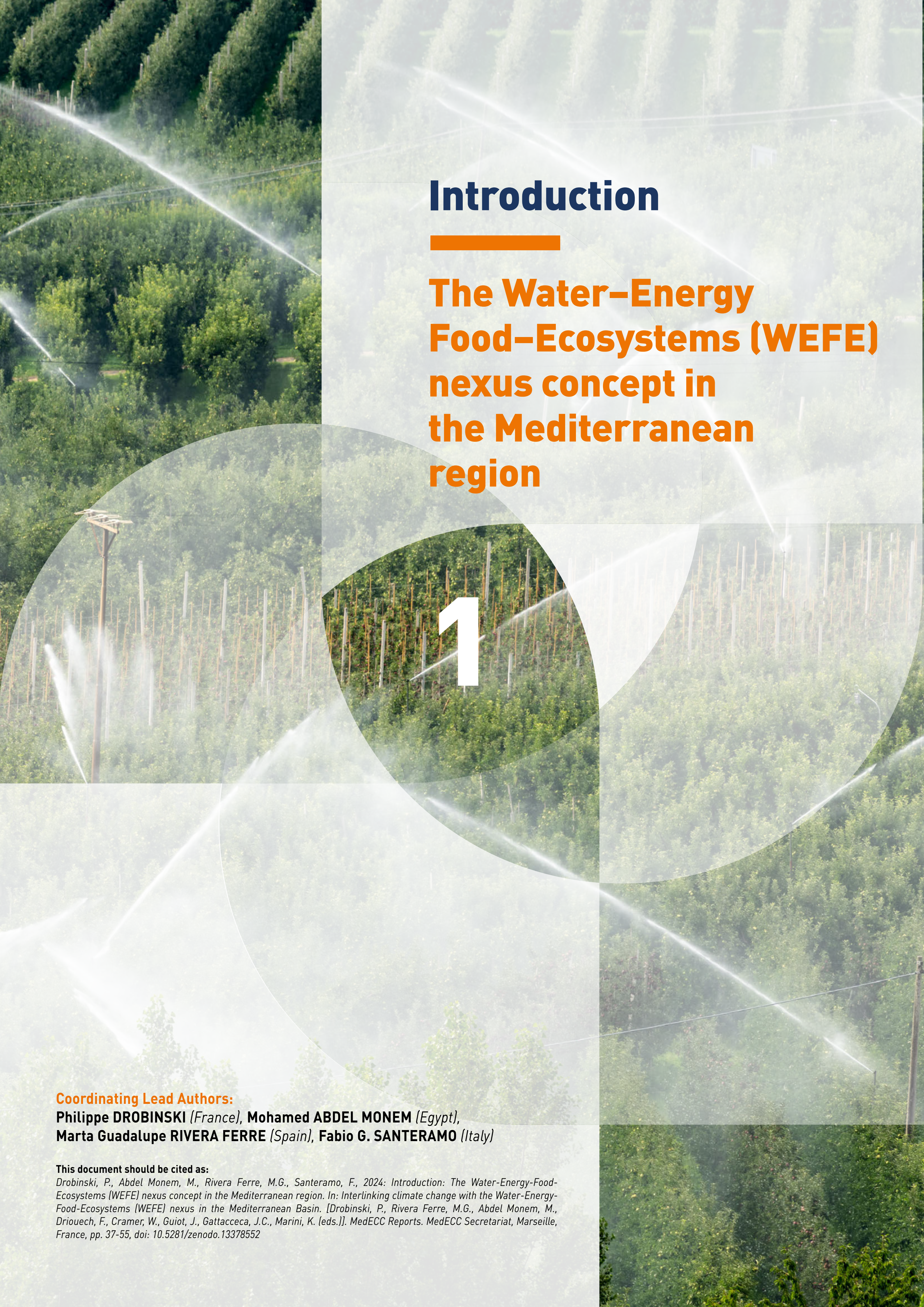

Introduction

The Water–Energy Food–Ecosystems (WEFE) nexus concept in the Mediterranean region

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Chapter 1

Introduction: The Water-Energy-Food-Ecosystems (WEFE) nexus concept in the Mediterranean region

Executive Summary

In the intricate web of interconnected social, economic, and ecological systems, the relationships between water, food, energy, and ecosystems stand as undeniable pillars. These essential resources are under strong pressure from both direct and indirect drivers, including climate change, pollution, population growth, unsustainable consumption and production patterns, rapid urbanisation and unsustainable natural resource management, negatively impacting the livelihoods of millions throughout the Mediterranean and hindering progress towards the Sustainable Development Goals (SDGs). The effects of these pressures on resources are far-reaching, with adverse effects on communities and economies only partially mitigated by external resource imports.

