




From nexus thinking to nexus implementation in South Europe and beyond: mutual learning between practitioners and policymakers

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Abstract

The Water-Energy-Food-Ecosystems (WEFE) nexus presents a complex web of interactions, capturing the attention of both academia and policymakers. Sectoral policies wield significant impacts across WEFE domains, necessitating a nuanced approach to sustainability initiatives. For a decade, research and policy discussions across Europe have sought to comprehend these interconnections and develop strategies that minimize unintended consequences while maximizing co-benefits. The NEXUSNET Regional Forum convened in Split, Croatia on September 28, 2023, spotlighting stakeholders-practitioners who shape and are shaped by the WEFE nexus. With a focus on Southern Europe, the forum delved into challenges and opportunities, fostering the exchange of experiences and mutual learning among practitioners and policymakers. Diverse organizations were represented by esteemed panelists contributing to a comprehensive exploration of the WEFE nexus. The forum unfolded across three sessions: “Sectoral perspective viewpoint”, “Implementation of nexus cases”, and “Bridging the gap between nexus research and policy”. This paper distills the outcomes, providing a synthesis that transcends individual sessions. It offers a cohesive overview of the forum’s rich discussions, emphasizing the collaborative efforts required to navigate the intricacies of the WEFE nexus and elevate its societal and policy impact.

1 Introduction

The Water-Energy-Food-Ecosystems (WEFE) nexus is a conceptual framework emphasizing the connectivity and interdependence of water, energy, food, and ecosystems. It acknowledges that actions in one sector can have

a considerable impact on others, and hence encourages integrated and comprehensive approaches to resource management and policymaking (Carmona-Moreno et al. 2021; Özcan 2023). There is a growing recognition of the complex interactions within the Water-Energy-Food-Ecosystems (WEFE) nexus. However, there are still significant issues

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and challenges with the nexus's implementation. One of the most significant difficulties is a lack of coordinated governance structures and policies that address the interconnections between water, energy, food, and ecosystems (González-Rosell et al. 2023; Jones-Crank et al. 2022; Kellner 2023; Melloni et al. 2022). Many existing policies are sectoral, failing to consider cross-sectoral implications and trade-offs. Next, there is frequently a scarcity of detailed data and information on resource availability, demand, and utilization across sectors. This impedes effective decision-making and planning at the nexus level (Hülsmann and Jampani 2020; Naidoo et al. 2021; Adamos et al. 2024). Inadequate infrastructure and technology limitations can make it difficult to use and manage resources effectively within the WEFE nexus. For example, outdated water and electricity infrastructure may hinder resource optimization and conservation opportunities (Laspidou et al 2020; Gondhalekar and Drewes 2021). Additionally, socioeconomic disparities and inequities can worsen vulnerabilities in the WEFE nexus, especially among vulnerable populations that may lack access to critical resources such as water, energy, and food (Bruns et al. 2022; Hlahla 2022). Despite these challenges, developing collaborative efforts, technological advances, and equitable policies is critical to fulfilling the WEFE nexus' full potential and guaranteeing sustainable resource management for current and future generations, in accordance with the Sustainable Development Goals (Ioannou and Laspidou 2023).

The interactions between the WEFE nexus sectors have captured the interest of both academia and policymakers due to the significant impacts that sectoral policies can have on other sectors, leading to challenges in effectively implementing sustainability initiatives related to the WEFE. The focus has been on understanding these interconnections and developing strategies to minimize unintended consequences while maximizing co-benefits. This has been a driving force behind research and policy discussions in Europe and beyond for the past decade. The increasing number of events in Europe addressing the nexus reflects a heightened emphasis on discussions among researchers, funding agencies, and practitioners. The 1st NEXUSNET Regional Forum of stakeholders, organized in Split, Croatia on September 28, 2023, particularly highlights stakeholders-practitioners, those influencing and being influenced by the WEFE nexus. NEXUSNET is an international network of researchers working with universities, research institutions, policymakers, and the business sector to better understand how the water-energy-food nexus promotes policy coherence and biophysical interactions in the domains of water, energy, and food, thereby supporting Europe's transition to a circular and low-carbon economy. The forum serves as a pivotal component within the NEXUSNET framework and the overarching WEFE nexus research and policy agenda.

It provides a platform for practitioners, policymakers, and researchers to convene and discuss the challenges and opportunities surrounding the implementation of WEFE nexus approaches. By focusing on practical implementation and mutual learning between stakeholders, the forum directly contributes to bridging the gap between nexus research and its real-world application. The overall process of the NEXUSNET Regional Forum, from pre-forum preparation to the presentation of major findings, is illustrated in Fig. 1. The objective of this paper is to disseminate the findings and suggestions derived from the forum to benefit nexus practitioners and policy-makers. Thus, this paper presents the findings derived from the minutes of the Forum, offering a comprehensive overview of the outcomes from each session. The structure of the article is organized as follows: methodology, session analyses and outcomes, and concluding

