Governance, policies and research options for the WEFE nexus

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Chapter 5
Governance, policies and research options for the WEFE nexus

Executive summary

There is an urgent need for coordinated WEFE policies in the Mediterranean to address water scarcity, food and energy insecurity, ecosystem health, and potential conflicts exacerbated by climate change. However, countries in the MENA region currently lack an integrated policy framework that connects water resources management, energy, food, and ecosystems. Given the profound impact of climate change on food and water security, implementing integrated, transformative, inclusive and WEFE-based policies in the MENA region is imperative in order to effectively manage water, energy, and food resources. Coordinated WEFE policies should take into account the intricate interconnections between biophysical and socio-economic systems. Transboundary considerations are also crucial, as policies in one country can affect WEFE security regionally and locally due to the inherent production and consumption linkages in global markets and trade. When designing WEFE nexus policies within the Mediterranean region, it is essential to account for their effects on other sectors, ecosystems, and countries through market interactions.

Governance for the WEFE nexus requires strengthened connections and better management through coordination, integration, coherence, and collaboration between actors and their respective strategies and actions, rather than through the creation of new institutions. In the Mediterranean Basin, especially in southern countries, there is insufficient cooperation between science and policy, with stakeholders often expressing different, and sometimes incompatible, goals, agendas, and priorities. Enhancing the science-policy interface in these countries presents an opportunity for integrated WEFE planning, management, and governance. It is imperative to avoid siloed approaches and instead focus on hybrid governance modes and policy instruments that are holistic and long-term. Citizens' assemblies based on deliberative processes can help overcome some limitations of current democratic systems and practices in responding to the climate crisis. WEFE challenges and interlinkages in the Mediterranean region can be more efficiently addressed by referring to frameworks such as social-ecological resilience, the Sustainable Development Goals (SDGs), or the 2050 Vision on Biodiversity.

Most projects funded under the Seventh Framework Programme for Research, such as ARIMNET and ERANETMED, have focused on technological and social innovations in the WEFE domains, and particularly water-ecosystem and energy-ecosystem links. Public-Private Partnerships have proven to be effective funding mechanisms for the WEFE nexus. Projects under Horizon 2020 and PRIMA programmes have significantly improved capacity-building and awareness among involved partners regarding WEFE components.

5.1 Overview of current policies

5.1.1 WEFE policy inventory

Numerous policy objectives have been formulated across the Mediterranean Basin, each linked to corresponding policy instruments, to achieve the policy goals set forth in the United Nations (UN) 2030 Agenda for Sustainable Development (UN, 2015c) and the UN Framework Convention on Climate Change (UNFCCC) (UN, 1992) – the two main policy documents related to the WEFE nexus at the international level (Munaretto & Witmer, 2017). Moreover, several other key policy documents are considered vital for resource efficiency, including the Convention on the Protection and Use of Transboundary Watercourses (UNECE, 1992) for water, the Paris Agreement for climate change and GHG mitigation (UN, 2015b), the Declaration of the World Summit on Food Security (FAO, 2009), the World Food Summit Plan of Action (FAO, 1996b), the International Treaty on Plant Genetic Resources for Food and Agriculture (FAO, 1996a), the OECD-FAO 2016 Guidance for responsible agricultural supply chains (OECD & FAO, 2016), the UN Convention to Combat Desertification (UN, 1994) (for managing land, food and ecosystems, and the Sendai Framework for Disaster Risk Reduction 2015 – 2030 (UN, 2015a). A pioneer of the WEFE concept at policy level is the Integrated Water Resources Management (IWRM) framework designed to improve water resources management adopted at the Dublin International Conference on Water and the Environment (ICWE) and the Rio de Janeiro Summit on Sustainable Development, both in 1992.

At the European level, WEFE-related policies are primarily focused on the just transition and sustainable development by fostering resilience in human and natural systems within the context of global environmental change. The European Green Deal (European Commission, 2021c) – the EU economic growth strategy, presented in December 2019, sets an ambitious and comprehensive roadmap for transforming Europe into the worlds' first climate-neutral continent by 2050, caring for

nature, boosting the competitiveness of the European economy, improving people's health and quality of life, and leaving no one behind. From a WEFE perspective, the EU Green Deal includes some relevant strategies and legal initiatives, including: (1) the Farm to Fork Strategy (European Commission, 2020a), which aims to accelerate the transition to a food system, (2) the EU Biodiversity strategy for 2030 (European Commission, 2020b), which aims to protect nature and reverse the degradation of ecosystems, (3) the EU Soil Strategy for 2030 (European Commission, 2021a), which aims, among other things, to combat desertification and restore degraded land and soil, including land affected by desertification, drought and floods, and (4) the EU Adaptation strategy (European Commission, 2021b), which aims to reinforce the adaptive capacity of the EU and minimise vulnerability to the impacts of climate change.

This transformation involves a shift to a greener economic model, aimed at (1) net zero greenhouse gas emissions by 2050, (2) economic growth decoupled from resource use, and (3) inclusivity, so that no individuals or regions are left behind (Filipović et al., 2022). The "Fit for 55" initiative represents a coherent and balanced EU framework, designed to achieve climate goals by enhancing innovation and competitiveness across economic sectors, while ensuring equity and social justice for all citizens. The Kunming-Montreal Agreement (UNEP, 2022) adopted at the 15th Conference of the Parties (COP15) to the Convention on Biological Diversity (Canada, December 2022), outlines a key goal of restoring at least 30% of degraded terrestrial, inland water, coastal, and marine ecosystems by 2030. Accelerating the pace and scale of nature restoration is critical to improving lives and livelihoods, mitigating biodiversity loss, and countering climate change impacts, considering that 50% of global GDP depends on nature and 50% of crops are at risk of soil erosion.

In the Mediterranean region, climate and agricultural policies represent critical priorities, stimulating progress in and being positively influenced by energy, water, and ecosystem-related policies (Papadopoulou et al., 2020). Unlike EU countries, MENA countries lack a common policy framework. Policy directions for the Arab countries have been developed by the League of Arab States (LAS) and its relevant institutions. LAS is an intergovernmental organisation of all Arab states in the Middle East and North Africa. The Council of Arab Ministers Responsible for the Environment (CAMRE) was set up to maintain coordination and cooperation among Arab countries in areas related to the environment and climate change. The Arab Ministerial Water Council (AMWC) has the mandate to address increasing water scarcity in the region. In 2012, AMWC adopted the Arab Strategy for Water Security. The Arab Water Council is responsible for raising awareness of current water resources management challenges in the region. The Arab Organization for Agricultural Development (AOAD) is another specialised organisation under the umbrella of the LAS with the main mandate of coordinating agricultural-related activities for ensuring food security among the countries of the region. However, MENA countries maintain multiple bilateral and multilateral frameworks for managing water, energy, and food resources. The Gulf Cooperation Council (GCC) is one such platform that has developed a Unified Water Strategy spanning 20 years, from 2016 to 2035. Countries in the MENA region, such as Egypt and Libya, rank among the most water-scarce areas worldwide. Historically, their inhabitants have shown great wisdom in water usage, both in terms of developing water infrastructure and establishing governance mechanisms (de Stefano et al., 2014). A prime example is the traditional *qanat* system (equivalent to *foggara* and *falaj*), practised in this region, which effectively provided ownership of groundwater rights. However, two critical aspects of Integrated Water Resources Management – demand management and cost recovery – are urgently needed but have not been achieved in the MENA countries. Moreover, explicit reallocation of water from rural to urban users and from agriculture to industry has not been undertaken, and increasing supply has so far been the predominant focus (*Table 5.1*).

Implementing multiple policies simultaneously can either promote or obstruct progress towards objectives due to the interconnectedness of systems. Therefore, when deciding on policies to implement, potential cross-sectoral implications must be thoughtfully considered (Laspidou et al., 2020; Sušnik et al., 2021). Practical implementation of WEFE nexus policies has been limited and lacks coordination between the different levels of managing authorities, sectoral departments, political actors, and stakeholders (Bazzana et al., 2023; Ghodsvali et al., 2022). Different political and social conditions within Mediterranean countries imply varying levels of WEFE nexus policy implementation (*Figure 5.1*).

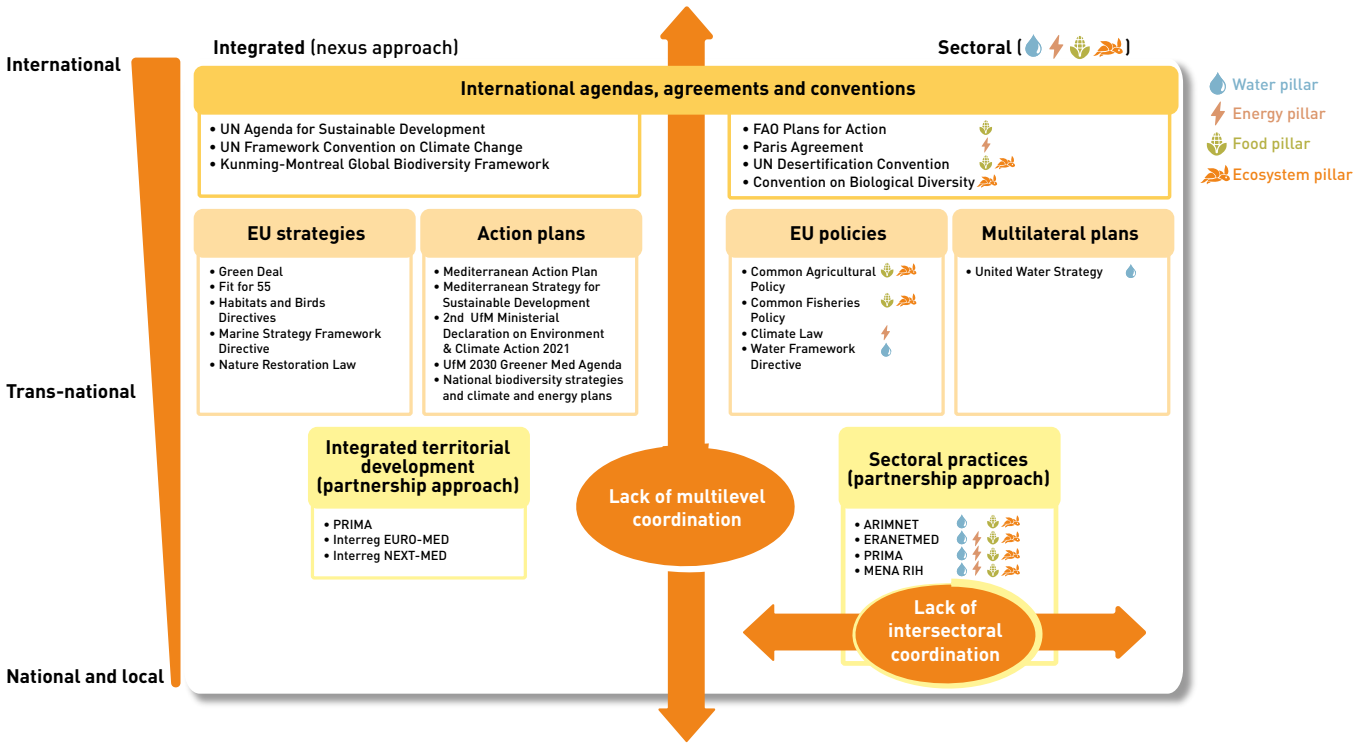

Figure 5.1 | Multi-level integrated and sectoral policies on the WEFE nexus in the Mediterranean (see *Sections 5.3.1* and *5.3.3* for AIMNET, ERANETMED, MENA RIH and PRIMA programmes description).