The Mediterranean Basin is recognised as a "hotspot" for both climate change and water scarcity. Over the past fifty years, per capita water resources have significantly diminished, especially in the eastern and southern Mediterranean regions. This scarcity is compounded by existing conflicts, economic vulnerabilities, and social disparities.

The Water-Energy-Food-Ecosystem (WEFE) nexus approach aims to increase security in these vital domains, without compromising ecosystem health. Through the analysis of connections and interactions between these components, the WEFE approach seeks to optimise synergies and manage trade-offs between different technical and strategic responses. The nexus concept is applicable across various scales, ranging from local to global-regional contexts, allowing for comprehensive management strategies. At regional scales, water, energy and food security include imports and exports.

There is a growing need for transformation, and a paradigm shift in consumption and production patterns alongside changes in governance. Adopting the WEFE nexus approach involves moving away from fragmented sectoral development interventions towards integrated natural resource management and use. It presents opportunities to transform agrifood towards sustainability and contributes to fostering peace, as well as resilience and security for both humanity and ecosystems. Integrating the WEFE nexus into national policies and development plans emerges as a way to support SDG implementation, aligning with the interconnected nature of these global objectives. With its components present in 14 out of the 17 SDGs, the WEFE nexus emerges as highly relevant in the pursuit of these goals. In summary, there is a need to adopt a comprehensive and integrated approach to address the multifaceted challenges posed by resource pressures, climate change, and sustainable development in the Mediterranean region.

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1.1 The nexus concept: from sectoral to systemic thinking

Water, energy, ecosystems and particularly food are essential resources required to meet human needs, and are inextricably linked through complex interactions (Salam et al., 2017; Zhang & Vesselinov, 2017). For instance, water and energy are essential inputs for food production. Similarly, water can be used for cooling and/or hydropower generation, while agriculture can produce biofuel crops and contribute to ecosystem degradation. Also, energy is needed to pump, treat and transport water. The interdependent relationships between these components have been highlighted as a web of complex relations and named the Water–Energy–Food (WEF) nexus (Dupar & Oates, 2012; Hoff, 2011; White et al., 2018). The term has strong implications for ecosystems, thereby extending the nexus concept to WEFE. *Figure 1.1* shows the WEFE nexus framework and describes its complexity. It illustrates the interdependencies with the lines surrounding the four nexus components. Each line represents a specific component, and when two lines cross, it identifies the interactions between the two associated components. More than two crossings, up to four, can occur, showing that the interactions do not necessarily go two–by–two but can also involve all nexus components.

