THE WATER-ENERGY-FOOD SECURITY NEXUS IN THE WESTERN MEDITERRANEAN

DEVELOPMENT AND SUSTAINABILITY IN THE 5+5 AREA

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Published by the European Institute of the Mediterranean and the Med Think 5+5 Network

Coordination: Roger Albinyana, Daniel Ruiz-Giménez and Fátima Fernández
Proof-reading: Neil Charlton and Pere Bramon
Layout: Núria Esparza
ISSN: in process
December 2018

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Development and Sustainability in the 5+5 Area

Foreword

European Institute of the Mediterranean

This publication is the outcome of the work undertaken after the III Forum *Med Think* 5+5 entitled "Human Development as a driver of cooperation in the 5+5 Dialogue", co-organized with the Union for the Mediterranean (UfM), that was held in Algiers (Algeria) in June 2018 and covered a broad range of thematic areas of cooperation within the 5+5 Dialogue, including the one that gives name to this Policy Study: the water-energy-food security triangle in the Western Mediterranean.

The organization of this conference brought together the 5+5 Dialogue's co-presidency, the Secretaries General of the Union for the Mediterranean (UfM) and the Arab Maghreb Union (AMU), 5+5 countries' Ambassadors from Algeria, France, Italy, Spain and Tunisia, as well as more than seventy academics and representatives of think tanks and institutes of public diplomacy from the ten Western Mediterranean countries. Based upon the Valletta Declaration of the Western Mediterranean Forum from October 2012, a network of think tanks and institutions of public diplomacy called *Med Think 5+5* was launched in Barcelona in May 2016 at a first conference. This III Forum held in Algeria was the largest event organized by the network in the year 2018 and the natural continuation of previous Fora and thematic workshops convened in the framework of the *Med Think 5+5.*

Throughout these two years of existence, the *Med Think 5+5* network has attempted to become a joint discussion platform of researchers, think-tankers and policy makers, most notably from the foreign affairs ministries of the ten countries of the Western Mediterranean. Additionally, the network has aimed to foster joint research, mainly focused on areas of thematic cooperation within the 5+5 Dialogue. In spite of the fact that most of the policy studies and reports published focus on critical subjects that arise in the realm of international relations and regional affairs within the Western Mediterranean sub-region, this Policy Study transcends this orientation as to embrace a more unconventional subject, but yet highly relevant and valuable in today's global and regional context.

The Paris Agreement and the 2030 Agenda for Sustainable Development, adopted respectively at the COP 21 and at a UN special summit in 2015, constituted a turning point in a global agenda that has been losing impetus since then, as a consequence of a rising nationalism that has eroded the multilateral system everywhere. If one thought that reaching these two agreements was more difficult than expected, the road towards their implementation, in particular of the Paris Agreement, has become very tortuous and convoluted.

As identified by the Intergovernmental Panel on Climate Change, the Mediterranean region is one of the main climate change hotspots with pessimistic projections of the

climate conditions for 2050, which highlights that the average temperature will rise by 2-3°C, that rainfall will drop by between 5% and 20% and that extreme weather events will be more common and harmful. These changes will have a direct impact on crops and water availability, which is already a problem today, especially in the south. Likewise, one of the most controversial aspects of the situation in the Mediterranean is that, while the countries of the north of the basin contribute highly on the central causes of climate change, it is the countries of the south that are most likely to suffer its effects.

In relation to these developments, too often the interaction between water, food and energy in the Mediterranean has been characterised by distortions that have triggered negative externalities rather than positive synergies. For instance, one can evoke the high level of use of fossil fuels for water and food production, while huge amounts of water are used for energy production and water-intensive crops. The use of food for the production of biofuels, which generates a rise in prices and increases their volatility, or the usage of oil revenues to import water and subsidise agricultural production, adding pressure on internal and external water resources, are also examples of these negative externalities.

One way to manage and govern resources in a holistic manner, thus providing significant potential to reduce distortions and increase complementarities between sectors to overcome scarcity in resources is by promoting an integrated nexus approach on the water-energy-food production (WEF). Among others, we welcome very much the launch of the PRIMA initiative, which supports research and innovation in nineteen Euro-Mediterranean countries in the field of water management and agro-food systems; or the draft UfM Work Plan on the Nexus, run under the ad-hoc UfM Task Force on the Water-Energy-Food-Ecosystems Nexus.

To this end, this Policy Study has been written by selected scholars who participated in the Algiers Conference. Each of the papers deals with one of the triangle vertices: water, energy, food production, whilst the last chapter focuses on the virtuous circle that the WEF nexus is able to generate.

The first chapter commissioned to Hachmi Kennou and Gert Soer (*Institut Méditerranéen de l'Eau*) deals with the water's vertex. Water resources in the Western Mediterranean region are scarce and unequally distributed. Global warming, insufficient wastewater treatment and demographic pressure in coastal areas further aggravate this situation. Given the strong relationship linking water, energy and food security, climate change and water scarcity imply significant energy and food shortfalls, with dramatic socio-economic

consequences. While significant progress has been made in the Mediterranean to improve the efficiency of the water-energy systems, many problems remain that are related to weak governance, market distortions and unsustainable investments. If the sustainability of water, energy, food and ecosystems is to be simultaneously secured, decision-makers need to consider the cross-sectoral consequences of their choices. For this, it is essential to raise awareness on the Nexus framework at different levels and scales. Accordingly, stakeholder involvement and quantitative and qualitative indicators would help cover and understand all the essential aspects of this relationship.

The second chapter commissioned to Emanuela Menichetti (*Observatoire Méditerranéen de l'Energie*) covers the energy's vertex. Although Western Mediterranean countries contribute moderately to global greenhouse gas emissions, they are severely impacted by the negative effects of climate change. Indeed, the IPCC warns that climate change is expected to impede economic activity in Southern Europe more than in other sub-regions, thus potentially increasing future intra-regional disparity. For its part, the author warns that without a drastic change in energy policy, CO_2 emissions from energy will double by 2040 in the same area, thus further exacerbating the current fragility of its ecosystem. Considering this critical situation, renewable energy technologies will have to be massively deployed within climate mitigation policies and with the help of international financing. However, until now, despite significant progress, the development of renewables in the Western Mediterranean is constrained by a series of institutional, technical, regulatory and economic barriers. To induce projects deployment, a number of countries have adopted a mix of supporting tools, including renewable energy plans and objectives, tendering, price mechanisms, quota systems and tax incentives, as well as long term power-purchase agreements.

The third chapter prepared by Fattoum Lakhdari (*Centre de Recherche Scientifique et Technique sur les Régions Arides*) covers the food security's vertex. In addition to its fundamentally nutritional nature, food security is also an indicator of economic development and, above all, a factor of national and even regional social stability. With the exception of France, all countries in the Western Mediterranean are dependent on imports of cereals, which are the basis of the Mediterranean diet. This deficit is due to natural factors as well as to poor and unsuitable modes of land exploitation and management. Additionally, the urbanisation process at the expense of agricultural land, particularly in coastal areas, as well as the effects of climate change aggravates scarcity of food production in the region. In this context, reducing water resources and changing the agricultural calendar are among the potential risks that can directly affect food

security. Therefore, for countries heavily dependent on food imports, some level of staple food needs to be ensured. At the same time, in countries facing water stress, efforts must focus on saving water from agriculture. At the regional level, north-south and south-south cooperation in agriculture and related areas will help to remove some constraints and bring the two shores closer together.

