strengths compared to Greece (orange line) and the EU (blue line).

The Regional Smart Specialisation Strategy:

The Smart Specialisation Strategy in Greece follows a hybrid model where there are overall national guidelines in innovation strategies while, at the same time, regions can shape their own specific focuses. Therefore, there is a unified national RIS3 strategy, with regional specialisations.

The 2021-2027 RIS3 focuses on **innovation**, **sustainability**, and **economic transformation** across multiple sectors. The main objectives are to enhance competitiveness, support regional development, and foster the digital and **green transitions.**

Sustainability and circular economy are core policies within the national smart specialisation, that seeks to promote resource efficiency, waste reduction, and sustainable production models. It also aims at supporting the adoption of circular economy principles, such as waste-to-product innovation.

The priority areas identified in the national strategy are:

- **Agrifood value chain**
- Biosciences, Health and Pharmaceuticals
- **Digital Technologies**
- Sustainable Energy
- **Environment and Circular Economy**
- Transport and Logistics
- Materials, Constructions and Industry
- Tourism, Culture and Creative Industries

The policies are tailored to the different key sectors, with targeted actions (Table 3):

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Table 3. Key policy actions of the Greek RIS3 2021-2027 strategy in sectors relevant to the nutrient management ecosystem

Sector	Key Actions & Implementation
Agriculture & Food	Smart farming, precision agriculture, digital monitoring systems
Energy & Environment	Investments in renewable energy, circular economy, green hydrogen.

The main priorities within the **agrifood** sector include: to implement advanced technologies such as precision farming, remote sensing, and decision-support systems; Promote holistic approaches to climate change adaptation, organic production, and circular economy practices; Improve water conservation and management, through innovative irrigation techniques, water footprint of crops and livestock and protection from agrochemicals, Protect soil quality through erosion control, organic matter enhancement, and chemical pollution reduction; Enhance agricultural biodiversity, including soil biodiversity and beneficial organisms for pest control; Rational management and utilization of waste & by-products (Reduction of environmental footprint, for energy production and other uses).

The strategy for the **environmental and circular economy** sector focuses on waste management, resource efficiency, pollution control, and sustainable development. Some of the established priorities target directly nutrient management, including the implementation of monitoring and restoration systems for degraded soils and water bodies, and the integrated management of contaminants, specifically nutrients, but encourages the use of nature-based solutions (NBS) to enhance biodiversity and ecosystem services.

Finally, the strategy targets some cross-sectoral initiatives of interest, such as the promotion of **digital technologies**, i.e. AI and IoT applications, for sustainable resource management.

[3.2.2] Central Catalonia

Key Stakeholders:

Table 4. Regional innovation ecosystem actors related to nutrient pollution and management in Catalonia. Characterization and roles.

Entity/ies	Category	Sub-category	Knowledge	Technology provider	End user	Policymaker, regulation	Local administration	Market actor	Capital, support, mentoring	Network and community
Universitat de Vic	R&D	University	■							
Campus Alimentació UdG	R&D	University	■							
Institut Català de Recerca de l'Aigua	R&D	Research and technological centre	■	■						
Institut de Recerca i Tecnologia Agroalimentària	R&D	Research and technological centre	■	■						
EURECAT	R&D	Research and technological centre	■	■						

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Diputació de Barcelona	Public	Local administration				■	■		■	
Oficina del Regant	Public	Other public entities							■	
ACCIÓ	Public	Other public entities							■	■
Agència Catalana de l'Aigua (ACA)	Public	Regional policymaker				■				
Departament d'Agricultura, Ramaderia, Pesca i Alimentació	Public	Regional policymaker				■				
Ministerio para la transición ecològica y el reto demogràfico	Public	National policymaker				■				
Ens d'abastament d'Aigüa Ter Llobregat	Public	Water management company						■		
Cicle de l'Aigua del Ter, SA	Public	Water management company						■		
Aigües de Vic	Private	Water management company						■		
Aigües d'Osona	Public	Water management company						■		
Depuradores d'Osona	Private	Water treatment company						■		
Aigües de Manresa	Private	Water management company						■		
Agbar Agriculture	Private	SME, enterprise		■				■		
REGABER	Private	SME, enterprise		■				■		
Remondis	Private	SME, enterprise		■				■		
Cooperativa Agrícola de la Plana de Vic	Private	Agrifood industry			■			■		
Catalan Water Partnership	Private	Business support organisation								■
BioHubCat	Private	Business support organisation								■
INNOVACC	Private	Business support organisation								■
Plataforma catalana dels nutrients	Private	Associations	■							■
Federació de Cooperatives Agraries de Catalunya	Civil society	Farmers and farmers associations			■					■
Joves Agricultors i Ramaders de Catalunya	Civil society	Farmers and farmers associations			■					■
Revolta Pagesa	Civil society	Farmers and farmers associations			■					■
AFRUCAT	Civil society	Farmers and farmers association			■					■
Grup de defensa del Ter	Civil society	Environmental NGO's	■							■
Associació Catalana de Comunitats de Regants	Civil society	Farmers and farmers associations			■					■

Region Innovation Performance:

Catalonia is a **Strong Innovator**. Innovation performance has increased since 2016 (11.5%). The strengths of the region are in the field of Research activities (international scientific publications and public-private co-publication), as well as non-R&D activities such as trademark applications and

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innovative products, **all of them indicators** above the EU average. It is noteworthy that almost all innovation indicators are at EU average or above. The weaknesses of the region are related to **employment in innovative companies**, **collaboration** between companies, and **innovation** in products and processes (Figure 6).

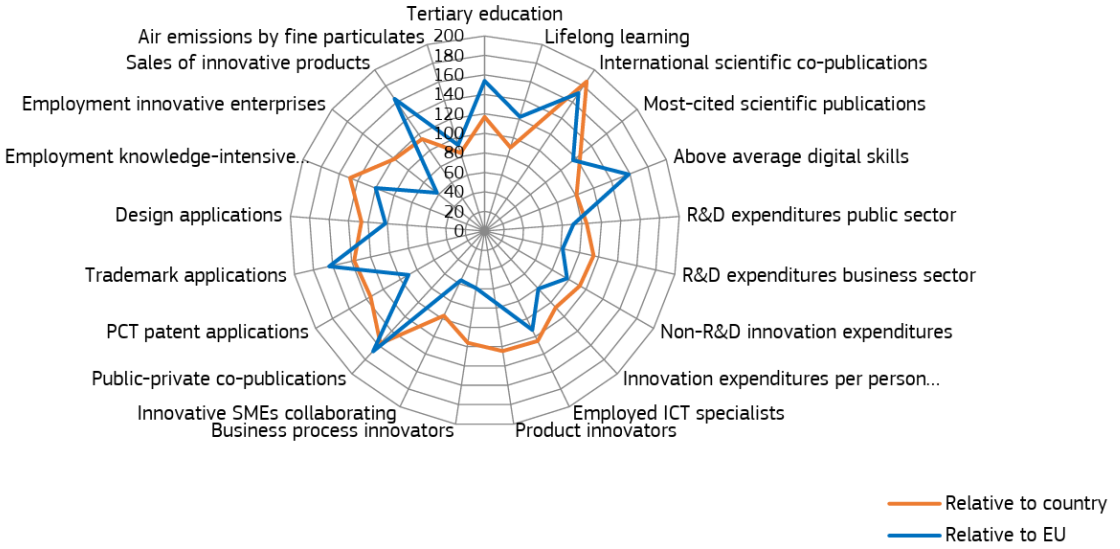

Figure 6. Radar graph of innovation performance of Catalonia, showing relative strengths compared to Spain (orange line) and the EU (blue line).

The Regional Smart Specialisation Strategy:

The Smart Specialization Strategy in Catalonia is oriented to the transition towards a more **green**, **digital**, **resilient** and **equal** socioeconomic model. To do so, it prioritizes a transformative and responsible research and innovation, the development of facilitator technologies and the creation of a system of **shared agendas** to achieve a systemic transformation.

The implementation of the strategy is made through sectoral policies, regulations and investment instruments in line with the European objectives and regulations, such as the Green Deal and Europe 2030 strategy, 2030 Sustainability Agenda and the Next Generation EU recovery plan.

Shared agendas are based on a collaborative governance model integrating public and private stakeholders, as well as R&D actors, to boost research, innovation and competitivity in the region and address common challenges (often related to the Sustainable Development Goals—SDGs). They are based on actions driven by local stakeholders and the research and innovation ecosystem, pointing at different priorities, among which the more significant for SEACURE activities are:

- An energy-neutral and environmentally friendly resource system
- A sustainable, equal, and healthy food system,
- A competitive and resilient industrial system

Although the specific configuration of these shared agendas depends on the challenge at hand (which may be sectoral, scientific, technological, environmental, or social), the territory, the stakeholders involved, and the transformative ambition, they share the following key characteristics:

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- They are based on the identification of strategic challenges and shared diagnoses. They rely on **cross-sector collaboration** and **knowledge generation** among diverse stakeholders to understand and manage complex problems from a holistic and dynamic perspective, considering long-term effects as well as direct and indirect impacts.
- Their actions focus on **change**, **transformation**, and **sustained collective impact** over time. being adaptive strategies that actively respond to unexpected developments, successes, and failures.
- They promote the design and experimentation of possible **solutions** and alternatives to address challenges. They **involve the stakeholder from scratch**, aiming to replicate successful solutions, scale them up, and connect them with broader strategies and agendas, such as the EU's research and innovation missions.

The S3 also identifies **biotechnology as** one of the facilitator technologies.

[3.2.3] Esino Basin

Key Stakeholders:

Table 5. Regional innovation ecosystem actors related to nutrient pollution and management in Marche. Characterization and roles.