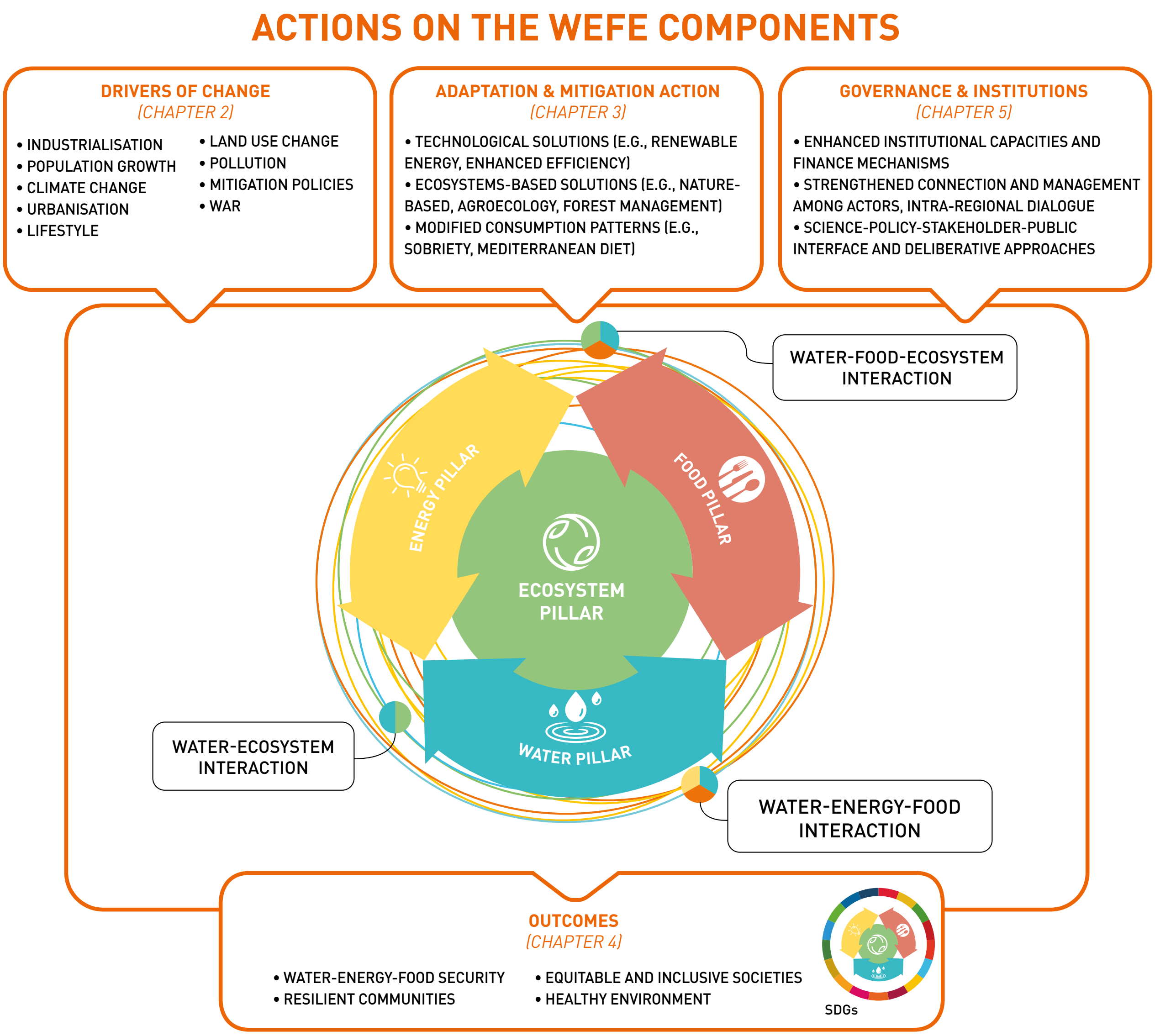

Figure 1.1 | Schematic of the WEFE concept.
WEFE components in the circle, with some examples of two-way interactions between them. Ecosystems are at the centre to highlight that all the other components depend on healthy ecosystems. Outer boxes refer to direct and indirect drivers of change impacting the WEFE governance and institutions action and outcomes achieved by implementing a nexus approach.

Figure 1.1 identifies the drivers of change that impact the nexus components, as well as the implemented actions in the Mediterranean Basin in terms of adaptation and mitigation. Adapted governance and specific institutional actions are essential to support the implementation of a WEFE nexus approach in the Mediterranean. The expected outcome of the nexus approach to address the sustainable development challenge in the Mediterranean Basin.

The formalised concept of cross-sectoral interlinkages, referred to as a "nexus", emerged in the 1980s, and gained prominence through the United Nations University's (UNU's) Food-Energy Nexus Programme, the World Summit on Sustainable Development, and the Bonn 2011 Nexus Conference, promoting systems integration, stakeholder engagement, and development pathway exploration (Estoque, 2023).

Like the nexus, the Sustainable Development Goals (SDGs) are defined as closely interlinked, but they are also key to the WEFE nexus approach. Over time, the nexus approach has been through various phases of development, resulting in more complex and diverse nexuses, whose components can be resource sectors/systems and/or specific socio-ecological issues (Estoque, 2023), and go as far as potentially covering all SDGs. However, the SDGs are today far from the target levels, as synergies and trade-offs were not considered in setting up the SDGs (UN, 2023a). SDG 6 (clean water and sanitation), SDG 7 (affordable and clean energy) and SDG 2 (zero hunger), but also SDG 13 (climate action), SDG 14 (life below water) and SDG 15 (life on land) in particular, are not only connected to each other but are also key to the WEFE nexus approach. Water plays a critical role in maintaining healthy ecosystems, reducing global disease, empowering women, enhancing the welfare and productivity of populations, adapting to climate change, and fostering peace, acting as a vital connection between the climate system, human society and the environment. Therefore, reaching SDG 6, of particular importance in the Mediterranean Basin, is essential to achieving all other SDGs (UN, 2023b). There is still no consensus with regards to the key nexus components that could potentially cover all the SDGs.

The main aim of the WEFE nexus is to analyse and communicate implications that consider the processes of producing, distributing, and consuming WEFE resources into a decision-making process and to manage them more effectively and efficiently (Abulibdeh & Zaidan, 2020). It means avoiding fragmentation in decision-making, recognising trade-offs and synergies across sectors, promoting improved governance across sectors, temporal scales and regions, and adopting integrated nexus thinking among policymakers. Sectoral policies need to be designed in a coordinated and integrated manner (Laspidou et al., 2020), including different geographical scales (Abulibdeh & Zaidan, 2020). An integrated nexus approach may ensure complementarities and synergies across sectors and help managing trade-offs and synergies in food, agriculture, water, energy, and ecosystems (Bizikova et al., 2013; Pittock et al., 2013) and reduces the risks of sectoral SDG (Nath & Behera, 2011). Some key benefits arising from using the WEFE nexus are for instance (1) exploiting co-benefits to improve overall performance by increasing resource use efficiency, changing waste into resources and fostering alternative practices to fulfil multi-sectoral needs; (2) streamlining development and improving resilience through benefits from healthy ecosystems, poverty alleviation and climate change mitigation and adaptation and (3) stimulating policy coherence and investments through collaboration between sectors and associated institutions (Adamovic et al., 2019). At regional scale, water, energy and food security also depends on how much is imported or exported (e.g. Allan, 2003; Jain et al., 2023) and a nexus approach makes it possible to understand the telecoupling effects of such dependency.

