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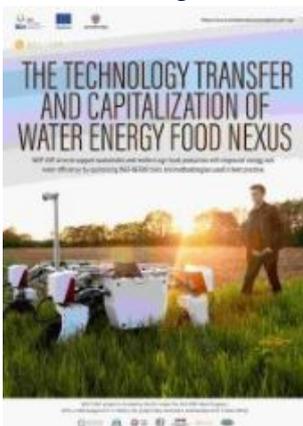
WATER-ENERGY-FOOD NEXUS:

The Way Forward for the Mediterranean Region in the Face of Insecurities

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WEF - CAP

The WEF-CAP project aims to support sustainable & resilient agri-food production with improved energy & water efficiency by capitalizing WEF Nexus tools & methodologies used in best practices.



1. Executive summary

As Water, Energy and Food Nexus (WEFN) is essential to sustainable development, the aim of this policy brief is to provide evidence on the need to shift from a pure sectoral approach towards the adoption of a WEF integrated approach. This will provide an innovative and efficient solution in the face of increasing demands for the limited natural resources. However, many challenges face the South Med region (i.e. Mediterranean Partners' Countries -MPCs¹) in implementing this approach, such as inadequate legal framework, lack of financial resources, lack of knowledge and availability of required skills, poor communications between different actors at all levels and limited regional and international cooperation.

This policy brief provides a summary of the major environmental challenges facing the MPCs with the objective to provide evidence-based recommendations on how to address these challenges through adopting a WEFN approach. After the introduction, highlighting the major environmental challenges, the brief provides evidence-based details about the interlinkages between water, food and energy sectors and proposing solutions for the way forward on how to adopt an integrated WEFN approach in the MPCs. The brief then presents the WEF-CAP project, its objectives and it provides details about the mapping exercise that was undertaken on WEFN best practices from several countries in EU-MPC² region with the aim of providing replicability options. Finally, the brief provides research-and-operational evidence-based recommendations on ways to move forward and adopt the WEFN approach.

* FEMISE is grateful for Dr. Stella Tsani, Assistant Professor at the Department of Economics, University of Ioannina, Greece for her peer review.

¹ For the purpose of our PB, South Med region is the same as the MPCs and include the following 7 countries: Algeria, Egypt, Jordan, Lebanon, Tunisia, Morocco and Palestine.

² The EU-MPC region includes the EU countries and the Mediterranean Partners Countries

2. Introduction

The increase in world population, urbanization and economic development coupled with the impact of climate change are leading to an unprecedented increase in demand for food, water, and energy and thus an over-usage of resources and a slowdown in their renewal. The MENA region is one of the **most water-scarce regions** of the world, with more than 80% of its freshwater coming from regions outside its boundaries. While its population represents about 6.3% of the world population, its share of fresh water is limited to only 2%³. As a consequence, and due to constraints on agriculture land and productivity, the region is one of the **most food import-dependent** regions in the world⁴, particularly imports of cereals, becoming thus a region with decreasing food security⁵. In contrast, being one of **the richest areas of natural energy resources** such as oil and gas, it holds about 57% of world's proven oil and reserves and 41% of proven natural gas resources⁶. However, countries outside the Gulf area are in fact net importers of oil and suffer from inefficiency use of energy resources. This certainly reveals a great deal of discrepancies across the region in terms of natural resources challenges and needs.

For the MPCs, recent stressors, including the impact of COVID-19 and the crisis due to the war in Ukraine, have aggravated the situation and made the somewhat limited efforts undertaken by governments to meet the Water-Energy-Food challenges, far from easing the tensions. This is raising an alarm that there is a need for a more proactive and urgent approach to avoid forthcoming disasters.

3. Interlinkage between Water-Energy-Food

There are manifest links to denote the interdependence between water, energy and food and the MPCs provide a perfect example to show how these three sectors are interlinked. Agriculture is a major consumer of water ranging from 65-86% of water resources in the region (compared to about 59% in Europe). Water is also considered key for energy production such as for generating hydropower energy, power plant cooling, etc. Energy is needed for water abstraction, distribution, pumping as well as treatment and discharge of wastewater. In addition to irrigation, more than one-quarter of the energy used globally is needed for food production including food supply, crops harvesting, food production and distribution, etc.