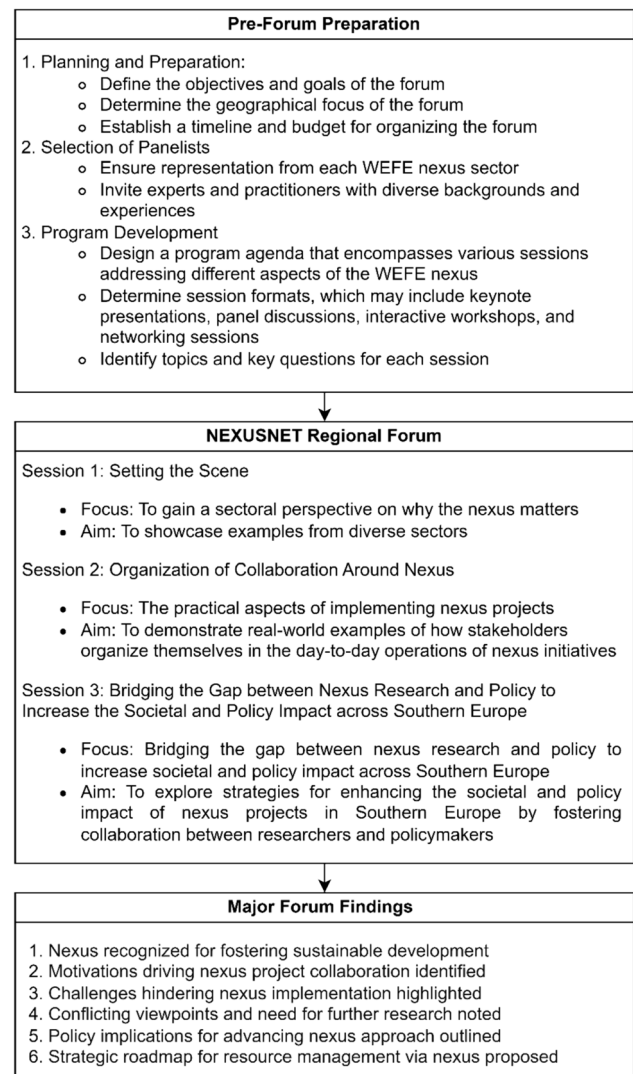


Fig. 1 Diagram depicting the pre-forum preparation, the forum content, and the key findings

remarks. The results from individual sessions are detailed in their respective sections, providing a thorough exploration of the insights and discussions that transpired during the event.

2 Methodology

We mapped the WEFÉ nexus projects funded through different European funding schemes (i.e., FP7, H2020, Horizon Europe, JPI Urban Europe, COST, PRIMA, and Interreg) between 2013 and 2022. This database was developed as part of a joint effort of the NEXUSNET project, and identified over 99 nexus projects with 311 case studies spread across Europe and the Mediterranean. Large majority of the case studies are located in southern Europe (124), followed by Western Europe (102). The remaining case studies are spread across Central and Eastern Europe (48) and Northern Europe (32). Therefore, the geographical focus of the forum is on Southern Europe, where almost half of European case studies on the WEFÉ nexus are located, with plans to extend the focus to other regions in future forums. During the selection of panelists, care is taken to ensure representation from at least one representative of each WEFÉ nexus sector to understand sectoral perspectives; and to ensure examples of how the nexus approach is implemented, experts/practitioners from the private sector, academia, and politicians are included. The presence of at least a single representative from each WEFÉ nexus sector guarantees that panelists represent diverse perspectives. Thus, the panelist's diversity allows for a greater understanding of sectoral difficulties, demands, and possibilities. The engagement of experts/practitioners from the commercial sector, academia, and policy domains provides real-world examples of how to execute the nexus method. This might aid in comprehending the tangible outcomes and techniques of implementing this approach. The convening of representatives from the private sector, academia, and policy enables the exchange of diverse perspectives, experiences, and information. This can help to design more complete and effective solutions. The panelists, representing diverse organizations including the Ministry of Agriculture of the Republic of Croatia (Croatia), Croatian Waters (Croatia), University of Wien (Austria), Terra Sintropica (Portugal), Natural Environment and Climate Change Agency (Greece), Ragn-Sells Group (Sweden), Defining Future Options (Portugal), Business Development Group (Romania), Regional Development Agency of Split-Dalmatia County (Croatia), Energy and Water Agency (Malta), Wansdronk Architectuur (Netherlands), G.A.C. Group (France), CNRS/GREDEG/University Côte d'Azur (France), Faculty of Agriculture and Food Sciences, American University of Beirut (Lebanon), University of Castilla-La Mancha (Spain), Finnish Environment Institute (SYKE) (Finland), Water Europe (Belgium), United Nations University Flores (Germany), European Research Executive Agency (REA), Unit B3 Biodiversity, Circular Economy and Environment (Belgium,) Stockholm International Water Institute (Sweden), and Technical University of Munich (Germany),

contribute to a diverse and comprehensive exploration of challenges and opportunities in the WEFÉ nexus approach. Detailed information about the esteemed panelists is given in Appendix.

The NEXUSNET Regional Forum of stakeholders comprises three sessions. In Session 1, titled "Sectoral perspective viewpoint: why the nexus matters?" the focus is on understanding the significance of WEFÉ nexus from a sectoral perspective, featuring a panel of practitioners influencing and being influenced by the nexus. In Session 2, titled "Implementation of nexus cases: focus on the organization of collaboration around nexus", the goal is to showcase examples of stakeholder collaboration, exploring drivers, bottlenecks, and missing elements in day-to-day operations. The main question addressed is how stakeholders collaborate horizontally and vertically across sectors and institutional levels. Finally, in Session 3, named "Implementation of nexus cases: bridging the gap between nexus research and policy to increase societal and policy impact across Southern Europe", the emphasis is on closing the gap between nexus research and policy for greater impact. The session explores strategies to enhance the societal and policy impact of nexus projects in Southern Europe.