1.2 The sectoral analysis of water, energy, food resources and ecosystems from the MedECC First Mediterranean Assessment Report (MAR1) and IPCC Sixth Assessment Report (AR6)

An extensive review of the drivers of climate and environmental change and their impacts on water, energy, food and ecosystems was conducted in the MedECC First Mediterranean Assessment Report (MAR1) published in 2020 (MedECC, 2020a) supplemented recently by a dedicated chapter in the IPCC sixth Assessment Report (AR6) published in 2022 (Ali et al., 2022). Drivers of change including both ecological (direct) drivers like climate change, pollution, land and sea use change and non-indigenous species (*Figure 1.2*) as well as social, cultural, economic, political and technological (indirect) drivers of change, like industrialisation, demography, war, consumption behaviours (e.g. diet, travel, energy consumption), increase pressure on resources. However, MAR1 addressed water, energy, food resources and ecosystems in silos but not the interlinkages between them. All the information provided in this section can be found in the MAR1 (MedECC, 2020) and AR6 (Ali et al., 2022).

The Mediterranean Basin is considered to be a major "hotspot" of climate change with paradoxical behaviour in the water cycle (Ali et al., 2022; Fader et al., 2020). Virtually all continental and marine sub-regions of the Mediterranean Basin are impacted by recent anthropogenic changes in the environment (Lange et al., 2020). Due to anthropogenic emissions of greenhouse gases (GHGs), the rate of climate change in the Mediterranean Basin, including land and sea, is greater than global trends. Indeed, when the globe warmed by 1°C compared to the pre-industrial level, the Mediterranean Basin (land and sea) warmed by 1.5°C, greatly exceeding 2°C in summer. Warming could additionally increase between 0.5°C and 6.5°C by 2100 depending on the climate change mitigation scenario. Only the lower limit is compatible with the 2015 Paris Agreement (Ali et al., 2022; Cherif et al., 2020). At sea, the consequences are the increasing acidification of seawater and the rise in mean sea level, which has already increased by 6 cm over the past 20 years. It could reach between 40 and 100 cm by 2100 depending on the emissions scenario[1]. (Le Cozannet et al., 2019; Thiéblemont et al., 2019), and possibly more than one metre, increasing the risk of coastal flooding (Ali et al., 2022). The sea surface temperature has warmed by about 0.3°C -0.45°C per decade (depending on the sub-basin) and is expected to warm by 1°C to 4°C depending on the scenario. The absorption of CO_2 by the sea results in sea water acidification, adding pressure on ecosystems. On land, the duration and maximum temperatures of heatwaves will intensify, and summer precipitation is likely to drop by 10 to 30% in some regions[2].

Water sector: Temperature increase and water cycle change cause a wide range of impacts on human health (Linares et al., 2020) and result in increased water shortages and desertification (Fader et al., 2020). The per capita availability of renewable water resources declined between 1962 and 2017 by 78% for the Eastern Mediterranean and 68% for the Southern Mediterranean (FAO, 2022). With the reduction in runoff and aquifer recharge together with a higher use pressure, water scarcity[3] is expected, especially in the southern and eastern regions, which already experience low resources. Groundwater resources are not only subject to pressures resulting from unequal distribution, overexploitation, and accessibility, but also quality issues. Agricultural activities, leakage of wastewater from urban areas, or saltwater intrusion are the main sources of groundwater pollution, which can make the resource unusable (Fader et al., 2020). Challenges related to overexploitation of water resources, unsustainable water use and water shortages, are due to a lack of sound water governance and in particular right implementation of Integrated Water Resources Management (IWRM) (Fader et al., 2020; Vafeidis et al., 2020)[4]. Already, 180 million people suffer from water scarcity in the Mediterranean, but the water quality is also deteriorating with increase of water salinity due to groundwater overexploitation. As a result of the general scarcity of water resources, conflicts arise in different water use sectors (agriculture, tourism, industry, domestic use, as well as biodiversity conservation). In southern and

1 Four trajectories of emissions and concentrations of greenhouse gases, ozone and aerosols, as well as land use called RCP ("Representative Concentration Pathways") used for the 5th phase of the Coupled Model Intercomparison Project (CMIP5).

2 Precipitation is projected to decrease by approximately 4% per 1°C global warming with high confidence for global warming levels above 2°C. A marginal increase is projected in winter at the northern boundary of the northern Mediterranean Basin (Ali et al., 2022).

