

## Article

# WEF Nexus Policy Review of Four Mediterranean Countries

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**Abstract:** The Water–Energy–Food (WEF) nexus describes natural resource use in the context of social needs and economic development, addressing food, water, and energy security. Population growth and rising economic prosperity will increase the demand for energy, food, and water in the Mediterranean region, compromising the sustainable use of resources. As governments are required to make decisions in order to cope with increasing demands for resources, this paper performs a review of the legislation and WEF policies, identifying the main political and institutional actors involved and the possible policy (in)coherence in four MED countries located on two continents: Egypt, Italy, Spain, and Tunisia. This choice will allow the identification of the barriers and catalysts influencing the implementation of WEF policies and will improve our understanding of the WEF trade-offs and synergies by exploring them on national, regional, and local scales.

**Keywords:** water–energy–food nexus; policy integration; Egypt; Italy; Spain; Tunisia



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## 1. Introduction

In recent years, globalisation and the continuous pursuit of economic growth have been forcing the world to face major issues in terms of ensuring a stable and sufficient supply of water, energy, and food to an ever increasing global population. In addition, accelerating urbanisation, together with changing lifestyles, habits, and diets, are increasing the demand for the three services above. The natural resources from which they derive are, however, very limited [1]. Moreover, the sustainable supply of water, energy, and food at sub-national (regional and local), national, and supranational levels is subject to the risk represented by unprecedented extreme weather and climate conditions [2,3].

The concept of the Water–Energy–Food (WEF) nexus emerged as a response to the need for the integrated sustainable management of these resources and defines a web of mutual interlinkages to ease the co-operation of those institutions in charge of their supply. The WEF nexus thus outlines and explores the interconnections between the three spheres, with the overall aim of identifying the optimal synergies and minimising the trade-offs between the three resources [4]. Co-operations and conflicts should be identified from a multi-level (regional/local, national, and supranational) perspective in order to fully understand the cascading effects of macro-policies on local communities [5,6].

It must be acknowledged that the literature to date has often also considered the ecosystem as a fundamental part of this interconnection, thus we are dealing with the Water–Energy–Food–Ecosystem (WEFE) nexus. Water is a crucial element not only for human beings and the function of their societies, but also for the ecosystem and the environment [7], which play a fundamental role in the nexus since they are usually placed at the centre of the relationship among the other sources.

The main issue of WEF nexus management is taking into account the number and the complexity of inter-linked effects caused by these three resources as a consequence

of the exploitation of each of them and their provision to the population [1]. Water, for example, is not only an important input for production and economic growth, but it is inextricably linked to energy and food production [7]. Agriculture is indeed the largest consumer of freshwater resources in the world, and water is fundamental to produce energy through most of the available technologies. Water is also required for fossil fuel extraction, transportation, and processing, as well as the irrigation of biofuel crops [8]. Moreover, water and energy are both necessary for food production, growing crops, tending to livestock, and preparing meals. A reduction of water availability automatically induces a reduction also of the production of the two other two resources, which, likewise, are indispensable for human beings.

The WEF nexus is essential to natural resource management and climate change strategies due to the fact that its main goal is to balance the different uses of ecosystem resources. The restoration and the protection of river (basin) integrity must be balanced with the multisectoral usage of water in order to deal with the WEF nexus [7].

Since the demand for all of these three factors is growing rapidly in order to manage current and future pressures effectively and efficiently, on the one hand, governments should have legislation in place to ensure the integrated and sustainable management of water, food, and energy. Legislation and actions should explicitly adopt a WEF nexus approach in a world that is increasingly being populated and urbanised [9]. On the other hand, humans should seek to adapt their lifestyle in order to reduce their environmental footprint. Indeed, mankind's own footprint on the planet is now particularly evident: a recent study has indeed shown that human over-exploitation of groundwater has a visible effect on sea level rise [10].

Therefore, this challenge requires new management strategies that can ensure the availability of these services to stakeholders, mediating national-scale impacts with possible tensions in the nexus in terms of resources security a local scale [11].

In particular, the nexus approach requires coordination and integration at the different hierarchical levels of the government [1]: Hoff [4] identified the main key for this approach, which is "strong institutions that are better interlinked", showing that only through the process of decision making it would be possible to identify and deal with the main challenges posted by the lack of resources.

Scott [12] affirmed that the "effectiveness of the Nexus approach is determined by institutional relationships and the capacities of governing organisations to cooperate one with the others". However, different barriers are present nowadays. Firstly, although the resource system is strongly and physically interconnected, one of the biggest problems concerns the administration of the system itself; decisions and policies are often sector-based ones that are made independently and separately by different bodies (such as ministers chosen ad hoc for each sector) [1]. Secondly, the literature has identified, as another barrier, the lack of willingness to cooperate and a general lack of trust across actors and policy makers that belong to different governmental sectors [12,13]. Thirdly, to date, stakeholders are not continuously involved in the decision-making process [14,15]; this is identified as a key element in determining what is politically acceptable, feasible, and where there is room for policy improvement [14,15].

The aim of this paper is precisely to investigate the role of political and institutional actors, policies, and legislations adopted in relation to the WEF nexus in four Mediterranean (MED) countries involved in NEXUS NESS (a PRIMA project lasting from 2021 to 2024): Egypt, Italy, Spain, and Tunisia. We review both the relevant legislation and the political and technical bodies responsible for addressing the design, implementation, and monitoring of appropriate policies to ensure security in the WEF domain.

In particular, this study applies a policy analysis and review, i.e., a systematic evaluation of the legislation, its implementation, and its impact. The analysis is based on actual data of a government policy, taking into account its strengths and weaknesses. Our aim is to provide information on the decision-making process, present legislative results, and suggest alternative options to better address the problems in each country at the national level.

In this perspective, several steps were taken to carry out the research.

First, we analysed the concert of the WEF nexus for each country, studying the levels of water, energy, and food security over a sufficiently long time span by using indicators recognised in the literature. Then, by studying the geographical and socio-economic context, we identified the main problems faced by each country and the challenges that governments, as well as local communities, have to address. Once the political issue had been defined, we analysed the actors involved in the decision-making process; referring to the institutional framework of each country and adopting a top-down approach, we identified the ministries in charge of the different areas and the other institutional and technical bodies, as well as their main competences.