The final chapter commissioned to Desirée Quagliarotti (National Research Council – Institute of Studies on Mediterranean Societies) is devoted to the WEF nexus in the Western Mediterranean. Whereas climate change and extreme scarcity in water and arable land have a considerable impact across the Western Mediterranean region, in particular its southern rim, a new approach that integrates management and governance along the water-energy-food production sectors is to be encouraged. The author believes that by increasing the production of alternative energy sources and by prompting an optimisation of the WEF nexus in the Western Mediterranean, it is possible to limit the effects of climate change and the vulnerability of those socioeconomic systems that are more exposed to the effects of global warming. In this regard, she points out at the existing opportunities of creating networks to increase renewable energy flows and knowledge transfers between the two rims.

The Role of Water in the Mediterranean Nexus

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Introduction

The Mediterranean region is on average scarce in water resources, a net energy importer and a net food importer as well. Indeed, water resources in the Western Mediterranean region are not only scarce, but also unequally distributed. Global warming, insufficient wastewater treatment and demographic pressure in coastal areas further aggravate this situation. Given the strong relationship linking water, energy and food security, climate change and water scarcity imply significant energy and food shortfalls, with dramatic socio-economic consequences.

While significant progress has been made in the Mediterranean to improve the efficiency of the water-energy systems, many problems remain that are related to weak governance, market distortions and unsustainable investments. If the sustainability of water, energy, food and ecosystems is to be simultaneously secured, decision-makers need to consider the cross-sectoral consequences of their choices. For this, it is essential to raise awareness on the Nexus framework at different levels and scales. Accordingly, stakeholder involvement and quantitative and qualitative indicators would help cover and understand all the essential aspects of this relationship.

Sectoral approaches (water demand management, more food for water, solar and wind energy) may solve part of the problem, but the Nexus approach will make investments in new technology more efficient. Benefits from the Nexus implementation are multiple: from security of sectors to socioeconomic and environmental aspects, including job creation. The Nexus approach is also particularly suited to be used for climate change adaptation.

Water Overview in the Mediterranean Region

In 2015, the total available freshwater resources in Mediterranean countries were approximately 1,217 billion m3 per year. Of this, 68% are surface waters and 32% are underground waters. Northern Mediterranean countries (European countries including Turkey) have a share of 83% of the total available freshwater resources (they have just 55% of the population of the region); Southern Mediterranean countries have a share of 11% and Eastern Mediterranean countries 5%. 94% of the water resources are internal, 6% external (mainly the Nile in Egypt and the Euphrates in Syria) (Burak & Margat, 2016).

The most water-scarce country in the region is Jordan, with a yearly availability of 95 m3/capita. This scarcity is aggravated by the refugee crisis caused by the civil war in Syria.

At the end of 2017, close to 20% of the population in Jordan were refugees. Jordan is followed by Libya, Malta, Palestine, Israel, Algeria, Tunisia, Egypt, Lebanon, Morocco and Syria. It should be noted in this context that, in reality, Palestine has even fewer resources than is indicated above, as the Israeli occupation only allows the Palestinians to exploit 20-30% of their available resources.

As was mentioned before, water resources are not only unequally distributed within the whole region and in its sub-regions, but also inside the different countries, in particular in the Southern and Eastern Mediterranean countries. The observed water scarcity puts considerable stress on water management. In the Eastern Mediterranean and the island states, but also in the south, most groundwater resources are severely overexploited, leading to exhaustion of aquifers and deterioration of their quality. Water stress is also growing because of the ever-increasing population. According to CIA World Factbook historical data, average population growth in the region is slightly less than 0.9%, 0.4% in the northern part of the Mediterranean region, and 1.5% in the southern and eastern parts. However, the population growth in the coastal areas of the northern part of the region is also around 1.5%, due to migration.

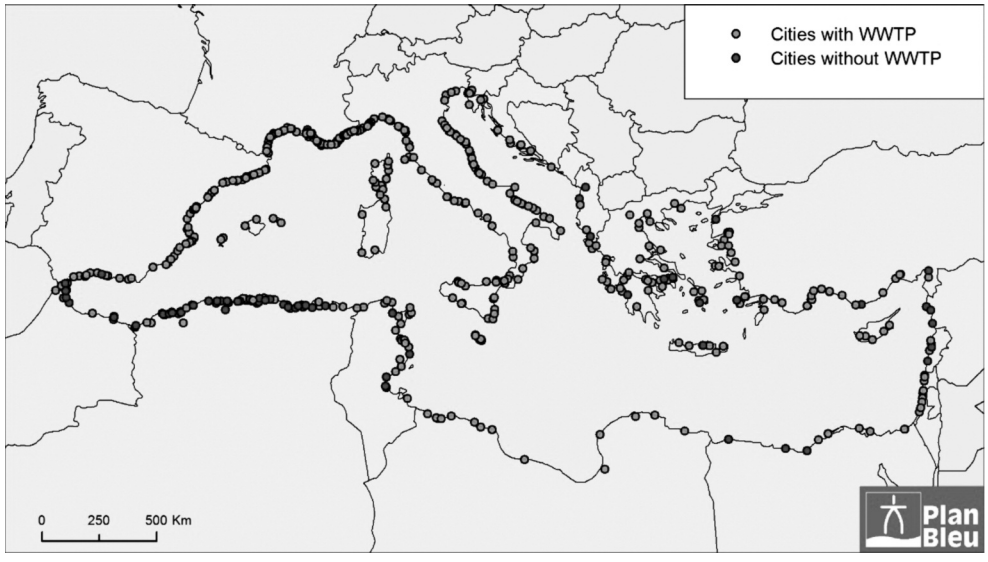
Water quality of land-based resources has been deteriorating over many decades. On the northern side of the Mediterranean Sea, lack of wastewater treatment, industrial pollution and inefficient solid waste management has deteriorated the quality of surface and groundwater over a long period. Over the last 10-15 years quality of surface water has improved, also due to the introduction of the EU Water Framework directive in the year 2000 and surface waters in the EU are much cleaner than 25 years ago, according to the European Environment Agency. It should be noted however, that groundwater quality did not improve significantly on average. In the Southern and Eastern Mediterranean – although there are large differences between the countries – pollution control is not always as well developed as in the North and regulations are in general not in place or not fully implemented.

In the northern part of the Mediterranean region, most cities have adequate wastewater treatment. In the southern part, the percentage of wastewater treated lags behind and most pollution comes from inefficient management of urban waste and chemical products. The next map gives an idea of the status of wastewater treatment of coastal cities. Please note that the map is based on 2010 data and the number of coastal cities in the southern and eastern part of the Mediterranean region has increased since.

Lack of wastewater treatment in the adjacent river basins also gives rise to pollution of the Mediterranean Sea and impacts the marine environment and the bathing water quality. On

the other hand, most of the pollution from agriculture and (to some extent) industry comes from the northern part of the Mediterranean region. Despite economic and technological advantages, the North still pollutes more than the South.

Map 1. Coastal cities with and without wastewater treatment plans (WWTP) in 2010



Source: GRID-Arendal

Water uses vary greatly from country to country. Overall, 52% of available water resources are being used for irrigated agriculture and the remaining is used for drinking water supply, industrial water and tourism (which is 46% in the European part of the region and 83% in the southern and eastern part of the region) The drier climate in this region requires large quantities of water for irrigation (Ferragina et al., 2010). This is not the place to discuss differences country by country, but it is noteworthy to mention that there is a latent conflict between efficiency and energy use. The more efficient irrigation is conceived (drip irrigation, etc.), the more energy needs to be used for pressurising irrigation systems. At the same time, it should be noticed that declining groundwater levels will also increase the energy footprint per cubic metre of water used (Daccache et al., 2014).

Efficiency of irrigation water use in the Mediterranean region is estimated at close to 60%. Efficiency for drinking water use is rather low as well; it is estimated at slightly over 60%. Interesting enough, improving drinking water use efficiency will reduce energy costs, while improving irrigation water use efficiency will most probably lead to a considerable increase of energy use. Improving water use efficiency, in particular in irrigation, seems to be more complex than thought at first sight.