3 Water scarcity and drought are related but distinct concepts, and both can have significant impacts on the Mediterranean region. Water scarcity has been defined by FAO (2012) as a gap between available supply and expressed demand for freshwater in a specified domain, under prevailing institutional arrangements and infrastructural conditions. It is a chronic condition that occurs when the renewable freshwater resources are insufficient to meet the needs of people and ecosystems. It can be caused by various factors, including population growth, inadequate water management, climate change, and inefficient water use practices. On the other hand, drought is a type of extreme climate that is characterised by prolonged dry weather conditions, which disrupts the hydrological balance (EDO, 2023). It is a natural and temporary phenomenon that arises when an area experiences significantly less rainfall than usual for an extended duration, resulting in water shortages. Drought conditions are associated with a lack of precipitation, soil moisture deficit, and low water reservoir storage, which impacts a wide range of sectors. It is important to distinguish drought from aridity, which is a long-term climatic feature, and water scarcity, which is a situation where the available water resources are insufficient to meet water demand.

4 In the context of the Mediterranean Basin, Integrated Water Resources Management (IWRM) may include Integrated Coastal Zone Management (ICZM) and a source-to-sea approach to address water resources management as a comprehensive network linking land, water, delta, estuary, coast, nearshore and ocean ecosystems holistically supported by specific mechanisms and measures such as the sustainable blue economy (Michels-Brito et al., 2023).

eastern countries, agricultural use reaches 76–79%. In the northern countries, the four sectors are much more balanced (18–36%). Water shortage will lead to more and more conflicts among users and sectors, in particular agriculture and tourism, as the needs of these sectors peak in summer, especially in the Middle East and North African (MENA) countries as well as in Spain, where agriculture is the largest consumer of water (Burak & Margat, 2016; Mrabet et al., 2020) accounting for nearly 85% of water uses (FAO, 2022). As a consequence, demand for irrigation is expected to increase by 4–18% by 2100. Meanwhile other needs from demographic change, particularly the growth of large urban centres, could increase this demand by 22–74% (MedECC, 2020b). Conversely, more heavy rains and therefore flooding and significant soil loss due to erosion are projected during other seasons. The vulnerability of the Mediterranean population may thus increase with higher probability of occurrence of events conducive to floods as well as longer and more severe droughts (meteorological, hydrological, agricultural and socio-economic droughts – Fader et al., 2020) caused by evaporative demand, temperature increase and precipitation decrease (Drobinski et al., 2020b).