3 Session analyses and outcomes

This section encompasses the objectives of each session, the questions addressed, and the outcomes derived from each session.

3.1 Session 1: setting the scene

The core focus of Session 1 is on gaining a sectoral perspective on why the nexus matters. A distinguished panel of WEFÉ practitioners, representing those influencing and being influenced by the nexus shared their insights. Each speaker is allocated 10 min to address the indicative question: "How are you affected by the nexus, and how do you deal with this?" The aim is to showcase examples from diverse sectors, illustrating why the nexus matters. The panelists were asked specific questions in order to identify sectoral challenges and their relationship to the nexus. Identifying these problems is critical for developing effective solutions and aiding the successful implementation of nexus initiatives (Al-Saidi and Elagib 2017; Daher et al. 2020; Opejin et al. 2020; Pahl-Wostl 2019).

3.1.1 Part 1: sectoral perspective viewpoint: Why the nexus matters?

The forum addressed the significance of the nexus across various sectors, emphasizing its relevance in fostering sustainable development. Stakeholders recognized the interconnectedness of agriculture, food production,

energy, bio-based industries, and research and development. Discussions highlighted the growing importance of bioeconomy strategies as a means to coordinate policies, ensure sustainable biomass use, and enhance the overall value of the bioeconomy. Waste management, particularly in the context of biodegradable and bioplastics production, emerged as a shared priority. The nexus was underscored as a conceptual framework that goes beyond individual sectors, promoting collaboration among diverse stakeholders, and offering a comprehensive approach to address environmental challenges.

3.1.2 Part 2: How stakeholders are affected by the nexus and how they address it: showcasing examples from different sectors

Stakeholders from various sectors shared insights into how they are affected by the nexus and illustrated diverse approaches in dealing with these challenges:

1. Water management challenges and innovations:

Stakeholders acknowledged the impact of climate change on water resources, especially in coastal regions and islands.

Traditional practices like rainwater harvesting and water transport were recognized.

Innovations such as desalination plants using brackish water were highlighted.

The integration of renewable energy sources with water management practices for sustainable development was emphasized.

2. Syntropic agriculture for sustainable land use:

- Syntropic Agriculture was introduced as a holistic strategy to address water scarcity and land desertification.
- Principles such as restoring the water cycle, rebuilding soil carbon sponges, and maximizing photosynthetic production were emphasized.
- The approach showcased a case study demonstrating its potential for sustainable agricultural production with minimal water consumption.

3. Holistic approach to sustainable energy production:

- Stakeholders discussed challenges in renewable energy and the need for efficient energy storage systems.
- Comprehensive sustainability standards, particularly in hydropower, were presented as a model for other energy sectors.

- The balance between ecosystem preservation and individual interests was considered, calling for integrated and sustainable energy practices.

4. Climate law and ecosystem management:

- Stakeholders discussed incorporating the nexus concept in response to the European Union's climate law.
- Initiatives such as the establishment of carbon budgets, discussions on emissions from aviation and shipping, and the Greco Island initiative were highlighted.
- Challenges in managing designated areas for conservation while accommodating human activities were acknowledged.

The examples showcased the varied impact of the nexus across sectors and demonstrated the importance of collaborative and integrated approaches to address environmental challenges.

3.2 Session 2: implementation of nexus cases: focus on organization of collaboration around nexus

In Session 2, the focus was on the practical aspects of implementing nexus projects, shedding light on the organizational dynamics of collaboration among stakeholders. The session aimed to showcase real-world examples of how stakeholders organize themselves in the day-to-day operations of nexus initiatives. Furthermore, Session 2 focused on examining stakeholders through an applied management lens. The discussion revolved around questions guided by existing literature in management and organizational studies concerning stakeholders. Scholars in these fields have long been intrigued by how value is generated through interconnected relationships and interactions among various stakeholders (e.g. Adner 2017; Jacobides et al. 2018). One prevalent concept in this discourse is the “nexus ecosystem”, which represents a particular way of organizing interactions (Klessova et al. 2024). Within such ecosystems, organizational actors often engage in collaborative efforts without formal contractual agreements. Together, they contribute to the creation of shared resources such as knowledge, innovations, products, or services, resulting in value that cannot be achieved individually (Adner 2006). The “why and how” questions posed during Session 2 aimed to uncover the motivations driving actors to collaborate within these nexus ecosystems and to elucidate their perceptions of success in such collaborative endeavors.

3.2.1 Part 1: Why do stakeholders collaborate?

The discussion explored the motivations driving collaboration in nexus projects, emphasizing a deep dive into stakeholder's intrinsic goals and values. The initial question

posed was, “Why do stakeholders collaborate?” The discourse highlighted the pivotal role of understanding the underlying motives that fuel collaboration. Insights from a live poll, involving both panelists and the audience, provided diverse perspectives on barriers to collaboration, contributing to a comprehensive understanding of successful nexus collaborations. Stakeholders collaborate in the context of nexus projects for several reasons. The discourse emphasized the multifaceted nature of these motivations:

1. **Underlying goals and values:** Collaboration is driven by a shared understanding of underlying goals and values. Stakeholders seek to align their efforts with common objectives that reflect their shared vision for success in nexus projects.
2. **Value creation:** Stakeholders engage in collaboration to create value. This involves the pursuit of outcomes that contribute positively to the goals of the nexus project, acknowledging the significance of the collective impact generated through collaboration.
3. **Motivations for engagement:** The discussion highlighted the importance of personal motivations and individual incentives for stakeholders to actively participate in collaborative efforts. Understanding “What’s in it for me?” becomes crucial for sustained engagement.
4. **Overcoming barriers:** Collaboration is seen as a means to overcome barriers and challenges inherent in nexus projects. By pooling resources, expertise, and perspectives, stakeholders can address complex issues that may be insurmountable for individual entities.
5. **Knowledge exchange:** Stakeholders collaborate to exchange knowledge and insights. The dynamic exchange of information fosters a learning environment, where diverse perspectives contribute to a richer understanding of the challenges and potential solutions.
6. **Network maintenance:** Collaboration is instrumental in establishing and maintaining stakeholder networks. The nexus project serves as a catalyst, initiating the emergence of these networks, which, in turn, become vital for the sustained implementation of nexus approaches.
7. **Common ground:** The identification of common ground, such as shared concerns about vital resources like water and energy, acts as a powerful driver for collaboration. This shared understanding facilitates discussions where stakeholders with diverse profiles align their perspectives.
8. **Systemic change:** Stakeholders recognize the need for systemic change, advocating for a shift towards circular and sustainable practices. Collaboration is viewed as an essential element in transforming traditional linear models into more dynamic and resilient systems.

In essence, stakeholders collaborate in nexus projects to leverage collective strengths, overcome challenges, and achieve outcomes that align with their shared goals and values. The collaborative process becomes a conduit for innovation, knowledge sharing, and the creation of meaningful, sustainable solutions.

3.2.2 Part 2: How do stakeholders collaborate (drivers to initiate and continue collaboration)?

Part 2 delved into the drivers initiating and sustaining collaboration within the nexus framework. The nexus project was characterized as a catalyst, sparking stakeholder networks, and emphasizing the interdependence between nexus projects and network maintenance. Real-world examples illustrated the collaborative dynamics required to address complex challenges, particularly in water management. The discussion underscored the need for systemic change, citing structural constraints in traditional models, with examples from diverse sectors amplifying the call for a shift towards sustainable practices.

Stakeholders collaborate in nexus projects through a variety of mechanisms and approaches, reflecting the complexity and interconnectedness of the challenges at hand. The discussion highlighted several key drivers and methods for initiating and sustaining collaboration:

1. **Catalyst of Nexus projects:** The nexus project itself serves as a catalyst for collaboration. It initiates the emergence of stakeholder networks, fostering an environment where diverse entities come together with a common goal.
2. **Dialogue and engagement:** Collaboration is facilitated through ongoing dialogue and engagement. Stakeholders actively participate in discussions, both structured and spontaneous, to share insights, experiences, and perspectives on the challenges and opportunities within nexus projects.
3. **Live polls and feedback:** Dynamic engagement strategies, such as live polls and immediate feedback mechanisms, contribute to real-time collaboration. These tools provide a platform for stakeholders, including panelists and the audience, to contribute diverse perspectives and opinions.
4. **Identification of drivers:** The discourse emphasized the identification of drivers for collaboration, particularly the motivations for initiating and sustaining collaborative efforts. Understanding the underlying motivations, whether personal incentives or shared goals, becomes crucial for effective collaboration.
5. **Pooling of resources and expertise:** Stakeholders collaborate by pooling their resources and expertise.

This collaborative effort enables a more comprehensive approach to problem-solving, leveraging the collective strengths of diverse entities involved in nexus projects.

6. **Shift towards circular systems:** Collaboration is seen as essential for driving systemic change, particularly a shift towards circular and sustainable practices. Stakeholders advocate for changes at a broader level, emphasizing the need for collaboration among policymakers, industry leaders, and various stakeholders.
7. **Addressing complex challenges:** Collaboration is essential for addressing complex challenges, such as those in water management. The discourse highlighted examples where collaboration among financial, operational, and engineering teams was necessary to overcome persistent issues.
8. **Creating meaningful networks:** Stakeholders collaborate to create and maintain meaningful networks. These networks extend beyond the project timeline, emphasizing the need for sustained engagement and a structured approach to network maintenance.
9. **Knowledge exchange and learning:** Collaboration facilitates the exchange of knowledge and insights. Stakeholders engage in a continuous learning process, sharing information that contributes to a deeper understanding of the intricacies involved in nexus projects.
10. **Transparency and communication:** Transparent communication is fundamental to collaboration. Stakeholders communicate their perspectives, challenges, and expectations openly, fostering an environment of trust and shared understanding.

In summary, stakeholders collaborate through ongoing dialogue, engagement, and the strategic pooling of resources and expertise. The collaborative process extends beyond the project's immediate goals, emphasizing the need for sustained efforts to address the complex and interconnected challenges within nexus projects.

3.2.3 Part 3: How do you see success in the nexus project? How do you see success in the nexus-related case studies in the project?

Success in nexus projects is multifaceted, with diverse perspectives and criteria contributing to the evaluation of achievements. The discussion on success in nexus projects yielded several key insights:

1. **Shared vision of sustainability:** Success is seen in the alignment of stakeholders towards a shared vision of sustainability. This involves a collective commitment to promoting practices and outcomes that contribute to the

long-term well-being of ecosystems, communities, and the interconnected sectors within nexus projects.