As the MENA region faces numerous challenges related to the water-food-energy nexus, some solutions and initiatives have been put in place to reduce such challenges, but they are still rather the exception. For example, despite water scarcity, 82% of wastewater is not recycled in the region, presenting a massive loss of opportunity to meet water demands. In fact, economic losses from climate-related water scarcity are estimated at 6–14 % of GDP by 2050⁷. Total water productivity in the MENA is only about half the world's average with some of the lowest prices in the world. In addition, energy insufficiency and soaring costs constitute another pressing challenge for the region.

³ UNICEF, 2019- <https://www.unicef.org/mena/water-doesnt-come-tap>

⁴ Le Mouél and Schmitt, 2018.

⁵ FAO, 2015.

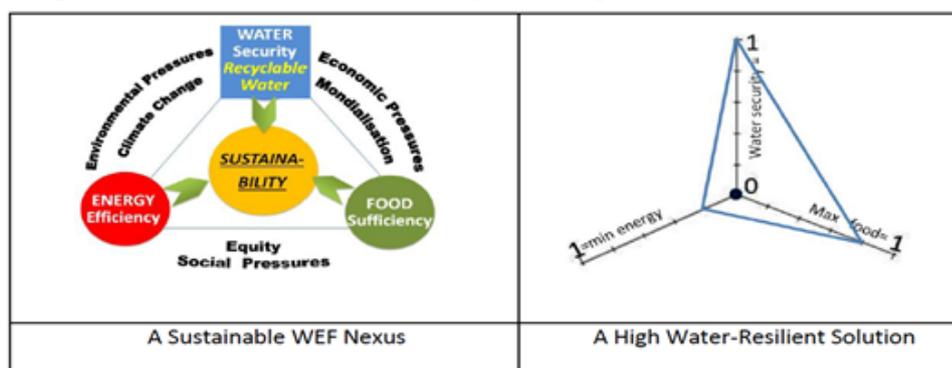
⁶ World Bank, 2010

⁷ World Bank, 2017

Finding solution starts with addressing these challenges in WEFN integrated approach rather than in each sector individually to ensure sustainable agriculture. The WEFN equation is thus a multi-objective, multidimensional and, non-stationary problematic. This approach is based on the fact that using water to maximise food production leads to the over usage of both water and energy, which makes the process of WEFN unsustainable. Therefore and since water is irreplaceable, prioritizing its preservation is a prerequisite to sustainable agriculture⁸. This entails the need to assess the long term renewable and stored water resources and consider alternative solutions for food production and energy use that take water security into account.

For the MPCs, a Hydro-centric-Energy Food approach (Figure 1) consisting of (1) increasing food production by *using renewable surface water, sustainable groundwater, recycled water, etc.*; (2) prioritizing Smart Agriculture (e.g. vertical, irrigation techniques, etc.) to decrease labor and maximize agricultural production; and (3) increasing the use of renewable energy sources (solar panels, etc.) seems to be a plausible and relevant approach, given the existent challenges.

Figure 1: Sustainable WEFN Policy with High Water Resilience



Source: Ganoulis, Jacques. 2021

In brief, the WEFN approach helps to strike the balance between maximizing food production while using renewable water and energy. Moreover, this paradigm implies building an Ecosystem where all stakeholders will be involved, allowing collaboration with Neighbouring countries.