5.1.2 Lessons learnt at nexus policy level so far

The water, food, and energy nexus are coupled at multiple levels, which reveal institutional opportunities and obstacles to collaborative decision-making. While local challenges and pressures are important, the specificities from each territory make up-scaling into a broader perspective difficult (Scott et al., 2011). This is a complex issue with various alternatives, conflicting objectives, and multiple uncertainties about key drivers. This complexity requires the collaborative involvement of stakeholders to develop meaningful policy objectives (Ghodsvali et al., 2022).

In water-scarce regions, water and energy are not fairly priced or efficiently allocated, which means, from an economic perspective, that the societal impact of resource use is not optimised (Wichelns, 2017). The adoption of cooling technologies in these regions is critical for maintaining the balance between water-energy supply and demand (Qin et al., 2015). Smart water management, and the extensive use of technologies capturing Greenhouse Gases (GHGs) may ensure water security in water-scarce Mediterranean regions (Papadopoulou et al., 2022). The concept of virtual water and international trade of agricultural products may mitigate the impacts of water scarcity and improve food security in high-income countries, although globally it aggravates water scarcity in low and lower-middle income countries (Zhong et al., 2023).

Bridging sectoral policies to form interdisciplinary sustainable management strategies could contribute to a more balanced use of natural resources and conservation of natural capital. The sustainable use of ecosystem services, including ecosystem restoration and green infrastructure, are key elements for successfully achieving sectoral development goals (Karabulut et al., 2019). Policies related to the WEFE nexus in the Mediterranean Basin should aim to increase resource efficiency, balance demand and needs with a focus on sufficiency, and reduce waste and losses (Pistocchi et al., 2022). Given political instability and conflicts in the region, WEFE nexus governance should promote transparency, participation, deliberation and accountability through dialogue and cooperation between Mediterranean countries, supplemented by collaboration with international organisations, the private sector, civil society and citizen participation.

5.1.3 Gaps and synergies at legislative level in the context of WEFE diplomacy

Examination of the legislative landscape in the Mediterranean region for the WEFE nexus shows that a prominent deficiency is the absence of holistic integration across sectors (Cremades et al., 2021). Legislation and policies for water, energy, food, and ecosystems often exist as independent entities in several Mediterranean nations, leading to inefficiencies and conflicts between nexus components (Giest & Mukherjee, 2022). Furthermore, disjointed legal frameworks, marked by diverse and frequently conflicting laws, particularly in relation to transboundary resources, are particularly evident on both sides of the Mediterranean region. Even legislation that appears robust on paper can encounter implementation and enforcement hurdles due to institutional weaknesses, corruption, and limited resources. Lastly, current legislation does not sufficiently take into account the potential impacts of climate change, even though it is predicted to significantly influence the WEFE nexus in this region (see *Chapter 2*).

While these legislative gaps pose challenges, there are existing synergies that offer the potential for a more unified approach to managing the WEFE nexus in the Mediterranean, with the caveat that achieving policy coherence is not always possible and not necessarily optimal (Wichelns, 2017). These include platforms for regional cooperation, like the Union for the Mediterranean (UfM), which provides opportunities for legal harmonisation and collaborative resource management. Initiatives under the umbrella of UNESCO, such as the Intercontinental Biosphere Reserve of the Mediterranean, can also provide useful legislative (though non-binding) frameworks for encouraging movement towards a more holistic approach to territorial planning which takes the WEFE nexus into account. Mediterranean nations that are either EU member states or maintain strong ties with the EU could reap benefits by aligning their policies with the more advanced EU frameworks pertaining to water, energy, food, and ecosystems. The United Nations SDGs offer an extensive roadmap that can guide the formation of WEFE nexus legislation. There are several instances of successful integration in the region, such as IWRM, that could be used as a model for multi-sectoral legislative unification.

5.1.4 WEFE nexus – policy effects on multidimensional security through market interactions

Fostering the WEFE nexus in the Mediterranean region requires integrated policymaking that avoids resource inefficiencies. But to prevent trade-offs and maximise synergies between the different WEFE dimensions, policymakers should consider the economic interconnections between food, energy, and water systems when determining the impact of policy measures on food, energy, and water security. Generally, nexus policies are defined as interventions that directly affect at least one nexus component (Nielsen et al., 2015). Integrated nexus policymaking must account for the multidimensionality of security, which needs to be ensured both at macro level, i.e. national level availability of water, energy or food, and at micro level of the economy concerned with access to these resources at the household or individual level, often dependent on income and prices (Schuenemann, 2018) as well as societal norms and power inequalities. Both types of security are inherently interconnected, so nexus policies that directly affect only one nexus component can indirectly influence the entire WEFE nexus due to multiple connections between the nexus components (Nielsen et al., 2015) (see *Chapter 2*). It is beneficial to distinguish between biophysical linkages through ecological processes and social and economic interconnections. Economic interconnections arise from production and consumption linkages through market interactions between consumers and producers. Consumption linkages occur when consumers purchase goods and services at markets, such as food and energy. The prices and supply at these markets, that is access and availability, determine whether consumers can fulfil their demand. For example, a policy that increases energy prices could directly reduce energy security but also indirectly food security because it reduces the available income of households for consumption of other goods. Production linkages are input-output connections between different producers. This could be upstream linkages, where producers purchase intermediate inputs from other producers, or downstream linkages, where a producer sells its output to another producer (Diao & Thurlow, 2012). Continuing with the above example of a policy increasing energy production costs, current industrialised food production could be negatively affected by increasing input costs because there is an input-output connection between energy and

food. As all economies in the Mediterranean region are open, producers and consumers can engage in international trade meaning that the supply and demand of trading partners can also influence the domestic WEFE nexus as well as WEFE in third countries through telecoupling (Garrett & Rueda, 2019; Liu et al., 2020). Türkiye, for example, is a major food hub for the MENA region (Schuenemann & Hess, 2023). If Turkish food production decreases or increases due to policy measures, it could affect exports and thus the availability of food in other countries within the MENA region if no internal measures are taken to enhance domestic production. In sum, market interactions lead to a multitude of linkages, so a policy measure invariably affects the rest of the economy and different parts of the WEFE nexus (Schuenemann, 2018). In the WEFE context, telecouplings between distal socio-ecological systems of production and consumption, as they become more visible, are giving rise to feedback mechanisms in the form of environmental and social governance (Garrett & Rueda, 2019).

Other policy options that can affect market interactions involve pricing. Water pricing aims to ensure that all water costs are accounted for, and encourages more efficient water use, thereby reducing impacts related to water use across the WEFE nexus (Cortignani et al., 2018). The European Water Directive encourages this, but other countries in the Mediterranean region have also started implementing it. Nevertheless, implementation of water pricing remains difficult, as in many parts of the region water use is subsidised, or prices have been frozen due to rising costs of other agricultural inputs (Molle & Sanchis-Ibor, 2019). Despite increases in water prices in many parts of the Mediterranean, full costs related to negative impacts of freshwater overuse and mismanagement are not covered or remain unaccounted for. In the food sector, correct pricing (including cost externalisation) is also being proposed to promote farming practices which are sustainable, and favour nexus approaches. The hidden costs of global food and land-based agricultural systems to the environment and public health have been estimated at around US$ 12 trillion per year and are expected to grow to US$ 16 trillion by 2050, mainly due to impacts on human health (including malnutrition) and pollution (FAO et al., 2021). This implies true price accounting to internalise the environmental, social and health costs of unsustainable farming practices and diets, including waste (Martin-Rios et al., 2023). This can take the form of taxes and financial mechanisms (e.g. taxes on sugar), but also repurposing current subsidies for the nexus so as to help reduce the price of sustainable and healthy food. The WEFE nexus therefore presents a suitable approach to start taking into account numerous impacts of water use on energy, food production and ecosystems.

5.1.5 From policy to action: levels and scales of WEFE nexus governance

Whether we are talking about extreme events, the frequency and intensity of which are on the increase (IPCC, 2021; Kron et al., 2019), or the continuing rise of temperatures, it is now recognised that the ability of governance systems to cope with uncertainty and surprise is an essential condition for their sustainability (La Jeunesse & Larrue, 2020). This is why Chaffin et al. (2014) propose defining adaptive governance and social learning as essential for governing socio-ecological systems during periods of abrupt change (Folke et al., 2005), such as ongoing climate change. However, knowledge of the relationship between the characteristics of governance regimes, the interactions between stakeholders, particularly water resource stakeholders, and their performance, is still fairly limited (Buchs et al., 2021; Pahl-Wostl, 2019), as is the ability to test them in the context of climate change (Sušnik et al., 2021). Moreover, the increase of water supply as an answer to increasing water demand is not being accompanied by the hoped-for radical changes in the dominant water consumption models for agriculture and tourism in the Mediterranean region (La Jeunesse et al., 2016).

In this chapter, WEFE nexus governance is not only the organisation of decision-making power at governance level, such as international (for transboundary basins), national, regional, and local levels, but also the ongoing decision-making processes that push (or block) for more cross-sectorality through interactions between stakeholders. Field studies have demonstrated two main facts (1) there are no universal solutions or plans for integrated resources management, and there are still wide-ranging debates about how to put the process into practice to make it effective (La Jeunesse & Quevauviller, 2016; Rogers & Hall, 2003); (2) capacity for action is found more in processes than in organisational structures. This concept, or

method of application, is in line with the idea of self-organisation advocated by E. Ostrom[10], for whom different self-organising systems are supposed to be resilient and capable of coping with change, vulnerability and uncertainty (Ostrom, 2010). On the basis of this assumption, the state of WEFE nexus governance in a territory can be assessed by evaluating the quality of interactions between stakeholders that influence cross-sectoral decisions (Hüesker et al., 2022), as developed in the contextual interaction theory detailed below (Bressers et al., 2016).

Problem perceptions and environmental awareness

Everything confirms that the level of perception of the problem and environmental awareness is a key condition (Adger et al., 2009; Koop et al., 2017; La Jeunesse et al., 2016) for stakeholders to engage in decision-making processes (Bressers, 2009; Bressers & Kuks, 2004) encouraging more cross-sectorality to adapt to climate change (La Jeunesse & Larrue, 2020). Stakeholders are usually aware that there is a clear link between the level of environmental awareness and the level of environmental education of adults who are part of decision-making processes. In this regard, one recommendation is to invest in educational actions targeting adults involved in activities and decision-making processes for WEFE nexus components (La Jeunesse, 2020).