2. **Continuous and inclusive process:** The ongoing journey and the process of bringing together diverse stakeholders are emphasized as integral components of success. Success is not solely measured by reaching a destination but by stakeholder's willingness to continually collaborate, express contentment with the collaborative process, and actively engage in ongoing dialogue.
3. **Trust regime and shared governance:** Trust emerges as a critical component of success in nexus collaborations. Building a trust regime involves mutual alignment, shared governance, and transparent communication among stakeholders. Success is measured by the establishment and maintenance of a trusting environment conducive to effective collaboration.
4. **Bridging the gap between systems:** Success is portrayed as bridging the gap between different systems, acknowledging the complexity of nexus projects. Achieving success involves overcoming silos and integrating diverse sectors, such as water, energy, and food, to address interconnected challenges comprehensively.
5. **Concrete results and tangible outcomes:** Success is associated with the delivery of concrete results and tangible outcomes that positively impact the nexus project's goals. Stakeholders express satisfaction when their collaborative efforts translate into real-world solutions, improvements, or advancements in resource management.
6. **Recognition and visibility:** Recognition from various stakeholders, including local authorities, traditional farmers, and difficult-to-engage actors, is considered an essential component of success. Visibility of the nexus approach, through labeling on projects and buildings, signifies the level of consideration given to integrated resource management and becomes a measure of success.
7. **Inclusive dialogues and stakeholder involvement:** Success is tied to the inclusivity of dialogues and the active involvement of stakeholders. Meaningful success stories are created when a broad range of stakeholders, with diverse backgrounds and perspectives, actively contribute to discussions and decision-making processes.
8. **Consideration of health in Nexus projects:** Health is identified as an essential aspect of nexus projects, particularly in light of the impact of the COVID-19 pandemic. Success involves recognizing and incorporating health considerations into the nexus framework, reflecting the relevance of health in the broader context of sustainability.

In essence, success in nexus projects goes beyond achieving predefined objectives; it encompasses a holistic, ongoing

process of collaboration, trust-building, tangible outcomes, and the integration of diverse perspectives to create sustainable solutions for interconnected challenges.

3.3 Session 3. Implementation of nexus cases: bridging the gap between nexus research and policy to increase the societal and policy impact across Southern Europe

Session 3 of the forum delved into a comprehensive analysis of Water-Energy-Food-Ecosystem (WEFE) nexus research in Southern Europe and the Mediterranean region. The objectives encompassed stocktaking through a presentation, mapping gaps and opportunities to amplify the influence of WEFE research projects beyond academia, and exploring methods for embedding nexus research into national and regional policies to provide insights for policymakers. The session fostered dialogue, identified challenges, and aimed to facilitate more effective collaboration between research, policy, and practice in the WEFE nexus field. It is critical to discuss these concerns with stakeholders because the intricate interactions across water, energy, food, and ecosystem sectors necessitate an integrated approach to supporting impact assessments and decision-making (De Roo et al. 2021; Karabulut et al. 2019; Ledari et al. 2023).

3.3.1 Part 1: What is nexus research telling us about Southern Europe and how can this knowledge retrofit policy and practice?

Question 1: In your view what are the key WEFE nexus challenges southern Europe and the Mediterranean are facing and there are still important gaps?

The Water-Energy-Food-Ecosystem (WEFE) nexus challenges facing Southern Europe and the Mediterranean are diverse, presenting both interconnected and distinct issues. One emphasis during the discussions was on the transferability of nexus solutions, suggesting that the challenges in the region may require tailored, context-specific approaches.

The critical role of biodiversity in supporting life-sustaining systems was underscored, emphasizing its interconnectedness with water, energy, and food systems. Preserving biodiversity emerged as pivotal for addressing nexus challenges in Southern Europe and the Mediterranean, aligning with the notion that a comprehensive understanding of ecosystems is essential for sustainable resource management.

There was recognition of the lack of coordination between sectors and limited permeability, indicating the need for a more integrated and collaborative approach. This suggests that the nexus challenges extend beyond technical aspects, involving overcoming institutional and organizational barriers, requiring a coordinated effort across various stakeholders.

Socioeconomic factors were highlighted as influential in the implementation of nexus solutions. Considerations such as population growth, power dynamics, political and financial stability, social norms, and cultural dynamics were identified as crucial. This emphasizes the importance of incorporating social sciences and participatory approaches in addressing WEFE nexus challenges, ensuring solutions are locally relevant and sustainable.

In summary, the key nexus challenges in Southern Europe and the Mediterranean involve a nuanced interplay of technical, ecological, institutional, and socioeconomic factors. Addressing these challenges requires a region-specific understanding, integrated approaches, interdisciplinary collaboration, and active engagement with local communities. It's imperative to bridge the identified gaps in research and policy to retrofit effective solutions that consider the unique context of Southern Europe and the Mediterranean.

Question 2: How can the research information that is being generated across Europe and projects inform RTD programs and EU policies?

The insights shared during the session underscore the potential of research information generated across Europe and various projects to significantly inform Research and Technological Development (RTD) programs and European Union (EU) policies. Several key points were highlighted during the discussion:

1. **Longevity of Nexus portfolio:** Emphasis was placed on understanding the longevity of the nexus portfolio under Horizon 2020 and Horizon Europe. This implies that the knowledge and outcomes from ongoing and completed projects can contribute to a cumulative understanding of nexus challenges and solutions.
2. **Historical water and Southern Europe focus:** The historical context of nexus projects, particularly in Southern Europe, was acknowledged. Leveraging the insights and outcomes from these projects provides a foundation for shaping RTD programs and policies that address region-specific challenges.
3. **Scientific methodologies optimization:** The need for optimizing scientific methodologies used in nexus projects was stressed. This optimization includes refining living labs, serious games, and observation integration. The improved methodologies can enhance the quality of data generated, contributing to more informed RTD programs and policies.
4. **Expanding Nexus concept:** The call to expand the nexus concept to include health-related challenges aligns with a global movement. This expansion broadens the scope of research information, providing a comprehensive understanding of interconnected issues. RTD programs and policies can benefit from incorporating a One Health perspective.