Entity/ies	Category	Sub-category	Knowledge	Technology provider	End user	Policymaker, regulation	Local administration	Market actor	Capital, support, mentoring	Network and community
Polytechnic University of Marche (UNIVPM)	R&D	University	■							
Carlo Bo University of Urbino	R&D	University	■							
University of Macerata	R&D	University	■							
University of Camerino	R&D	University	■							
Environmental Protection Agency (ARPAM)	Public	Local administration				■				
Region Marche	Public	Regional policymaker				■				
SVEM (Developent Europe Marche)	Public	Other public entities				■			■	■
Ancona Province	Public	Regional policymaker				■	■			
Macerata Province	Public	Regional policymaker				■	■			
Pesaro e Urbino Province	Public	Regional policymaker				■	■			
Ascoli Piceno Province	Public	Regional policymaker				■	■			
Fermo Province	Public	Regional policymaker				■	■			
Municipality of Jesi	Public	Regional policymaker				■	■			
Municipality of Falconara Marittima	Public	Local policymaker				■	■			

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Authority of the Central Apennine District	Public	Regional policymakers				■				
Chamber of Commerce	Public	Business support organisation							■	
Ripa Bianca Reserve	Public	Natural parks and environmental reserves					■			
Gola della Rossa and Frasassi Regional Park	Public	Natural parks and environmental reserves					■			
Unione Montana dell'Esino Frasassi	Public	Regional policymaker				■				
The Italian Confederation of Farmers (CIA)	Private	Associations						■		
Viva Servizi	Private	Water management companies:			■			■		
CIIP spa	Private	Water management companies:			■			■		
Marche Multiservizi	Private	Water management companies:			■			■		
Enel	Private	SMEs and larger enterprises			■			■		
The Food farming innovation cluster (Agrifood Marche)	Private	Associations			■					■
General Confederation of Italian Agriculture (Confagricoltura)	Private	Associations								■
The Hive	Private	Business support organisations		■				■		
PB Cube	Private	Business support organisations		■				■		
The Marche Foundation	Private	Business support organisations		■				■		
Fileni	Private	Agrifood industry			■			■		
Coldiretti Marche	Civil society	Farmers and farmers associations			■					■
Agricoltori Custodi di Biodiversità	Civil society	Farmers and farmers associations			■			■		■
Legambiente	Civil society	Environmental NGO's	■							■
Associazione pesca e ambiente	Civil society	Consumer association			■					■

Region Innovation Performance:

Marche region is a **Moderate Innovator**. Innovation performance has increased since 2016 (27.8%). The stronger elements of the innovation system are the number of **designs** and **innovation** indicators: private innovations, both in terms of products and business processes, and private-public co-authored research publications, all of them above EU average. Low **digital workforce**, number of patent applications, **R&D investment** in the public and private sectors and persons with **tertiary education** are the weaker areas of the region, at 40 to 60% of the EU average (Figure 7).

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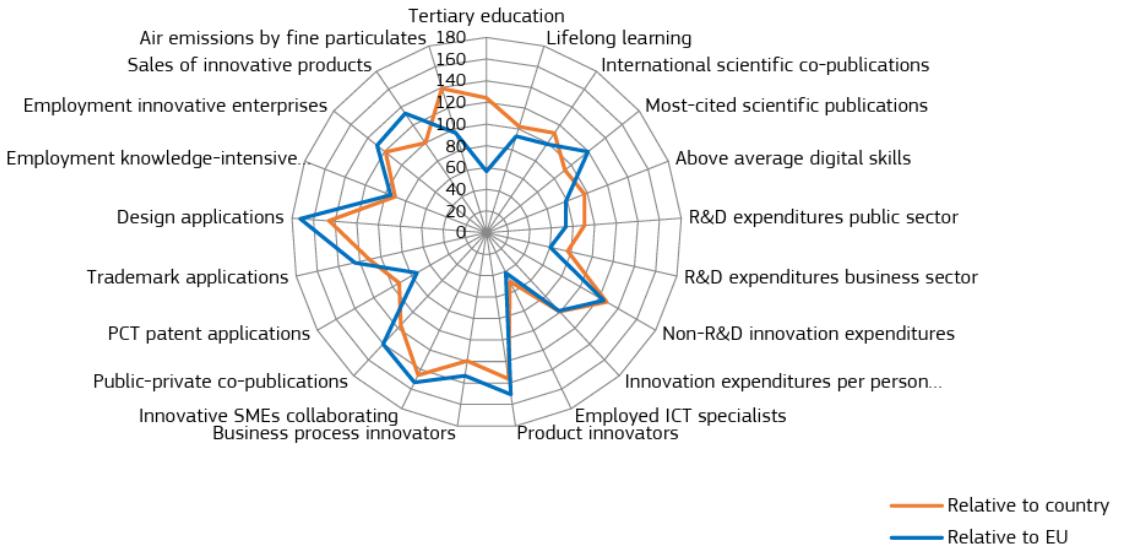

Figure 7. Radar graph of innovation performance of Marche, showing relative strengths compared to Italy (orange line) and the EU (blue line).

Despite its strong manufacturing base—the highest in Italy—Marche's economy is characterized by small businesses and a high presence of artisanal production. This structure, combined with a dispersed urban landscape of small towns and rural areas, has made it difficult to transition to an innovation-driven economy. The region lacks a strong presence of medium-sized, research-intensive companies, which are crucial for fostering competitiveness and an innovation ecosystem

The Regional Specialisation Strategy:

The Marche Region has revised its S3 to address structural challenges, including declining competitiveness and slow adoption of technological innovation. Now classified as a "transition region" in the EU's funding allocation, Marche aims to align industry needs with technological opportunities through a more bottom-up approach.

The regional government is addressing identified innovation gaps through new policies, oriented to support industry cluster and start-up growth (legge regionale 6/2021)[6], digitalization in SMEs (legge regionale 17/2022)[7], and reinforcement of the innovation ecosystem (legge regionale 17/2022)[8], among others.

The strategy focuses on three key dimensions, and in all of them relevant aspects to nutrient-management pollution are highlighted:

1. Strategic industrial specializations, which include specifically the agri-food and engineering sectors.
2. Scientific and technological competencies, and in particular digital technologies, engineering, and biotechnology.
3. Market drivers, among which it targets sustainability and circular economy.

The policy measures to support the S3 include core actions managed by the region to support R&D projects, prioritizing sustainability and digitalization, support measures to enhance competitiveness, including green and circular economy initiatives, and the integration with national and European policies among which it emphasizes the sustainability and climate action strategies (green energy,

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circular economy, and waste reduction) and support for rural and internal areas, combining industrial and agricultural innovation.

The agrifood sector is one of the targeted sectors of the strategy. It prioritizes the development and implementation of methodologies for the rational use of resources, including water, such as advanced technologies for reducing water consumption, the transformation of agrifood industry by-products, or precision agriculture.

[3.2.4] Mar Menor Lagoon

Key Stakeholders:

Table 6. Regional innovation ecosystem actors related to nutrient pollution and management in Murcia. Characterization and roles.

Entity/ies	Category	Sub-category	Knowledge	Technology provider	End user	Policymaker, regulation	Local administration	Market actor	Capital, support, mentoring	Network and community
Polytechnic University of Cartagena UPCT	R&D	University	■							
University of Murcia UMU	R&D	University	■							
Centro de Edafología y Biología aplicada del Segura CEBAS	R&D	Research and technological centre	■							
Instituto Murciano de Investigación y Desarrollo Agrario y Medioambiental IMIDA	R&D	Research and technological centre	■							
Centro Tecnológico de la Energía y del Medio Ambiente CETENMA	R&D	Research and technological centre	■							
Instituto Español de Oceanografía IEO	R&D	Research and technological centre	■							
Local City councils	Public	Local administration				■	■			
Wastewater management authority ESAMUR	Public	Regional and national policymakers				■				
Confederación Hidrográfica del Segura	Public	Regional and national policymakers				■				
Technical office of Mar Menor	Public	Regional and national policymakers				■				
Concejalía de turismo	Public	Regional and national policymakers				■				
Dirección General del Agua	Public	Regional and national policymakers				■				
Dirección general del Mar Menor	Public	Regional and national policymakers				■				

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Entidad de Saneamiento y Depuración de Aguas Residuales de la Región de Murcia	Public	Water management agency				■				
Parque Regional de Salinas y Arenales de San Pedro del Pinatar	Public	Natural parcs and environmental reserves					■			
Parque Regional Calblanque, Monte de las Cenizas y Peña del Águila	Public	Natural parcs and environmental reserves					■			
GLOBAL OMNIUM	Private	Water management company						■		
HiDROGEA	Private	Water management company						■		
Federación de cooperativas agrarias de Murcia (FECOAM)	Private	Association/Business support organisation			■			■		■
Asociación Agraria de Jóvenes Agricultores (ASAJA)	Private	Association/Business support organisation			■			■		■
Verdimed	Private	Agrifood industry			■					
AMFRESH	Private	Agrifood industry			■					
GRUSAMAR	Private	SMEs and larger enterprises		■						
UPA Murcia	Civil society	Farmers association			■					■
Asociación de Naturalistas del Sureste (ANSE)	Civil society	Environmental NGOs	■							■
Irrigation communities	Civil society	Consumer association			■					■

Region Innovation Performance:

Murcia region is a **Moderate Innovator**. Innovation performance has increased since 2016 (7.1%). The region is strong in **digital skills** and **lifelong learning**, as well as in trademark applications and innovative products sales, all of them above EU average. **R&D scientific publications and citations** are in the EU average. Its main weaknesses are related to **employment**, in knowledge-intensive and innovation companies as well as of ICT specialists. Innovation fields like business processes and products are also below the EU average (Figure 8).