Lack of environmental expertise

A lack of environmental expertise in organisational structures impacts the capacity of governance to encourage more cross-sectorality. This can be associated with a low mobilisation of resources for the environmental sector and can occur at different levels in the decision-making process. When the lack is situated at the top level[11], it can block all the processes of designing national strategies and plans to support actions in territories. When it occurs at other levels, it can restrict the process of bottom-up initiatives and thus restrict implementation of actions. The mobilisation of environmental expertise and related resources can therefore increase the chance of being more effective (Bressers et al., 2016; Crona & Parker, 2012; OECD, 2018a).

Levels and scales of WEFE nexus governance

In multi-level systems, devolved governance should enable responsibilities to be allocated to the least centralised level, with potential for development at other levels (Lockwood, 2010). Moreover, governance is truly supportive of cross-sectorality when WEFE nexus governance issues can be addressed at different levels (upscaling and downscaling) and where WEFE domains work together in a coordinated manner (Bressers et al., 2016).

One of the difficulties faced by governments with the transformation processes required to respond to climate change by considering cross-sectorality is that they are looking for the effectiveness of a top-down framework which support bottom-up initiatives. While a climate-focused approach is considered to be top-down, since it starts with global projections of climate change and works down to the more local projections needed to analyse the local impacts on which adaptation policies are based, the bottom-up approach involves initiating reflection on the basis of local information regarding the possibilities for responding to the impact of climate change on resources (water, energy, food) (Bhave et al., 2014). This "bottom-up" approach is generally based on extensive consultation of the various local stakeholders and their networks who are involved in the decision-making process, including non-governmental organisations.

To conclude, the development of WEFE nexus governance in the Mediterranean region requires including all categories of stakeholders at different levels for top-down strategies and bottom-up initiatives to meet the same goals.

10 Elinor Ostrom, winner of the 2009 Nobel Prize in Economics, has developed analytical tools and identified the key factors for self-organisation in natural resource management. This has enabled her to develop hypotheses on the success of collective action. Her empirical approach is presented in her book "Governing the Commons: the Evolution of Institutions for Collective Action", first published in 1990. Prior to this theory of self-organisation, the theoretical models widely used to analyse the governance of "the commons" ultimately focused on government intervention and the market, which inevitably failed to manage public environmental resources because of the "tragedy of the commons" or the "crowding effect".

11 A top-down, vertical or hierarchical approach reflects a traditional conception of power. Orders emanate from above and are implemented at each level by a subordinate authority. Its classic graphic representation is the pyramidal organisation chart, with arrows going from top to bottom. In politics, the centralised State is an illustration of this. The criticisms levelled at this form of organisation are its rigidity, and its inability to take account of specificities and realities on the ground. The bottom-up or horizontal approach is a response to these criticisms: innovations and ideas emanate from "the bottom", i.e. from the local level, and are then passed on to the other hierarchical components of the entity in question so that they can be taken into account and implemented. Collaborative or participative approaches, federal or decentralised models are all part of this approach, which also aims to give responsibility to the lower level of the decision-making context.

Main WEFE policies in EU and non-EU countries of the Mediterranean region

	EU	Middle East	North Africa
WATER	- Water Framework Directive. - Groundwater Directive. - Urban Waste Water Directive. - Circular Economy Action Plan *(substances released in water bodies).* - Floods Directive. - Action Plan on the Sendai Framework for Disaster Risk Reduction (2016). - EU Parliament and Council decision on Union Civil Protection Mechanism.	- Mediterranean Action Plan (21 Mediterranean Countries and EU): aimed at protecting the Mediterranean Basin from pollution and promoting sustainable development. Includes a range of measures to improve water quality, prevent marine pollution, and promote sustainable use of coastal resources. - The Arab Strategy for Water Security (2013) and its Action Plan (2014) are based on the Integrated Water Resources Management (IWRM) principle. Priority objectives include strengthening adaptation to climate change. - Unified Water Strategy of the countries of the Gulf Cooperation Council (GCC). **CYPRUS** - The Water Development Department of Cyprus has developed a Water Policy for the Mediterranean Basin which includes several key components: Integrated Water Resources Management, water conservation, water quality, climate change adaptation, and international cooperation. In addition to the above-mentioned components, the water policy of Israel includes desalination and reuse. **LEBANON** - National Water Sector Strategy (NWSS) of Lebanon (2010): the key objectives are to increase water availability, improve water quality, ensure water distribution, and strengthen institutional capacity. **TÜRKIYE** - National Water Plan 2019–2023. - Water Efficiency Strategy Document and Action Plan 2023–2033 for Adaptation to Changing Climate Conditions.	National climate plans in North Africa concerning water resources: - Water saving, construction of dams and hill reservoirs, adaptation of technical itineraries, introduction of technical practices (direct sowing), reconversion of production systems, fight against erosion and desertification, anti-drought programmes, protection and rehabilitation of steppe lands, development of watersheds, rural projects, diversification of activities, safeguarding and extension of forests, development of agricultural insurance. - Strategies for responding to water-related disasters. - Water mobilisation (dams, desalination with cogeneration, underground injection, wastewater recycling, inter-regional transfers). - Water saving (supplementary irrigation, optimal techniques, leakage reduction, pricing, training and awareness). - Flood and drought control (vulnerability map, watershed management and reforestation, flood control, protection of urban areas, development of monitoring and information systems and decision-making tools). **ALGERIA** - Law no. 05–12 of 4 August 2005 on water. - National Water Plan 2035. **EGYPT** - National project to improve irrigation water management to reduce losses and waste (rehabilitation of the irrigation network by improving the condition of the irrigation canals) and the use of drainage water. - National plan for water desalination using solar energy. - Nexus of Water, Food and Energy (NWFE) programme. - National mega wastewater treatment projects. **MOROCCO** - The National Climate Change Plan in Morocco subsidises the construction of runoff storage basins to collect water from heavy rainfall. This programme focuses on conversion to localised irrigation. The Green Morocco Plan recommends developing arboriculture on dry land that is less sensitive to droughts. - National drinking water and irrigation water supply programme 2020–2027. - National Water Plan (PNE) 2020–2050. - National Plan for Flood Protection. - Green Generation Strategy 2020–2030. - National Programme for Mutual Sanitation, which aims at improving water quality by reducing pollution. **TUNISIA** - Sectoral water strategies. - Water Code of 1975. Several versions of the draft organic law on the Water Code have been prepared and submitted for consultation. Last version adopted in September 2019. - Water Sector Strategy 2030.

Main WEFE policies in EU and non-EU countries of the Mediterranean region			
	EU	**Middle East**	**North Africa**
ENERGY, Climate Change Mitigation	- European Green Deal: climate neutrality by 2050. - European Climate Law (Regulation (EU) 2021/1119). - EU Strategy on Adaptation to Climate Change (COM(2021) 0082). - Fit for 55 Package. - Integrated climate and energy policy for 2030. - Energy Union strategy (COM(2015)0080). - Governance of the Energy Union Regulation (EU) 2018/1999). - Risk-Preparedness Regulation (EU 2019/941). - Energy Efficiency Directive (2018/2002). - Energy Performance of Buildings Directive (EU 2018/844). - Renewable Energy Directive (EU 2018/2001). - EU Agency for the Cooperation of Energy Regulators (EU Regulation 2019/942). - Just Transition Fund (COM(2020)0022). - Bio-economy strategy.	- Mediterranean Strategy for Sustainable Development 2016–2025. - Union for the Mediterranean (UfM) Energy Ministerial Declaration (2017). - Mediterranean Energy Observatory. - Mediterranean Solar Plan (2008). - Euro-Mediterranean Energy Efficiency Forum. - Eastern Mediterranean Gas Forum. - MENA Renewable Energy Strategy (2020). **TÜRKIYE** - Türkiye National Energy Plan (2022). - Türkiye Hydrogen Technologies Strategy and Roadmap (2023). - 2024–2030 Climate Change Mitigation Strategy and Action Plan. - Environment Law No. 2872 (last amended by the Law No. 7456 of 2023).	**ALGERIA** - National Climate Plan (2018). A plan preceded by a Risk and Vulnerability Analysis (RVA) for climate change, mobilising tools and methodologies applied on an international scale. Includes more than 70 action measures that cover the transition to cleaner energy sources, the expansion of forest areas, and electrification of railway transport. - National Action Plan for the Environment and Sustainable Development (PNAEDD). - National Strategy for Integrated Waste Management (SNGID). **EGYPT** - Updated Nationally Determined Contributions (NDCs) (2030). - National Climate Change Strategy 2050: sustainable low-emission economic growth, build capacity to adapt to climate change and reduce the negative impacts of climate change, improve governance in the field of climate change, strengthen the role of research and technology in the field of climate change, improve green infrastructure and promote green economy activities, climate change risk management programme. **MOROCCO** - National Plan Against Global Warming (PNRC) (2009).[12] **TUNISIA** - National strategy for the adaptation of Tunisian agriculture and ecosystems to climate change (2012).[13] - Programme for Adaptation to Climate Change in Vulnerable Rural Territories of Tunisia (PACTE) (2017–2022). - NDCs submitted to UNFCCC in 2021. - National Strategy for Sustainable Development (NSSD) (2014). - Disaster risk reduction policy 2015–2030.

12 The stated aim is to "protect water resources against the impacts of climate change and improve the living conditions of rural populations through sustainable resource management".
13 The objective is to contribute to the sustainable development of Tunisian agriculture through the development and implementation of a set of mechanisms for the continuous adaptation of the agricultural sector and natural resources to climate change.

Main WEFE policies in EU and non-EU countries of the Mediterranean region			
	EU	**Middle East**	**North Africa**
FOOD (and soil)	- Common Agricultural Policy (2023–2027). - Green Deal: · Farm to Fork Strategy · Soil strategy for 2030 · Common Fisheries Policy · Long-term vision for Rural Areas	- Mediterranean Strategy for Sustainable Development. - Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean. - MENA Food Security Strategy (2014). - MENA Sustainable Agriculture and Rural Development Initiative (2012).	**ALGERIA** - Development of Saharan agriculture, production cooperatives, food security; promotion of technical innovations (digitalisation and creation of start-ups). **EGYPT** - 2030 Sustainable Agricultural Development Strategy: sustainable management and preservation of resources (management of irrigation water and the recycling of agricultural waste as a source of income in rural areas), current agricultural policy encourages the abandonment of sugarcane cultivation in favour of sugar beet (less water consuming). **MOROCCO** - New agricultural sector development strategy, "Generation Green 2020–2030" "giving priority to the human element, to bring about the emergence of an agricultural middle class (350,000 to 400,000 households)"; new generation of young entrepreneurs, through the mobilisation and development of one million hectares of collective land and the creation of 350,000 jobs for young people; digitalisation and creation of start-ups. **TUNISIA** - Towards a new agricultural policy: Development Plan 2023–2025. "New Tunisian agricultural green deal".