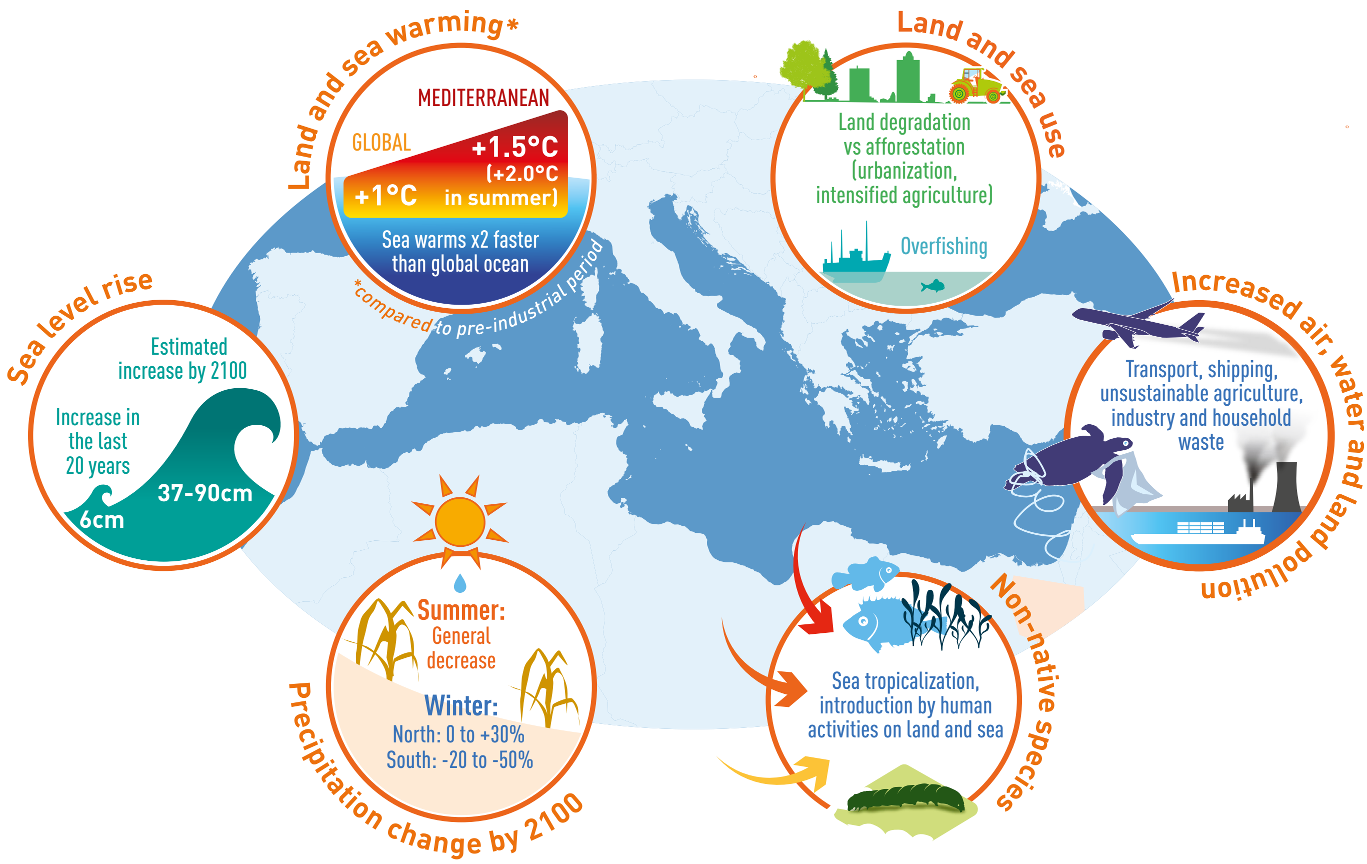

Figure 1.2 | Main drivers of environmental change in the Mediterranean Basin.
This infographic represents the key messages on climate and non-climate drivers of environmental changes in the Mediterranean Basin, based on Chapter 2 of the First Mediterranean Assessment Report (MAR1) (MedECC, 2020a)[5].

5 https://www.medecc.org/outputs/infographic-mar1-drivers-2022/

Food sector: Food production in the Mediterranean Basin is impacted by climate change in combination with land degradation, overfishing, sea level rise, and salinisation of coastal soils. Crop yield reductions are projected for the next decades in most current areas of production and for most crops (5% to 22% yield reduction for maize and wheat by the end of the 21st century without adaptation measures in the highest emissions scenario) (Mrabet et al., 2020). The cultivation of some crops with high water demand like maize or vegetables may even become impossible in many Mediterranean regions without enough water for irrigation (Mrabet et al., 2020). This may potentially be worsened by emerging plant and animal pests and pathogens, and perturbations in global food markets due to environmental crises elsewhere as most Mediterranean countries are net importers of cereals and fodder/feeding products. Climate change mitigation through innovative agricultural management practices, which can enhance agricultural systems resilience, can be implemented through a combination of carbon sequestration techniques, water-efficient strategies, and agroecological approaches (IPCC, 2019).

Ecosystems: Climate change and non-climatic factors are causing the invasion of non-indigenous species, impacting ecosystems and biodiversity. These non-native marine and terrestrial species are invasive, affecting sectors like fishing, agriculture, tourism, and resource scarcity (Balzan et al., 2020). Air pollution is increasing mainly due to land transport and maritime activity, with high temperatures increasing the effects of this pollution on ecosystem health. Land ecosystems are also vulnerable to increased risk of wildfires due to more favourable climate conditions (Balzan et al., 2020). Marine pollution, which can provoke outbreaks of jellyfish, mucilage and algal blooms, comes from agricultural, industrial and household waste, including plastics. Unsustainable fishing, adding to the already observed decline of fish landings of 28% from 1994 to 2017, warmer temperatures, acidification and water pollution, including underwater noise, will likely reduce marine productivity, affect species distribution and trigger local extinction of more than 20% of exploited fish and marine invertebrates around 2050 (Balzan et al., 2020; Moretti & Affatati, 2023).

Energy sector: The Mediterranean Basin's greenhouse gas emissions are 6% of global emissions, equally distributed between Northern and Southern Mediterranean countries, with fossil energy accounting for 76% of the energy mix with large variation between countries (Crippa et al., 2019; Drobinski et al., 2020a). The power production sector represents 30% of the total, while industry represents 14%, the building sector 16%, the transport sector 28% and other sectors 12% (Crippa et al., 2019). Renewable energy consumption accounts for only 11% of the total energy consumption in the region, about nine percentage points lower than the European Union and three percentage points lower than the global level (Bartoletto, 2021), while the Mediterranean countries have significant potential to mitigate climate change through an accelerated energy transition (Drobinski et al., 2020a).The Mediterranean Basin's potential for renewable energy, particularly in the South and East, must be capitalised on to meet the Paris Agreement (Drobinski et al., 2020a). Adverse effects of climate change on thermo-electric production and hydropower (down -20% for global warming levels up to 3°C) and to a lesser extent solar (less than 2% decrease for global warming levels up to 3°C due to the temperature effect on solar photovoltaic (PV) cell efficiency and wind energy production (less than 8% decrease for global warming levels up to 3°C due to wind resource decline and temperature effect on efficiency) (Drobinski et al., 2020a). should be accounted for to meet the energy demand, expected to decrease by 10 to 23% in 2040 in the North of the basin and increase by 55 to 118% in 2040 in the MENA countries (OME, 2018).