We then reviewed the national legislation that has been adopted and that is planned for the coming years, first assessing its stated aims and objectives in relation to the problems previously identified. In a final step, in the concluding section, we suggest ways in which the policy approach, and hence the effectiveness of the legislation, can be improved.

The paper is structured as follows: Section 2 is dedicated to an in-depth look at the situation in the MED region, then, Section 3 is devoted to addressing the institutional environment of the states under analysis, and finally, Sections 4 and 5 close with a discussion and concluding remarks, respectively.

## 2. The WEF Nexus in the Mediterranean Region

Productivity and the availability of water, energy, and food vary enormously between regions and production systems [4]. The situation in the Mediterranean region, which is exceptionally rich in sociocultural and biological diversity, in these three bordering continents [16] appears to be alarming. More specifically, empirical studies highlight the presence of increased variability in meteorological phenomena as a consequence of climate change, with unavoidable impacts on food, water, and energy security. However, these observations cannot be generalised at the continent scale due to local differences [17,18].

Food security is defined as the situation “when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” [19]. Water security refers to “the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability” [20], whereas energy security is “the uninterrupted availability of energy sources at an affordable price” [21].

In 2020, the MED region was inhabited by approximately 542 million people, but this number is expected to increase to 657 million by 2050 and 694 million by 2100 [16]. As a consequence of population growth, the demand for resources will inevitably grow as well. Moreover, climate change threatens water availability, reducing the river flows and annual runoff by 5–70%, thus also decreasing the hydropower capacity [16]. Therefore, these great vulnerabilities make the Mediterranean countries a hotspot at extremely interconnected high climate risk.

This area is an almost closed basin connected to the Atlantic Ocean through the Strait of Gibraltar and to the Black Sea through the Dardanelles. The consequent lack of exchange with other bodies of water makes heat exchange difficult, implying a high evaporation rate and salinity that affects both aquatic and terrestrial life [22]. Climate change can also influence the water cycle on spatial and temporal scales; rising temperatures could lead to varying hydrologic regimes with an increase (decrease) in rainfall in the northern (southern) part of the basin, and an increase in dryness throughout the Mediterranean, thus accentuating its vulnerability [22].

Human activity has then contributed to making this naturally occurring vulnerability worse. Ecosystem degradation and biodiversity loss, mainly due to excessive land use and overfishing [16], have been evident across Europe since 1950. This unprecedented pace of environmental change has not allowed many species and ecosystems to adapt

effectively. For example, plants and animals are adversely affected by heatwaves, and their feeding dynamics are also challenged, as climate change alters their biological processes. Furthermore, from an ecosystem perspective, the excessive warming of a region favours the immigration of invasive species that compete with the native flora and fauna [16].

Moreover, southern and eastern countries are particularly exposed to stronger heat waves, an increased number of droughts, and the risk of coastal flooding [16], while all of the economic sectors of all of the MED countries are vulnerable to climate change in one way or another. For example, in the countries in the Middle East and North Africa, a loss of around 10–13% of the GDP is expected in the event of a global average temperature increase of 4.8 °C by 2100 [23]; in Southern Europe, the average loss of labour productivity would decrease by about 2% in case of 2 °C of warming, along with a loss of the GDP of 0.1% by 2030, and then 0.4% by 2080 [24].

However, besides the macroeconomic indicators, the issue of available freshwater quality and quantity, both maximally affected more than anything else by climate change and by growing demand, is of great concern. Countries such as Tunisia, Algeria, and Libya are already below the water scarcity threshold set by the Food and Agriculture Organisation (FAO) of the United Nations. In Spain, indeed, 11 out of the 15 river basin districts are under water stress due to the increasing demand of agriculture [16]. In addition, given the close interconnection between water and food, it is necessary to consider that the agri-food sector in the MED region is an important element for global food supply chain; several large countries, such as France, Italy, and Morocco, are net exporters of many essential micronutrients to developing countries [16]. A change in the quantity and quality of exports would clearly have direct and indirect consequences on their buyers. A recent example of this phenomenon is the Russian–Ukrainian conflict, the consequences of which include slowdowns and interruptions in international supply chains of key sectors, such as energy, food, and fertilisers [25]. According to these authors [25], the WEF nexus indicator can also be exploited to evaluate the social and environmental impacts of conflicts and political tensions.

However, from the point of view of catastrophic events, it is predicted that due to the absence of adaptation and management, many regions of the world, especially coastal areas, will be the most affected by hydro-climatic extremes, especially in terms of the number of people at risk of flooding, due to a joint increase in storm surge levels and population [26].

Given the particularity of this region, and in light of possible future scenarios, the challenge represented by the adaptation of Mediterranean society to climate change requires a new cross-sectoral approach to the management of water, energy, and agricultural resources, which is aimed at “doing more and better with less” [27]. Possible solutions should be inspired by the logic of interconnection and mutual benefit between the different sectors. For this reason, decision makers should carefully evaluate the impact of a policy or of a legislation on all sectors, even those not directly affected, as they may be damaged [27].

Moreover, in addition to resource scarcity, the Mediterranean region faces conflicts and migration, and all of those issues are closely interconnected [28]. In light of all of this, future agricultural policies will have to rely heavily on other sources of irrigation, such as the reuse of wastewater, while following stricter guidelines for waste reduction. The interconnections between the spheres (water, food, and energy) and basic natural resources (water, land, and soil) are, therefore, extensively discussed by the scientific community, highlighting the lack of adequate consideration in government policies [28].

Figure 1 shows the behaviour of a selection of WEF security indicators of the four countries considered in this study, together with the average of MED area for the period between 2000 and 2020. (Due to data unavailability, the average of the MED region does not include Gibraltar, the principality of Monaco, Montenegro, and Palestine. Only in the case of food insecurity, Cyprus, Malta, Syria, and Turkey are also excluded.) The top charts regard water availability, depicting, respectively, the share of population using at least basic drinking water resources (left) and the level of water stress represented as the ratio between freshwater withdrawal and freshwater resources (right). The upper-left graph