Water is One Key to the Nexus Virtuous Circle

Water, food, energy and ecosystems are essential for human well-being, poverty reduction and sustainable development. They are interlinked through a Nexus of natural, institutional, economic and social frameworks. The Water-Energy-Food-Ecosystems Nexus approach aims to facilitate enhancement of water, energy and food security while preserving ecosystems and their functions and increasing climate resilience.

Water and energy are strongly interrelated and becoming increasingly linked as the water scarcity in the Mediterranean region increases. In the water value chain, energy is required in all segments and energy is used in almost every stage of the water cycle. Moreover, water and energy are linked with food production and environment/ecosystems, as the consumption of food, water and energy impacts ecosystems and natural resources. Numerous factors are increasingly affecting the use of these resources, namely: population growth and mobility, economic development, urbanisation, technical and technological changes and climate change. All those factors are very relevant in the Mediterranean region, with its endemic water scarcity, its irregular allocation of rainfall in time and space and its distribution of population, more concentrated in the coastal areas. Climate change and migratory movements are drivers of paramount importance, as they will exacerbate the current imbalances of the region. In this context an inescapable challenge has arisen to face the predicted significant shortfalls in water, energy and food in the future while preserving the ecosystems: this is the Nexus challenge.

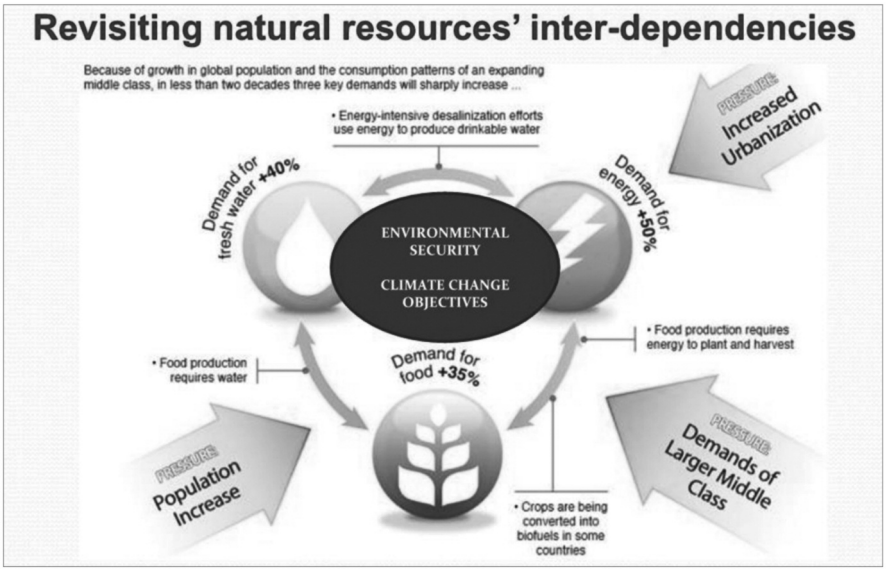
While significant progress has been made in the Mediterranean region to improve the efficiency of the interrelated water-energy systems, primarily through efforts for implementing innovative solutions, many problems are still lingering: weak governance systems, limited awareness, distortions from subsidies and unsustainable investment show the need to build on more innovative solutions to archive water, energy and food solutions. If the sustainability of our water, energy, food and ecosystems are to be simultaneously secured, decision-makers need to consider their choices' and decisions' broader cross-sectoral consequences. The increasing urbanisation of the Mediterranean region and the migration movements require water to be transferred from wet areas to populated ones, increasing energy consumption. Also, the rapid growth of the urban population increases energy consumption in terms of water treatment and distribution.

On the other hand, an important development has been achieved in terms of increasing the energy efficiency in desalination plants, with values closer to or even less than 1 kWh/m^3. Moreover, advances have been made in terms of re-valuing urban waste in

Waste Water Treatment Plants (WWTPs), to the point of generating more energy than needed for wastewater treatment. The specific conditions of the Mediterranean weather make the region appropriate for developing renewable energies. Combination of solar and wind energy with hydropower pump-storage systems has been proved as a solution to provide regulation to the currently still unregulated renewable energy sources. This solution is especially interesting in the Mediterranean islands, where conventional energy sources based on carbon are more difficult to implement.

The food element is also of great relevance in the Mediterranean context of the Nexus, with agriculture being the major water consumer in the region, water being a keystone for the entire agro-food supply chain and energy required to produce, transport and distribute food. It is noted that, globally, agriculture accounts for 70% of total freshwater withdrawals, while about 30% of total global energy is used by the food sector.

The scenarios expected take into account main factors such as climate change, population movements, development (especially in the south of the Mediterranean region) and cultural and technological changes. In these scenarios, the competition between different sectors will increase and will have an unpredictable impact on the environment. Technological solutions will not solve this situation by themselves, so the Nexus approach should be included as part of sensible policies that encourage cooperation among different actors to tackle existing and emerging challenges



Source: GWP-Med.

The challenge could be approached by gaining a better understanding of the Nexus framework and identifying interrelations and links at different scales. Quantitative and qualitative indicators should be developed to evaluate the aforementioned links and interrelations. Models should be developed to support the analysis of the Nexus. Impulses should be created at the scientific/technological level (improvement of water and energy efficiency), at the policy level (revision of existing policies and legislation), at the social level (stakeholder dialogue to create effective frameworks) and at the governance and institutional level.

Confirming the above, the following has been extracted from the position paper "A frame for a comprehensive understanding of Water-Energy-Food Nexus" (3rd EMEG Meeting – Malta, 30 September-2 October 2015):

> *"During the Davos Summit, The Global Risks 2011 report, issued by the World Economic Forum (WEF, 2011), brought to political attention, and for the first time, the risk correlation between the water, energy and food sectors.*
>
> *Later on, the interdependencies between water, energy and land resources became the focus of many global and regional conferences and meetings held in preparation for the United Nations Conference on Sustainable Development (Rio+20) held in June 2012 (UN, 2012). In particular, the Bonn 2011 Nexus Conference (held in November 2011), "The Water Energy and Food Security Nexus – Solutions for the Green Economy", organized by the Federal Government of Germany, was a major milestone to place the Nexus perspective on the international agenda (SEI, 2011). More recently, the Bonn 2014 conference, "Sustainability in the Water-Energy-Food Nexus" (GWSP, 2014), emphasized the need for coherence of cross-sector policy efforts and cross-border cooperation for jointly improved efficiency as a successful strategy to achieve environmental sustainability. The conference called for the following Actions: 1) Responsible governance of natural resources; 2) Broad involvement of stakeholders to collaboratively work toward sustainable development; 3) Need to expand financial, institutional, technical, and intellectual resources for Nexus research."*

The countries of the Mediterranean basin are well aware of water, energy, food and eco-system challenges. A Nexus approach to sectoral management through enhanced technical assessment, policy dialogue, governance improvements, investment mobilisation, collaboration and coordination is necessary to ensure that appropriate safeguards are put in place to mitigate their detrimental effects.

Because of this multiplicity of conceptual expansions, the Nexus represents a promising vehicle for promoting considerations on cross-cutting issues (e.g. gender, stakeholder engagement, rights, poverty, etc.). The Nexus can assist in the efforts to further mainstream these issues in addition to its pivotal role in promoting green job creation.

Conclusions

- Benefits from the Nexus application are multiple: from security of sectors to socioeconomic and environmental, including job creation. However, it is important to make explicit these benefits for a wider acceptance of the Nexus approach by means of developing a monitoring framework to evaluate the level of success when implementing Nexus applications and by the application of ex-post analysis of specific examples to strengthen the case of the Nexus at different levels and scales.

- It is necessary to provide targeted support, including structural aspects, for institutions to tackle the difficulties of handling complexity relating to the Nexus application. This includes paying attention to the allocation of responsibilities of ministries and how they affect the Nexus application.