5. **Simplifying communication:** Highlighted was the importance of simplifying the nexus concept for diverse stakeholders, including politicians, investors, and the general public. Clear and accessible communication of research findings ensures that the generated information can effectively influence policy decisions and RTD program priorities.
6. **Impact on policy making:** Emphasizing the need for enhanced impact on policymaking, the proposal was made to create concise materials, such as two-page leaflets or policy briefs. These materials, backed by concrete examples and data, serve as powerful tools to communicate the practical significance of nexus implementation to policymakers and stakeholders.
7. **Testing Nexus on existing legislation:** The suggestion to test the nexus approach on existing European legislation, such as water-related directives, demonstrates a strategic use of research information. By aligning with ongoing legislative revisions, researchers can actively contribute to shaping policies and programs.

In conclusion, the insights from the session highlight the dynamic role of research information in shaping RTD programs and EU policies. The strategic optimization of methodologies, expansion of the nexus concept, and effective communication are key components in ensuring that the wealth of generated knowledge contributes meaningfully to policy development and implementation.

3.3.2 Part 2: What is needed to promote a greater uptake of nexus research into policy and practice?

Question 3: How can we maximize the social and policy impact of research? Any tips?

In addressing the question of how to maximize the social and policy impact of research, valuable insights were provided during the session. Key points include:

1. **Holistic approach and strong leadership:** Emphasizing the importance of adopting a holistic approach that transcends sectors, governments, and regions. This holistic perspective, combined with strong leadership across all sectors, is crucial for reinforcing the connections between science, policy, and practice.
2. **Complexity of nexus thinking:** Acknowledging the complexity of nexus thinking, the need for an integrated systems approach was highlighted. This involves breaking down silos and promoting cross-sectoral dialogue, collaboration, and alignment of goals. Such an approach is fundamental for addressing the diverse challenges within the Water-Energy-Food-Health nexus (WEFH).
3. **Cross-sectoral dialogue and collaboration:** Stressing the importance of cross-sectoral dialogue and collabora-

tion, the need for clear communication and understanding across different sectors was underlined. This includes translating research into metrics and approaches, providing training programs to practitioners, and promoting interdisciplinary research.

4. **Localized governance and policy approaches:** Recognizing the significance of localized governance, the need for new policies and governance structures at the local level was underlined. Policy-centric governance can promote cross-sectoral collaboration and involve local actors in decision-making.
5. **Translation of Nexus thinking into practical terms:** The importance of translating nexus thinking into practical terms is emphasized. To make the nexus approach understandable for politicians, focusing on practical examples rather than relying solely on intellectual concepts was suggested. This approach can effectively convey the benefits of nexus implementation.
6. **Involvement of researchers in policy discussions:** Highlighting the role of researchers, using existing European legislation, such as water-related directives, was proposed to underscore the added value of nexus thinking. Researchers can actively contribute to ongoing policy discussions by preparing policy papers and providing input to legislative revisions.

In summary, the insights underscore the need for a comprehensive and collaborative approach to maximize the social and policy impact of nexus research. By breaking down silos, promoting cross-sectoral collaboration, and translating complex concepts into practical terms, researchers can play a pivotal role in shaping impactful policies and practices.

Question 4: How successful is the industry to pick up innovations from researchers, and how successful is innovation in being translated into legislation? What are the main difficulties in the process? What are the key ingredients to be successful?

In addressing the question of the success of the industry in adopting innovations from researchers and the translation of innovation into legislation, key insights were provided during the session. Key points from the discussion include:

1. **Industry uptake of innovations:** Challenges were highlighted in the industry's uptake of innovations generated by researchers. A specific concern raised was the perceived 'Lack of Interest' in certain critical areas, citing an example where water-related issues received minimal attention. This poses a significant hurdle in translating research innovations into practical applications within the industry.
2. **Demonstrating policy impact:** Emphasizing the need to demonstrate the policy impact of the nexus approach, it

was pointed out that showcasing how the nexus approach differs from others is crucial. This aspect is vital for garnering interest and support from both industries and policymakers.

3. **Role of legislation:** Discussing the role of legislation, the importance of long-term policy processes was acknowledged. The significance of expert groups guiding the implementation of various directives was highlighted. Furthermore, introducing the concept of ‘water on the living lab’ was proposed as a means to address specific problems geographically and time-limited, including the need for legal derogations to experiment with different approaches.
4. **Challenges in the process:** The difficulties in the process were acknowledged, including the need for clear communication to make politicians understand the cost and impact of the nexus approach. Stressing the importance of translating nexus thinking into practical terms and providing concrete examples for better understanding was highlighted.
5. **Key ingredients for success:** While not explicitly stated, the underlying theme suggested the key ingredients for success include overcoming the lack of interest, ensuring effective communication strategies, and actively involving industries in the innovation process. Additionally, the role of legislation and policy frameworks was underscored as crucial components in facilitating the successful translation of innovations into actionable measures.