shows that Tunisia had serious deficiencies in water access at the beginning of the period under consideration, which have been largely resolved since this time. In fact, access to water has shown a rapid and steady improvement. A similar, though less pronounced, dynamic can also be observed relative to the MED area average. On the other hand, the upper-right graph shows how water availability in the driest countries, namely Egypt and Tunisia, is achieved by overexploiting or exploiting natural availability to the limit. The MED area average also shows a critical value of the water stress level. Spain and Italy, on the other hand, despite climate change, show a water stress level that is below 50%, and in general, it declined during the period under consideration. The middle plots then focus on energy-related issues and represent the primary energy intensity level (left) and the net energy import as a share of total energy use (right), respectively. It is worth noting that with the sole exception of Egypt until 2005, the energy intensity level of primary energy decreased in all of the cases considered, although Italy and Spain have lower levels. These countries, however, show a clear inclination of energy imports, which account for about 75 percent of their consumption. In contrast, Tunisia and the MED area average much lower levels, while, on the other hand, Egypt remains a net exporter of energy. Finally, the bottom charts focus on food security and show, respectively, the per capita food supply variability (left) and the number of moderately or severely food-insecure people (right). What is mainly noticeable is that there is a very large variability in the food supply per capita, particularly in Egypt, showing a peak of about 90 kcal, and in Tunisia. In contrast, the MED area average, thanks to the contributions of Italy and Spain, shows steady behaviour, which for the period considered this index, ranges between 40 and 50 kcal per person per day.

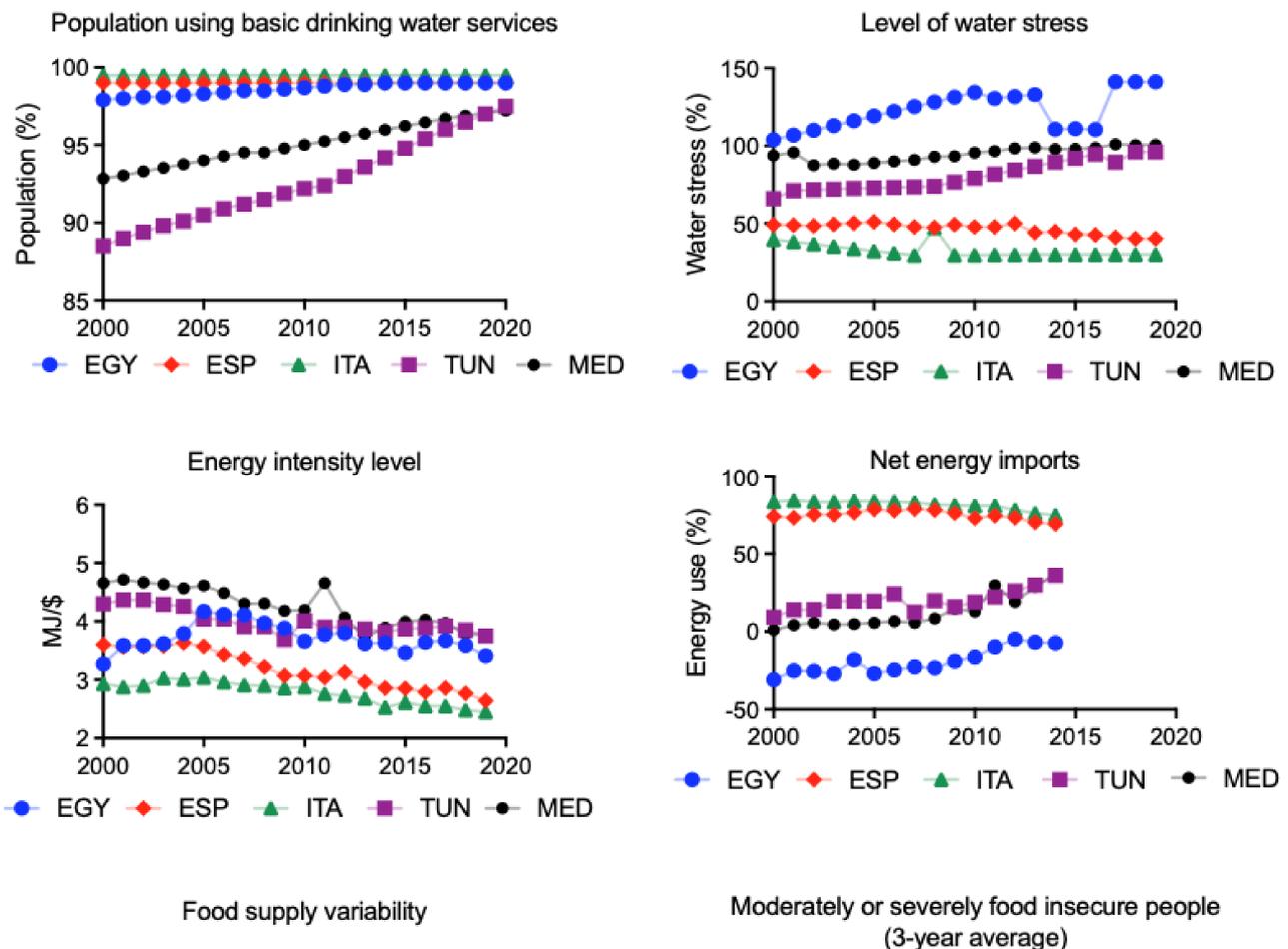


Figure 1. Cont.

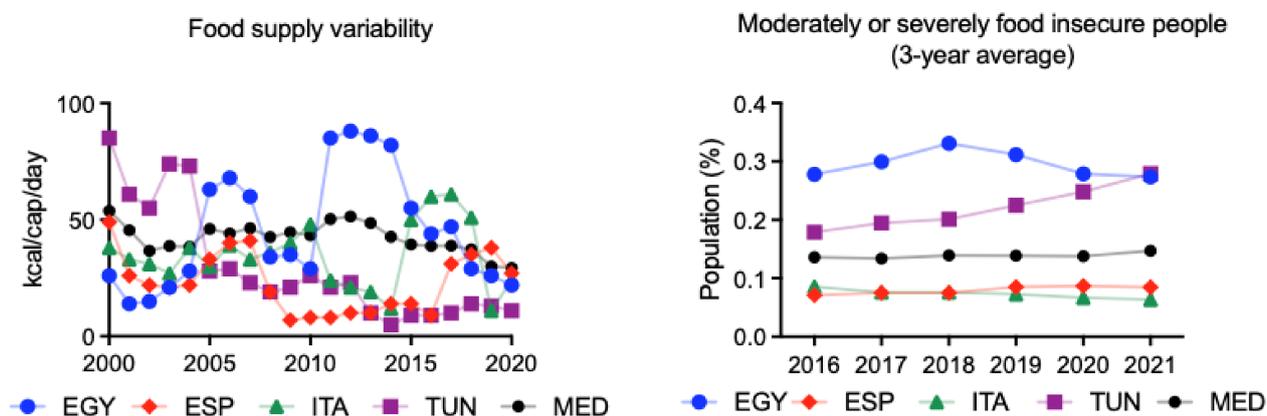


Figure 1. WEF security indicators for the years 2000–2020.