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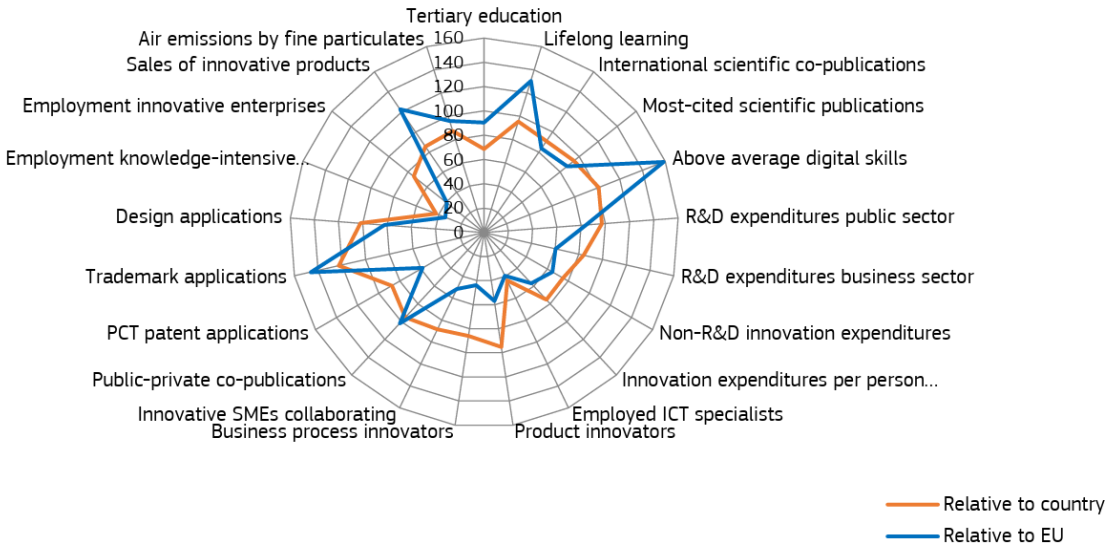

Figure 8. Radar graph of innovation performance of Murcia, showing relative strengths compared to Spain (orange line) and the EU (blue line).

The Regional Specialisation Strategy:

The Strategy 2021–2027 for the Region of Murcia identifies the agri-food sector as the region's primary area of leadership, positioning it as a driver of economic and technological transformation. In this sense, the strategy promotes a shift toward a more sustainable, resilient, and innovative production model., where efficient use of water resources and the incorporation of emerging technologies are central components. Indeed, the strategy focuses on activities within agrifood value chain, primary activities such as agriculture, livestock, fishing, and food industry, but also addressing specifically activities related to **water cycle** (management and treatment) and **environment**.

Within the agri-food sector, it highlights the need to respond to global trends such as the demand for healthy and sustainable food, by-product valorisation, animal welfare, and precision agriculture. To address these challenges, it promotes the use of advanced technologies including crop monitoring sensors, drones, autonomous tractors, plan-t biotechnology, genome editing, and active packaging. Sector sustainability is also supported by improvements in water use, both in quantity and quality, through solutions such as water cycle management, desalination, advanced wastewater treatment, water reuse, and the removal of microplastics and emerging contaminants.

In this context, identified key challenges for water management are the need to improve irrigation efficiency, preserve water quality, reduce pollution in aquatic ecosystems (specifically Mar Menor), and address water scarcity in a context of climate change. To tackle these, the region is investing in technologies such as carbon capture using algae, green filters, hydrological modelling, the use of biofertilizers, and the recovery of degraded soils—advancing principles of the circular and green economy.

The identified facilitator technologies and tendencies identified in the agrifood and water leadership areas in the Murcia region are summarised below:

Table 7. Facilitator technologies and tendencies in the prioritized areas of Murcia S3

Leadership area	Trends	Technologies
Agri-food	• Food design: nutraceuticals, antioxidants, vegan products	• Plant biotechnology

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	• Personalized nutrition • Healthy diets and lifestyles • Waste reduction and by-product recovery • New protein sources (insects and by-products) • Sustainable production processes • Animal welfare, food safety and traceability • Precision agriculture, sensorisation • Crop monitoring • Varieties of herbaceous and fruit crops • Intelligent and sustainable farms and greenhouses • Shelf-life extension of food	• Biotechnology in waste and by-product management • Genome editing • 4.0 technologies • Active packaging • Pest control technologies • Hydroponics • Animal reproduction technologies • Driverless tractors • Drones
Water	• Green filters • Contaminant capture with porous materials • Water cycle management technologies • 4.0 technologies • Technologies for microplastics removal • Desalination technologies • Carbon capture – algae	• Technologies for microplastics removal • Desalination technologies • Carbon capture – algae
Environment	• Technologies for biofuel production (biomass) • Teleworking support technologies to reduce commuting impact • Bioenergy (carbon capture and storage) • Technologies for sustainable biofertilizer production • Water footprint, environmental footprint, eco-costs • Water consumption reduction • Wastewater management • Removal of emerging contaminants • Water quality improvement • Irrigation system optimization • Blue Economy • Pathogen removal from water used in food processing • Hydrological modelling • Reservoir evaporation • By-product/waste valorisation • Bioeconomy. Circular economy • Biodiversity preservation • Resource consumption reduction and reuse • Climate-resilient crop varieties • Soil as a carbon sink • Degraded soil recovery • Erosion control • Green economy: business models	• Biofuel production technologies (biomass) • Carbon capture and storage • Technologies for sustainable biofertilizer production • Water footprint and resource optimization technologies • Hydrological modelling and water purification • Technologies for biodiversity and soil preservation

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[3.2.5] Po River delta

Key Stakeholders:

Table 8. Regional innovation ecosystem actors related to nutrient pollution and management in Emilia-Romagna. Characterization and roles.

Entity/ies	Category	Sub-category	Knowledge	Technology provider	End user	Policymaker, regulation	Market actor	Capital, support, mentoring	Network and community
University of Ferrara	R&D	University	■						
University of Parma	R&D	University	■						
Ecosister	R&D	Research and technological center	■						
Po River Basin District Authority	Public	Local administration/ Regional and national policymakers				■			
Arpae Emilia-Romagna	Public	Local administration/ Regional and national policymakers		■		■			
Ferrara Province	Public	Local administration/ Regional and national policymakers				■			
Goro Municipality	Public	Local administration				■			
Comacchio Municipality	Public	Local administration				■			
ANBI – National Association of Irrigated Water and Land Management and Protection Consortia	Public	Regional and national policymakers/ Water management agency				■			
ANBI Emilia-Romagna	Public	Regional and national policymakers/ Water management agency				■			
Romagna Acque	Public	Water management agency				■	■		
CONFAGRICOLTURA	Private	Associations					■		■
Consorzio di Bonifica Delta del Po	Public	Water management agency					■		
The Italian Confederation of Farmers (CIA)	Private	Water management companies					■		■
Circolo Legambiente Delta del Po, Il Melograno	Civil society	Environmental NGOs	■						■

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Regioanl Park of the Po Delta of Emilia-Romagna	Public	Natural parkcs and environmental reserves	■		■			■
Goro Pesca s.r.l.	Private	SMEs and larger entreprises	■				■	■
CoPeGo – Goro Fishermen Consortium	Private	Associations	■				■	■

Region Innovation Performance:

Emilia-Romagna region is a **Strong Innovator**. Innovation performance has increased since 2016 (15.8%). The region is around EU average in most innovation indicators. It is particularly strong in **R&D publications**, both in terms of international scientific co-publications and public-private co-publications, as well as some non- R&D activities as for example **design applications.** Its main weaknesses are related to **employment of ICT specialists,** and **population with tertiary education**, (

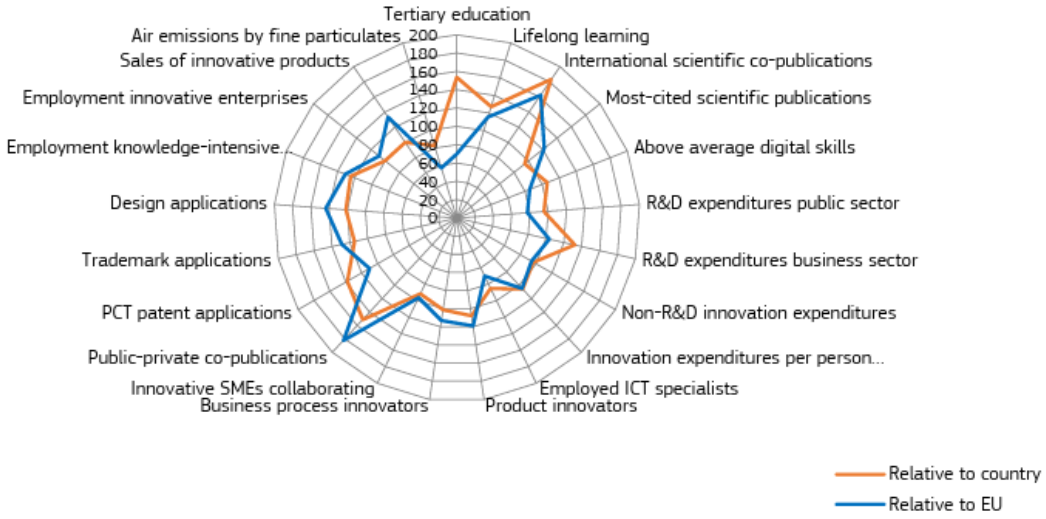

Figure 9).

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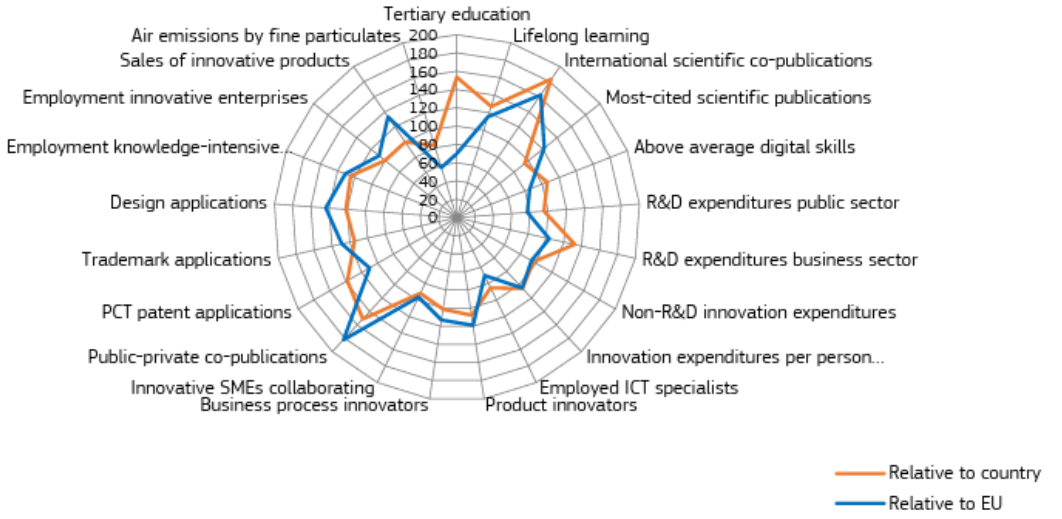

Figure 9 Radar graph of innovation performance of Emilia-Romagna, showing relative strengths compared to Italy (orange line) and the EU (blue line).