- When applying Nexus approaches, there is a need to include different stakeholders from all levels, ensuring their active involvement through appropriate legal and regulatory frameworks.

- Technology needs to be adequately integrated in all activities to accelerate the meeting of sustainable development objectives.

- Water professionals need to think beyond the water box and consider options for integrating and synergising energy and food production aspects as well.

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Clean Energy as a Driver of Sustainable Development in the Western Mediterranean

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Introduction

Sustainable development has been at the heart of pioneering multilateral cooperation initiatives in the Mediterranean region since the adoption of the United Nations Environment Programme (UNEP) Mediterranean Action Plan (MAP) in 1975. Twenty years later, the Barcelona Declaration stressed the importance of a regional approach by underlining the interdependencies of the member states in terms of environmental concerns, as well as the importance of combining economic development and environmental protection. The establishment of the Euro-Mediterranean Partnership (ENP), also known as the Barcelona Process, in 1995, marked a turning point in relations between the European Union (EU) and its Mediterranean partners, as it laid the foundations of a process designed to build a multilateral framework for dialogue and cooperation on several issues, including energy and the environment. In 2004, the EU launched the European Neighbourhood Policy (ENP) to further strengthen the ties with its southern and eastern neighbours. The ENP has created a framework for defining and discussing a series of priorities between the enlarged EU and its neighbouring countries. Environmental protection and the sustainable use of energy sources are among the stated objectives of the ENP. More recently, the establishment of the Union for the Mediterranean (UfM) in 2008 further reiterated the need for regional integration on a series of strategic aspects, including energy, climate and the rational use of natural resources.

In this context, the establishment of the Western Mediterranean Forum in 1990 made an important contribution to regional dialogue across the Mediterranean region. With a forward-looking approach, the Western Mediterranean Forum delegates convening at the First Meeting of the Foreign Affairs Ministers in Rome strongly highlighted the need for concerted action and cross-border cooperation on the environment as a way to increase stability in the region. These strategic lines are clearly reflected in the Oran Declaration of April 2010, as well as other important documents such as the Lisbon Declaration of March 2015 and the Algiers Declaration of January 2017, among others.

Clean Energy Development in the Western Mediterranean

A fragile ecosystem in the quest for long-term solutions

Although Western Mediterranean countries contribute moderately to global greenhouse gas emissions (less than 4%), they are severely impacted by the negative effects of

climate change. The entire Mediterranean region is considered as a climate change hotspot, and the Western Mediterranean is particularly vulnerable to climate change impacts. The fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC) highlights important challenges that these countries will face before the end of the 21st century: a rise in temperatures, decreased rainfall, reduced water availability and substantial impacts on ecosystems. These factors may exacerbate the vulnerability of agricultural systems and create hazards to public health and other socioeconomic impacts. In the same way, Southern European countries are very likely to experience increased frequency and intensity of heat waves, with most adverse implications for health, agriculture, forestry, energy production and use, transport, labour productivity and the built environment (Kovats et al., 2014). The IPCC warns that climate change is expected to impede economic activity in Southern Europe more than in other sub-regions, thus potentially increasing future intra-regional disparity.

The 2018 Special Report on Global Warming of 1.5°C clearly indicates that the risk of drought in the Mediterranean can be greatly reduced if the increase in temperature is limited to 1.5°C instead of 2°C compared to the pre-industrialisation level. In contrast, higher temperatures could increase the vulnerability of the region, exacerbated by very significant demographic dynamics.

Since the early 2000s, many efforts have been made in the Western Mediterranean context in adapting to climate change with significant feedback in several areas of implementation, as well as many cases of good practice. However, there is a need to pursue a strong policy of climate change mitigation. The IPCC estimates that the increase in temperatures in the North African region will be well above the global average, with a particular rise in minimum temperatures. The Western Mediterranean Forum indicates that, according to the Euromed Centre on Climate Change projections, by 2050 the average temperature in the Mediterranean will rise by 2-3°C, rainfall will drop by between 5% and 20% and extreme weather events will be more common and harmful. These changes will have a direct impact on crops and water availability, which is already a problem today, especially in the south (Medthink 5+5, 2018).

Meanwhile, the Observatoire Méditerranéen de l'Energie (OME) warns that without a drastic change in energy policy, CO2 emissions from energy will double by 2040 in the Southern Mediterranean region, thus further exacerbating the negative effects on its fragile ecosystem.

There is a strong need to speed up the energy transition towards a low-carbon energy future in the Western Mediterranean region. The challenge will be to match economic,

social and cultural development with the need to secure clean, reliable and affordable energy. Such a challenge calls for strengthened regional cooperation and a long-term, shared strategy at regional level. In this respect, the Western Mediterranean Forum has a relevant role to play.

The energy context: current state and future scenarios

The Western Mediterranean region has an abundance of renewable energy resources. It is well suited to the development of renewable energy technologies for different applications. As far as solar energy technologies are concerned, most of the southern countries lay in the so-called Sunbelt, with global horizontal irradiance (GHI) values ranging from 1,600 kilowatt-hour per square metre per year (kWh/m²/y) in coastal areas of the Mediterranean to 2,600 kWh/m²/y in the desert, and direct normal irradiance (DNI) varying from 1,800 kWh/m²/y to more than 2,800 kWh/m²/y. This is one of the best endowed areas of the world with respect to solar energy for both solar photovoltaic (PV) and concentrating solar power (CSP) applications (Al-Shalabi et al., 2014). The potential for wind energy is also very high in several Western Mediterranean countries.

Despite this encouraging picture, today the energy mix is still largely dominated by fossil fuels, which account for more than 60% in the five countries of the northern shore and for over 90% on average in the southern countries. Overall, in 2015 renewable energy supply reached about 76 Mtoe, or 12% of the Western Mediterranean primary energy supply. However, significant differences can be observed across the region, as the five northern countries generated 73 Mtoe, with the remaining 3 Mtoe in the southern countries.

Historically, the most exploited renewable energy sources have been biomass and hydro. Traditional (unsustainable) biomass is still commonly used for heating and cooking in several countries of the south Western Mediterranean region. In more recent years, however, more innovative renewable energy technologies have entered the energy mix, namely wind and solar, the latter both for electricity and heat production. The deployment and significance of renewable energy is particularly notable in the power sector. As far as installed electric capacity is concerned, more than 164 gigawatts (GW) were in place as of 2017, of which 160 GW in the north Western Mediterranean countries and almost 4 GW in the southern ones (IRENA online database; OME renewable energy database). In terms of technologies, the north Western Mediterranean countries have a more balanced mix with hydropower accounting for 52 GW, wind for 51 GW, solar PV for more than 33 GW, geothermal for 0.8 GW, bioenergy for 3, solar CSP for more than 2 GW and marine energy for 0.2 GW. In the south Western Mediterranean countries

hydropower accounts for 1.6 GW, wind for 1.3 GW and solar for 0.8 GW (IRENA online database; OME renewable energy database). All other renewable energy technologies are still in the early stages of development. Nevertheless, a number of countries have made significant progress in implementing renewable energy projects. For instance Morocco is on track to achieve its 2020 renewable energy targets of 42% of total capacity installed. As of 2017, renewables became the first generating source, reaching around 3 GW (around 34% of total installed electricity capacity).

A number of large-scale projects are either under construction, under development or in the final test stages, including the 850 MW wind project and the second, third and fourth phases of the Ouarzazate Noor solar complex, as well as other solar projects.

After its slow uptake of the Tunisian Solar Plan, renewable energy investments are gaining momentum in Tunisia, with the recent pre-qualification calls for tender for wind and solar photovoltaics projects announced in May 2018. Whereas Algerian progress is still slower than expected (important milestones are achieved, however, with several off-grid PV installations in 2016 and 2017 in the south of the country), the political situation in Libya is still holding back the implementation of renewables.