The observed and projected degradation of natural resources, freshwater availability, water and food quality can impact most socio-economic sectors (Ali et al., 2022), such as agriculture and tourism, as the Mediterranean Basin accounts for one-third of global tourism (Tovar-Sánchez et al., 2019). It will also impact maritime transport and trade, since the Mediterranean Basin accounts for 25% of all international seaborne trade (Manoli, 2021). Conflicts caused by resource scarcity and human migration are likely to increase due to drought, reduced suitable agricultural land caused by land salinisation due to sea level rise, desertification especially in the Southern and Eastern Mediterranean, and the deterioration of agricultural and fishery resources. However socio-economic and political factors are likely to still play a major role (Ali et al., 2022; Koubi et al., 2020).

1.3 WEFE nexus implementation in the Mediterranean

The Mediterranean faces challenges in water, energy, food, and ecosystem insecurity due to climate and non-climatic changes. These issues are characterised by large disparities between countries and multiple interlinkages between the WEFE components. The complex web of interactions can result in cascading effects, with changes in one pillar causing changes in the other, followed by multiple loops and feedback paths between the many interacting entities.

1.3.1 Data, indicators and assessments

In the Mediterranean Basin, the observation of available data has been key to the creation of monitoring tools and spatial indicators for nexus indexes and related SDGs specific to the region. They have been used to assess characteristics of WEFE pillar interdependencies and progress towards SDGs in the Mediterranean region. They have helped to highlight the high heterogeneity both within and between countries, making it possible to rank Mediterranean countries, and identify pathways to loosen inter-dependency between the water, food and ecosystem pillars to improve the impact of the nexus approach, especially when relying on renewable energy and enhanced efficiency in resource use (e.g. Casini et al., 2019; de Vito et al., 2017; Lacirignola et al., 2014; Papadopoulou et al., 2022; Saladini et al., 2018; Simpson et al., 2022). Regional assessments of nexus approach impacts are however limited by the lack of complete and disaggregated observations on the components of the WEFE nexus together with other issues related to their quality and accuracy. The unwillingness of authorities to provide certain types of required observations to researchers and other stakeholders also represents a major barrier to harmonised, integrated and interoperable data from different sectors and to wide adoption and application of the WEFE nexus in the Mediterranean region (Laspidou et al., 2020; Lawford, 2019; Markantonis et al., 2019; Saladini et al., 2018; Simpson & Jewitt, 2019).

1.3.2 WEFE nexus local implementation

At territorial level, both ecosystem-based solutions, which are cost-effective and community-oriented (Aguilera et al., 2013, 2020; Almenar et al., 2021), and technological solutions, which rely on technical innovation, have been implemented locally in the Mediterranean countries for more integrated and efficient resource use (de Roo et al., 2021; Hoff, 2011; Karabulut et al., 2019; Lucca et al., 2023; Malagó et al., 2021). A number of those solutions support food system sustainability while minimising water and energy demand (e.g. Casini et al., 2019; Daccache et al., 2014; El Gafy, 2017; El Gafy et al., 2016; Espinosa-Tasón et al., 2020; Huang et al., 2023; Lacirignola et al., 2014; Mayor et al., 2015). They include new irrigation techniques or recovering ancient ones, the use of renewable energy in agriculture, or bio-energy crop production in marginal areas[6], the use desalinated water, agrivoltaics, or agroecological practices, such as agroforestry and cover crops (e.g. Barron-Gafford et al., 2019; Harmanny & Malek, 2019; Hoff et al., 2019; Kalavrouziotis et al., 2015; Lequette et al., 2020; Martínez-Blanco et al., 2013; Pulighe et al., 2019). A large fraction of water is used throughout the energy industry for cooling thermal power plants, so more efficient cooling technologies are critical for the water-energy supply-demand balance (Qin et al., 2015; van Vliet et al., 2016). Smart water management, precision agriculture, water conservation and using integrated water management principles and practices may ensure water security in the Mediterranean (Papadopoulou et al., 2022). Implementing renewable energies in the Mediterranean region also benefits the water, ecosystem, food and energy pillars when it does not involve high environmental costs or resource degradation (e.g. Adamovic et al., 2019; Karabulut et al., 2019; Lange, 2019; Malagó et al., 2021; Pacetti et al., 2015). Behavioural solutions, such as adoption of the Mediterranean diet, including reducing meat consumption with differences among Mediterranean countries, and generally reduced consumption, have shown a high potential for adaptation and mitigation (Capone et al., 2014; El Bilali et al., 2017; García et al., 2023). Finally, digital solutions, like early warning