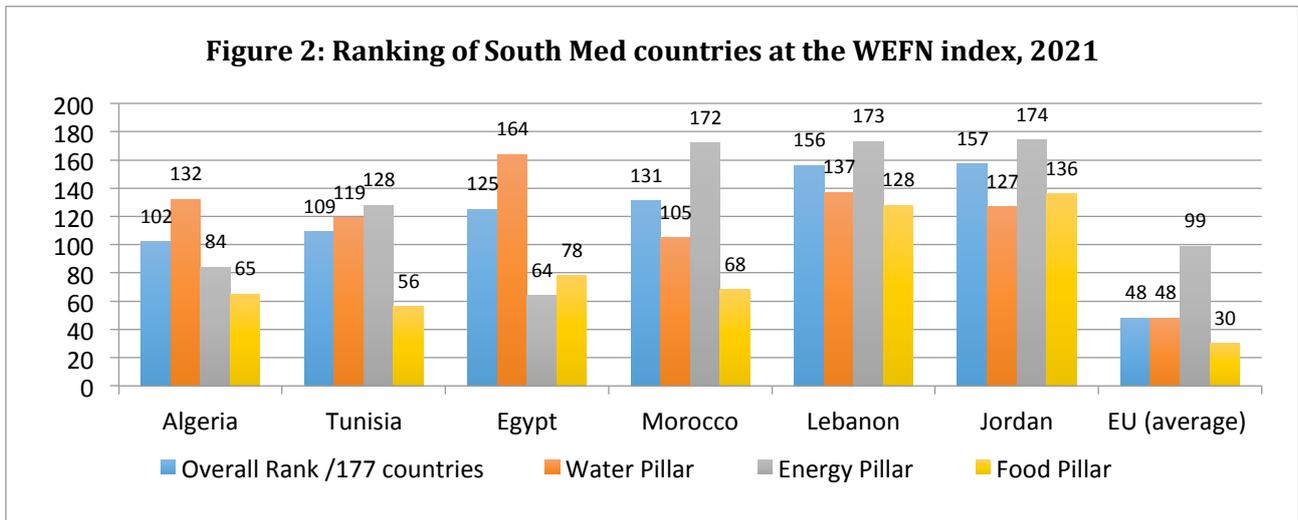
4. Challenges for an EU-MPC WEF Nexus approach

Despite evidence that the integrated WEFN approach improves environmental, climate, food, human and political security, this approach is rarely applied as a national strategy, particularly in developing countries, including the MPCs. This is due to a number of reasons including, but not limited to, sectoral silos, insufficient incentives for integrated planning, inadequate legal framework, poor coordination and communication between the different actors including policy making at all levels, and limited national vision, financial resources, knowledge, and practical experience to guide successful implementation⁹.

⁸ Ganoulis, Jacques, 2021.

⁹ Holger Hoff, et.al. 2019.

Figure 2: Ranking of South Med countries at the WEFN index, 2021



Source: the WEFN index, 2021

This is reflected in the measurable WEFN index¹⁰, where the MPCs are still lagging behind (even compared to other developing countries). Algeria has the best overall ranking of 102 (over 177 countries), followed by Tunisia and Egypt (Figure 2). It is worth noting that the food pillar (overall) has the best ranking for most MPCs (with 3 MPCs ranking lower than 70). In addition, while the water sector reflects the biggest challenge for Egypt and Algeria, the energy sector is identified as the biggest challenge for the remaining MPCs.

National strategies could be implemented that would be better suited for each country's conditions and more specific challenges. This is particularly true as governments of the MPCs are working towards achieving the SDGs. In addition, there is a global interest from international organizations to reduce the implications of climate change and to provide support to implement further this type of integrated approach of the WEFN; this includes the ENI CBC MED capitalization projects on WEF-Capitalization.

5. The WEF-CAP-Project¹¹

There is an urgent need for societal adaptation to climate change in the EU-MPC region, through new cross-sectoral approaches to efficiently administer energy/water resources, foster agricultural productivity and thus stimulate social and economic development and resilience. This implies the necessity to capitalize WEFN innovations and best practices. In this context, the WEF Capitalisation (WEF-CAP) project aims to strengthening a regional metacluster that stimulates cooperation and tech-transfer while mainstreaming policy impact for innovation-driven progress to effectively supporting education, research, technological advancement, and innovation. WEF-CAP has grasped an opportunity to efficiently capitalize WEFN practices, commercialization tools and methodologies.