In conclusion, insights from the discussion shed light on the challenges and considerations surrounding the industry’s uptake of innovations and the translation of innovation into legislation within the nexus approach. Addressing these challenges requires a concerted effort in communication, policy engagement, and collaborative initiatives.

3.3.3 Part 3: Wrap up from the panel discussion

Question 5: Please highlight one issue that is blocking the implementation of nexus in our own region, and how can it be improved.

Based on the answers given by the panelists, the list of issues blocking the implementation of the nexus approach is as follows:

1. **Transferability:** The challenge of transferability of the nexus approach across different regions and contexts.
2. **Demonstrating policy impact:** The need to effectively demonstrate the policy impact of the nexus approach and differentiate it from other approaches.
3. **Lack of interest:** Identified as a major hurdle, where certain aspects of the nexus, such as water, received minimal attention.
4. **Recognition of Nexus approach:** The struggle for recognition, particularly when the nexus is water-centered, leading to a lack of interest and understanding.
5. **Competing interests between governmental bodies:** Highlighting the presence of competing interests among governmental bodies as a barrier.
6. **Variations in Nexus approach:** Challenges associated with variations in the nexus approach on local, regional, and global levels.
7. **Dissemination of Nexus research:** The difficulty in disseminating nexus research to different stakeholders and governmental bodies.
8. **Coordination between sectors:** The lack of coordination between sectors and their limited permeability.

These issues collectively contribute to the challenges faced in the practical implementation of the nexus approach, and addressing them requires targeted efforts and collaboration across various sectors and stakeholders.

3.4 Synthesis of nexus forum sessions

Synthesizing the discussions from the Nexus Forum’s three sessions reveals various overarching themes, reoccurring concerns, and consensus points, emphasizing the linked nature of water, energy, food, and ecosystem management. By collecting related content from each session, we aim to provide a complete summary of the forum’s important discoveries and implications.

1. **Interconnectedness of sectors and challenges:** Throughout the sessions, the panelists emphasized the significance of recognizing the interconnectedness of water, energy, food, and ecosystems. Discussions highlighted how challenges in one sector can have cascading effects across others, underscoring the importance of adopting a holistic approach to nexus management.

Selected Quotes:

“The nexus was underscored as a conceptual framework that goes beyond individual sectors, promoting collaboration among diverse stakeholders...” (Session 1)

“Success in nexus projects is multifaceted, with diverse perspectives and criteria contributing to the evaluation of achievements...” (Session 2)

“Addressing these challenges requires a region-specific understanding, integrated approaches, interdisciplinary collaboration, and active engagement with local communities...” (Session 3)

2. **Collaboration and Stakeholder engagement:** Stakeholder collaboration emerged as a prominent issue throughout the sessions, with talks focusing on the motives, drivers, and procedures for effective collaboration in nexus initiatives. Shared aims and values, value generation, barrier removal, knowledge exchange, and network maintenance are all key drivers of collaboration.

Selected Quotes:

“Collaboration is instrumental in establishing and maintaining stakeholder networks...” (Session 2)

“Success in nexus projects goes beyond achieving predefined objectives; it encompasses a holistic, ongoing process of collaboration, trust-building, tangible outcomes, and the integration of diverse perspectives...” (Session 2)

“By breaking down silos, promoting cross-sectoral collaboration, and translating complex concepts into practical terms, researchers can play a pivotal role in shaping impactful policies and practices...” (Session 3)

3. **Policy integration and implementation:** The integration of nexus research into policy and practice emerged as a significant focus topic, with conversations emphasizing the importance of bridging the research, policy, and practice gaps in order to successfully address social and environmental concerns. The key hurdles include showing policy effects, overcoming institutional impediments, and promoting localized governance and policy alternatives.

Selected Quotes:

“Stakeholders discussed incorporating the nexus concept in response to the European Union’s climate law...” (Session 1)

“The need to effectively demonstrate the policy impact of the nexus approach and differentiate it from other approaches...” (Session 3)

“Emphasizing the need for enhanced impact on policymaking, the proposal was made to create concise materials, such as two-page leaflets or policy briefs...” (Session 3)

4 Conclusion and discussion

The NEXUSNET Regional Forum emerged as a dynamic platform fostering in-depth discussions and knowledge exchange on the Water-Energy-Food-Ecosystems (WEFE) nexus in Southern Europe and the Mediterranean. Session 1 set the stage by elucidating sectoral perspectives, revealing a consensus on the nexus’s significance in fostering sustainable development across diverse sectors. Session 2, focusing on collaboration, underscored the multifaceted motivations driving stakeholders

to collaborate in nexus projects, emphasizing shared values, knowledge exchange, and the pursuit of systemic change. In Session 3, a comprehensive analysis of WEFE nexus research in the region highlighted key challenges, including the need for tailored, context-specific approaches, and the importance of addressing socio-economic factors.

The panel discussion highlighted several major challenges to implementing the nexus method in the region. These include obstacles in translating the strategy across contexts, effectively showing its policy effects, and generating interest from stakeholders. Furthermore, there is a struggle for acknowledgment, especially when the nexus method is focused on water, which can result in a lack of understanding and support. Competing governmental interests, as well as variances in how the nexus strategy is interpreted and utilized, hamper implementation attempts. Disseminating nexus research and fostering cross-sector collaboration are also mentioned as important challenges.