All south Western Mediterranean countries have set medium-term objectives for renewables. In particular, Algeria aims to reach 5 GW of wind, 13 GW of solar PV, 2 GW of solar CSP and 1 GW of bionergy by 2030; Mauritania seeks to achieve 20% of renewables in the energy mix by 2020; Morocco has an objective of 5 GW of wind and 5 GW of solar PV by 2030; Tunisia aims to reach 1.8 GW of wind, 460 MW of solar CSP and 1.5 GW of solar PV by 2030. As for Libya, the country has set renewable energy objectives by 2025 as follows: 1 GW wind, 844 MW solar PV, 375 MW solar CSP.

Reaching the aforementioned objectives requires adding an extra-capacity of more than 3 GW per year over the next ten years on average. The OME projections to 2040 indicate a cumulative renewable electricity capacity of 40 GW under a business-as-usual scenario (ten times more than current levels). Under the so-called “proactive scenario”, i.e. assuming that all sustainable energy and climate policy targets are correctly met, the cumulative renewable electricity capacity would be over 56 GW.

Overall, the entire Western Mediterranean region would see a cumulative renewable electricity capacity of more than 300 GW in the business-as-usual scenario and over 410 GW in the proactive scenario.

Benefits of renewable energy for sustainable development

As mentioned, although renewable energy technologies have not yet fully taken off in the Western Mediterranean, the picture is gradually evolving and could potentially drastically change the regional energy landscape if the national plans that have been announced by the south Western Mediterranean governments are implemented effectively.

The positive spillover effects of the development of renewable energy technologies have been highlighted in several reports (KAS, 2007; IRENA, 2016; World Future Council, 2016). Increased renewable energy leads to a series of socioeconomic, health and climate benefits including higher GDP, improved welfare, job creation and security of supply, amongst others. In terms of climate mitigation, the role of renewable energy technologies is essential to drastically reduce lifecycle emissions of plants. Considering the critical situation in the Western Mediterranean region in terms of climate change impacts, renewable energy technologies will have to be massively deployed within climate mitigation policies. All countries but Libya have submitted their national determined contributions (NDCs) to the Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC). However, one important point to be considered is that to fully implement the announced plans availability of international financing is key, particularly in the south Western Mediterranean countries.

According to the IRENA database, total investment flows associated to the development of renewable energy as indicated in the NDCs of the south Western Mediterranean countries amount to over 46 billion USD.[1]

In addition to the relevant contribution in terms of climate change mitigation, there are other benefits from the development of renewable energy in the region. Deploying renewable energy technologies at a wider scale would undoubtedly well position the region to play a leading role in global energy markets, especially through energy savings that could be gained through renewables, and thereby freeing more oil and gas for export (particularly relevant for Algeria and Libya). Furthermore, the implementation of large-scale energy projects could favour international partnerships that could project the Western Mediterranean countries into global energy markets.

Barriers and the need for concerted action

Despite significant progress, particularly over the last few years, the development of renewables in the Western Mediterranean region is still constrained by a series of institutional, technical, regulatory and economic barriers, which undoubtedly represent a challenge for both

[1] No information is available for Libya.

private investors and public decision-makers. An enabling environment would require a series of transformations that address the following: i) Setting mandatory renewable energy targets within a stated deadline; ii) Establishing an institutional framework with clear allocation of roles and responsibilities to allow a transparent market; iii) Defining fair rules to guarantee market access to independent power producers; iv) Adoption of policy support measures for renewable energy projects based on the project scale, the degree of maturity of the technology and the type of application (electricity vs. other use); v) Gradual phase out of subsidies to conventional energy technologies; vi) Accurate market design and overall assessment of the impact of increasing RE share on the grid; and vii) Easier access to finance and raising capital, especially access to lower cost finance, would be required for a wider-scale deployment of renewable energy technologies (Menichetti & El Gharras, 2017).

Although the costs of several renewable energy technologies are rapidly decreasing, market competitiveness and grid parity are unlikely to be reached if subsidies to fossil fuels and low electricity tariffs are maintained. The progressive adjustment of energy prices, including incorporating the externalities from energy production and the removal of subsidies, will help ensure a more level playing field for renewables. Of course, such a process should be implemented smoothly, taking into account local social and economic constraints. Another main barrier to large-scale deployment of renewables in the Western Mediterranean region is represented by current limited grid capacity and weak interconnections. The creation of a fully integrated Euro-Mediterranean electricity market will necessarily require a significant reinforcement and integration of the south Western Mediterranean power network. Capacity-building in the sector is also key to ensuring that renewable energy installations are accurately designed, installed and maintained by a network of local professionals.

To induce project deployment, a number of countries have adopted a mix of supporting tools, including renewable energy plans and objectives, tendering, price mechanisms (feed-in tariffs and feed-in premiums), quota systems and tax incentives as well as long term power-purchase agreements (PPA). In particular, government-backed tenders have resulted in some of the most cost-effective projects at the global level for solar and wind. In Morocco, the 850 MW wind project with record bids of around $30/MWh is among the lowest prices announced for wind energy in the world (Menichetti & El Gharras, 2017). However, compared to other world regions, the Western Mediterranean is still not attractive for public and private finance. If Western Mediterranean countries want to position themselves as sustainable energy market champions the above-mentioned challenges have to be addressed with a commonly shared, long-term political vision in order to attract the necessary public-private partnerships that can trigger the needed investments in renewable electricity capacity and infrastructure. In particular, joint partnerships have the potential to

reduce investment risk, make projects bankable and enable the creation of a sustainable energy market and industry.

Such a vision needs to recognise the positive implications of investing in new strategic interconnecting networks and the enormous potential of renewables in the Western Mediterranean, which represent a huge opportunity for energy security and diversification, market creation, economic development and cooperation.

Conclusion

- The Mediterranean region has been a pioneer in the establishment of a framework for the promotion of sustainable development. Being a very fragile ecosystem, the Mediterranean has to keep up the momentum to avoid overly severe impacts deriving from climate change and environmental degradation. In this context, clean energy technologies have an important role to play to foster a drastic change and lead to a more sustainable future in the region.

- The Mediterranean is endowed with a vast renewable energy potential, but the development growth rate has been moderate until very recently. As a result, the energy mix is still dominated by fossil fuels. Nevertheless, ambitious plans have been launched in several Western Mediterranean countries to deploy clean energy technologies.

- Meeting the established targets would imply adding about 3 GW of new electricity capacity from non-hydro renewable technologies per year over the next 10 years on average. The regional energy market would then be completely reshaped. To take advantage of the benefits derived from the development of clean technologies, several barriers have to be removed.

- If Western Mediterranean countries want to position themselves as sustainable energy market champions, current challenges have to be addressed within a commonly shared, long-term political vision. Such a vision needs to recognise the positive implications of investing in new strategic interconnecting networks and the enormous potential of renewables in the Western Mediterranean, which represent a huge opportunity for energy security and diversification, market creation, economic development and cooperation.

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Sécurité Alimentaire en Méditerranée Occidentale : Enjeux et Défis

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Introduction

Au sens du consensus adopté au sommet mondial sur l'agriculture et l'alimentation (FAO, Rome 1996), la sécurité alimentaire est une condition indispensable pour le bien être humain. Cette question interpelle tout à la fois le politique, le scientifique et le citoyen[1]. Au-delà de son caractère nutritionnel, le niveau de sécurité alimentaire est aussi un indice de développement socio-économique et, bien sûr, un facteur de cohésion sociale, particulièrement en Méditerranée occidentale.

Les politiques agricoles mises en œuvre ces dernières décennies privilégiant l'intensification des systèmes de production ont permis à la région d'accroitre les productions, toutes spéculations confondues, et d'être exportatrice de fruits et légumes, notamment vers les marchés européens.