¹⁰ The Water-Energy-Food (WEF) Nexus Index is a national-level composite indicator founded on 21 relevant indicators for 3 pillars: Water, Energy and Food with regards to their access and availability: <https://wefnexusindex.org/>

¹¹ The WEF-CAP project full title is: "The Technology Transfer and Capitalization of Water-Energy-Food Nexus" and was selected following a call for proposal by the ENI-CBC-Med for funding in 2021. More details about the project : <https://www.enicbmed.eu/projects/wef-cap>

5.1. Approach and Methodology

As one of the explicit objectives of the WEF-CAP project is to identify effective WEFN implementation practices, through a mapping exercise, that could be adequate for replication based on pre-designed criteria, a targeted questionnaire was defined and sent to 626 WEFN stakeholders across the EU-MPC region¹². Based on the responses, a total of 21 best practices were initially mapped revealing some common trends such as having an international coverage with regard to geographic scale and showing good starting levels of Technological Readiness (TRL). Mapped practices are denoting almost equal social, scientific and economic impacts and are stimulated by solution providers or public private partners that are able to raise the necessary funding. Most practices are also mission-oriented ecosystems aiming for value creation while being at the adoption deployment or pilot implementation technological development phase. Regarding the number of mapped practices, they are as follows: Spain (8), Jordan (6), Greece (6), Egypt (2), Lebanon (2), Tunisia (2), France (2) and Italy (1)¹³.

5.2. Results

A transversal analysis of the data collected based on a series of delineated Key Performance Indicators (KPIs) was conducted with the aim of understanding which are the pivotal issues and driving trends that make the mapped practices suitable for replications in the Mediterranean region to address the future challenges posed by the WEFN. The analysis also served to appraise the different projected scenarios of current pivotal issues and drivers forces in the region over the next two to twenty years about the identified practices and the potential for their replication. The main observed outputs include:

- 1. Geographic coverage:** most mapped best practices have an international approach (48%), followed by a regional one (36%), while the number of practices following a cross-border (6%), local (6%) or national (3%) approach were much lower.
- 2. Technological Readiness Level (TRL)¹⁴:** about half (48%) of the practices surveyed have already a high level of starting TRL of +7. This percentage increased to reach about 68% of the practices at the achieved TRL, showing a good progress. At the same time no practice had a lower level than 5 as an Achieved TRL. Linking the level of TRL to the geographic coverage, we found that cross-border, international and local practices reveal a higher achieved TRL levels compared to those of the regional and national ones. However, the greater evolution is observed for the international and regional ones. This perception could be linked to a wider exposure of actors to different ecosystems and challenges that promote a wider evolution of the TRL practice.
- 3. Scientific impact generated:** when taking into account the effects of these best practices on producing high quality new knowledge, reinforcing the human capital, or stimulating the dissemination of knowledge and open science, the analysis shows a practically equivalent distribution. Moreover, practices addressing a regional approach are those that are more likely to generate new knowledge (50%), whereas international practices tackle a more emphasized impact on stimulating knowledge dissemination (37%) and building human capital (42%).