The Regional Specialisation Strategy:

The Emilia-Romagna regional specialisation strategy targets **Agrifood** industry and **Energy and sustainable growth** as two of the 12 regional specialisation production systems, and connect them with 15 co-identified cross sector areas, among which we emphasize:

- Circular economy
- Climate and natural resources
- Blue growth
- Innovation in materials
- Ground and space-based connectivity of systems
- Territorial heritage and regional identity, Made in E-R

The strategy also identifies policy tools to implement the strategy, based on 6 pillars:

1. Technopoles, spaces and research infrastructures
2. Strategic innovation, research and innovation, system actions projects
3. Skills development and higher education
4. Development and consolidation of innovative startups
5. Implementation of the Emilia-Romagna Digital Agenda: Data Valley
6. Networks, partnerships, cooperation and synergies with European programmes

[3.2.6] Thessaly Plain

Key Stakeholders:

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Table 9. Regional innovation ecosystem actors related to nutrient pollution and management in Thessaly. Characterization and roles.

Entity/ies	Category	Sub-category	Knowledge	Technology provider	End user	Policymaker, regulation	Market actor	Capital, support, mentoring	Network and community
University of Thessaly (UTH)	R&D	University	■						
National Technical University of Athens	R&D	University	■						
Hellenic Agricultural Organization "DEMETER" (ELGO)	R&D	Research and technological center	■						
Region of Thessaly	Public	Regional policymaker				■			
ΔΕΥΑ Karditsas	Public	Water management agency					■		
ΔΕΥΑ Larissa	Public	Water management agency					■		
ΔΕΥΑ Magnesia	Public	Water management agency					■		
ΔΕΥΑ Trikala	Public	Water management agency					■		
Ministry of Environment	Public	National policymaker				■			
The Hellenic Agricultural Organization (ELGA)	Public	Other public entities						■	
Ministry of Agriculture	Public	Regional and national policymakers				■			
Ministry of Rural Development & Food	Public	Regional and national policymakers				■			
Water Supply and Sewerage Municipal Enterprise of Larissa (DEYAL)	Private	Water management company					■		
Water Supply and Sewerage Municipal Enterprise of Elassona (DEYAEL)	Private	Water management company					■		

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Thessaloniki Water Supply & Sewerage Company (EYATH)	Private	Water management company								
Thessaly Water Management Organization (ΟΔΥΘ)	Private	Water management company								
Hydraspis	Private	SME, enterprise								
DEKAGRO	Private	SME, enterprise								
KAFSIS	Private	SME, enterprise								
Agricultural cooperative of Thessaly	Private	Agrifood industry								
Agricultural cooperative of Thessalic fruits	Private	Agrifood industry								
Agricultural cooperative of Thessaly's tomato producers	Private	Agrifood industry								
TOEB Enipea-Farsala	Private	Agrifood industry								
TOEB Karla's Lake	Private	Agrifood industry								
TOEB Larisa	Private	Agrifood industry								
TOEB Mati-Tirnavos	Private	Agrifood industry								
TOEB Pinios River	Private	Agrifood industry								
TOEB Sellanon	Private	Agrifood industry								
TOEB Tavropos	Private	Agrifood industry								
TOEB Thessalotidas	Private	Agrifood industry								
Hellenic Association of Municipal Water and Sewerage Companies (EDEYA)	Civil society	Environmental NGO's								

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Region Innovation Performance:

Thessaly region is a **Moderate Innovator**. Innovation performance has increased since 2016 (25.9%). The region is strong in **innovating** in products and business models, collaboration initiatives and public-private publications, as well in expenditures in innovation, employment in innovative companies and sales of innovative products, all of them above the EU average. **R&D investment and scientific publications and citations** are in the EU average. Its main weaknesses are related to **ICT specialisation** and knowledge-intensive employment, far below the EU average, as well as patent applications (Figure 10Figure 10).

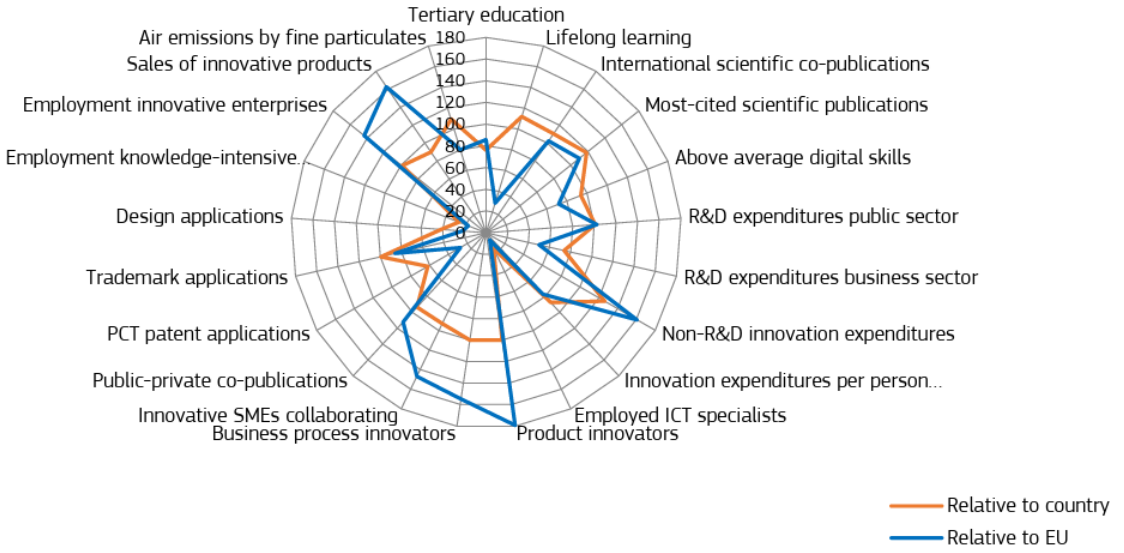

Figure 10 Radar graph of innovation performance of Thessaly, showing relative strengths compared to Greece (orange line) and the EU (blue line).

The Regional Specialisation Strategy:

As mentioned before, S3 in Greece follows a national model that regions shape to their specificities.

Past initiatives in Thessaly have focused on the agrifood sector and related industries and the value chains linked to agriculture[9]. Significant progress has been made in basic and applied research in the region, however the interaction of the academic world with the local economy is still limited, which impedes a cross fertilisation of the academic knowledge with the regional economic capacities. There are several long-standing business and agricultural associations, local development agencies (e.g. ANKA for Karditsa), that operate on a project-by-project basis to deliver business support or rural development (LEADER) etc. initiatives.

The 2021-2027 Strategy for Smart Specialisation (RIS3) focuses on innovation, sustainability, and economic transformation across multiple sectors. The main objectives are to enhance competitiveness, support regional development, and foster digital and green transitions. Below is a summary of the key policies and their implementation approach:

Promote research, innovation, and smart transformation: The strategy prioritizes policies to strengthen collaboration among research centres, universities, and industry. It supports technology transfer and knowledge exchange while encouraging investment in research and development, particularly in strategic technology areas such as artificial intelligence, the Internet of Things, and **clean energy**.

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Digital transition and smart industry: The strategy point at Industry 4.0 initiatives, including automation, robotics, and digital manufacturing. It aims to facilitate the integration of digital technologies into traditional industries and expand cybersecurity and digital infrastructure to enhance economic resilience.

Most important regarding SEACURE objectives is the policies for increasing **sustainability and the circular economy**, intended to promote resource efficiency, waste reduction, and sustainable production models. Investments in renewable energy solutions and low-carbon technologies are also prioritized, alongside support for businesses adopting **circular economy principles**, such as **waste-to-product innovations**.

Strengthening regional competitiveness and resilience: This priority area involves enhancing the competitiveness of small and medium-sized enterprises through financial support and skills development, encouraging the formation of regional clusters to drive sectoral growth, and supporting smart agriculture and sustainable food production.

human capital and workforce development: This includes actions and investments in education and training programs aligned with future labour market demands, the promotion of entrepreneurship and start-up initiatives, and measures to address brain drain by attracting and retaining skilled professionals.

To ensure these priorities are realized, the strategy incorporates several implementation mechanisms, from which we highlight the leveraging European funding instruments to support sustainable business practices and environmental innovation, as well as financial incentives to stimulate investment in renewable energy, resource-efficient technologies, and sustainable agricultural models.

The strategy monitoring and evaluation system includes specific indicators to measure progress on sustainability targets, including indicators related to water use, circularity, and environmental performance.

[3.3] SWOT analysis of each region

In this section, the information gathered in each region is shown in a SWOT analysis of the regional innovation ecosystems dealing with nutrient management and pollution, one SWOT per region.

In the SWOT tables (tables 10 to 15), pictograms represent the four dimensions of the nutrient challenge identified in T1.1.:

 environmental dimension,

 socioeconomic dimension,

 technical dimension,

 regulatory dimension,

Colour indicates whether the statement is supported with available data (black), or is based on the stakeholder's perception (orange, i.e. ).

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[3.3.1] Axios River delta

Table 10. SWOT analysis of the nutrient pollution and management regional innovation ecosystem of the Axios river delta.