From the last graph, however, it is clear that food security is a major problem for below 10% of the population in Italy and Spain, while in Egypt and Tunisia, this is a problem for 20–30% of the population. On the other hand, the average for the entire MED region is almost constant and is just under 15 percent.

### 3. The WEF Nexus at Country Level

The practical implementation of the WEF nexus approach is very challenging for different reasons. On the one hand, it requires coordinated efforts from people at several hierarchical levels, primarily political ones and stakeholders. On the other hand, not all the interdependencies among the involved resources are fully understood [28]; finding a balance among the resources while avoiding prioritising one over another is indeed a real challenge at present. Political actors and institutions should lead through the adoption of legislation and policies towards an integration of sectors and a more conscious and sustainable use of resources.

In this study, we focus on the national level even though for the two European countries under analysis, recent legislation is mainly the transposition of directives at the EU level. Indeed, according to the “Treaty on the Functioning of the European Union” (Article 4 of the TFEU), the agricultural and fisheries policy, the environmental policy, and the energy policies are among the shared competences between the European Union and Member states. The latter ones can exercise their own competence, whereas the EU does not exercise (or has decided not to exercise) its own competence. In the opposite case, the Member states have to transpose the community directive within the specified deadline.

#### 3.1. Egyptian Context

In Egypt, the challenges posed by the need to ensure water, energy, and food security are amplified both by political instability and the sharp decline in the economy following the 2011 revolution [29]. Other elements contribute to amplify the precariousness of the situation. The main issue is represented by the absence of a proper agreement with upstream neighbouring countries, mainly Sudan and Ethiopia, about the joint management of the Nile’s waters, which represent the main source of this resource for Egypt. Upstream countries with which the Nile’s drainage basin is shared may exert geostrategic control over Egypt’s water share and it put it at constant risk, which may lead to conflicts and unbalanced management of resources. As noted by Hurst [30], the Nile, in its natural cycles, is governed by a “power law”, whereby extreme events (floods) can be disastrous. The long-term memory of the river determines an inertial drive that drags in the past and accumulates at the present, enhancing the effects [31], further increasing the difficulty of water management. Finally, this situation is exacerbated by population growth, which puts further pressure on water resources.

As far as energy is concerned, Egypt is heavily dependent on its oil and gas reserves [29]. The demand for energy is also set to grow due to the increase in energy consumption in the agricultural and water sectors as a result of population and economic growth.

Additionally, with regard to food, it has been estimated that one in five Egyptians is currently facing food insecurity due to structural problems in the food supply system [29]. The country is, furthermore, dependent on the global food market to meet the population's demand, but a reduction of imports now seems very difficult to achieve for two reasons: (i) production yields and land availability are low; (ii) with the reduction of water availability, the small portion of agricultural land available cannot be used efficiently.

In the long run, all of this will be exacerbated by global climate change, but the Egyptian government has already developed several strategies to ensure the country's sustainable development and the resources' provision. To date, Egypt's priorities, such as water distribution, the sustainable use of resources, energy diversification, and environmental protection, have been defined, and responsibilities have been divided among the major institutions and technical and scientific bodies, as well as regional and local authorities; however, there is no shortage of major barriers and difficulties to the concrete implementation of new measures to achieve the set goals.

To achieve water security, the country has created many institutions and technical bodies responsible for water management, as well as monitoring the parties and local units, which play a key role in this context [32]. The Ministry of Water Resources and Irrigation is legally responsible for governing all of the water resources. More in detail, it is in charge of (i) the issuance and cancellations of drainage in the Egyptian water passages, (ii) examinations of the drainage water treatment facilities, (iii) monitoring the feed stations of the drinking water units, (iv) the treatment of polluted water by sewage and industrial wastewater, (v) specifications of terms and standards related to drainage in the water passages, and (vi) for the issuance and monitoring of the necessary licences required to establish any facility that introduces wastewater directly into the water passages [32].

In addition, in terms of water security, it is worth noting that the efficient management of water resources has been the main concern for the Egyptian government for a long time [33]. Egypt introduced its first water policy in 1975, after the completion of the Aswan High Dam. Since then, a number of national water policies, strategies, and plans have been developed. Between 1997 and 2017, Egypt's water policy was developed following the so-called "allocation base": water was distributed among various activities according to the needs of each one and according to the revenue generated by each single cubic metre of water [32]. Nevertheless, Egypt's water policy grants domestic users a higher priority with respect to production sectors, however, in case of shortages, the domestic water demand will be satisfied, if needed, at the expense of other sectors [34].

Moreover, although Egypt could protect areas from further pollution, as well as improve the sanitation value chain [29], the fact of it not having a general law on water management to replace several water legislative frameworks and laws governing the sector [34]—such as Law 12/1984 concerning the Irrigation and Drainage Issue and Law 48/1982 concerning the Protection of the River Nile and Waterways from Pollution—does not help the country in the mission of granting water security.

As far as energy is concerned, Egypt currently has an underutilised potential of renewable energy resources, and these could be implemented to meet the growing energy demand [29]. However, in the future, the country will have to consider importing energy produced by the Grand Ethiopian Renaissance Dam to cope with all the growing problems [29]. Today, the overall governance of the energy sector is guided at the strategy and policy level by the regulations and directions issued by the Supreme Energy Council and is managed at the execution level by two ministries: the Ministry of Petroleum and Mineral Resources and the Ministry of Electricity and Renewable Energy [35].

Looking at the main policies in the energy sector, for decades, Egypt has relied on subsidised energy prices as a tool for social protection and wealth sharing, which has led to a rapid increase in demand [35]. The fiscal burden of Egypt's energy subsidies grew

continuously for two decades up to 2014, a year in which energy subsidies (indirect, direct and cross-subsidies) accounted for 22% of the government budget and nearly 7% of Egypt's GDP [35]. As a result, in 2014, Egypt embarked on an ambitious energy subsidy reform programme, aiming to phase out these subsidies within 5 years (the due date later extended to 8 years). Furthermore, to meet the growing demand for energy and to ensure the continuous security and stability of the country's energy supply, the Egyptian government developed an energy diversification strategy known as the Integrated Sustainable Energy Strategy to 2035. This new strategy involves speeding up the development of renewable energy and energy efficiency [35].