Main WEFE policies in EU and non-EU countries of the Mediterranean region			
	EU	**Middle East**	**North Africa**
ECOSYSTEMS	- Forest Law Enforcement Governance & Trade Action Plan (2003). - Habitats Directive - Birds Directive. - Forest strategy for 2030. - Biodiversity strategy for 2030. - Nature restoration law (under negotiation, EC proposal). - Pollinators Initiative. - Strategy on adaptation to climate change. - Strategy on green infrastructure.	- Mediterranean Action Plan. - MedWet Initiative. - Mediterranean Forest Strategy. - Arab Strategy for Disaster Risk Reduction, adopted in 2018. - The Arab Strategy for Sustainable Agricultural Development, adopted in 2007	**ALGERIA** - National Action Plan for the Environment and Sustainable Development (PNAEDD) (2002). - National Strategy for the Environment and Sustainable Development (SNEDD) for the period 2017–2035, which constitutes the strategic reference document in the field of the environment. - Forest strategies: National Forestry Development Plan, National Reforestation Plan and National Protected Areas Management Plan. - Conservation strategy for natural ecosystems in arid zones in Algeria. - National Plan to combat desertification. - Strategy and National Action Plan for Biodiversity (SPANB). **EGYPT** - Sustainable Development Strategy to 2030: sustainable management of natural resources, reduction of pollution and sustainable waste management, reservation of ecosystems and biodiversity. **MOROCCO** - National Climate Plan 2020–2030 (NCP) which aims to establish the fundamentals of low-carbon and climate change resilient development. Organised around five pillars: establishing stronger climate governance, strengthening resilience to climate risks, accelerating the transition to a low-carbon economy, including territories in the climate dynamic, strengthening human, technological and financial capacities. **TUNISIA** - National strategy for water and soil conservation by 2030. - National Plan for Adaptation to Climate Change and Strategy for Resilient Development (SNRCC) under preparation. - Nationally Determined Contributions (NDC) (September 2015). - National Drought Plan (November 2020). - National Action Programme to Combat Desertification. - National Strategy for the Development and Sustainable Management of Forests and Rangelands, 2015–2024.

Table 5.1 | Main WEFE policies in EU and non-EU countries of the Mediterranean region.

5.2 Governance

5.2.1 Key actors and stakeholders in WEFE governance and dynamics

In recent years, the nexus concept has been gaining ground, providing an opportunity to shift IWRM from a sectoral focus to improving cross-sector efficiencies, considering telecoupling impacts and accomplishing cross-cutting objectives (Hindiyeh et al., 2023; Hoff, 2011; Taylor-Wood & Fuller, 2017). This shift has many implications for governance. Indeed, the approach gives equal importance to each sector and aims to better account for the trade-offs and synergies involved in meeting future demand for interconnected resources (Kahil et al., 2019). From this perspective, the WEFE nexus expresses the mutual interlinkages of the water, energy, and food sectors, and specifies how they depend on, and impact, ecosystems (e.g. forests, wetlands, grasslands, etc.). In line with the holistic approach of the SDGs, the WEFE perspective enables us to focus on achieving human well-being, poverty reduction and sustainable socio-economic development, rather than a narrower objective (Bervoets et al., 2018; Pistocchi et al., 2022) (see *Chapter 4*).

The nexus concept has been widely debated with regard to its impact on WEFE governance, especially in the policymaking arena, since 2011. This is a holistic way of thinking that considers long-term implications across the four nexus components, simultaneously balancing socio-economic and environmental objectives. While debate is ongoing regarding the meaning and application of the nexus concept, since reflexion and construction is still underway to achieve balance between the four components (Zhang et al., 2018), there is a common fundamental agreement about the importance of the approach (Simpson & Jewitt, 2019b) and the various governance implications it may trigger.

Undeniably, WEFE governance is a polycentric system, with diverse and varying decision centres or actions within sectors, which means identifying independent and overlapping key state and non-state actors – governments (acting through different ministries and public institutions), subnational (local and regional) authorities, civil society organisations, private sector, citizen groups, funders (e.g. PRIMA), multilateral and regional organisations (e.g. FAO, Plan Bleu, UfM, UNECE, etc.), national and international research institutions (Association of Agricultural Research Institutions in the Near East & North Africa (AARINENA), CIHEAM, Center for Mediterranean Integration (CMI), CNRS, European Commission's Joint Research Centre, Global Water Partnership-Mediterranean (GWP-Med), IRD, etc.), and national and International Development Agencies (e.g. ENABEL, GIZ, SIDA, USAID, etc.). WEFE governance requires that their respective roles become embedded in relevant policymaking processes, and that their goals, values, transactions and strategies support nexus related challenges and are continuously monitored and adjusted to meet their potential for enhancing WEFE dynamics. The various state and non-state stakeholders are building cooperative agreements and dialogue platforms to connect together, enhance and mainstream WEFE governance. WEFE governance also requires sound governance of each of its components, and implementation of the mechanisms required for achieving it, as for instance the implementation of IWRM in the case of water governance.

WEFE governance is not a matter of defining or creating new institutions. It is more about how existing institutions and actors at all scales and regions are empowered, strengthened, managed and interlinked. In other terms, the WEFE nexus requires ensuring that the existing governance settings integrate all other mechanisms and frameworks to encourage more coherence and collaboration between actors and their respective strategies and actions (Mohtar & Daher, 2014). For example, the principles, processes and obligations arising from IWRM or the Convention on Biological Diversity need to be integrated across all regimes. It is then necessary to reduce WEFE nexus knowledge gaps for all stakeholders.

However, on the ground, the various actors involved in WEFE governance need to develop or organise dialogue and review their missions (including strengths and weaknesses), and the extent to which they adopt a synergistic and integrated approach in order to develop consistency between nexus strategies and actions, while simultaneously avoiding or reducing nexus trade-offs and heterogeneity and strengthening legacy effects and institutional interlinkages (Malagó et al., 2021). In this regard, optimal policy mixes and governance arrangements across sectors, scales, and regions are those that

accomplish all the policy objectives, rather than just selected ones. The complex links between the four WEFE nexus components need to be systematically integrated into the policy and project design or evaluated using a more holistic approach, which considers all stakeholders, including policymakers and advisors, civil society and private investors (Adamovic et al., 2019; Terrapon-Pfaff et al., 2018).

Discovery of policy mixes is a context-based process, with key elements of their identification and development being integration of policy objectives and ambitions (Glass & Newig, 2019; Jung et al., 2021) and participation of local stakeholders (Norström et al., 2020). Attention also needs to be paid to dynamics between policy instruments and their interactions (Kanger et al., 2020). When adequately developed, the nexus approach has the potential to simultaneously improve water, energy, food security, and ecosystem health by increasing the resource use efficiency, reducing trade-offs, strengthening synergies, and enhancing sustainability and governance across sectors (e.g. agricultural, health and industrial), boundaries, and scales (in time and space) (Hindiyeh et al., 2023; Malagó et al., 2021).

5.2.2 Coordination and cooperation between actors at all levels and scales of WEFE governance

In a world that has transgressed boundaries of safe human development (Persson et al., 2022; Steffen et al., 2015), pathways for a more sustainable future require an immense shift towards co-developing and scaling innovations and solutions that are more sustainable and systemic than conventional ones (Kılkış et al., 2020). The Mediterranean region is one of the most vulnerable regions in the world, presenting a large spectrum of problematic issues ranging from water pollution (Malagó et al., 2019) and natural resource degradation to water scarcity, large amounts of food loss and waste, and increasing demand for energy and food (Markantonis et al., 2019).

A sustainable and secure future in the Mediterranean area requires consistent and effective cross-cutting policies, which need coordination and cooperation across actors, places, scales and issues, and must address the indirect and hidden drivers underlying sustainability issues (Visseren-Hamakers et al., 2021). Existing policies and allied dynamics for negotiation and cooperation should enable better understanding of nexus interdependencies, which are critical for the development of a sustainable, secure, and resilient future in the Mediterranean region. These coordination mechanisms are of great importance and are crucial to achieving human security, well-being, poverty reduction and sustainability (Simpson & Jewitt, 2019a). In other words, strong coordination at the regional and local levels will help alleviate the huge challenge of development and societal issues and achieve the SDGs.

Another option could be to manage the water-energy-food nexus on an integrated geographical scale and consider comparative advantages as a nexus-smart opportunity at sub-regional and regional levels. As the WEF nexus approach aims to support policy and decision-makers in managing resource trade-offs across different economic sectors and actors, adopting such an approach by taking into consideration comparative advantages between countries could help securing water, energy and food at different levels. When complementarities and synergies between the three sectors cross national borders, potential WEF nexus net benefits may increase (Abulibdeh & Zaidan, 2020; Carli & Quagliarotti, 2022).

5.2.3 Science-Policy Interface (SPI) as one way of reinforcing coherence

There is a scarcity of literature with concrete nexus implementation practices, and few studies report real nexus application (e.g. Hoff et al., 2019; Malagó et al., 2021; Pistocchi et al., 2022). This can be explained by a number of constraints, such as insufficient incentives and limited vision, knowledge, development and investment, as well as insufficient empirical evidence of the potential benefits of the WEFE nexus approach (Hoff et al., 2019). It could also be due to insufficient understanding of nexus trade-offs within science-policy-stakeholder interactions (Liu et al., 2020).

Given the importance of dealing with climate change as a risk amplifier within the nexus, as shown in *Chapter 2*, uncertainty regarding climate events poses significant challenges to nexus governance systems in various ways. These include challenges to planning and decision-making, challenges to

resource management, and challenges to social cohesion and equity (Termeer et al., 2012).

In the Mediterranean Basin, in addition to the above-mentioned constraints, and due to complex challenges, there is customarily an insufficient level of cooperation and integration between science and policy, especially in southern countries. Focus on science as a tool for overcoming poor integration has arisen in recent years in the Mediterranean region (Penca, 2021), particularly in the environmental area (Plan Bleu, 2018). This provides an opportunity to foster linkages in various forms, governance levels, and scope of interaction between different types of knowledge (scientific and "non-scientific", such as traditional knowledge and practices) and decision-making and policymaking processes relevant to the WEFE. Within such a perspective, and by reference to the science-decision interface, the WEFE approach needs to operate at the appropriate level of decision-making, mainly country- or region-based, without however excluding integration across national borders when the benefits are evident.

Universities and research organisations serve as knowledge generators and brokers and could integrate nexus thinking and organised policy dialogue into their research agendas and curricula. Governments and other institutions could improve or build their dialogue capacities and decision-making processes as well as strategic partnerships (Markantonis et al., 2019). Research priorities and aims, scales, technologies, models and data availability could be developed in order to reduce knowledge gaps and increase WEFE solutions and innovation. In this regard, there is a need to enforce WEFE nexus thinking within the SPI and relate it to SDG implementation and tracking. Also, society and associated grassroots NGOs could have a key role in WEFE governance and decision-making, implementation, and evaluation. At the same time, it is necessary to remove existing barriers and strengthen triggers to ensure the shift is optimal (Adamovic et al., 2019).