STRENGTHS	WEAKNESSES
Axios delta's wetland harbors a large amount of biodiversity[10,11,12] being a perfect research case study. The delta has also relevant agricultural use, being able to be used as a pilot site [10,12,13] The ecosystem services of the site promotes its importance towards the stakeholders[10]. There is an important awareness among the local stakeholders regarding the importance of the zone. Track of past solutions and activities successfully implemented[14]. Axios delta has a set traditions and cultural activities linked to the river, the delta and related wetlands[15]. There is a research ecosystem with academic support centring its activities in the delta[16]. Region with research and innovative development linked with technical improvements[4]. Axios delta is a protected area [10, 11]. The administration has been increasingly involved in the conservation of the site[17].	There is a large portion of delta's terrain affected by nitrates[18]., Moreover, in many parts, the soils is experimenting a loss in its fertility[19] An incipient loss has been noticed regarding some environmental services[19:] A generalized lack of cooperation is historically found among the Axio's delta actors, especially between farmers, industries and water management entities. Many of these actors also present a lack of knowledge regarding the innovative solutions and technologies, including overuse of fertilizers[10,20]. In recent years a lack of financial resources for the delta's activities has occurred along with an increase of its costs[21] There is a misplanification of water infrastructures and urbanization strategies in the delta [10,22]. The lack of monitoring of the delta's dynamics hindrances the planification and execution of activities. Low digitalisation and intensive-knowledge employment Some local stakeholders perceive a lack of regulation's definition and enforcement [10]. Some economic actors encounter a lack of guidance regarding the accomplishment of environmental standards.
OPPORTUNITIES	**THREATS**
In the Axios delta climatic-resistant crops are being produced [23,24,25,26]. Possibility of receiving funding through external incentive and collaboration programs[27] opens a lot of opportunities. The education and awareness-rising among the actors should promote the planification and collaboration in the forthcoming years[28,29,20]. The implementation of new innovative technologies and research programs is promising in the future [27].	Effects of hydrological extreme events derived from climate change[35] threatens the longstanding collaboration and viability of economic activities. An observed loss of biodiversity (partially originate by pollution and salinization) also compromises the suitability of some local activities [35]. The recent intensification of agricultural and industrial activities together with unregulated markets confronts the individual aims with the longstanding collaboration in sustainability. The area is experiencing a loss of rural population and traditional economic activities[36].

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Some actions have been taken regarding the excessive urbanization that implies a low soil's permeability[30]..	The lack of future regulations may make it difficult for the alignment of the stakeholders in environmental objectives [22,37.]
A regulatory framework at EU level accompanying actions to prevent nutrient pollution: EU's Soil Strategy 2030 and proposal for a Soil Monitoring Law[31], Water Framework Directive (WFD), Zero Pollution Action Plan, Nitrates Directive, Urban Wastewater Treatment Directive and its impacts in the country [32,33,34,14]	The excessive bureaucracy and project execution will difficult for the stakeholders the implementation of solutions for the most short-term challenges

[3.3.2] Central Catalonia

Table 11. SWOT analysis of the nutrient pollution and management regional innovation ecosystem of Central Catalonia.

STRENGTHS	WEAKNESSES
The area has an important agricultural activity that is strongly linked with the landscape[38,39]. There is a strong awareness for the environmental preservation among local actors[40]. Some collaborative actions to give response to environmental challenges have been done in the past[41]. There are ongoing actions supported by administrations and researchers[42]. There is a strong and dynamic R&D infrastructure that boosts technological development and knowledge transfer in the area. The zone is considered as a vulnerable area[43]. The area is protected by the local regulation in line with regional and EU strategies[44].	A significant portion of the territory has been designated as Nitrate Vulnerable Zones, covering 39.9% of the land and 49.2% of municipalities[43,18] . Ten aquifers are classified as vulnerable, with nitrate levels in the Osona aquifer exceeding 150 mg/L[45]. There is still an important lack of knowledge among some stakeholders and lack of digitalization and technology adoption[46,47]. The collaboration among actors should be reinforced. More economic resources would be necessary to solve the challenges. The region shows limited investment in research, development, and innovation[46]. The adoption of innovations in the market is slow, hindered by strict regulations, sector maturity, and social, ethical, and safety concerns. There are some challenges related to the planification of water infrastructures and urbanization [48]. An important percentage of inefficient and outdated irrigation systems resulting in inefficient water and nutrient use and related infrastructures[49]. A low response time is observed to face the challenges. The enforcement of regulations should be better. There is a lack of guidance from the administration to accomplish the required environmental standards.
OPPORTUNITIES	**THREATS**
There are funding and incentive programs[50]. An educational task is being carried out to raise the awareness and empower administration and local actors[51]. The number of innovative technologies enable local actors to take action to solve the challenges[52,53,54,55]. A regulatory framework at EU level accompanying actions to prevent nutrient pollution: EU's Soil Strategy 2030 and proposal for a Soil Monitoring Law[31], Water Framework Directive (WFD), Zero Pollution Action Plan, Nitrates Directive, Urban Wastewater Treatment Directive and its impacts in the country	The effects of climate change endanger local and agricultural activities at mid and long term[45]. The reduction of population reduces the capability of the territory to promote actions at local scale[51].

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[3.3.3] Esino Basin

Table 12. SWOT analysis of the nutrient pollution and management regional innovation ecosystem of the Esino basin.

STRENGTHS	WEAKNESSES
The importance of agricultural activities[56] forces the local actors to act against the degradation of the ecosystem. The area includes significant protected sites such as the Ripa Bianca di Jesi Regional Nature Reserve and the Gola della Rossa and Frasassi Regional Park [57],[58]. Some projects have been successfully implemented in the zone, entangling a previous collaboration network among local actors[59],[60],[61],[62]. Some technologies and monitoring systems have been successfully implemented in the area[63]. There is awareness of the environmental challenges among academy and institutions[64]. The region demonstrates moderate to high levels of innovative activity. The rise in public-private R&D publications indicates moderate to intense R&D activity. Success initiatives in the area such as voluntary contracts, joint guidelines implementation [65],[66].	There is a lack of knowledge and cooperation among local actors[56]. R&D investment in the private and public sectors is limited. The share of people with tertiary education is below the EU average. It lacks a monitoring system to assess the state of the pollution in the area[65]. There is a lack of specialised digital workforce. There is an inadequate or insufficient regulatory framework to address the local pollution challenges[67].
OPPORTUNITIES	**THREATS**
The ecosystem services provided by the basin encourage stakeholders to engage in its preservation[68],[69]. There are funding and incentive programs in the region[59]. The actors' network is well interconnected and aware of local challenges[67],[56]. There are new technologies and pilot programs to respond to local pollution trends [70],[65],[71]. A regulatory framework at EU level accompanying actions to prevent nutrient pollution: EU's Soil Strategy 2030 and proposal for a Soil Monitoring Law[31], Water Framework Directive (WFD), Zero Pollution Action Plan, Nitrates Directive, Urban Wastewater Treatment Directive and its impacts in the country[65].	The region's high seismicity affects population distribution and shapes human activities[72],[56] There is a loss in local population that compromises the economic activities in the mid-term[73]. Economic activity concentrated along the coast, coinciding with more productive agricultural areas and nitrate vulnerable zones, can slow down sustainable practices. Agri-environmental collective initiatives do not have enough institutional and policy support[67].

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[3.3.4] Mar Menor Lagoon

Table 13. SWOT analysis of the nutrient pollution and management regional innovation ecosystem of the Mar Menor lagoon.

STRENGTHS	WEAKNESSES
The environmental importance of Mar Menor aligns the local and national stakeholders to preserve it at local and national levels[74,75,76,77].	The limited availability of adequate water makes the local producers dependent of technologies that can have environmental impacts. [90]
Alliances and collaboration platforms have been created to improve the situation in the region in all dimensions[78].	There is a lack of technical knowledge and grounded information available to the public.
There is a general local awareness of the problem and its implications with national-scale impacts[79 80 81].	Economic responsibilities need to be clearly defined.
Relevant industrial collaboration in Murcia[82].	The region shows a scarcity of innovative SMEs and highly trained professionals[88].
The region shows strong performance in lifelong learning indicators.	Low levels of employment in knowledge-intensive industries and the ICT sector.
Operative monitoring system to assess the quality and evolution of the water system[83].	Insufficient resources to effectively implement existing regulations.
Ongoing research actions to address Mar Menor's challenges[84,85].	Some of the actions undertaken will have medium or long-term results due to the natural system inertia.
The region features high-tech agriculture supported by cutting-edge digital solutions[82,86].	Coordination among multi-level competent authorities should be improved.
Pilot-scale testing has been conducted on technical solutions for nitrate removal[87].	
The region demonstrates strong performance in digital skills indicators.	
There is an important involvement of the administration, with action plans being put in place[88].	
The zone is recognized as a protected area according to the EU and national criteria[11].	
New regulations that address the problematic with a multi-actor approach are being implemented [78]	
Mar Menor Lagoon is recognized as a legal personhood with specific protection status and laws[89,81]	
OPPORTUNITIES	**THREATS**
Future environmental recovery can provide social and economic benefits for many local stakeholders.	The effects of climate change worsen the pollution problems in the area, and specifically endangering biodiversity[79].
Dedicated funding programs for Mar Menor area[91,92,93].	High politization of the conflict threatens the achievement of agreements between the parties.
The concept and benefits of organic farming are spreading among consumers and producers[94].	Socioeconomic activities depending on the good health of the area (fishing and tourism) are at risk[96,97]

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Economic incentives for the installation of biogas plants in the area create opportunities for the market entry of bio-based products, such as digestate or compost[95]. The acquisition of new knowledge and advanced technologies as well as the collaboration among innovation environment to face environmental challenges is a priority in the RIS3 strategy of Murcia Region[88]. Technical advancements in the market that can be applied to the area, such as slow-release fertilizers. There are EU funding programs[50]. There is a government-defined plan to assess the challenges of Mar Menor[75]. A regulatory framework at EU level accompanying actions to prevent nutrient pollution: EU's Soil Strategy 2030 and proposal for a Soil Monitoring Law[31], Water Framework Directive (WFD), Zero Pollution Action Plan, Nitrates Directive, Urban Wastewater Treatment Directive and its impacts in the country	Dependence on external funding sources[88]. Lack of results to address the future challenges regarding the effects of climate change. There is a low implementation of legislative actions. There is a lack of coordination in the implementation of strategies

[3.3.5] Po River delta

Table 14. SWOT analysis of the nutrient pollution and management regional innovation ecosystem of the Po River delta.