With a growing population, Egypt will not be self-sufficient in terms of food security; the country must therefore increase food imports, but without worsening the structural food deficit. Trade-based food security may not be sustainable in the long run if Egypt is unable to change its economy [29]. The Egyptian government has tried for some time to improve the food subsidy system; however, the reforms remained incomplete due to restrictive laws and difficult cooperation between the actors involved [36]. The Ministry of Agriculture and Land Reclamation has the main task of defining agricultural strategies and policies following article 79 of the Constitution of the Arab Republic of Egypt, which states that each citizen has the right to healthy and adequate food, and that the state must provide food resources to all citizens, ensure food sovereignty in a sustainable manner, and guarantee the preservation of agricultural biodiversity and local plants to preserve the right of future generations.

In order to address the current challenges, Egypt would need to resolve the structural weaknesses in the economic sector and attract private investment to ensure sustainable economic growth. Nevertheless, the food subsidy system suffers from cost inefficiencies, leakages, waste, corruption, and ineffective targeting.

### 3.2. Italian Context

In recent years, global warming has strongly influenced the precipitation volumes in the Alps, reducing the contribution of rain and snow to water resources, and also, affecting the timing of snowmelts. The water supply problem is becoming a social and economic emergency in several parts of Italy, mainly due to the increasing demand and lack of management good practices. In many Italian regions, meeting the water demand is, therefore, becoming a challenging issue, especially where intensive agriculture is practised on a large scale. This situation will certainly be exacerbated in case of a further decrease in average precipitation, raising water stress by 25% by the end of this century [37].

The governance of water sources in Italy is characterised by a very complex multilevel model [38,39]. This complexity is mainly due to a historical process that uses developed specific bodies for regulating and managing each specific sector [39]. In addition, the legislative framework, as well as the transfer of many relevant tasks and responsibilities from the central government to the regions, have made the situation even more complex [39].

The Italian government has directly introduced different adaptation strategies, even when the main institutional body responsible for water policies is the Ministry for Ecological Transition. Policies devoted to wastewater use play a central role, as they can prove that water reuse can be a viable solution to meet the water demand. More in detail, the Ministerial Decree of 2 May 2006 established discharge limits for wastewater, measures for the prevention of water pollution, and the technical rules for the reuse of urban and industrial wastewater [38], while Ministerial Decree of 7 April 2006 and Ministerial Decree 25 February 2016 set the standards for wastewater from agronomic activities [40]. These legislative initiatives are the result of transposing the EU directives on water quality, e.g., Bathing Water Directive (2006/7/EC) and the Groundwater Directive (2006/118/EC). In addition, the law adopted in 1994 (Law number 36 of 1994) recognised the public nature of all water resources (surface and groundwater) and initiated a profound process of modernization and reorganisation of the Italian water sector. Among the main innovations

introduced by this law, there is the unification of all the different water services (supply, sewage, and waste-water treatment) into a single Integrated Water System [41].

Moreover, at the national level, the government has adopted a National Plan for irrigation; this plan involves water management and allocates funds in order to deal with extreme events, such as droughts. At the local level, each region has drafted a Water Protection Plan, which is an implemental tool based on the management plan of the river basins to which the region belongs.

These plans include a series of measures to achieve the qualitative and quantitative goals required by the Water Framework Directive (2000/60/EC), which are implemented with the Environmental Code, which was adopted in order to replace and update all previous water legislation, creating a comprehensive legislative framework coherent with the EU directive [38].

As far as energy is concerned, Italy is a well-performing country despite its high dependence on imported natural resources [21]. However, Italy has relatively high retail prices for electricity and gas, mainly due to increased taxes and duties; the country's success in promoting and spreading renewable energy has come at a high cost [21]. Complying with the (EU) Regulation 2018/1999 on the governance of the energy union, Italy was required to prepare a National Energy and Climate Plan (NECP), a 10 year plan for the period 2021–2030. The country's final NECP set very ambitious targets for renewables by 2030, with the goal of reaching 30% total energy consumption and 55% electricity generation [42].

Moreover, to transpose to the EU directives, several other laws have been introduced into the Italian legislative framework to stimulate energy transition, improve energy efficiency, and fight climate change [43]. For instance, Decree Law No. 34 of 19 May 2020, the so-called “Decreto Rilancio” (Relaunch Decree), introduced a significant tax deduction to prompt a substantial increase in the energy efficiency of buildings. This incentive is also provided for the installation of photovoltaic systems and electric vehicle charging points [43]. The Institute for Environmental Protection and Research (ISPRA) and the National Agency for New Technologies, Energy, and Sustainable Economic Development are in charge of providing data, information, and technical and scientific support. They operate in strict cooperation with the Ministry for Ecological Transition and the Ministry of Economic development, both of which in charge of managing the energy policy. The ISPRA is also responsible for reporting national emission data to the European Union and the United Nations Framework Convention on Climate Change [42].

Regarding food, the Ministry of Agriculture, Food, and Forestry Policies is responsible for drawing up agricultural, agri-food, fisheries and aquaculture, and forestry policies, as well as coordinating the national policy with the European and International standards.

Aiming to fulfil the current and forthcoming growth in demand for food, as part of the Common Agricultural Policy (CAP) of the European Union, Italy has had to define five eco-schemes (the first Pillar of the CAP) to support farmers who are adopting agricultural practices beneficial for the environment and climate. More specifically, rural development (the second Pillar of the CAP) in Italy is implemented through twenty-two Rural Development Programmes (RDPs), one at the national level and twenty-one regional RDPs. In addition, a national rural network programme supports activities of pooling and transferring knowledge among the different actors of rural development. Specifically, the National Rural Development Programme (NRDP) outlines the priorities for Italy for the use of approximately EUR 2.9 billion of public expenditure (EUR 1.3 billion from the EU budget and EUR 1.6 billion of national co-financing) for the period 2014–2022.