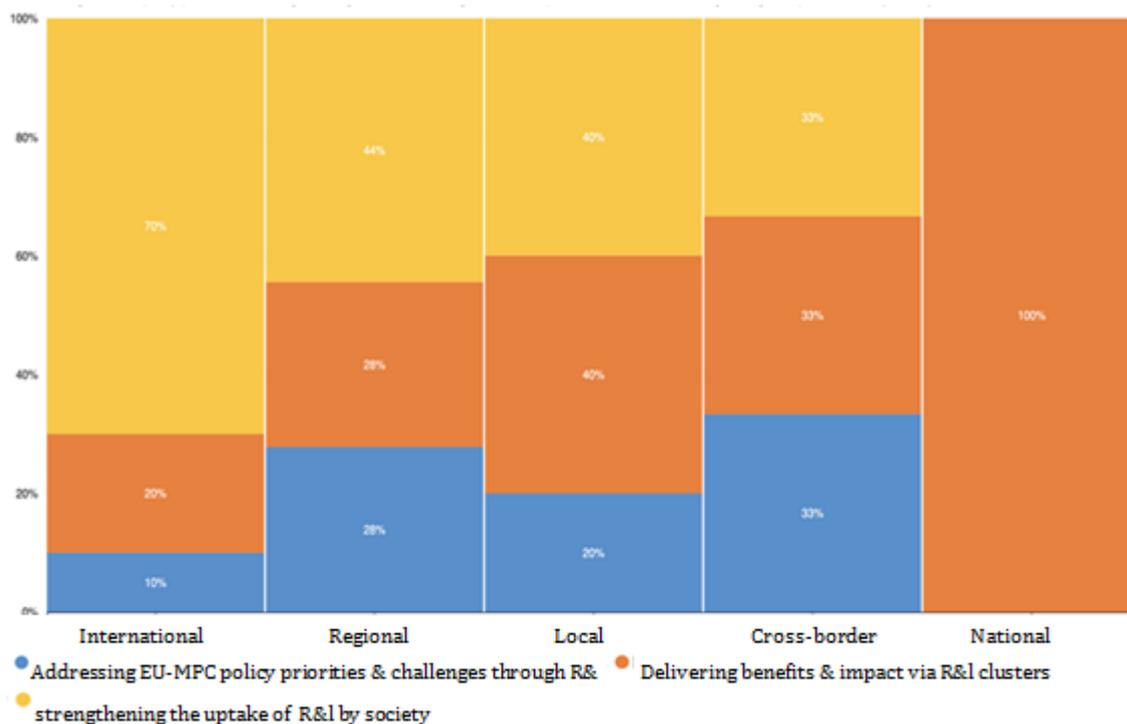
¹² Six blocks of KPIs were established to delineate the criteria of best practices for replications.

¹³ The profiles produced for each country according to the practices examined reveal very different guidelines, strategies, objectives, and achievements, as well as different political, economic, social, technological, legal, and environmental aspects that could affect the replication of practices to address the WEF NEXUS challenges.

¹⁴ TRL is a method for estimating the maturity of technologies of a program. TRLs are based on a scale from 1 to 9 with 9 being the most mature technology.

4. **Social impact generated**¹⁵: most practices endorse the societal adoption of WEFN, particularly those with an international coverage approach (68%), and they are less likely to consider political priorities and WEFN challenges (11%), compared to the practices tackling a regional coverage approach reflect (28%) (Figure 3).

Figure 3: Societal Impact/Geographical Scale



Source: Databases on the survey questionnaire for WEF practices conducted by WEF-CAP team, 2022

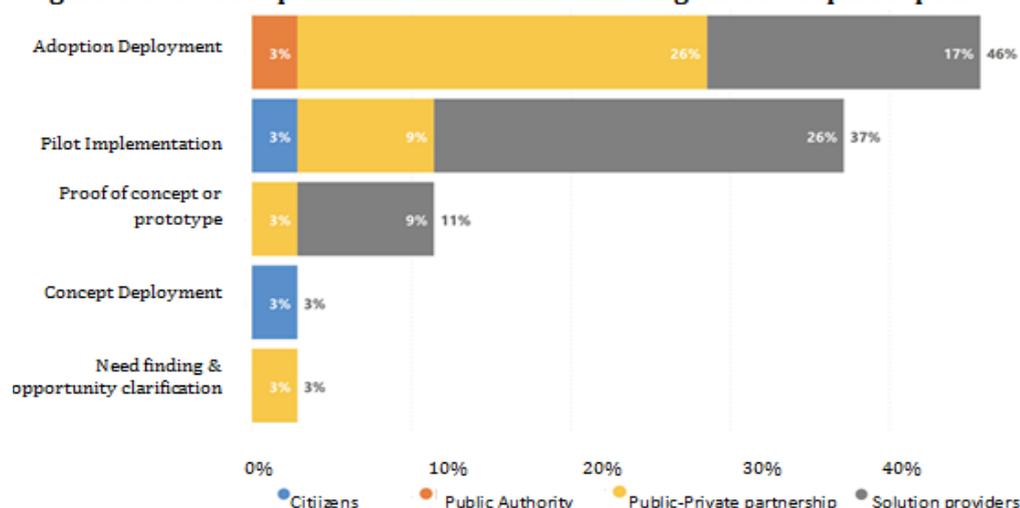
5. **Economic impact generated**: most of the practices are producing innovation-based growth related to WEFN, especially those that are identified as regional or local practices. International ones are focused on leveraging investment in WEFN Research and Innovation (R&I). The creation of more and better jobs is an indirect impact resulting from their implementation, being the typical derived impact of cross-border practices.