Ensuring the long-term health of global environmental commons requires a strong commitment. Science and academia, society and citizens, public and private sectors – what is called quadruple helix– should join forces to bridge existing gaps and develop a unique language to decomplexify the WEFE nexus and ensure awareness and implementation for higher economic growth and increased resilience and security (de Roo et al., 2021). All stakeholders, including decision makers, need to act based on deep and reliable knowledge and understanding of the linked pillars at all levels. There is a need to make WEFE interactions and trade-offs visible in order to reinforce or develop governance structures (Voelker et al., 2022).

To further streamline efforts, a profound and intentional departure from business-as-usual models is needed, and substantial changes are required from stakeholders in implementing the WEFE nexus and developing its metrics in line with the SDGs. Multiple entry points for getting away from business as usual have been recognised, including enabling approaches (Scoones et al., 2020). These include science/knowledge and technology as agents of change. The Science-Policy Interface (SPI) should set frameworks and tools that can be applied to facilitate decision-making at all levels and scales. In this regard, an open and inclusive assessment of the Mediterranean WEFE nexus SPI structure, processes, and skills, based on the categorisation in the Global Sustainable Development Report (Independent Group of Scientists appointed by the Secretary-General, 2019), is recommended. Such an assessment will make it possible to draw out key recommendations for strengthening and future enhancement of the SPI. In order to support the SPI, levers of transformation should be enforced, including multidimensional transfer of technology approaches, and technology should be facilitated and receive appropriate long-term funding.

5.2.4 Enhancing WEFE governance and a transformative framework

In the Mediterranean Basin, potential success stories for the implementation of good nexus practices have shown a focus on the use of suitable technologies and practices, but the nexus approach involves more than technical and economic efficiency (Malagó et al., 2021). The WEFE concept draws attention to the link between different environmental and societal areas, and potentially entails substantive shifts in, and transformation of, governance processes.

In this perspective, the WEFE is attracting new interest from scholars, policymakers, and development agencies across the Mediterranean, but disparities

across countries and regions are still considerable. For the transition to sustainability, governance and a country's investment play a central role in driving change in WEFE metrics and SDGs. There is therefore a need to avoid siloed approaches and hierarchies and focus thinking on hybrid governance modes and policy instruments that are more appropriate for better management of WEFE challenges and interlinkages.

In this regard, the notion of "transformative governance" promotes a set of principles to support integration, inclusivity, empowerment, reflexivity and pluralism (Visseren-Hamakers et al., 2021). A transformative framework combines procedural and substantive aspects of biodiversity benefits (Penca, 2023), where governance goals should specifically target equality and inclusion of marginalised stakeholders as well (New et al., 2022). Concepts such as societal resilience, well-being and livelihoods can be useful, as well as a synergistic implementation of consensually agreed goals, such as SDGs promoting inclusive sustainable development or the Kunming Montreal Framework for Biodiversity focusing on living in harmony with nature. External linkages could worsen or sustain WEF resources and may significantly be affected by the nexus boundaries (ecological and technical components).

5.2.5 Deliberative democracy

Current democratic systems lack efficiency in adequately responding to the climate crisis and are insufficiently implementing climate plans to meet the goals of the Paris Agreement, for which the nexus components play a significant role both in terms of mitigation and adaptation (see *Chapter 3*). Political scientists identify several reasons for this failure, including (1) issues of temporality, or the ability of democratic decision-making to consider the medium- to long-term; (2) the way in which technical, scientific, and expert advice is used in the political process; and (3) questions of power, and the influence of entrenched interests on political decisions; and (4) the extent to which citizens' views and values are considered in democratic decision-making (Willis et al., 2022). To overcome some of these barriers, public authorities are increasingly using deliberative processes to involve citizens more directly in solving policy challenges. Deliberative approaches are some of the most innovative methods of citizen participation with the potential, according to some evidence, to help public authorities take difficult decisions on a wide range of policy issues (OECD, 2020; PACE, 2021). When conducted effectively, deliberative processes can lead to better policy outcomes, enable policymakers to make hard choices and enhance trust between citizens and government (OECD, 2020).

For the OECD (2020), they are part of a bigger picture of the systemic change that is needed and should be institutionalised, since they have the potential to help address some of the key drivers of democratic malaise in dealing with complex and long-term problems such as climate change; the need for careful use of scientific and technical evidence; the disproportionate influence of powerful political interests; and the distance between politicians and the citizens they represent (OECD, 2020; PACE, 2021; Willis et al., 2022). Deliberative approaches are also reflected in the United Nations 2030 Agenda for Sustainable Development Goals, with Goal 16 mentioning "responsive, inclusive, participatory and representative decision-making at all levels", and the United Nations Security Council, calling for "people action" as part of the "decade of action" from 2020 to 2030. In 2021, the Parliamentary Assembly of the Council of Europe urged governments "to combine a clear political engagement and top-down leadership with bottom-up, participatory governance, to tackle the urgency of the climate crisis and ensure meaningful contributions from citizens" (PACE, 2021). An important element of deliberative approaches is that despite the fact that while they focus on facts, and require consideration of evidence and the vital input of scientific and technical information into the decision-making process, they also recognise that political decisions cannot be reduced to technical considerations. Deliberative approaches acknowledge the existence of a variety of sources and forms of evidence as well as the value of knowledge from differently situated actors, particularly those most vulnerable to the impacts of climate change (Hammond, 2020), and they make explicit the consideration of moral and ethical positions in decision-making.

Deliberative processes therefore work well for: (1) values-driven dilemmas; (2) complex problems that require trade-offs; and (3) long-term issues that go beyond the short-term incentives of electoral

cycles (PACE, 2021). This is the case for WEFE management in the context of climate change, where different response options may lead not only to different cascading effects, but also to different impacts on different social groups. This is particularly true for marginalised groups such as women or different ethnic groups. Hindmarsh (2008) assessed the relevance of deliberative approaches for water, energy and ecosystems management to avoid unintended consequences of policies and deliver options which are more inclusive with fewer trade-offs. He states, "people desire to be involved in debates about the life politics areas to be reassured that the ethical, social, health and environmental implications are carefully considered by, and incorporated into, decision-making." (Hindmarsh, 2008, p. 190). Smith (2003) proposed that the enhancement and institutionalisation of democratic deliberation will improve reflection on the wide range of environmental values that citizens hold.

One emerging type of deliberative democracy is citizens' assemblies (CA). They take place on all political levels, from local to international (PACE, 2021). They have four broad characteristics: (1) members are selected through random sampling and this is often weighted along socio-economic criteria, to enable the inclusion of a broad range of perspectives and experiences and to ensure that no social group is excluded, so that they are as representative of the broader population as possible; (2) they involve a learning phase, often receiving scientific input or supported by experts in the related field, allowing participants to consider evidence to develop their understanding of the issue in question; (3) deliberation, typically led by trained facilitators; and (4) the production of conclusions or recommendations. CAs usually meet over several months or years (PACE, 2021; Willis et al., 2022). For governments, citizens' assemblies can help address politically contentious issues. They can increase the legitimacy of political decisions and actions; indicate the willingness of citizens to accept potentially controversial policy interventions, and provide useful information on people's preferences and what compromises they are ready to make (PACE, 2021; Willis et al., 2022). For participants, they can represent a unique learning environment and harness a sense of pride in contributing to national decision-making (PACE, 2021). For citizens, the knowledge that policies have been proposed by people like themselves, having gone through an intense process of learning and deliberation, may increase trust and confidence in recommendations (Willis et al., 2022).

Contrary to what might be expected, citizens are widely open to behavioural change, and numbers are particularly high in countries where the effects of climate change are most frequently felt, such as the Mediterranean countries. The European Investment Bank Climate Survey (EIB, 2023), found that 72% of EU citizens are aware that their own behaviour can make a difference in tackling climate change, broken down as follows for Mediterranean European countries: 86% Portugal, 80% Spain and Italy, 78% Malta, 77% Slovenia, 71% Cyprus, 69% Greece, 65% Croatia, 63% France. 66% of EU citizens would be in favour of stricter government measures imposing changes in people's behaviour to tackle climate change, and again the numbers are higher than average in European Mediterranean countries (84% Portugal, 77% Slovenia, 76% Malta and Italy, 75% Croatia, 74% Spain, 72% Cyprus, 67% France, 66% Greece). Behavioural changes affecting the WEFE may include labelling all food in order to limit climate change and environmental impact, to pay extra for locally produced food with a lower impact on the environment or limiting the consumption of meat and dairy (*Figure 5.2*). It is therefore not surprising that national climate assemblies have developed positions which are more ambitious, and offer a more comprehensive response to the climate crisis than national governments (Willis et al., 2022). Lage et al. (2023) analysed the mitigation policies proposed by all the national climate assemblies run up to now globally, including France and Spain, and found that compared to National Energy and Climate Plans (NECP), the CA recommendations included a higher share of sufficiency policies (factor three to six; *Figure 5.3*) with a stronger focus on regulatory policies. Numbers were particularly high in the agriculture and nutrition sector as compared to the NECP. Indeed, despite the growing body of scientific evidence supporting sufficiency as an inevitable strategy for mitigating climate change, together with efficiency or the expansion of renewable energy, sufficiency plays a minor role in existing climate and energy policies. In terms of types of instruments, members of the CAs proposed

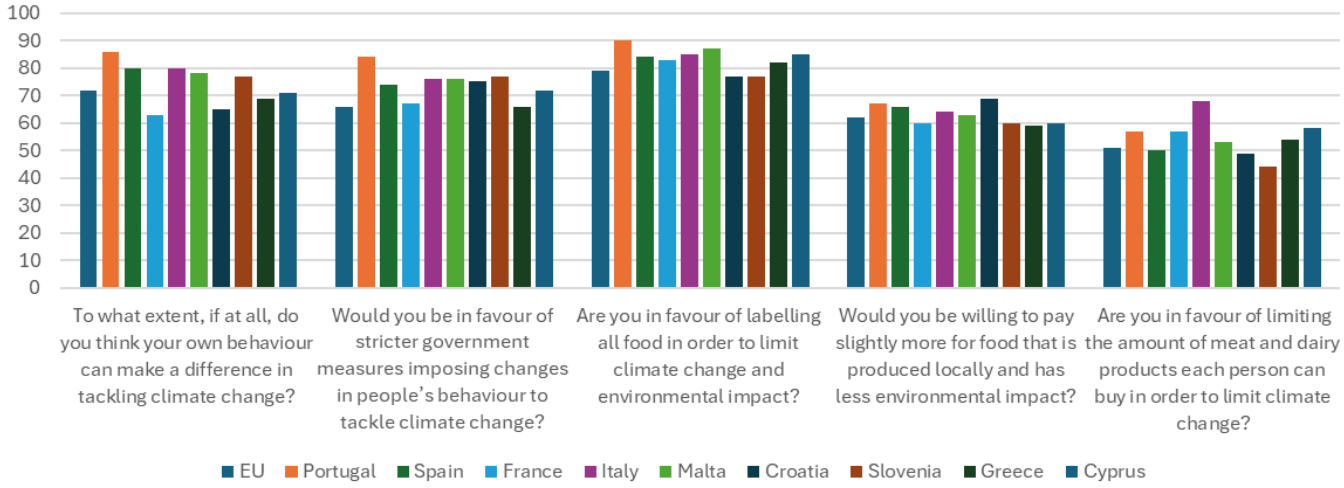

Figure 5.2 | Attitudes towards behavioural change in Northern Mediterranean countries (in %).
Source: own elaboration based on EIB (2023).