Furthermore, in order to adopt a WEF nexus vision, in January 2021, the Italian parliament approved the Italian National Recovery and Resilience Plan (Piano Nazionale di Ripresa e Resilienza, PNRR), which includes the component “Sustainable Agriculture, Green Enterprises and Circular Economy”. This part “aims on the one hand at achieving an agri-food sector that is sustainable, by improving the logistics and competitiveness of farms and their climatic-environmental performance, on the other hand at developing production plants for secondary raw materials and at modernising and constructing new

plants” (PNRR, p. 24). This approach is in line with the new CAP and the Farm to Fork Strategy. The first one will be fully applied in 2023, and it contains a number of policy reforms aimed at enhancing the contribution of agriculture to EU environmental and climate goals, providing more target support to smaller farms, and allowing greater flexibility for Member States who are adapting measures to local conditions. The latter one is one of the key initiatives included in the European Green Deal aiming to shift the EU food system towards a sustainable model by explicitly adopting a nexus approach. Food production should ensure a neutral or positive environmental impact on land and on freshwater resources (water sphere). Moreover, the supply chain of food should also ensure crop yields and economic returns (food sphere), while reversing the trend of producing excessive nutrient emissions into the environment or reducing biodiversity. For this reason, farmers should seize the full potential of the circular bioeconomy, e.g., by developing renewable energy production by investing in anaerobic digesters for the production of biogas from agricultural waste and residues (energy sphere).

### 3.3. Spanish Context

The main water sources in Spain include surface and groundwater, together with water collected by dams and obtained by means of desalination plants. Most of the clean, drinkable water is obtained from rivers, for example, the Llobregat, which almost completely satisfies the demand in Barcelona. Fresh water is mostly used for agricultural and industrial purposes and urban consumption [44]. However, it must be emphasised that, in recent years, especially in some regions, the availability of fresh water has dramatically decreased, and the amount of loss of water availability is expected to grow [45].

Climate change and poor water management are the main causes of water insecurity in the state. However, according to the Spanish law, water is a public domain over which the state has ultimate authority [46]; it is prohibited to make use of water resources without the authorization of the State. This limitation, however, often results in informal consumption, and therefore, non-uniform distribution and use among users. The legal framework used by the national government to set the direction of water management in terrestrial areas is the National Water Law (1985, amended in 1999 and in 2003), which defines water services as all activities related to water management that enable its use, such as the extraction, storage, conduction, treatment, and distribution of surface or groundwater. Among the measures taken to combat water scarcity, a National Irrigation Plan was adopted between 2002 and 2008 by the Spanish government; the main objective of this plan was to improve and consolidate the infrastructure for the distribution of water intended for irrigation in order to improve efficiency and reduce the overall share of water used in agriculture. Competencies in freshwater management are, in general, highly decentralised, even if the Secretary of State for the Environment, within the Ministry of Agriculture, Food, and the Environment, has the main role of directing and coordinating national environmental policies, including those related to water resources [46].

Given the high decentralisation, in order to ensure the cross-cutting coordination of water policies between state and local actors, a National Water Council has been established, and it acts as advisor of the Ministry of Agriculture, Food, and Environment on water planning and management, since here, ministries, agencies, and sectors are represented. The National Water Council has, therefore, to be involved whenever national authorities have to make decisions regarding freshwater. Aiming to adopt WFD 2000/60, at the regional level, the River Basin Authorities act according to the territorial division of River Basin Districts. Lastly, at the local level, municipalities manage urban water supply and wastewater treatment and, if applicable, contract the day-to-day management of private or semi-public enterprises committing themselves to the directives 2006/118/EC and 2020/2184.

With regard to the energy sector, it is worth noting the globally positive reputation of Spain, thanks to the development of renewable energies, in which the country is a global leader. Nevertheless, Spain imports electricity and fossil fuels from other countries,

including North and West Africa, the Middle East, and Russia [47], since the country does not produce any. In line with the EU Regulation 2018/1999, Spain is working on its National Energy and Climate Plan for the period 2021–2030, which was submitted to the European Commission in 2020. This document aims to define a number of policy actions in different sectors meant to support the country's climate targets. The policies defined include increasing renewable energy installations and incentivizing the use of renewable gas in the power sector, modal shift and electrification in the transportation sector, renovation and increasing the use of renewable heating in the residential and commercial sectors, promoting energy efficiency and fuel switching in the industrial sector, and improving energy efficiency in the agricultural sector [48].

Moreover, in January 2020, the government issued the Climate Emergency Declaration, which has defined thirty action areas that aim to reach the climate neutrality goal. The main pillars of this declaration are (i) the Climate Change and Energy Transition Law; (ii) the Just Transition Strategy; (iii) the Long-Term Strategy. A supplemental National Energy Poverty Strategy was adopted too.

The Climate Change and Energy Transition Law puts the fight against climate change and the need for energy transition at the centre of the economy and society. Its goals include achieving at least 70% renewable electricity energy by 2030 and 100% by 2050, at least 35% renewable energy in terms of the final energy consumption quantity by 2030, and reducing the primary energy consumption by at least 35% [48]. The use of renewable energy as well as energy efficiency are indeed placed at the centre of the energy transition.

The Just Transition Strategy is based on the idea according to which it is important to optimise the outcomes that could possibly derive from the ecological transition. For this reason, it includes measures to promote job opportunities in the energy transition, supported by a vocational training framework, active labour policies, support measures for the most vulnerable areas, and economic stimulus plans for the regions most affected by the energy transition.

The Long-Term Strategy finally defines a pathway to achieve an energy system almost entirely based on renewable energy and plans the transition to climate neutrality in 2050. The document includes intermediate milestones for 2030 and 2040, capturing the benefits from the energy transition and supporting the transformation and competitiveness of the economy.

These targets are fully in line with those defined by Regulation (EU) 2021/1119 (known as the "European Climate Law"), which sets a binding EU target of a national net reduction of greenhouse gas emissions by at least 55% (compared with 1990 levels) by 2030 and intends to set a climate target for 2040 within six months of the first global stocktaking under the Paris Agreement aiming to make Europe the first climate-neutral continent by 2050.

Food security is stable in Spain and must be guaranteed in accordance with article 130 of the Spanish Constitution. Therefore, the availability of food allows sufficient resources for each household, but in order to maintain this goal, the national food policy strategy aims to improve the marketing and quality of agri-food products. Key aspects of this policy that help to define the rules of the economic sector are support for the values of agri-food quality and organic farming, as well as balance in the value chain. In addition, as part of the European Union, Spain is one of the countries that benefits most from the Common Agricultural Policy, both from the first Pillar devoted to direct payments and financing of market measures and the second Pillar, which is about Rural Development. The National Rural Development Programme focuses on three priorities: (i) enhancing the economic performance and the competitiveness of agricultural cooperatives; (ii), promoting an efficient use of natural resources, combating climate change, and preserving rural heritage; (iii) fostering innovation and collective approaches in the agricultural sector.