La question de la sécurité alimentaire se pose aujourd'hui avec acuité en Méditerranée Occidentale, eu égard aux besoins alimentaires sans cesse croissants, avec l'évolution démographique et l'amélioration du niveau de vie. À l'exception de la France (pays exportateur), tous les pays de la région sont dépendants des importations en céréales dans des proportions variables : Malte 90%, Portugal 75%, Algérie 68%, Tunisie 55%, Maroc 38%, Espagne 35% et Italie 28%. En termes quantitatifs, les principaux importateurs de la région sont l'Algérie, l'Italie et l'Espagne, avec environ 10 millions de tonnes chacun (IEMed, 2017, p. 471).

À cela s'ajoute la volatilité des prix des denrées de base sur le marché international, induite par la conversion de certaines productions agricoles en biocarburants. L'autre élément à ne pas négliger est celui du nouveau mode de consommation alimentaire, de plus en plus déconnecté de la diète méditerranéenne, particulièrement chez les plus jeunes. Cela n'est pas sans conséquence sur la santé, si l'on en juge par rapport à l'émergence de certaines pathologies telles que l'obésité ou le diabète. La situation méditerranéenne risque de se compliquer sous l'effet des changements climatiques sur les ressources naturelles, surtout sur l'eau.

À propos de la dépendance alimentaire en Méditerranée occidentale

Au sens de la définition adoptée par les Nations Unies à Rome en 1996, on entend par sécurité alimentaire l'accès à une nourriture suffisante et saine en tout moment, permettant à chacun une vie saine et active. Cela met en exergue à la fois l'aspect

[1] Déclaration d'Alger du 27 novembre 2013 et Forum du dialogue 5+5, Alger 26 et 27 juin 2018 (Med Think, 2018).

quantitatif et qualitatif des aliments, ainsi que leur disponibilité. Pour l'apprécier, on se réfère le plus souvent à la ration alimentaire exprimée en Kcal/j/hab et à sa teneur en protéines animales et végétales.

La ration alimentaire

Pour l'ensemble de la région, une nette progression de la disponibilité alimentaire s'est enregistrée au cours des cinquante dernières années, mais avec une marge d'avance pour les pays de la rive Nord. En rive Sud, pour les trois pays du Maghreb central (Algérie, Maroc, et Tunisie), aussi bien la disponibilité alimentaire et la part des protéines totales, que celles des protéines animales, ont été multipliées par 1.5 à 2 fois, voire par 3 dans le cas de l'Algérie, et ce en référence au début des années soixante (Bedrani, 2015). L'apport calorifique varie selon les pays entre 3174 Kcal/jour/personne pour l'Espagne et 3579 pour l'Italie (tableau 1).

Tableau 1. Apport calorifique et taux de dépendance dans les pays méditerranéens

Pays	Portugal	Algérie	Maroc	Tunisie	Espagne	France	Italie	Malte
R A Kcal/our/ personne	3477	3296	3403	3349	3174	3482	3579	3378
taux de dépendance céréales	75%	68%	38%	55%	35%	-90%	28%	90%

Source : IEMed, 2017, (p. 471).

Cependant, pour l'ensemble des pays méditerranéens, à l'exception de la France et de Chypre, les calories d'origine végétale dominent avec 50% de l'énergie totale et atteignent 80% au Maghreb (Palma et Padella, 2008). En termes de qualité alimentaire proprement dite, et ce en référence à l'indice IQA, apprécié sur la base du taux de consommation de certains aliments recommandés par l'OMS, l'étude comparative sur plusieurs pays réalisée par l'équipe du CIHEAM montre une tendance à la dégradation de l'alimentation (Palma et Padella, 2008), avec tout de même un attachement culturel pour la diète méditerranéenne.

Dépendance alimentaire

L'augmentation de la disponibilité alimentaire au Nord s'est accompagnée d'une hausse

des calories d'origine animale (viande, produits laitiers) et des huiles végétales, associée à un accroissement de la consommation en sucres simples (boissons, gâteaux…) alors que la part des protéines végétales (céréales et légumes secs) régresse. En rive Sud, l'alimentation demeure essentiellement à base de céréales et de légumes secs, couplée à une forte consommation de sucres simples (Padilla, 2008).

Notons aussi que la cherté de certains produits (viande et poisson surtout) ne permet pas leur accessibilité ou, du moins, très peu, à une frange de la population à faible revenu, notamment en rive Sud. On y estime dans cette dernière que 12 à 24% des enfants de moins de cinq ans accuseraient un retard de croissance. Pour cette même classe d'âge, 2 à 3% des enfants présentent un surpoids et 10 à 14% sont en sous poids (Bedrani, 2015 ; IEMed, 2017), ce qui n'exclue pas ces cas de figure en rive Nord, où un certain taux de pauvreté persiste (8 à 40% selon le pays) (Palma et Padella, 2008).

Jusqu'à présent, la disponibilité alimentaire est assurée, du moins quantitativement, grâce au recours aux importations et à l'application de subventions aux produits de base. Or, cette situation peut basculer suite à la crise économique et à d'autres facteurs qui pourraient conduire les États à moduler le système des subventions. Pour toute la région méditerranéenne, la dépendance alimentaire se chiffrait en 2014 à 212 milliards de dollars pour 16 pays riverains au Nord et à 75 milliards de $ pour 11 pays au Sud et à l'Est (Garcés, 2017), ce qui indique que la situation est critique pour l'ensemble de la région, mais à des degrés variables d'un pays à l'autre.

Ce déficit tient tant à des facteurs naturels (récurrence des sécheresses et donc déficit hydrique, médiocrité des eaux disponibles, pauvreté des sols, désertification...) qu'à des modes d'exploitation et de gestion peu performants voire inadaptés (manque de technicité, inorganisation des filières et des acteurs, manque de régulation des marchés, déperdition de productions et de produits alimentaires…), auxquels il faut ajouter la conversion de terres agricoles au profit d'une urbanisation accrue, notamment dans les zones littorales à forte potentialité agricole.

La sécurité alimentaire dans la démarche intersectorielle

Il convient de préciser qu'assurer sa sécurité alimentaire ne signifie pas produire tous ses besoins alimentaires au niveau national, ce qui est d'ailleurs impossible quelque soit le pays. En outre, la sécurité alimentaire implique la mise en œuvre d'une stratégie intersectorielle nationale, voire régionale (eau, agriculture, énergie, industrie, formation, recherche, commerce…) afin de faire face aux défis de l'heure (globalisation, changements climatiques, crise économique…). Toutefois, les interrogations que suscite

de nos jours cette question mettent l'agriculture et l'agroalimentaire au cœur des débats, à la fois pour le volet quantitatif et qualitatif (production des terres et qualité des produits agricoles et agro-industriels), avec une question centrale : Comment produire mieux et durablement ?

Il faut alors rappeler que la succession des civilisations et des cultures au fil du temps a permis à la Méditerranée de capitaliser des pratiques et des savoirs ancestraux, notamment dans l'usage de la terre et surtout de l'eau, faisant d'elle une terre agricole par excellence, ornée de paysages riches et diversifiés malgré les aléas climatiques qui la caractérisent tant en rive Nord que Sud (Drain, 2002). L'ingéniosité humaine a même fait naitre des lieux de vie, les oasis, en plein milieu désertique, là où la sédentarisation de l'homme n'aurait pas été possible sans ces établissements humains (Lakhdari et al., 2015).

Somme toute, la Méditerranée occidentale est passée au cours des dernières décennies d'une agriculture d'autosuffisance à une agriculture industrielle orientée vers le productivisme, transformant les paysages, impactant le milieu nourricier (eau/sol) et la biodiversité, mais aussi notre mode de consommation. Cela suscite des débats de plus en plus chauds, notamment sur les aspects sanitaires des produits agricoles et des aliments. Ces systèmes de production gagnent de plus en plus la rive Sud, et l'Algérie n'est pas en reste.