STRENGTHS	WEAKNESSES
The significant role of agricultural activities and mollusc farming acts as a key driver for conservation efforts. [98],[99]. The activities done in the delta have a large tradition which highlights its importance in front of the authorities and local agents[100]. Previous actions can be considered as success stories showcasing the potential of collaboration and innovation[101],[102]. The area has a solid research infrastructure with valuable R&D actors[103],[104],[105]. The local stakeholders have access to technologic advancements and monitoring systems. The delta is a protected area and the practices that generate N pollution are regulated[106],[107]. The local administration is willing to provide support to the implementation of solutions[108].	Lack of knowledge of local stakeholders prevents them from being involved in joint actions. There is a perception that some of the regulations are not well defined or implemented[67],[109].
OPPORTUNITIES	**THREATS**
The ecosystem services of the delta reinforce the will of all kinds of local and national actors to preserve it[110],[111]. Sustainable fertilization practices are being promoted among the local farmers[112],[113] There are novel technologies available related to nature-based solutions, precision agriculture and pollution monitoring systems[112]. A regulatory framework at EU level accompanying actions to prevent nutrient pollution: EU's Soil Strategy 2030 and proposal for a Soil Monitoring Law[31], Water Framework Directive (WFD), Zero Pollution Action Plan, Nitrates Directive, Urban Wastewater Treatment Directive and its impacts in the country[108].	The increasing effects of climate change leading to eutrophication and loss of local biodiversity along with the appearance of invasive species may be difficult to overcome more complex challenges.[114],[115],[116],[117] The area is classified as of high hydraulic risk [118],[109] Progressive loss of fishery and attractiveness of recreational areas may hinder economic development of the Delta and prioritize non-protective actions[119]. The pollution problems get more complex as they combine with societal challenges such as increase of agricultural costs, social resistance to change, decrease of rural population or property devaluation, among others[120].

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[3.3.6] Thessaly Plain

Table 15. SWOT analysis of the nutrient pollution and management regional innovation ecosystem of the Thessaly plain.

STRENGTHS	WEAKNESSES
The plain is a biodiversity hub with important ecosystem systems and agricultural activity, being valuable assets to be preserved[121],[122],[123].	The progressive limitation of soil quality and available water puts the focus of many local economic activities in maintaining productivity rather than in environmental challenges[133].
Some actions to prevent pollution have been successfully implemented in the past[124],[125].	The weather-related impacts are also another drawback for local communities when allocating their resources between short, and medium-long term actions[134],[135].
Agriculture has been historically important in the plain, and deep-rooted traditions offer a strong cultural foundation to adopt sustainable practices.	High adoption cost and financial constraints: advanced technologies such as precise irrigation and digital monitoring systems remain financially inaccessible for small-scale farmers, hindering broader adoption[136].
Strong and renowned institutions in the area that foster innovation and provide support[126]	Lack of knowledge and inefficient information flows lead to the use of outdated or inefficient fertilization practices that increase pollution[136].
Ongoing research activities are taking place in the area[127],[128],[121],[129]	Low ICT specialisation and knowledge-intensive employment
Capital allocation towards innovation initiatives.	Aging and outdated water management and supply infrastructure, resulting in water loss and system inefficiency[137]
New technologies are available for efficient water and nutrient management such as digital tools, precision farming, NBS, etc[130],[131],[128],[121],[129].	Insufficient nitrate and water quality monitoring networks impede early detection and pollution mitigation[138],[139].
Good performance in innovative companies and products.	Excessive bureaucracy and complexity are reported by stakeholders.
The zone is a protected area and polluting activities, especially the introduction of N into the system, are regulated[132],[122].	Overlapping responsibilities and lack of coordination among competent authorities slows water management and agricultural reforms [140]
OPPORTUNITIES	**THREATS**
Climatic resilient crops may facilitate the rational management of resources and fertilizers[141] (i.e. orphan crops [142]).	Extreme weather events related with climate change pose challenges to the implementation of effective measures, as well as effects on soil degradations and salinization [149],[135].
The perspective of boosting ecosystem services as a future asset motivates local and national-scale stakeholders to find solutions to the degradation of the plain[143].	The increase of agricultural costs hinder the implementation of innovative solutions by local producers[150],[151].
The funding and incentive programs may be key actions to enhance positive impacts, adopt innovative technologies and promote sustainable practices[144],[21].	Some of the actors may be reluctant towards the effectiveness of modern practices, new technology and joint actions[136].
The alignment of consumer behaviors and the implementation of sustainable agritourism and educational tourism will enhance the local economy and raise environmental awareness[145],[146].	Rural depopulation can restrain economic development in the area[152]
Public–private partnerships act as key drivers of innovation within the region[147]	The enforcement of regulation should be better and more methodical[139],[140].
	Delays in administrative processes and lack of political urgency hinder the implementation in time of necessary action to combat water scarcity and pollution[139],[153].

Water management policies and regulations recently created in Thessaly [148] There are EU funding programs[50] A regulatory framework at EU level accompanying actions to prevent nutrient pollution: EU's Soil Strategy 2030 and proposal for a Soil Monitoring Law[31], Water Framework Directive (WFD), Zero Pollution Action Plan, Nitrates Directive, Urban Wastewater Treatment Directive and its impacts in the country	

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[3.4] Integrated SWOT Analysis

This integrated SWOT analysis consolidates the strengths, weaknesses, opportunities, and threats identified in six regional innovation ecosystems tackling nutrient management and pollution. This exercise permits to evaluate what are the commonalities between the regions, the shared values and experiences, as well as highlight what are their specificities.

In the table below (Table 16), we highlight common treats shared by at least two of the demo regions, which will be later used for the strategic orientations analysis.

Table 16. Integrated SWOT analysis of the 6 demo regions, showing the shared SWOT elements (AR (Axios River Delta), CC (Central Catatonia), EB (Esino Basin), MM (Mar Menor), PR (Po River Delta), TP (Thessaly Plain)).

SWOT dimensions	Message	AR	CC	EB	MM	PR	TP
Strengths	Area of great ecological importance, conservation is essential for preserving biodiversity	■			■		■
	Agriculture and the area's natural value hold significant cultural importance	■				■	■
	Strong R&D infrastructure	■	■			■	
	Support from the administration, the private sector, and academia for research	■	■	■			
	Competent administration involved in the conservation of the area	■			■	■	
	Strong awareness among stakeholders regarding the conservation of the area	■	■	■	■		
	Area is classified as vulnerable or has some level of protection	■	■		■	■	■
	New technologies for process improvement and monitoring are transferred and implemented		■	■	■	■	■
	Agricultural activities highly important and play a key role in ecological and landscape conservation	■	■	■		■	■
	Projects developed and platforms created to enhance conservation	■	■	■	■	■	■
Weaknesses	Area faces issues related to nitrate contamination	■	■				
	Soil is experiencing a loss of fertility	■					■
	Limited cooperation among local actors	■	■	■			
	Limited monitoring of water contaminants	■		■			■
	Little coordination within the administration and lack of guidance towards stakeholders	■	■				■
	Limited funding and economic resources	■	■	■	■		
	Old water infrastructure and limited planning	■	■	■			■
	Lack of regulation	■	■	■		■	
	Lack of technical knowledge	■	■	■	■		■
Opportunities	Recovery and utilization of ecosystem services are considered			■	■	■	■
	Plans to implement methods, platforms collaboration between stakeholders	■		■	■		■

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SWOT dimensions	Message	AR	CC	EB	MM	PR	TP
	Incentives for end users to implement changes and new technologies						
	Funding opportunities for regional projects						
	Project and plans aimed to increase the knowledge and formation						
	Implementation of new technologies in the area						
	Existence of EU directives favouring sustainability, water management and protection						
Threats	Increasing in hydrological risk of droughts and floods in the region						
	Future loss of biodiversity and ecosystem quality						
	Rural depopulation difficult agricultural improvement						
	Degradation of the environment hinders economic development						
	Climate change impacts the ecosystem with unknown consequences						

Color code (number of regions):

2	3	4	5	6

[4] Strategic Orientation Analysis

This section focuses on establishing strategic directions that guide the activities of SEACURE to achieve the objectives of the project and maximize results. They are based on the results of the integrated SWOT analyses of the six regional innovation ecosystems and aim at orienting the action entrenching on the strengths of the regions, contributing revert their weaknesses, taking advantage of identified opportunities and overcoming threats.

The strategic orientation analysis follows a twofold approach:

1. Leveraging the strengths of each region to revert weaknesses:

The analysis has identified core strengths in each region, some of them shared with others, and some of them specific. The strengths are innovation levers to be used to prioritise activities and improve the identified weaknesses in the region.

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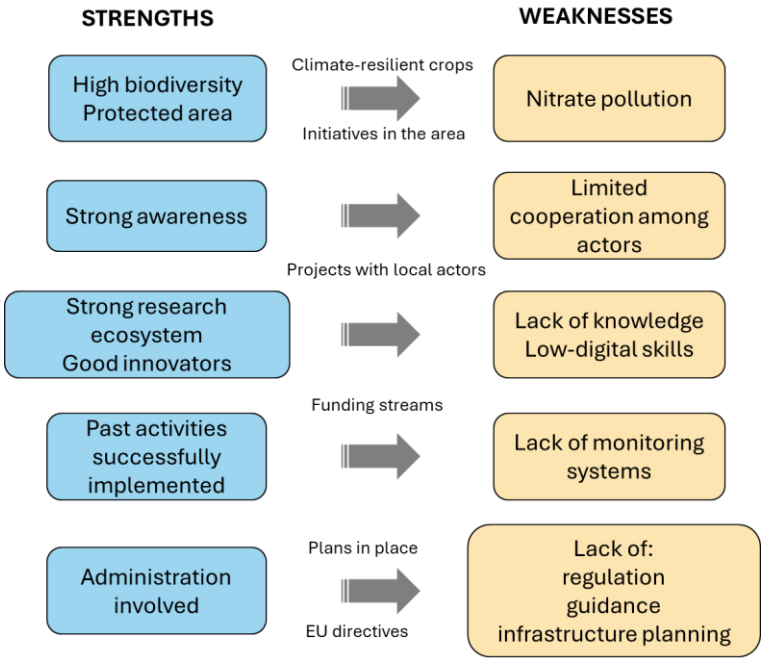

Figure 11. Analysis of potential areas of activity in Axios River delta demo region based on the SWOT analysis. Left: Main strengths. Right: Identified weaknesses. Centre: outstanding external opportunities that can support action.