### 3.4. Tunisian Context

Tunisia is classified as a water stress country [49], as it appears to be clear from Figure 1, as its water renewable resources are limited, and this situation is exacerbated by both climate change and political and socio-economic issues. As a consequence, increased pollution and environmental degradation have been observed in the long run, together with unsustainable resource exploitation and increasing food insecurity, especially within the most vulnerable groups [49]. Water stress is most affected by agriculture for two reasons. On the one hand, pollutants, pesticides, and excessive quantities of fertilisers are released into the environment. On the other hand, ancient and inefficient irrigation techniques induce an overexploitation of the available natural resources [50]. More in detail, the freshwater supply relies excessively on groundwater aquifers in the centre of the country, mainly due to an inconsistent institutional framework that cannot guarantee a uniform and sustainable use of groundwater. Added to this are the numerous uncontrolled land-use practices that inevitably contaminate the country's aquifers, and equally numerous are the unauthorised drilling practices for aquifer exploitation [50].

Considering that in the WEF nexus, water, energy and food are closely interlinked, the particularly high energy demand for irrigation and water transfer, as well as for wastewater treatment and desalination processes, need to be properly considered. The use of solar energy systems has recently made access to water resources and solutions for desalination systems easier [50]. Regarding the resources of the nexus, the Tunisian government has introduced two main national strategies, which, however, do not directly address the interconnections between the elements: (i) the Water Sector Strategy to 2030 and (ii) the Tunisian Solar Plan (TSP).

The Water Sector Strategy to 2030 takes stock of the quantity and quality of the country's water resources and the state of water infrastructure, such as dams and canals [51]. This strategy considers the technical, economic, institutional, and legislative factors involved in water management and the risk associated with floods and droughts. A greater role for the private sector in the construction of public works (dams, reservoirs, and wells) and the maintenance of drinking water and irrigation systems is also envisioned [51]. In addition, the study known as the Water 2050 Strategy aims to complement the Water Sector Strategy to 2030 defining a strategic vision for 2050 based on the assessment of the overall balance of water resources. Policies in the water sector are usually adopted under the control and the supervision of the Ministry of Agriculture, Water Resources, and Fisheries, which acts with the support of two bodies, the National Water Council and the Commission of the Public Water Domain, which is represented by the Agricultural Development Regional Offices at the regional level.

The Tunisian Solar Plan (TSP) for the year 2030 is a renewable energy development project, which was elaborated by the National Agency for Energy Management in 2015 and officially adopted by the government the following year. The TSP main tool to implement the strategy is increasing the share of renewable electricity within the national energy mix to 30% by 2030 [50]. The TSP was first launched in 2009, but its present version derives from several improvements made over the years to reflect Tunisia's national strategy and targets. To achieve the country's goals, the TSP has set targets for the total installed renewable energy capacities of 1860 MW by 2023 and 3815 MW by 2030. The targets, as previously mentioned, have been increased to reflect Tunisia's commitment to reduce the country's carbon emissions by 41% from the 2010 levels by 2030 compared to an unconditional target to reduce the carbon intensity by 13%, as pledged in its determination at the national level under the Paris Agreement. The TSP has been developed by the National Agency for Energy Management, which is controlled by the Ministry of Energy, Mines, and Energy Transition in charge of managing the Tunisian electricity sector, the electricity infrastructure, for planning and implementing national policies in the field of electricity, energy efficiency, and renewable energy [35]. In addition, it also controls the Tunisian Company of Electricity and Gas, the major and historic electric utility, which since 1962, has had a vertically integrated monopoly on the transmission, distribution, and marketing of electricity in the

country [50]. Under the Ministry, the General Directorate for Electricity and Renewable Energy oversees issues related to renewable energies and carries out the main task of implementing state policy in the renewable energy sector, considering requests for private production and self-consumption of electricity from renewable sources too.

Finally, in the food sector, since the 1980s, with the implementation of the Agriculture Structural Adjustment Program, Tunisia's agricultural sector has been subjected to a series of reforms aimed at liberalising the sector and bringing the country into the globalisation process following various free trade agreements [52]. Nevertheless, this policy has led to the elimination of agricultural support and the reduction of subsidies. As a result, while the yields of some crops (such as olives and citrus fruits) and livestock production have decreased, the production of milk, sugar, beef and cereals have increased, driven by food security reasons [52]. Additionally, for this reason, over the past two decades, Tunisia has pursued an agricultural development strategy geared toward economic growth and social stability. A program of particular emphasis on the agricultural sector is the Agricultural Sector Adjustment Program, which provides recommendations based as much on the International Monetary Fund as it is on the World Bank and acts as an advocate for state disengagement from support to the agricultural sector [53].

To sum up, the fact that competences in the environmental field are still highly centralised certainly does not help the implementation of ad hoc policies towards the specific problems encountered in the territory. On the contrary, policies that are too general have often led to a reduction of support and of subsidies, resulting in a decrease in the natural resources available.

#### 4. Discussion

The concept of the WEF nexus arises from the recognition that these three spheres are interdependent and that linkages between them are directly relevant for resource governance and sustainable development. This may generate cross-scale tensions among the different cross-sectoral resource uses or the multi-level objectives and needs (from the international scale to the local one). Although there is growing consensus among academics and politicians that citizens should not be passive, but should stimulate change by lobbying and playing an active role [54], the analysis proposed in this study focuses on the institutional and political levels, as different levels and structures of government are primarily responsible for policy implementation.

Looking at the country level, for example, a strategy for reducing the tension between Egypt and its upstream neighbouring countries, namely Ethiopia and Sudan, could be to negotiate, as soon as possible, a mutually beneficial agreement on the sustainable management of the historic waterway, the river Nile. To date, the absence of such an agreement has inevitably led to conflicts and unbalanced resources management. The Egyptian government has also been trying for some time to improve the food subsidy system; however, reforms remain incomplete due to restrictive laws and unsuccessful cooperation between the actors involved. In addition, the Egyptian government has developed several strategies that are aimed at achieving the country's development, including policy proposals from the African Union. This country's priorities, such as water distribution, the sustainable use of resources, energy diversification, and environmental protection, have been defined. Moreover, the responsibilities and competencies have been divided among the major institutions and technical and scientific bodies, as well as regional and local authorities.