6. **Drivers**: most of the best practices are carried out equally by public and private partnerships or by solution providers disposed to prove the achievability of their growth. These constitute the representative supporting profiles for international and cross-border geographic coverage approaches. It is also important to highlight that the analysis resulting from the assessment of the technological progress related to the practice implementation, depicts that the adoption deployment¹⁶ is the standard outcome of the practices driven by solution providers or public-private, tailed by pilot implementations (Figure 4). Most public-private partnerships are the ones that raise more funding or finance to ensure their implementation (average from 1M€ to 5M€) compared to those of solution providers, which are featured by a broader range of typical budgets supporting the projected practices.

¹⁵ Social impact is defined as: 1. addressing EU-MPC policy priorities & WEF Nexus challenges through Research & Innovation (R&I); 2. delivering benefits & impact on WEF Nexus via R&I clusters; and 3. strengthening the uptake of WEF Nexus R&I by society.

¹⁶ Deployment requires that technological advancement be dispersed in order to reach a given target audience. The adoption statement indicates that the target audience of the practice uses the application, platform, or service it has deployed.

Figure 4: Drivers of practice and achieved technological development phase



Source: Databases on the survey questionnaire for WEF practices conducted by WEF-CAP team, 2022

7. **Created value:** most of the added value denoted by the examined practices is emphasized on platform, mission-oriented ecosystems, and validation studies. Whereas practices with local and national geographic coverage are concentrated on single values (respectively, mission-oriented ecosystems and individual project-based), the international, regional or cross-border ones tackle a wider range of values delivered. It is also worth noting that, when scrutinizing the added value from the standpoint of collected funding, platforms and mission-oriented ecosystems necessitate greater amounts for their implementation and strengthening whereas the individual project-based practices target various possibilities in accordance with the regional coverage and ambition.
8. **Technology Development:** while practices driven at regional, cross-border and local levels are more inclined towards pilot implementation (ranging from 50-75%), those deployed internationally focus on the adoption deployment of the technology (81%). Meanwhile, the national ones are more prone for the proof of concept. It is observed that practices focusing on adoption deployment reach the highest TRL (48%) compared to proof of concept which is far away from market (12%).
9. **Maturity evolution¹⁷:** At the outset, the practices are almost evenly distributed to involve the community of stakeholders, offer innovative scenarios, and provide requirements analysis or services. At a second stage, they become more centered on the interaction with end users, understanding their experience, offer the space for the development of ideas, or deliver services for adequate mock-up developments where to assess new concepts or ideas. At the third stage, the mapped practices are emphasized in providing training and demonstration capabilities, experimentation and validation with users, the incorporation of tools and services or offer field trials preparation for the launch of full-scale testing. At the fourth stage, the practices display a wider palette of services to deliver to the community of stakeholders and stimulating field trials for full user experience and exploit new avenues for cooperation or adaptation of functioning business models and innovation systems.

¹⁷ Maturity reflects the evolution status of the practice timeline, from their initial services provision to a more hub/ecosystem of actors working around.

10. Services Offered: most of the services provided by the mapped practices aim to foster networking activities, and pilot innovative environments with the intent to apply innovation and implement development services for related communities. It is worth noting that the emphasis on commercialization, living labs services or user development methods is not elaborated to the same degree as practices tackling prototyping and project preparation, development, and management services. The utmost progress discerned is accomplished by practices emphasized on Living Labs services, or the pilots, and innovation environments. It should also be noted that practices deployed by solution providers lay out a broader palette of services than those driven by public authorities and citizens that are mainly centered on networking.