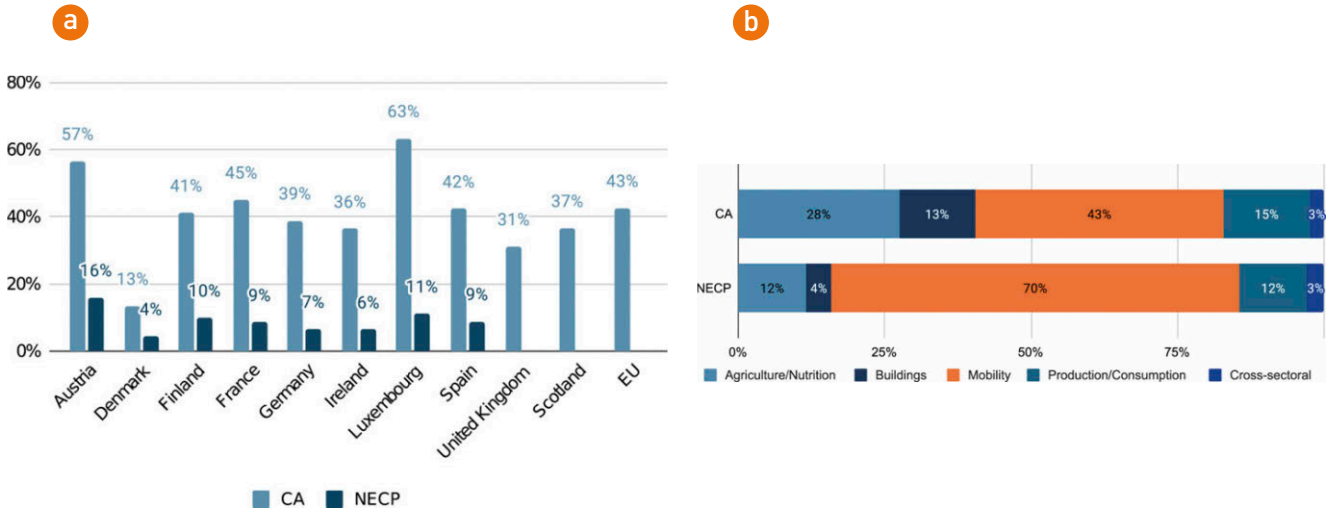

Figure 5.3 | (a) Share of sufficiency policies in total climate-mitigation policies from Citizens Assemblies (CA) and National Energy and Climate Plans (NECP) by country (UK, SC and EU did not submit a NECP). **(b) Sufficiency policies from CAs and NECPs by sector.**
Source: Lage et al. (2023).

regulatory policies more often than any other instrument type (34 %) and in a significant way for all sectors, as opposed to NECPs (11 %). In contrast, NECPs tend to rely more on fiscal and economic instruments. The share of "other" instruments, which include a number of policy plans that do not clearly specify instruments, is three times higher in the NECPs. Lage et al. (2023) state that CAs' recommendations can be interpreted as a call for a sufficiency turn and a regulatory turn in climate mitigation politics, suggesting that the observed lack of sufficiency in climate policymaking is not due to a lack of legitimacy, but rather reflects a reluctance to implement sufficiency policies, the constitution of the policymaking process and competing interests.

5.3 Factors enabling the WEFE nexus approach

5.3.1 Supporting research for technological and social innovations

Innovation, in the context of the WEFE nexus, must be considered with a systemic approach, as innovation in one of the WEFE pillars is likely to impact the others. (e.g. Bazilian et al., 2011) (see *Chapter 3*). Given the correlation between water, energy, and food prices (Chen et al., 2010), any regulation in one of these sectors would trigger sustainable innovations in the others. This effect, known as the weak Porter hypothesis, would be intensified by the existence of knowledge spillovers between water-, energy-, food- and ecosystem-related technologies.

Over the last decade, innovations have tended to be less area-specific to address the broader systemic challenges raised by the nexus, with a particular focus made on improving agricultural and energy production resilience to water scarcity (Sarni, 2015). Different types of innovation related to the WEFE nexus have been implemented in the Mediterranean region: they may be broadly categorised into technological innovation and social innovation (see *Chapter 3*). Technological innovations include the development of new or improved technologies for managing and conserving WEFE resources (e.g. (Yuan & Lo, 2022). Social innovations include new approaches to policy, financing, governance, and other social systems that can facilitate the adoption and diffusion of new technologies, organisational forms or practices in the WEFE domains. Examples of social innovations include new business models, community-based approaches to resource management, and policy initiatives that promote sustainability and equity. For instance, co-housing or ecovillages can potentially reduce the environmental impact of households by fostering shared and responsible consumption of water, energy and food and integrated management of such resources (Daly, 2017; Pérez-Sánchez et al., 2022). Other types of social innovation include organisational innovations, such as new partnerships or collaborations between different stakeholders, and cultural innovations, such as new values or behaviours that support the sustainable use of WEFE resources. For instance, the urban roofs developed in densely populated Mediterranean cities provide food, energy, water, and environmental services and thus address the complexity of the nexus (Toboso-Chavero et al., 2019, 2021).

Several organisations have innovated on how they address the nexus issue (Hertel & Liu, 2016). Technological and social innovations along the WEFE nexus should focus on:

- optimising the use and efficiency of WEFE resources;
- ensuring resource security at national and global levels, including access to WEFE to address environmental change and adapt societies to change;
- enabling the achievement of the Sustainable Development Goals (SDGs), by offering support for decision-making with proper monitoring of progress using relevant indicators; and
- consolidating integrated infrastructure for supporting multiple sectors and enhancing the opportunities and benefits of innovative technologies.

The first EU-Med Ministerial Conference on Higher Education and Scientific Research held in Cairo in 2007 endorsed the implementation of coordination activities for the EU-Med region, under the Seventh Framework Programme for Research. This is how the first two ERANET5 programmes, ARIMNET (in 2009) and ERANETMED (in 2012), were implemented, launching seven transnational calls for proposals in the fields of agriculture, water, food and energy (Zebakh et al., 2022). The two programmes funded 96 transnational projects. Results show that 73 projects (76 %) directly address interaction between at least two WEFE sectors. These projects offer sustainable technological approaches and solutions to impact the European and Mediterranean ecosystems. ARIMNET projects are mostly related to the food-ecosystem nexus (*Figure 5.4)*. ERANETMED programmes focus more on WEFE interactions, in particular on water-ecosystem interactions (38.5%) and energy-ecosystem interactions (15.4%). This differentiates it from the ARIMNET programme. The PRIMA programme is launching annual calls for innovative research proposals covering four thematic areas, one of which is dedicated to the WEFE nexus. PRIMA aims to build sustainable connections by mainstreaming the WEFE nexus approach into PRIMA's future calls. By mainstreaming the WEFE nexus approach into all PRIMA's topics and thematic areas, PRIMA aims to promote the development of innovative solutions that address the complex

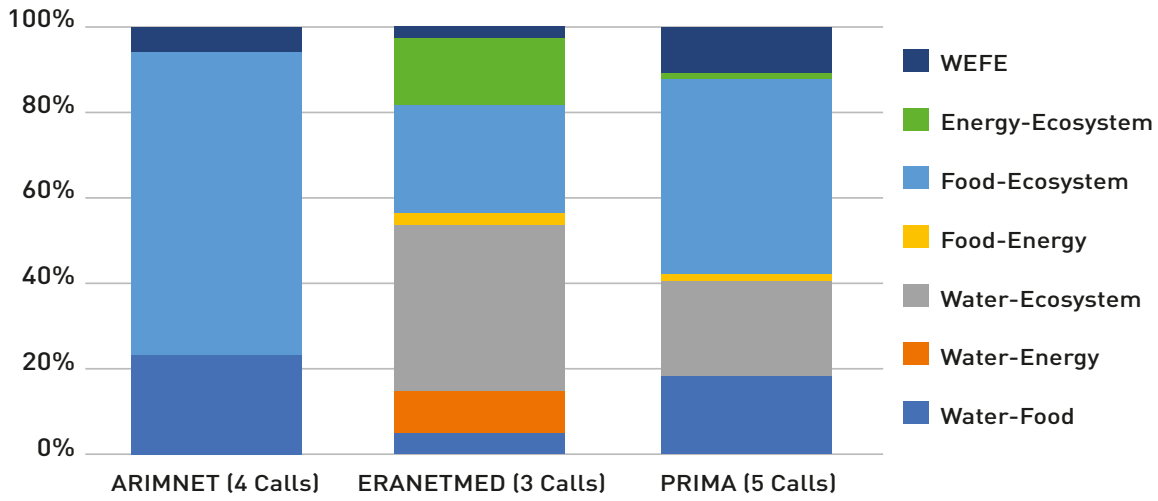

Figure 5.4 | Water-Energy-Food-Ecosystem nexus in EU-MED research programmes.
Sources: ARIMNET, ERANETMED, PRIMA.