On the contrary, in Tunisia, the competences in the environmental field are still highly centralised, and this certainly does not help the implementation of ad hoc policies towards solving the specific problems encountered in the territory. Policies that are too general have often led to a reduction of support and of subsidies, resulting in the over-exploitation of natural resources. Nevertheless, the strengths of the Tunisian legislative system are the constant revision and implementation of new policies aimed at achieving the sustainable management of natural resources and biodiversity. For example, the legislative and regulatory framework of the water sector and its conservation have undergone several

reforms that, unfortunately, have not always achieved the intended objectives. Indeed, despite the existence of a plan to combat climate change by 2020, the country's efforts have not been successful at protecting the environment from issues such as soil erosion and desertification.

Considering the two EU countries, Italy's main barriers to an efficient resource management are bureaucracy, institutional conflicts, and the extensive use of derogations or exemptions in the implementation of policies. The long path towards the full implementation of new EU regulations also represent a critical issue, also because of the comprehensive multi-level model in which the legislation is organised. However, it should be emphasised that it is precisely due to the complexity of the system and the fact that many competences are delegated from the top down (specifically, from the national to the regional and local levels) that many local initiatives have been able to take place, taking care of what are strictly local needs. Regional authorities are, for instance, responsible for regional plans for agriculture. The recent amendment of the Constitution of Articles 9 and 41, which integrated the protection of the environment, biodiversity, and the ecosystem as part of the fundamental principles, emphasised a greater commitment of the Italian state to the environment and sustainable development.

Spain has also an evident commitment to the environment, which is recognizable from the many laws and policies adopted by the government; numerous sustainability programmes have enabled the country to meet the Kyoto Protocol targets. Furthermore, a fundamental element of the Spanish policy is the vision of sustainability also as an opportunity to create jobs, stimulate the economy, and support vulnerable groups by implementing research and development. Environmental competences are decentralised, and this allows local authorities to adopt more territorial policies, however, the strong decentralisation also makes it difficult to prosecute violations of environmental law. In particular, although the Spanish Constitution provides for the duty of citizens to preserve and take care of the environment, those who do not comply with this obligation are unlikely to be punished due to the lack of resources and due to the difficulty of violation detection.

In conclusion, it is possible to see how water, energy, and food security have become crucial issues in the four analysed countries, but none of them are implementing a fully integrated WEF nexus approach. Indeed, the majority of the governments have implemented their Constitution in order to grant, generally, the "right to environmental protection" (Italian Constitution, Article 117), and more specifically, "the right to have water" (Tunisian Constitution, Article 44), "the right to have adequate food" (Constitution of the Arab Republic of Egypt, Article 79), and "the right to have protection of resources" (Spanish Constitution, Article 45). All these rights are focused on some specific domains of the WEF nexus and are counterbalanced by the "duty" of the authorities to guarantee constitutional provisions. This can be explained by the different political priorities and tensions that governments define or have to face. For example, in countries facing more political instability or tensions (e.g., Tunisia or Egypt), the government prioritises those single domains of the nexus and needs that may be more urgent to their population and stakeholders. EU countries do not face such tensions, moreover, the EU is developing an explicit approach to the WEF nexus, as demonstrated by the latest CAP reform and the European Green Deal, of which the Farm to Fork Strategy is a key component.

Being a Member of the EU constrains the countries to implement or transpose the EU legislation, hence if the EU adopts a WEF nexus perspective, this will directly affect the degree of implementation of a fully integrated WEF nexus approach by its Members. Apart from this legal constraint, the European Union may condition the funding programmes to its members on the implementation of given laws or the compliance with certain standards.

From the analysis conducted in this paper, it appears to be evident that different political and social starting conditions imply different possibilities of achieving the sustainable development goals. We recognise that each country faces specific challenges in attaining the Sustainable Development Goals, and that the most vulnerable and developing ones deserve more aid and attention, as well as those in a conflict or post-war scenarios [55]. On this

point, the United Nations in the 2030 Agenda states that “there can be no sustainable development without peace and no peace without sustainable development” [56], emphasising the connection between the two scenarios. Furthermore, we believe that it is necessary to prepare an overall plan of action that, despite the political, economic, and social instabilities, allows the achievement of several goals; in this way, human beings will be able to reach social technological progress in harmony with nature. According to the “Leaving no one behind” principle of the 2030 Agenda, this could be achieved by implementing a funding scheme comparable to the interstate consortium and programmes to promote the sustainable development of forests (see, for example, the Amazon Multi-Partner Trust Fund or the UN-REDD programme (for more information, see: <https://mptf.undp.org/> and <https://www.un-redd.org/>, accessed on 30 January 2023)) aiming to reach WEF security and sustainability in countries facing instability (political, economic, and environmental forms). If this multilateral and communitarian approach spreads to the Mediterranean basin, there will be the possibility to facilitate a proper transition toward a sustainable development, with full awareness of the local communities’ needs.

## 5. Conclusions

The main aim of this review is to investigate the role of political and technical actors and the policies and national legislations implemented in four MED countries, adopting a WEF nexus perspective. In this respect, four countries in the Mediterranean region were studied with the purpose of understanding their legislative approaches towards the WEF nexus.

What emerges from the analysis is that, despite the commitment of governments, the practical implementation of the WEF nexus approach remains very challenging, both because there is not yet a full and complete understanding of the interdependencies between the resources involved and because there is still a lack of real coordination between the political actors and stakeholders.

In this regard, we believe that the EU policy on the WEF nexus should first involve all of the stakeholders by actively engaging with them, including civil society organisations, local communities, and industry representatives, to ensure a more inclusive and effective policy implementation process. This process should also aim to promote sustainable development by encouraging the use of renewable energy and water resources, as well as sustainable agricultural practices, explicitly considering and addressing the impacts of climate change on the interdependent nature of water, energy, and food systems.

In addition, data sharing is and will be essential in the coming years; the EU should facilitate the exchange of information among stakeholders to better understand the interlinkages of the Water–Energy–Food nexus and identify areas for improvement.

Finally, in order to propose sustainable and equitable solutions, the EU needs to regularly monitor and evaluate Member States’ policies to assess their effectiveness and make necessary adjustments.

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