This mapping exercise and analysis have emphasized the important roles played by those practices that adopted a Nexus approach in not only achieving better performance, but to also have environmental, societal and economic impacts on their communities within the EU-MPC region. Even if this approach is still in its early phase (and often not fully understood by some practitioners), it is clear that it has plenty of potentials in the region. Hence, these pioneering practices represent a source of knowledge and learning lessons that will contribute to diminish the learning curve and facilitate their replication and implementation all around the region.

6. Conclusion

Water, Energy and Food Nexus represents a paradigm shift in the international development agenda, from sectoral development interventions to integrated resource use in a green economy. This approach requires context-specific solutions based on different levels of interventions to achieve long-term economic, environmental and social goals. Greater recognition of sectoral interdependence can help to overcome these barriers¹⁸. However, bringing the Nexus debate from the academic sphere into development practice faces significant barriers, including challenges to cross-sectoral collaboration and the complexity and incompatibility of current institutional structures.

This policy brief intends to support evidence based on research, national initiatives and best practices on how the WEFN integrated approach may provide mutually beneficial responses and reinforce the efficient and suitable use of these resources, in the context of climate change threats, particularly for the MPCs. There is an urgent need to accelerate this paradigm shift: moving from a pure sectoral approach towards the adoption of a WEF integrated approach. However, many challenges face the MPCs in implementing this approach such as inadequate legal framework, lack of financial resources, lack of knowledge and availability of required skills, poor communications between different actors at all levels and limited regional and international cooperation.

¹⁸ Water, energy, food, and ecosystem nexus, European Commission, https://international-partnerships.ec.europa.eu/policies/climate-environment-and-energy/water-energy-food-and-ecosystem-nexus_en

7. Recommendations

In view of current situation and existing pioneering practices, there is hope to improve the situation for the MPCs, but countries and societies need to act quickly. Some of the recommendations derived from the performed analysis could include:

1. The need to improve the **legal framework** that links to the usage of natural resources and enhance cooperation between different relevant ministers and national agencies. This requires the integration of the WEF nexus approach in national policies and implies closer communication between the relevant actors, such as ministries of water, agriculture, energy and environment through the creation of high-level WEFN committee that contributes to the national strategy and a vision. This might also require some institutional reforms to ensure advancing adequate national strategies.

2. **Technological advancements** must be implemented under appropriate framework conditions, comprising adequate policies, regulation and monitoring mechanisms to ensure that the benefits of the nexus approach spring, without generating environmental or adverse socio-economic conditions in other sectors or at other scale.

3. The need to **raise bi-directional awareness** among all stakeholders, starting from the policy makers to the general public on the challenges their countries and communities face, suggest solutions and provide support on how to mitigate and adapt to forthcoming impacts.

4. As adopting the WEF approach requires knowledge and technical skills, this implies the necessity to integrate it within the **technical education** at different levels but also among farmers, and within the suitable stakeholders' ecosystems. There are great potentials for job creation within this approach; however, supplying the right skills to match the markets' needs will be essential.

5. Further participation from the **private sector** and international donors to invest in the region needs to be encouraged and this would require facilitating their entries and providing incentives and better and more stable business environment.

6. There is a need to better integrating **entrepreneurs** across the region and support their innovative ideas "from lab to market" and provide them with needed support.

7. **Regional cooperation** around WEF is becoming a necessity given that the region share most of its natural resources (e.g. 60% of surface water resources in the MENA region are trans-boundary), hence leveraging resources and exchanging knowledge to develop innovative and inclusive solutions across the region would be beneficiary. A regional cooperation that would use comparative advantages would ensure the best usage of available resources; provide platforms for the youth and NGOs, researchers and civil society to exchange and share experience in order to solve the WEF challenges in the region and provide incentives to move from theory to practice; and encourage the engagement of the international community such as the European Union and the Union for the Mediterranean to provide technical support through training and knowledge transfer and through financial support through funding WEF related projects (e.g programs such as ENI CBC MED, PRIMA, Horizon 2020 and interreg). This could motivate the creation of regional EU-MPC WEF Committees that stimulate cooperation and **strengthen a regional metacluster** that promotes tech-transfer and mainstreams policy impact for innovation-driven progress, such as those organised through the WEF-CAP project.

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