Le défi algérien de la sécurité alimentaire

En quête de sa sécurité alimentaire depuis trois décennies au moins, l'Algérie a entrepris de vastes programmes de développement agricole (PNDA, FNRDA, PPDRI, Renouveau Rural) étendus jusqu'aux régions arides (le Bas Sahara surtout). Outre leur production dattière de renommée, avec des rendements allant jusqu'à 1200 qx/ha pour la tomate, 875qx/ha pour le poivron et 250 à 300 qx/ha pour la pomme de terre, aujourd'hui ces régions contribuent à l'approvisionnement du marché national en légumes et fruits frais à hauteur de 28% et tentent de se frayer un chemin pour l'exportation. Outre la dynamique agricole enregistrée à l'échelle nationale, ces programmes ont conduit l'Algérie vers une certaine satisfaction en fruits et légumes, ainsi que viande blanche et rouge. La productivité de la terre est passée de 94 $/ha à 208 $/ha et le taux de croissance de la productivité totale des facteurs, de 1.6 à 6.6%.

Dans ce contexte particulier, la question qui nous interpelle concerne la durabilité de ces nouveaux systèmes à caractère intensif, conduits sous forme compartimentée par comparaison au modèle oasien intégré. Aujourd'hui, cette agriculture doit faire face à un

double défi : le socio-économique (transformation, conservation, commercialisation, main d'œuvre, organisation…) et l'écologique, notamment concernant la préservation de la ressource hydrique, majoritairement à caractère fossile (Lakhdari & Dubost, 2011 ; Lakhdari, 2017).

Toutefois, le déficit persiste pour les céréales et tout particulièrement en blé tendre, légumes secs, lait et dérivées et huile, denrées de base pour la population algérienne. La facture des importations se chiffre autour de 12 à 13 milliards de dollars, dont 5 à 6 milliards pour les céréales, 1.5 pour le lait, 1.5 pour l'huile et 1.5 pour le sucre et le reste pour les intrants agricoles (Bedrani, 2015).

Menaces climatiques en Méditerranée occidentale

Pour le Maghreb, des études indiquent une hausse des températures de 1 à 2°C, soit le double de la moyenne mondiale (0.74°C) à partir de 1970. Il y a eu également une augmentation des sécheresses et des vagues de chaleur, ainsi qu'une accélération du processus de désertification (GIEC, 2007).

Sur l'Algérie, les projections climatiques réalisées sur la base d'une comparaison de séries climatiques (1931-1960 et 1961-1990), avec l'application du modèle anglais (UKHI), indiquent d'ici 2025 une augmentation de 1°C et plus de la température, une diminution des précipitations de 15 à 20% par rapport à 1990, ainsi qu'un déplacement agro-climatique de 100 km vers le Nord avec extension de la désertification (Kara, 2008) et une hausse des vagues de chaleur.

Pour les deux rives de la Méditerranée les prévisions ne sont pas à l'optimisme à l'horizon 2050 (augmentation de la moyenne de la température de 2 à 3 C°, une réduction des précipitations de 5 à 20% et accentuation des sécheresses)[2]. On signale aussi une avancée généralisée du calendrier agricole et un raccourcissement des cycles des cultures (céréales, maïs, arbres fruitiers et surtout le vignoble) (Seguin et al, 2006), ainsi qu'une vulnérabilité accrue à la désertification notamment en Espagne, où 31% des terres seraient menacées de désertification. Paradoxalement, les deux rives seraient confrontées périodiquement à des pluies exceptionnelles crues et inondations. Autrement dit, elles se trouvent d'ores et déjà face à une alternance croissante des phénomènes extrêmes.

Bien que l'empreinte climatique soit plus marquée en rive Sud, celle du Nord encoure les mêmes risques avec le temps. Il nous faut souligner surtout les risques potentiels

[2] Données repérées lors du III Forum Med Think à Alger (Med Think, 2018). Pour plus d'informations, consulter http://med-think5plus5.org/wp-content/uploads/2018/09/Report-16Alger-EN1.pdf

(interdépendants) pouvant impacter directement la sécurité alimentaire, à savoir :

- Une réduction de la ressource hydrique et par conséquent l'accroissement des tensions entre les différents utilisateurs de l'eau.
- La modification du calendrier agricole, avec le risque d'une diminution des productions agricoles, des cultures irriguées et surtout celles des cultures sèches (céréales et fourrages).
- La hausse des canicules amplifie l'impact des sécheresses (augmentation de l'ETP et, par conséquent, l'accroissement de la salinisation des terres irriguées et la chute des rendements). La vulnérabilité de la forêt méditerranéenne aux incendies est accentuée et la désertification aussi. À son tour, cette dernière contribuera à l'effet de serre.

Faire face au défi alimentaire en Méditerranée occidentale

Assurer sa sécurité alimentaire dans le contexte actuel (marqué d'une crise économique quasi générale, d'ébullition géopolitique et de menaces climatiques lourdes) est un défi majeur pour toute la région et, tout particulièrement, en rive Sud. Cela impose une démarche stratégique globale et multisectorielle permettant de repenser l'agriculture ou, du moins, corriger ses faiblesses et planifier ses projections dans l'avenir selon une vision claire et des lignes directrices correctement ciblées et quantifiées.

À cet effet, il faudra d'abord considérer les facteurs endogènes de chaque pays, que ce soit concernant les besoins alimentaires et leur projection selon échéancier, les potentialités agricoles exploitables et/ou optimisables, l'impact climatique sur les ressources naturelles -l'eau en particulier-, le capital d'expérience agricole et enfin les leçons que l'on peut en tirer, sans négliger les pratiques ancestrales. Le mode de coopération et d'échanges inter-espaces méditerranéens, notamment en matière de transfert technologique et d'échanges commerciaux, ne sont pas non plus à négliger.

Pour les pays fortement dépendants des importations alimentaires, des efforts doivent être maintenus afin d'assurer un certain niveau de leur alimentation de base (niveau à évaluer par le pays lui même sur la base d'études socio-économiques fiables). En termes d'augmentation des productions, il est toujours possible de recourir à l'intensification et/ou l'extension des superficies, sachant que chacune de ces options a des avantages et des inconvénients.

Extension des superficies agricoles

L'extension des superficies agricoles n'est envisageable que si le potentiel (eau et sol)

le permet. Cela nécessite avant tout une concertation intersectorielle périodique entre l'agriculture et les ressources en eau sur la base d'études intégrant les prévisions relatives à l'eau et une cartographie des sites aptes à la mise en valeur, prenant en considération les risques majeurs potentiels (la désertification en particulier).

Pour les cultures irriguées, des aménagements hydro-agricoles idoines doivent être de règle notamment en rive Sud, où l'aridité climatique est souvent couplée à la salinité du milieu nourricier (eau/sol). En effet, pour les pays confrontés au stress hydrique et à la pénurie, tels que l'Algérie et la Tunisie, l'effort doit être concentré sur l'économie de l'eau mobilisée pour l'agriculture. Cet effort concerne également certains pays de la rive Nord confrontés à des stress conjoncturels et/ou localisés (l'Espagne, par exemple).

Par ailleurs, la valorisation du m3 d'eau agricole requiert aussi un choix judicieux d'espèces, voire des variétés les moins exigeantes en eau et des apports d'eau fractionnés selon les besoins réels des cultures et non selon les volumes disponibles. Elle requiert aussi le développement des techniques d'irrigation « économisatrices » d'eau.