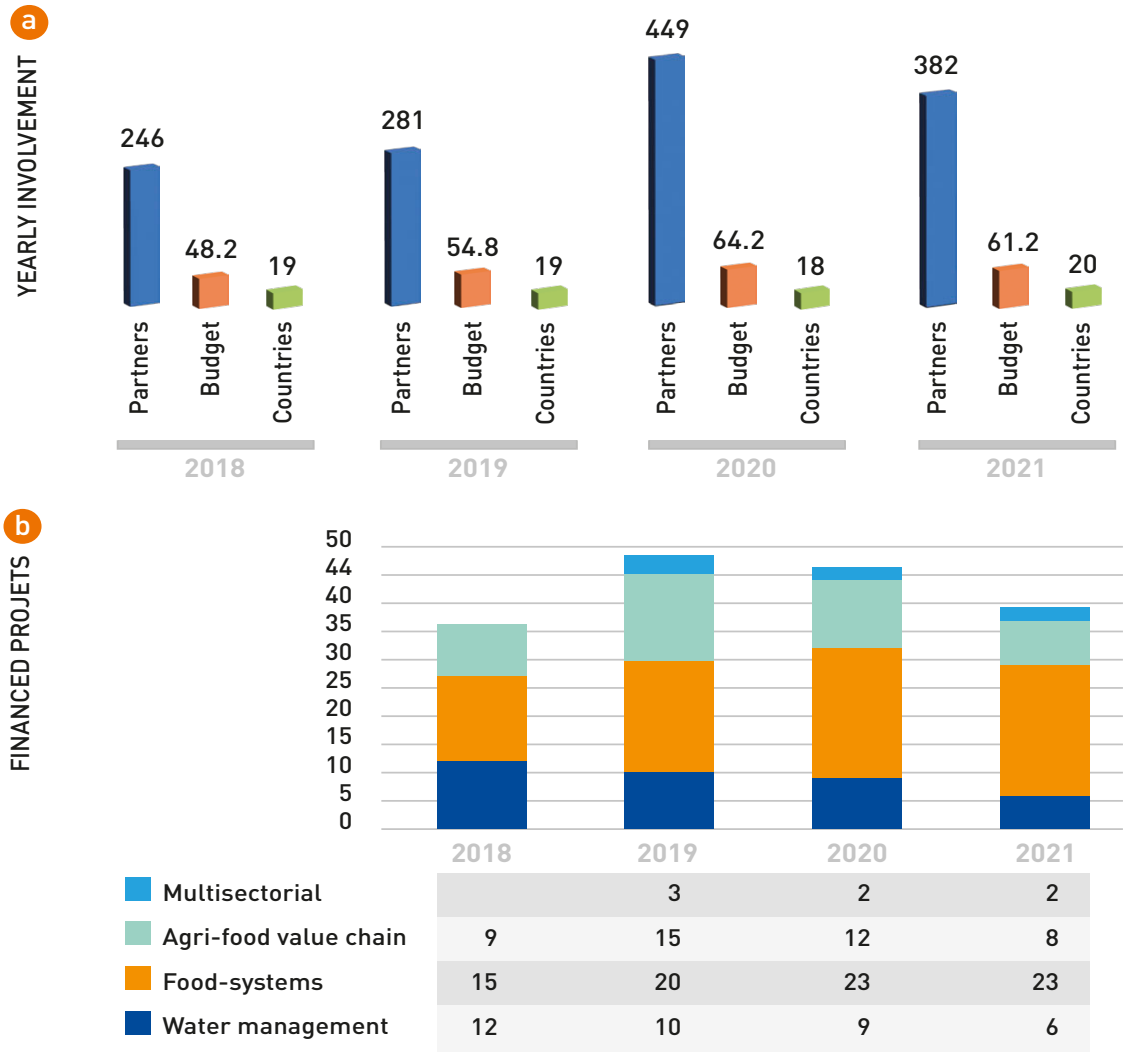

Figure 5.5 | PRIMA Foundation "Partnership for Research and Innovation in the Mediterranean Area" in numbers.
Source: PRIMA (2018, 2019, 2020, 2021).

interconnections between water, energy, food, and ecosystems. PRIMA has built numerous partnerships with different actors. In 2018 alone, they supported 36 projects in the fields of water management and food systems including the entire agrifood value chain. Implementation of these projects received a total budget of €48.2 million and involved 246 partners which included multiple countries' governmental institutions (such as Ministries for Education), research centres, universities and private partners (e.g. consultancy firms, cooperatives, agrifarm industries). Those numbers increased in 2019 and have only slightly been impacted by the Covid era (2020–2021) highlighting the relevance of the WEFE nexus topic (PRIMA, 2018, 2019, 2020, 2021; *Figure 5.5*).

A concrete shift towards sustainability would entail nexus collaborative models or processes becoming part and parcel of development planning at local, regional and national levels. To do so, high-level political will, supported by a sound governance system and informed by science and data are key to ensure that the WEFE nexus is integrated and mainstreamed in planning, monitoring and evaluation systems at all levels.

5.3.2 Capacity-building and awareness-raising

WEFE nexus discussion and applications are mainly focused on global or national scales and on macro-level drivers. This approach neglects the fact that major challenges related to the WEFE nexus are faced at the local level. The responsibility to operationalise the WEFE nexus, at the micro level, falls on institutions, communities, small businesses, and households (*Box 5.1*). This is the first barrier to the implementation of the WEFE nexus. The engagement of all the key actors of the Mediterranean region is an essential element for the WEFE nexus approach, given its demand for strong cooperation and mutual trust (Markantonis et al., 2019). A second limitation of many, is the existence of structural and process asymmetries that lead to a lack of coordination between the main stakeholders and other external influences (Alamanos et al., 2022). These are major obstacles to building the long-term confidence and trust of citizens (Nardi & the NEXUS-NESS Consortium, 2022), but they are not the only ones. Missing information exchange and lack of collaboration across WEFE nexus resource boundaries are also issues (Jones & White, 2022), leading to the persistence of strong sectoral silos (Hoff et al., 2019). Undeniably, multi-sector, multi-disciplinary, and multi-actor approaches are currently not systemically incorporated into decision-making (Nardi & the NEXUS-NESS Consortium, 2022). The picture is even more problematic when national boundaries are, and need, to be overcome. For example, due to the specific conditions of the region and sub-regions, it is difficult to establish a dialogue network appropriately involving local stakeholders (Markantonis et al., 2019). The combination of a limited vision, lack of knowledge, and practical multi-sided experience hampers the successful implementation of the nexus approach within the awareness sphere (Hoff et al., 2019) and, this should be taken note of for the Mediterranean area.

To overcome these problems, there are some enabling factors that can be fostered (Yuan & Lo, 2022). Clearly, a first area of improvement should be stakeholder involvement (Lamonaca et al., 2022). Rather than one-way communication of research results, a multilateral exchange approach could be taken (Wade et al., 2020). Decision-making demands the inclusion of diverse stakeholder interests (Bielicki et al., 2019) so that their participation can lead to more innovative, decision-relevant and publicly-accepted solutions (Wade et al., 2020). This involvement can be achieved both horizontally and vertically (Hoff et al., 2019): citizens and stakeholders from a broad range of sectors and interest groups, including economy and finance, as well as from different levels of governance – like mayors, farmers, irrigation agencies, energy utilities, national government representatives – should be included (Flammini et al., 2014). Importantly, the private sector must be involved along with the public sector (Carmona-Moreno et al., 2021; Markantonis et al., 2019). The private sector plays a crucial role in fostering technological advancement through the implementation of novel approaches and best practices, thus facilitating the democratisation of data generation and the development of cost-effective solutions (FAO, 2022). Since interlinkages across sectors for an integrated approach in decision-making is not yet adequately reflected in policies, governments and policymakers need to address this as a priority political focus. FAO (2022, p. 4) underlines a good example in the MENA region

which comes from the setting up "in 2019 by the League of Arab States of the High-Level Joint Water-Agriculture Technical Committee, with support from FAO and the United Nations Economic and Social Commission for Western Asia (ESCWA), and making the WEF Nexus one if its priority areas". For this to be feasible, key stakeholders need to be aware of and acknowledge the WEFE nexus and its challenges, in order to successfully tackle them.

As anticipated, communication must be enhanced in order to transfer information. A nexus-oriented platform for dialogue can be designed with versions for each specific context – local, regional, national – and for a transboundary, basin-level too (Flammini et al., 2014). As jargon is a barrier to broader collaboration, the terminology, paradigms, and theoretical frameworks need to be understood by all involved actors, with a view to the development of a shared language (Wade et al., 2020). An important asset to engage WEFE stakeholders, who all have different competing targets, is to implement a new framework that supports data transparency, which is key to generating trust (Piera et al., 2014). Strategically, the exchange of commonly understandable information is the basis not only for capacity-building activities, but also for setting agreements for sharing data and information systems (Markantonis et al., 2019) and for lowering the barriers to understanding nexus complexity (Howarth & Monasterolo, 2016).

This final aim can be a powerful tool as the integration of data, techniques, and methodologies from two or more disciplines helps to solve problems whose solutions are beyond the scope of a single area and need to be operationalised (Dalla Fontana et al., 2021). In fact, this is what the nexus is: a wicked problem (i.e. "a problem resisting definitive formulation and clear-cut solutions and whose complexity demands new modes of inquiry") (Wade et al., 2020, p. 1, citing Rittel & Webber, 1973). It follows from the nature of the nexus, and its requirement for deep integration across fields and transcendence of boundaries, that interdisciplinary teams and transdisciplinary methods should be brought into play (Balaican et al., 2023). A broader participation and enhanced incorporation of knowledge from various sources, such as academic research, on-the-ground practitioner experience, and civil society knowledge have to be integrated (Albrecht et al., 2018), since people's everyday experiences are often overlooked.

The younger generations will be most affected by changes in the resources covered by the nexus (Trajber et al., 2019). Future generations (as well as current ones) will need to employ systems thinking and learn to thrive in interdisciplinary teams with effective communication. These skills will prepare them to build innovative, actionable solutions and to successfully lead across a variety of dynamic challenges (Wade et al., 2020).

The above-mentioned problem of mutual trust between experts and the citizens can be explained by the objections to the knowledge-deficit model (i.e. the assumption that, if they knew more, non-scientists would integrate scientific information into their decision-making processes), largely refuted on the basis that people's perceptions and use of science are influenced by their beliefs and ideologies (Eveland & Cooper, 2013; Fiske & Dupree, 2014; Simis et al., 2016). To cope with this limitation, two strategies can be adopted, including at basin level. The first understands that the public, as traditionally interpreted, would be better reached by informative communications. Messages should be targeted to specific audiences and appropriate communication frames should be selected to resonate with the belief systems of the intended listeners (Wade et al., 2020). If science is communicated properly, by accounting for required adaptations, the public's appreciation and understanding can increase, achieving public support and commitment (Hannibal & Portney, 2019).

The second strategy is to assign an active role to the public, and not only a passive one. Participatory approaches are very useful tools for improving decision-making processes in complex systems. Since the object of study is a wicked problem, they make it possible to co-produce and co-test avenues by assisting and enabling stakeholders to examine the implications of possible future changes and to navigate emergent difficulties and opportunities so as to address environmental challenges effectively (Larkin et al., 2020). These exercises can include different types of activities such as community of practice, role-play games, demonstration sites and living labs carried out or integrated through workshop events, meetings and also lessons that contribute to this task (*Box 5.2*). Citizens' assemblies can play a relevant role here. The general advantages

Box 5.1

The WEFE nexus at the household level

Recent studies have started to explore the dynamics and sustainability of the WEFE nexus at the household level by developing novel approaches such as the "Nexus at home" (Foden et al., 2019). However, empirical evidence grounded in the different Mediterranean regions required to extract tailored useful lessons and political implications about the household WEFE nexus is still incipient and fragmented (11.4% of nexus research by researchers affiliated with Mediterranean countries, particularly from the Northern Mediterranean - Itayi et al., 2021).

Available empirical evidence about the water and energy nexus at household level has highlighted the shared and accumulated difficulties of accessing and affording both resources – commonly known as basic services – by vulnerable families (Fankhauser & Tepic, 2007; Yoon et al., 2019). Water and food insecurity have also been studied in conjunction, particularly in low- and middle-income countries such as Lebanon, showing that household water insecurity is a fundamental driver of household food insecurity (Brewis et al., 2020; Stoler et al., 2020).