In the Axios river delta, actions may go toward increase cooperation among local actors, reinforcement of knowledge transfer activities, especially regarding digital skills, monitoring networks and align the participation of the administration with local needs can be considered in the future.

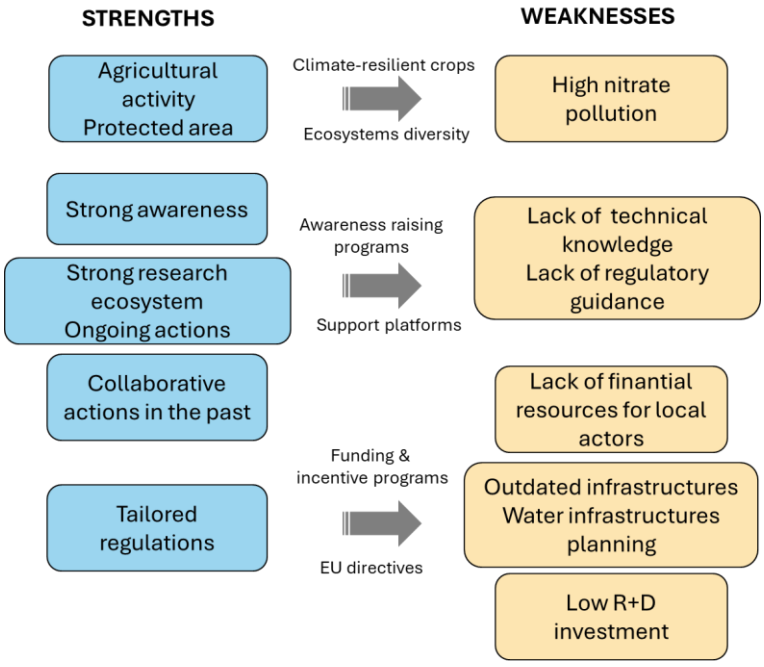

Figure 12. Analysis of potential areas of activity in Central Catalonia demo region based on the SWOT analysis. Left: Main strengths. Right: Identified weaknesses. Centre: outstanding external opportunities that can support action.

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In Central Catalonia, the existence of a strong research and innovation hub both in the agrifood and water sectors, together with current and past implemented successful collaborative activities, can serve as a basis to push knowledge transfer activities at technical and regulatory level for local actors. The existence of regional tailored policy and regulatory initiatives, aligned with EU directives, can pave the way towards the irrigation and water infrastructures modernization, as well as provide financial incentives to agricultural transformation and leverage investment in R&D initiatives.

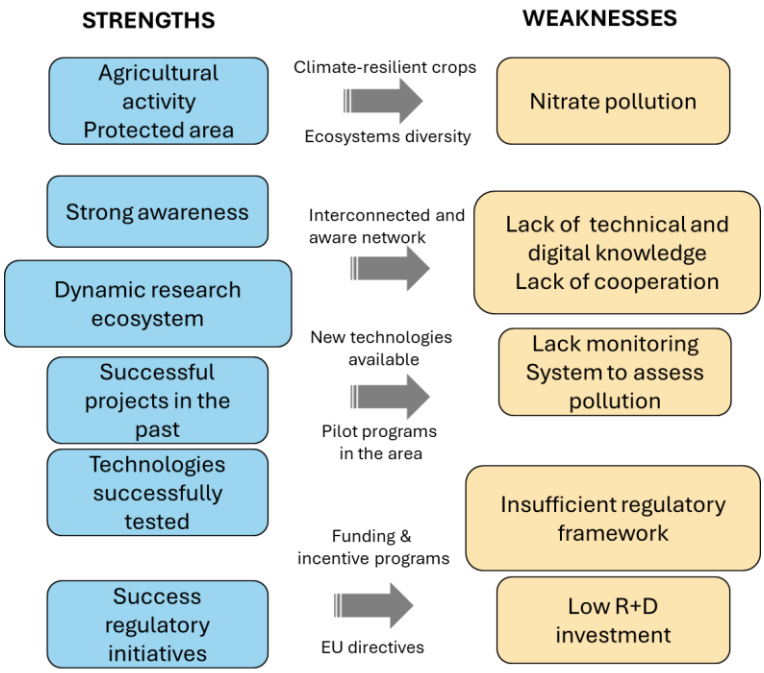

Figure 13. Analysis of potential areas of activity in Esino basin demo region based on the SWOT analysis. Left: Main strengths. Right: Identified weaknesses. Centre: External positive opportunities that can support action.

In the Esino basin, the existence of a dynamic research ecosystems, successful technologies and projects implemented in the past and a strong awareness among local actors, can help increase the digital and technological knowledge, and expand the monitoring network. There are success regulatory initiatives, such as the voluntary contracts, that can provide a basis for enhancing the regulatory framework, which can be a success case to be transferred to other regions.

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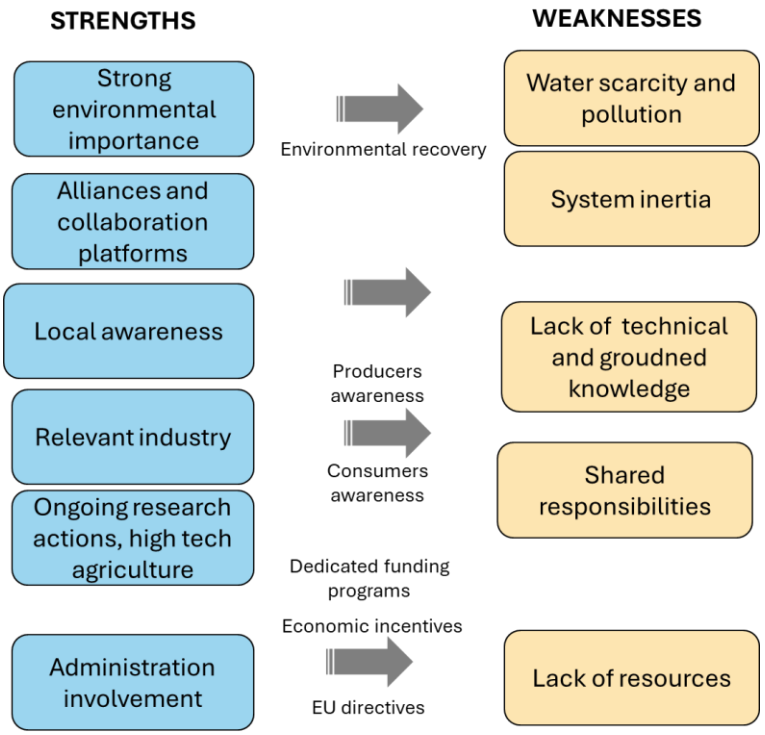

Figure 14. Analysis of potential areas of activity in Mar Menor lagoon demo region based on the SWOT analysis. Left: Main strengths. Right: Identified weaknesses. Centre: External positive opportunities that can support action.

In Mar Menor, the area has a strong importance from the environmental perspective, and the administration are highly involved at all levels (from local to national), which demonstrates the willing to address the environmental problems in the region. The existence of a well-established R&D ecosystem, with existing research actions, together with a relevant and technical agricultural industry, and a high awareness among local actors, can help increasing the technical and grounded knowledge, and to establish clear and define responsibilities for tackling the pollution challenges.

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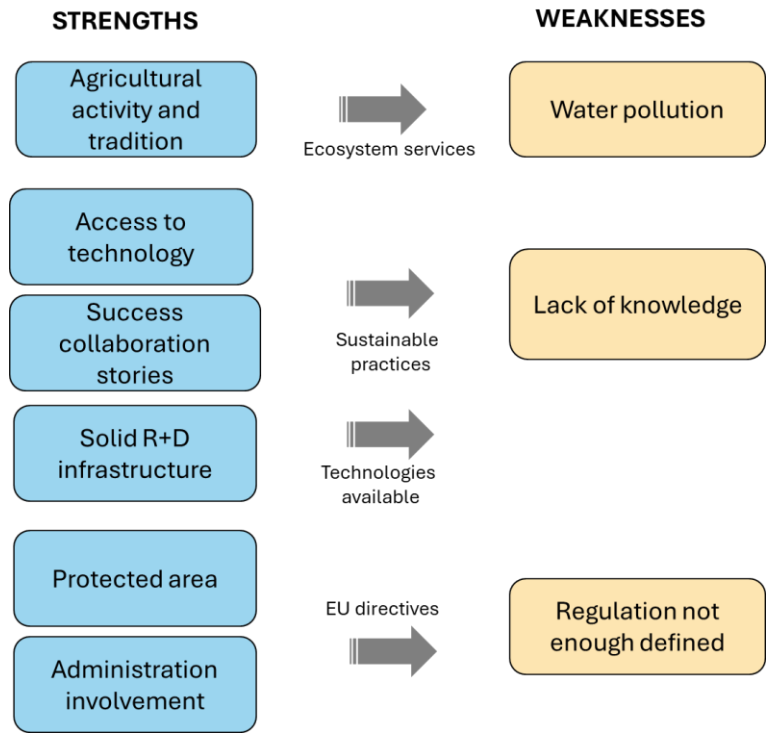

Figure 15. Analysis of potential areas of activity in Po River delta demo region based on the SWOT analysis. Left: Main strengths. Right: Identified weaknesses. Centre: External positive opportunities that can support action.