Based on the forum discussions it can be stated that there were indications of potential conflicting viewpoints and areas where further research is needed. Conflicting viewpoints may arise regarding the significance of different challenges hindering the implementation of the nexus approach, as well as divergent opinions on the most effective strategies for addressing these challenges. For instance, while one panelist may emphasize the importance of enhancing coordination between sectors, another may prioritize the need for better dissemination of nexus research. Additionally, areas such as the transferability of the nexus approach across diverse contexts and the demonstration of its policy impact may require further investigation to develop nuanced understanding and effective solutions. Furthermore, gaps in knowledge regarding specific aspects of the nexus approach or its implications for different sectors and regions suggest the necessity for ongoing research to fill these gaps and inform evidence-based decision-making. Therefore, further research and exploration are warranted to reconcile conflicting viewpoints and advance understanding in areas crucial for successful implementation of the nexus approach.

The forum discussions underscore several critical policy implications for advancing the implementation of the nexus approach. Policymakers must tailor nexus frameworks to specific regional contexts, emphasizing flexibility while upholding core principles. Evidence-based policy-making, including robust monitoring and evaluation mechanisms, is essential for demonstrating impact and informing decision-making. Raising awareness and advocacy efforts are crucial for garnering support, while addressing competing interests among governmental bodies requires enhanced collaboration and coordination. Disseminating nexus research, building stakeholder capacity, and promoting sectoral integration are also paramount for successful implementation. These policy implications highlight the importance of concerted efforts to overcome barriers and realize the nexus approach’s potential for sustainable development and resource management.

Informed by the discussions and outputs of the forum, a strategic roadmap encompassing both short-term actions and long-term strategies is essential for addressing the complex challenges of resource management and sustainability in implementing the WEFE nexus approach. In the short term, immediate actions are required to tackle pressing challenges and lay the groundwork for long-term success in implementing the WEFE nexus approach. This includes launching targeted awareness campaigns to educate stakeholders about the interconnectedness of water, energy, food, and ecosystems, while also organizing policy workshops to facilitate dialogue among governmental bodies and stakeholders. Knowledge-sharing platforms should be established to disseminate nexus research and best practices, and pilot projects should be implemented to demonstrate the feasibility and effectiveness of integrated approaches. Concurrently, capacity-building initiatives should equip practitioners with the necessary skills, and institutional coordination should be fostered through cross-sectoral working groups and joint initiatives. In the long term, sustained efforts and strategic investments are necessary to consolidate gains and achieve transformative change in resource management and sustainability. This entails

institutionalizing the nexus approach into national and regional policies, investing in long-term capacity development programs, and supporting ongoing research and innovation. Participatory governance mechanisms should be fostered, investment strategies developed, and policies evaluated periodically to assess their effectiveness. Strengthening international cooperation and collaboration is crucial for addressing transboundary challenges and leveraging partnerships to advance the WEFE Nexus agenda on a global scale.

Appendix

See Table 1.

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Table 1 Panelists and their affiliated organizations participating in the NEXUSNET regional forum on the water-energy-food-ecosystems (WEFE) Nexus, held in split, Croatia on September 28, 2023

Name and surname	Position/title	Organization	Country	Type of panelists
Mrs. Anita Sever-Koren	Director	Ministry of agriculture of the republic of Croatia	Croatia	Policy sector
Ms. Alena Vlastic	Senior coordinator	Croatian waters	Croatia	Policy sector
Prof. Eduard Doujak	Assistant professor	University of Wien	Austria	Academia
Prof. Catarina Roseta Palma	Associate professor	Terra Sintropica	Portugal	NGO
Prof. Maria Papadopoulou	Professor	Natural environment and climate change agency	Greece	Policy sector
Mr. Pär Larshans	President, board member, chief sustainability officer	Ragn-Sells group	Sweden	Private sector
Mr. Francisco Machado	Executive director	Defining future options	Portugal	Private sector
Ms. Florentina Nanu	Managing director	Business development group	Romania	Private sector
Mr. Mili Novak	Senior advisor, project Manager	Regional development agency of split-Dalmatia county	Croatia	Policy sector
Mr. Manuel Sapiano	Chief executive officer	Energy and water agency	Malta	Policy sector
Mr. Renee Wansdronk	Architect	Wansdronk Architectuur	Netherlands	Private sector
Dr. Svetlana Klessova	Director—research Associate	G.A.C. Group		
CNRS/GREDEG/University Côte d'Azur,	France	Private sector—Academia		
Dr. Rania Bou Said	Researcher	Faculty of Agriculture and Food Sciences, American University of Beirut	Lebanon	Academia
Dr. Jose Gonzalez Piqueras	Research staff	University of Castilla-La Mancha	Spain	Academia
Prof. Anna-Stiina Heiskanen	Professor, director	Finnish Environment Institute (SYKE)	Finland	Academia
Mr. Durk Krol	Executive director	Water Europe	Belgium	Policy sector
Ms. Aishwarya Raja	Phd student	United nations university flores	Germany	Academia
Mr. Giulio Pattanaro	Research program manager	European research executive agency (REA), unit B3 biodiversity, circular economy and environment	Belgium	Policy sector
Mr. Thomas Rebermark	Director	Stockholm international water institute	Sweden	NGO
Dr. Maria Vrachioli	Senior researcher	Technical university of Munich	Germany	Academia

Declarations

Conflict of interest The corresponding author states that there is no conflict of interest.

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