6 Marginal land is land that is of little agricultural or developmental value because crops produced from the area would be worth less than any rent paid for access to the area.

systems and climate services, have also shown broad applicability across various sectors in the Mediterranean (Cramer et al., 2018; de Roo et al., 2021; Dell'Aquila et al., 2023; Koutroulis et al., 2016; Marcos-Matamoros et al., 2020; Sánchez-García et al., 2022; Terrado et al., 2016). A model-based nexus approach assessment based on different climate, socio-economic and demographic change scenarios may finally help assessing the resilience level of sustainable development options and avoid maladaptation and unanticipated effects when changing variables in the system. This should be considered when designing integrated policies (e.g. Fader et al., 2016; Kebede et al., 2021; Khan et al., 2016; Martinez et al., 2018; van Vliet et al., 2016).

1.3.3 Upscaling local WEFE nexus experimentation to institutional implementation

In water-scarce regions like the Mediterranean Basin, water, food and energy are often not priced or allocated efficiently, so that resource use is not optimised (Wichelns, 2017). Several regional organisations in the region have launched programmes and initiatives to build mechanisms for supporting the WEFE nexus approach at various levels (Aboelnga et al., 2018). Upscaling the nexus approach from local experiments to global implementation however encounters difficulties. There is still a lack of concrete examples of global implementation of this approach, with many measures still designed in "silos" (Lange, 2019; Malagó et al., 2021; Zarei, 2020). This limited effective implementation of WEFE nexus approaches in the region is attributed to insufficient understanding of nexus trade-offs within science-policy-stakeholder interactions, insufficient incentives and limited vision, knowledge, development and investment (Hoff et al., 2019). The WEFE nexus approach also requires collaborative governance and involvement of stakeholders to develop meaningful policy objectives based on the principle of equity and social inclusion (Abaza, 2017; Ghodsvali et al., 2022; Halbe et al., 2015; Hoff et al., 2019; Jalonen et al., 2022; Karabulut et al., 2019; Sušnik et al., 2018). It also requires intra-Mediterranean trans-national collaboration to face the climate emergency and promote equitable sharing of the risks and burdens associated with sustainable development through the nexus approach (Bremberg et al., 2022; Lange, 2019; Malagó et al., 2021).

1.4 Report structure

In this report, the Water-Energy-Food-Ecosystem (WEFE) nexus is addressed as a key concept for a more resilient adaptation to the climate crisis in the Mediterranean region. It addresses the interlinked issues of water, energy and food security — and their connection with the surrounding ecosystems. Security issues, and therefore adaptation actions, are thus the key focus of this report, leaving the mitigation consequences of the nexus approach as potential synergies and trade-offs derived from the interconnections between WEFE components. The emphasis is on the nexus between water, energy and food security extending to the coasts of the Mediterranean Sea, and it does not focus on the details of the marine environment, including ecosystems, and the impact of other factors on its services. The following chapters detail and develop this introduction. The outline for this report was agreed upon by the Coordinating Lead Authors during the meeting in Barcelona (Spain) in June 2022 and underwent consultation with policymakers and stakeholders in December 2022. The report consists of a Summary for Policymakers (SPM), five main chapters and several annexes, as follows:

- Summary for Policymakers, including an Executive Summary.
- Chapter 1, "Introduction: The Water-Energy-Food-Ecosystems (WEFE) nexus concept in the Mediterranean region", frames the motivation and main components of the MedECC WEFE nexus report.
- Chapter 2, "Drivers of change and their impacts on the WEFE nexus in the Mediterranean region", focuses on the physical, biochemical and human drivers of changes to the WEFE components and how the changes cascade through the various components of the WEFE, sometimes with feedback on the drivers of change (*Figure 1.1*).
- Chapter 3, "WEFE nexus adaptation and mitigation strategies", based on the analysis of the interactions between the various components of the WEFE nexus in Chapter 2, reviews the adaptation and mitigation measures adopted in the Mediterranean based on the nexus approach. It also identifies the challenges of mitigation and adaptation interventions (*Figure 1.1*).
- Chapter 4, "Contributions of the WEFE nexus to sustainability", focuses on the link between the WEFE nexus approach and the United Nations (UN)

Sustainable Development Goals (SDG), especially SDG 6 (clean water and sanitation), SDG 7 (affordable and clean energy), SDG 2 (zero hunger), SDG 14 (life below water) and SDG 15 (life on land) (*Figure 1.1*).

- Chapter 5, "Governance, policies and research options for the WEFE nexus", reviews the governance bodies to support the nexus approach in Mediterranean countries, policies implemented and research options for the WEFE nexus (*Figure 1.1*).
- Supplementary information is given in the annexes.

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