In the Po delta, the existence of a large agricultural tradition and culture is a major strength to help tackling the nutrient management and pollution challenges. The existence of a solid R&D infrastructure and success collaboration stories in the past, together with the fact that technological advancements are available to users can support the knowledge transfer activities to increase the technical and regulatory awareness of the local actors.

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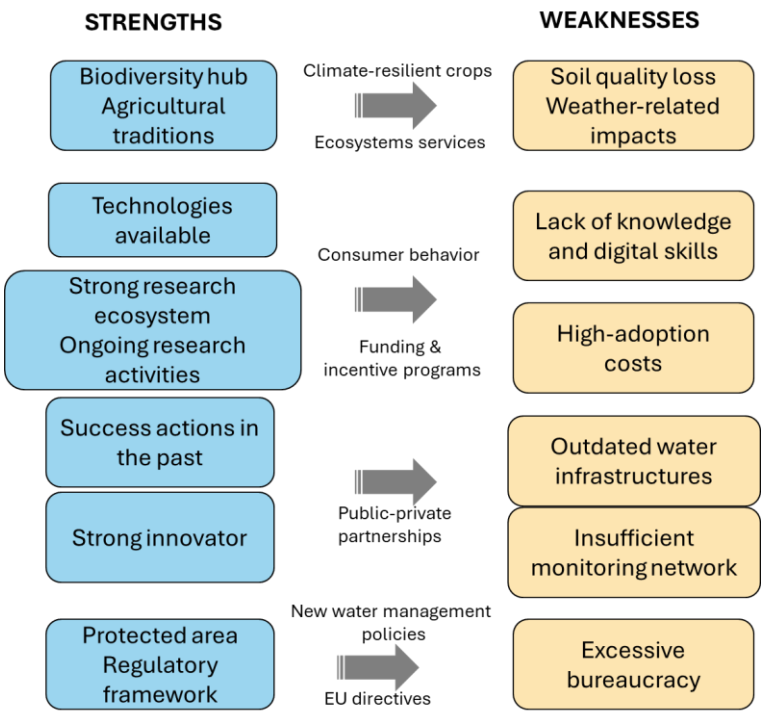

Figure 16. Analysis of potential areas of activity in Thessaly plain demo region based on the SWOT analysis. Left: Main strengths. Right: Identified weaknesses. Center: External positive opportunities that can support action.

In Thessaly, the existence of strong and deep-rooted agricultural traditions, together with a biodiversity hub in the plain, can act as a booster for activities to reverse the loss of soil quality, and environmental impacts in the area. The existence of a strong research ecosystem, with successful ongoing research activities, technologies already available, and strong innovation indicators, are a valuable and core strength that can help improving digital and knowledge skills of local actors, promote technological uptake, and improve water network and monitoring systems.

2. Identify joint strategies to maximise impact

The second approach of the strategic orientation analysis is based on the integrated SWOT analysis, the shared elements among the regions, and their uniqueness. Based on this evidence, four joint strategies have been identified as the most effective pathways for maximizing impact of the SEACURE activities (Figure 17).

Strategy 1: Knowledge Transfer
A critical element across all regions is the need for improved communication and transfer of knowledge to the stakeholders, specially to end users. While most regions boast strong research and innovation capacities, the fragmentation of information and insufficient outreach to practitioners limit the adoption of effective nutrient management practices. So, to reinforce intra- and interregional knowledge exchange should be one of the strategies of the project, either through training programs, peer-learning activities, or dissemination of good practices.

Strategy 2: Replication
There are selected initiatives that are being currently developed, or have been in the past, within a particular regional context, that has a strong potential to inspire or be adapted to others. This is the case of some governance models, regulatory initiatives, collaboration platforms, etc. that can be shared beyond their original setting, also outside of the project regions. These initiatives can be explained and showed to all regions aiming at transferring them to other demo regions and beyond.

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Strategy 3: Technology uptake

While technological innovation in nutrient removal, recovery, and monitoring is progressing rapidly, the uptake by end-users—particularly SMEs and municipalities—remains slow, due to several factors (high initial costs, lack of skilled workforce, uncertainty over regulatory frameworks, among others). This strategy puts the focus on activities to characterize user needs, identify administrative procedures and provide support, or identify gaps to facilitate technology uptake.

Strategy 4: Upscaling

Several demo regions demonstrated successful initiatives and will go even further within SEACURE project. These proven solutions and approaches can be scaled up by addressing barriers such as investment gaps, regulatory complexity, limited adoption, etc.

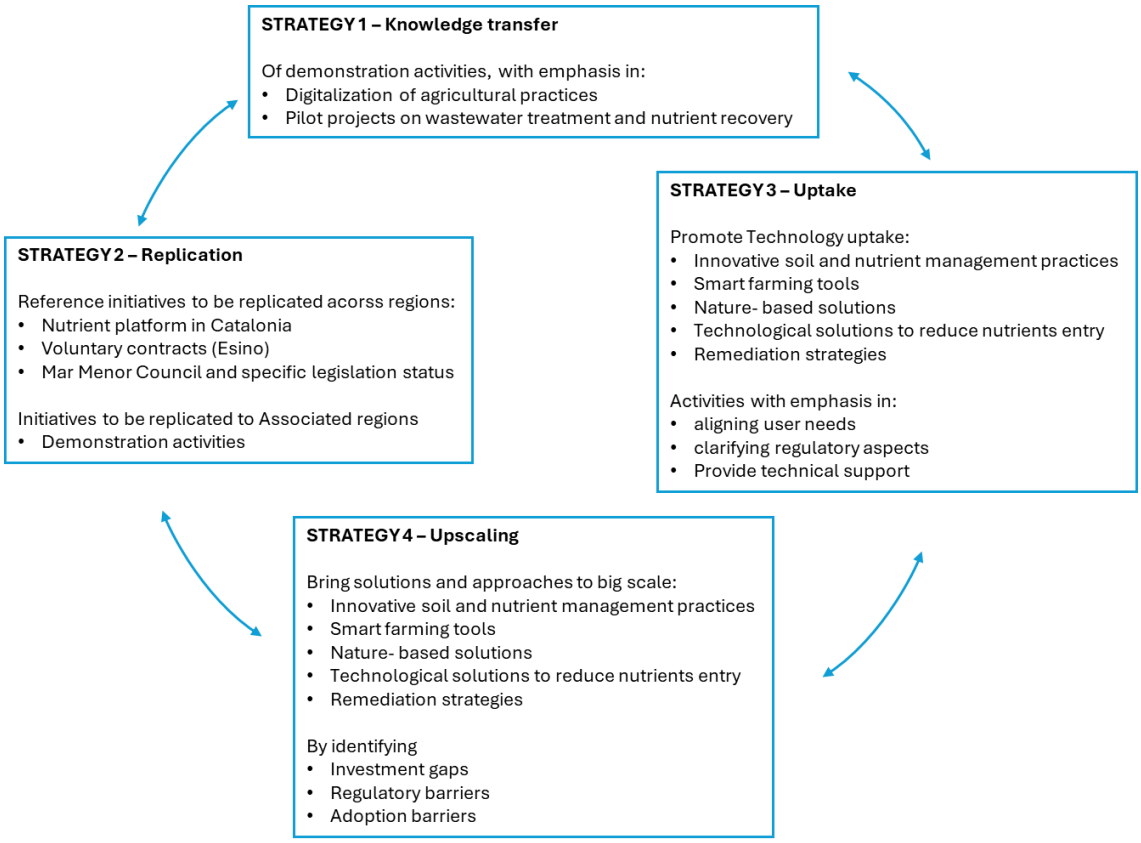

Figure 17. Strategies for ensuring consecution and impact of SEACURE activities

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[5] Conclusions

In conclusion, the SWOT and the strategic orientation analysis was able to delineate the strengths and weaknesses of each innovation ecosystem, to find the common issues and possible local solutions, to guide each region in the study. As it has been seen, the main common problems are the lack of knowledge transfer, the lack of replication (lack of implementation of promising past projects), uptake (lack of technological integration by the actions and municipalities), and upscaling (apply and develop successful demo projects).

This SWOT analysis is intended to guide the next steps of the SEACURE project by leveraging the solid innovation ecosystems in each demo region. Through collaboration with local stakeholders, the project can enhance the flow of knowledge, support the adoption of innovative technologies, and identify viable sources of financial support. Effective knowledge transfer will help alleviate uncertainties, build stakeholder confidence, promote the proper use of new technologies, and ultimately improve both social awareness and operational efficiency.

Highlights in each region, insights from the SWOT analysis:

Axios River Delta: There is a need to strengthen cooperation among local actors. Enhancing collaboration can facilitate knowledge transfer and support the development and application of digital and monitoring technologies.

Central Catatonia: This region benefits from a strong research and innovation hub in the agri-food and water sectors. These strengths, along with alignment with EU directives, can serve as catalysts for scaling knowledge transfer activities, guiding regulatory frameworks, and stimulating economic investment and incentives.

Esino basin: A dynamic research ecosystem, combined with a success past implemented projects and strong local awareness, creates fertile ground for advancing knowledge transfer and expanding the monitoring network. The existence of voluntary contracts offers a promising framework for future regulatory implementation.

Mar Menor: The ecological importance of the area, along with the high level of awareness among local and national actors, together with a well-established R&D ecosystem and a strong agrifood industry, provides a solid foundation for increasing both the technical knowledge of stakeholders and the region's monitoring capacity.

Po delta: A deep-rooted agricultural tradition, strong R&D infrastructure, and a history of successful collaborations can support further knowledge transfer and enhance local stakeholder awareness and engagement.

Thessaly: Like Po Delta, Thessaly combines a rich agricultural heritage with a biodiversity hub. The region benefits from past and ongoing research projects that have made new technologies available, that can ease their transfer to local actors and facilitate activities aimed at improving soil quality and sustainability.

It is essential to foster not only intra-regional collaboration but also inter-regional exchange. Promoting cross-regional knowledge sharing will ensure that innovations and solutions developed in one area can accelerate progress across all SEACURE regions and beyond.

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