Unravelling the interlinkages and interdependencies between energy poverty, water poverty and food insecurity is therefore key to downscaling nexus approaches at local, community and household levels (Santeramo, 2021). The Mediterranean regions face crucial challenges regarding energy poverty, with implications for water and food access. While the dynamics and drivers of energy poverty have been increasingly and more systematically assessed for European Mediterranean countries (Bouzarovski & Tirado Herrero, 2017), recent research is covering other areas of the Mediterranean traditionally overlooked (El-Katiri, 2014) such as Türkiye (Dogan et al., 2021), Cyprus (Kyprianou et al., 2022), and Egypt and Morocco (Rao et al., 2022). This new situated knowledge will be key to identifying contextual factors and barriers to ensuring household's rights to energy, water and food across different geographies. Nevertheless, whenever focusing policies on local and indigenous communities, it is essential that affected stakeholders participate in all the decision-making processes that may impact their lands, resources, cultures, and livelihoods. Local communities have the right to prior and informed consent through engagement, transparency, and knowledge-sharing (FAO, 2015). The consent given to a project can be given and withheld before any decision is made, on the basis of detailed information provided in a format the stakeholders can understand (from a cultural perspective, i.e. language, and technicalities of the project).

Beyond the local context, other global and multiscale drivers and processes condition the food-energy-water interlinkages at home. On the one hand, climate change will intensify these multiple interlinked vulnerabilities shaping water, energy, and food domestic security (Živčič & Tirado Herrero, 2021). On the other hand, the recent energy crisis or the volatility of food and energy prices may aggravate situations of WEF vulnerability, but also offer opportunities for transforming policies towards alleviating vulnerability and improving security (Osička & Černoch, 2022; Santeramo & Lamonaca, 2021; Siksnelyte-Butkiene, 2022).

of these approaches can also be beneficial for Mediterranean communities. They are twofold: on the one hand, there is a contribution to understanding the nexus, enabled by the emergent co-production of knowledge, action and critique. By participating in the research process and testing and implementation phases, stakeholders may help guiding or redirecting research questions and study design so as to address real issues more directly (Albrecht et al., 2018). It is very important that the future nexus framework considers a human-centric approach in which citizens could transform their opinions into relevant knowledge through the use of friendly simulators and serious games (Piera et al., 2015). On the other hand, these participatory settings raise the awareness of involved actors. Stakeholder engagement hastens social learning – which leads to greater consensus and higher likelihood of solutions achievable through joint action (Collins & Ison, 2009), and also legitimacy of the actions. Furthermore, broader processes of engaging and discussing with key stakeholders and experts – including a nexus community of practice (NCoP) to promote this integrative approach (Mohtar & Lawford, 2016) – enables longer-lasting impacts (Flammini et al., 2014).

Finally, for the implementation of this kind of approach to stakeholder-related enabling factors, planning is needed. The requirement for a comprehensive stakeholder awareness roadmap and action plan should be supported and shared by all involved parties with the goal of developing the nexus approach at a local, but never disconnected, level (Markantonis et al., 2019).

Box 5.2

Examples of participatory approaches: living labs (LLs) and serious games (SGs)

Living labs (LLs) are *"open innovation ecosystems in real-life environments using iterative feedback processes throughout a lifecycle approach of an innovation to create sustainable impact. They focus on co-creation, rapid prototyping and testing and scaling-up innovations and businesses, providing (different types of) joint-value to the involved stakeholders. LLs operate as intermediaries/orchestrators among citizens, research organisations, companies and government agencies/levels"* (European Network of Living Labs (ENoLL)[14]– Living labs are an effective solution for providing a transdisciplinary, experimental process that can bridge the technical and social divide, helping to identify relevant solution pathways (Wahl et al., 2021). A good practice is the SUSTAIN adapt project[15], whose methodological framework aims to facilitate the engagement of key stakeholders (e.g. decision-makers, NGOs, civil society, private sector) and evaluate policy coherence through four LLs, one for each of the following sectors: agriculture, forestry, water resources, and urban settlement.

Serious games (SGs) are interactive games in which players perform activities that enable them to develop skills and achieve aspects beyond simply being entertained by the tasks (Djaouti et al., 2011). The Horizon2020 project, SIM4NEXUS, provides various examples (2016–2020): serious games investigating potential cross-nexus synergies for 12 multi-scale case studies where stakeholders and partners are involved from case study conceptualisation, quantitative model development and implementation and validation of each serious game (e.g. Balaican et al., 2023; Melloni et al., 2020; Sušnik et al., 2018; Zhang et al., 2021).

5.3.3 Innovative funding mechanisms

Given the intrinsic complexities of the WEFE nexus, and the increased challenges posed by climate change, urgent action is now required. All key actors at all levels must take part, and no stone should be left unturned. Sound governance and strong political will are the essential enabling factors for the assimilation of new objectives into the socioeconomic and financing context. On this last point, the OECD suggests integrating the SDGs into national plans, by considering the synergies between *"investment financing needs for water, agriculture and energy infrastructure"* (OECD, 2014, p. 11) and therefore the need to act accordingly when supporting projects. The expectation is that governments should act in support of "nexus-friendly" multi-purpose infrastructures, projects or policies by avoiding the creation of market distortions which, in turn, may work against the purpose (OECD, 2014).

Public policies are believed to be a first essential enabling factor for mobilising private financing (FAO, 2022; Wu, 2015). For this reason, the GISD Alliance (2020) has developed a definition of Sustainable Development Investing, to harmonise national approaches and therefore enable clearer communication between investors. On the basis of the Sustainable Development Investing principles, in order to foster technological innovation and the adoption of best practices, policymakers must involve the private sector and support stakeholders' projects through innovative strategies and tools such as de-risking, partnerships or by checking the quantity and quality of investments. In fact, financing mechanisms need to be defined to upscale proven solutions (FAO, 2022). The best-known economic instruments available to governments to incentivise or disincentivise certain behaviour are surely subsidies and taxes. Historically, these are widely applied when addressing the WEFE nexus with the aim of increasing desirable actions (such as research and development) or reducing the consumption of certain goods (e.g. water or energy). Nevertheless, such solutions are likely to hit only one nexus component, entailing only marginal benefits for the others. Public institutions are therefore now encouraged to put in place or facilitate innovative

14 European Network of Living Labs. Available at: www.enoll.org

15 https://www.cmcc.it/it/sustainadapt par www.cmcc.it/it/sustainadapt

financing mechanisms to promote appropriate business models and capacity-building in the private sector, or implement direct technical interventions (FAO, 2014):

- Blended finance: strategic use of development finance through the use of public resources to attract the private sector and mobilise additional finance towards sustainable development in developing countries. Its use aims to mitigate political and commercial risks by various instruments (OECD, 2018b). Given their focus on risk mitigation to attract a higher number of investors on more desirable projects (Carmona-Moreno et al., 2021), these practices are generally called de-risking and include, among others, co-investment, co-financing (where public actors provide equity or debt alongside private players), cornerstone stakes (public actors commit in advance to certain desirable investments as a demonstrative action) and loan guarantees (OECD, 2021). These instruments are expected to have a capital return at the end of the investing period. Clearly, to properly address the WEFE nexus, these approaches should not only involve multiple actors, but also multiple sectors. The UN encourages governments to engage and promote de-risking, in order to involve private investors in sustainable development projects (UN, 2021). Similarly, a combination of subsidies, tax incentives, leases of public land and blended capital solutions is a potential enabling strategy to develop large-scale agribusiness projects, compliant with WEFE nexus requirements, in the Mediterranean area (Markantonis et al., 2019).

- Green bonds and green bonds for climate resilience: Green bonds are issued by companies or governments to mobilise capital through the debt market in favour of low carbon and climate resilient investments (OECD, 2017). Similarly, green bonds for climate resilience issue capital for projects, which, at least partially, can support climate adaptation and increase the capacity to cope with physical climate risks (GCA, 2021). These could therefore be issued to fund adaptation projects addressing the WEFE nexus (e.g. multi sectoral water infrastructure) (GCA, 2021).

- Public-Private Partnerships (P3s): contracted partnerships between private and public entities to deliver a certain public service. Cooperation between the contracting parties is desirable whenever there is an imbalance between the involved actors in terms of knowledge, capacity or capital, but especially when there is a need to leverage resources to increase the commercial potential of solutions. To reach this final goal, P3s may also embrace blended finance tools (Carmona-Moreno et al., 2021).

Any of these innovative financing strategies should respect the principles of equality and sustainability: that is no one should be left behind, gaps should be filled, and actions should foster SDG achievement (OECD, 2020). In this context, P3s are particularly valuable solutions as they allow for extreme flexibility. They can be proposed and built both with a bottom-up or top-down approach (and can therefore respond to the needs of any actor of society), with any timespan and at any spatial scale. Moreover, they allow not only for cross-sectoral focus but also for multiple stakeholder involvement and exchange. For this reason, multiple studies on the implementation of WEFE projects indicate P3s as one of the most preferable solutions (FAO, 2022; Markantonis et al., 2019; Mayor Rodríguez, 2016). In fact, such inclusive solutions may be particularly effective in heterogeneous and fragmented areas, such as the Mediterranean, where the involvement of local actors is necessary to target specific needs.

Multiple strategies applied for the implementation of WEFE nexus projects at the Mediterranean Basin level show that project features, actors involved, and capacities need to be adapted to local vulnerabilities, in line with site specificities. Large foundations and consortiums in the area are particularly active as they can operate between multiple countries, involve different actors and, therefore, build synergies faster and more efficiently. Examples are PRIMA, the Partnership for Research and Innovation in the Mediterranean Area, which involves both EU and non-EU countries, the MENA Regional Innovation Hub (MENA RIH), operating exclusively in the MENA region, and the Interreg MED (now Interreg Euro-MED) and ENI CBC MED (now Interreg NEXT MED) programmes supporting the development of several territorial cooperation projects tackling some WEFE nexus components. The MENA RIH is an accelerator, empowering private businesses engaged in the WEFE nexus: projects must focus on increasing

food production while reducing water and energy usage. In collaboration with investors and allies, the MENA RIH endeavours to grow mid-to-later stage businesses that have a positive effect on the environment and society within the water-energy-food nexus by offering investors different innovative financing solutions. Additionally, Mediterranean developing countries can access specific climate finance funding to address the nexus in the context of climate change, such as the Green Climate Fund, a fund established to support climate change adaptation and mitigation for developing countries with a view to the implementation of countries' Nationally Determined Contributions (UN, 2021). This is reserved for developing countries, and could be used by most Mediterranean states except for the EU-27, including Albania, Algeria, Egypt, Jordan, Lebanon, Libya, Montenegro, Morocco, North Macedonia, Syria, Tunisia and Türkiye.

So far, projects focusing on the WEFE nexus at Mediterranean level tend to effectively target the SDGs connected to the WEFE nexus and to provide significant benefits for society. Nevertheless, most tend to prioritise a single specific sector and therefore fail to create synergy effects (Malagó et al., 2021).

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