On peut également jouer sur l'amélioration de la capacité de rétention en eau des sols via des pratiques agro-écologiques bien connues en Méditerranée (travail du sol et amendement organique notamment). Aujourd'hui, plus qu'en tout autre moment, la recherche doit être impliquée et soutenue de façon conséquente pour nous proposer des variétés aptes au stress hydrique, salin et thermique à travers la valorisation du patrimoine génétique local, notamment en ce qui concerne les grandes cultures pour l'alimentation humaine et animale. L'innovation technologique en matière d'épuration des eaux pour une réutilisation agricole sans risques sanitaires et environnementaux doit être aussi encouragée.

Intensification raisonnée

Pour ce qui est de l'intensification agricole, le problème se pose actuellement surtout en termes de qualité de productions par rapport à la santé publique et celle de l'environnement. Aujourd'hui, il est bien difficile de dire que l'on peut stopper du jour au lendemain tout recours aux intrants chimiques, mais on ne doit pas non plus laisser de telles pratiques en l'état, notamment concernant les pesticides. Il y va de la santé des populations. Une démarche visant leur réduction progressive à travers différentes actions parait soutenable dès à présent, à savoir :

- Une maitrise des itinéraires techniques associés à des pratiques agro-écologiques (pratique d'assolement ou rotation ; nettoyage des sols après récolte, maitrise des irrigations et de l'aération, surtout pour les cultures sous serres…).

- L'information, la sensibilisation et la formation des agriculteurs par rapport aux substances autorisées est capitale.
- La promotion de l'agriculture biologique sur les nouveaux périmètres et l'encouragement à une reconversion de l'agriculture conventionnelle, du moins progressivement.
- Le suivi et le contrôle du devenir des produits utilisés à travers un observatoire des périmètres agricoles et des productions.
- Enfin, sur cette question en particulier, la recherche est interpellée pour proposer des alternatives aux intrants chimiques (pesticides en particulier), ce qui va permettre une réelle transition vers un mode de production et de consommation durable (Objectif 12 des ODD). A cet effet, les chercheurs aussi bien en rive Nord qu'en celle du Sud doivent s'atteler pour la mise au point de telles alternatives malgré les contraintes matérielles rencontrées.

Nécessité d'un raisonnement global

Sur tout un autre volet, la sécurité alimentaire ne doit pas être raisonnée et mesurée qu'en termes de production alimentaire de base, mais plutôt en termes de balance commerciale (import/export). Cela revient en fait à rechercher d'autres sources (agricoles ou non) permettant d'infléchir la facture des importations alimentaires de première nécessité.

A cet effet, les pays de la Méditerranée occidentale recèlent des ressources et des produits d'excellence spécifiques au milieu naturel et aux paysages façonnés par les activités socioéconomiques et culturelles des populations. Tel est le cas des produits des terroirs, de certaines plantes à haute valeur ajoutée, mais aussi de l'artisanat, du potentiel touristique riche et diversifié, ainsi que des sources énergétiques renouvelables jusque-là peu valorisées.

Un autre atout de la Méditerranée occidentale est sa ressource humaine, notamment sa jeunesse réceptive au progrès et qui peut jouer le fer de lance dans cette transition vers des modes de production et de consommation durable. Or, cela nécessite un encadrement et un aiguillage vers des filières d'économie verte, autrement dit, une orientation dès la formation vers ces filières, source d'emploi et de richesses durables.

Dans le même sens, raisonner sa sécurité alimentaire implique impérativement la lutte contre le gaspillage alimentaire, qui pèse lourd dans la facture des importations des produits subventionnés (de la parcelle agricole au consommateur).

Conclusion

- En Méditerranée occidentale, l'agriculture doit s'inscrire dans une option de durabilité et d'aridification du milieu, autrement dit, en privilégiant les cultures peut exigeantes en eau, selon spécificité et vocation des agrosystèmes dans leur diversité, tout en s'appuyant sur la recherche et l'innovation.

- L'organisation de la petite paysannerie en coopératives revêt une importance capitale pour la valorisation des moyens, des productions et la pérennité des activités en place. A cet égard, la valorisation des métiers agricoles rendrait plus attractive l'agriculture notamment chez les jeunes, autrement dit, la relève de demain.

- Une coopération Nord-Sud et Sud-Sud dans le domaine agricole et dans les volets connexes (technologie/innovation, échanges d'expériences notamment dans l'organisation des filières, valorisation des produits des terroirs, échanges commerciaux) contribuera à coups sûr à lever certaines contraintes et à rapprocher davantage les deux rives.

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Moving Towards a Virtuous Water-Energy-Food Nexus in the Western Mediterranean

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Introduction

The Mediterranean basin is considered a "hot-spot" of climate change. Rise in temperature, drop in rainfall, increase in the number and intensity of extreme weather events, and sea level rise are all factors that could exacerbate existing environmental problems in the region. Focusing the analysis on the Western Mediterranean, several disparities emerge between the two rims, both in terms of contribution and vulnerability to global warming. While North-Western Mediterranean countries (NWMCs) show higher levels of CO_2 emissions per capita and, consequently, are more responsible for human-induced climate change, South-Western Mediterranean countries (SWMCs) are and will be more affected by its impact. The main reason for this is that, on the one hand, they are more exposed to soil aridity and water scarcity and, on the other, they hold economic structures that are more strictly dependent on natural resources. In addition, technical and financial capacities are too limited to implement large-scale adaptation options.

Given the current trends in population growth and associated water, energy and food (WEF) demands in SWMCs, WEF security is closely linked, perhaps more than in any other region in the world. Despite the extreme resource scarcity in these countries, which would normally require improvements in resource use efficiency, cross-resource use efficiency is generally low. Particularly, conventional sectoral approaches have entailed significant trade-offs and negative externalities in other respective sectors as a result of very high "perverse" subsidies on resource use.

In such a scenario, integrated WEF nexus approaches, which manage and govern resources in a holistic way, should provide significant potential to reduce distortions and increase complementarities between sectors, enhancing resource efficiency and overcoming scarcity in resources.

The main sector through which it is possible to minimise trade-offs and maximise synergies within the WEF nexus is that of renewables. Through the development of renewable energy sources and greater cooperation between ten countries of the Western Mediterranean region, it is possible to both reduce greenhouse gas emissions (GHG) and turn the conventional WEF nexus into a virtuous circle.

The Challenges of Climate Change in the Western Mediterranean

Climate change and inequality are ineluctably linked both in terms of who contributes

most to climate change and who is most affected by it. These disparities are also partly reflected in two United Nations (UN) processes: the Paris Agreement of the UN Framework Convention on Climate Change under which countries agreed to hold the increase in the global average temperature to below 2°C above pre-industrial levels, and the UN's Sustainable Development Goals aiming to achieve a better and more sustainable future for all.

The 5th Intergovernmental Panel on Climate Change Report states with 95% confidence that more than half of the observed increase in global average surface temperature from 1951 has been caused by the anthropogenic increase in GHG concentrations and other anthropogenic forcings, thus identifying humans as the main agent of the current climate crisis.

The ten Western Mediterranean countries emitted, jointly, about 3.6% of the aggregate world emissions of carbon dioxide in 2016. The aggregate emissions of SWMCs account for a mere 0.8% of the aggregate global emissions. Thus, NWMCs contribute for more than two thirds of the CO2 emissions for the whole Western Mediterranean (Table 1).

Table 1. Total and per capita CO2 emissions in the Western Mediterranean, 2016

Country/Region/World	Total CO2 emissions (MtCO2)	Per capita CO2 emissions (tCO2)
France	344	5.3
Italy	359	6
Malta	1.8	4.2
Portugal	51	4.9
Spain	261	5.6
NWMCs Total	**1015**	
Algeria	154	3.8
Libya	60	9.6
Mauritania	2.8	0.7
Morocco	60	1.7
Tunisia	31	2.7
SWMCs Total	**307.8**	
WM Total	**1322.5**	

Source: Global Carbon Atlas, 2016

Emissions from electricity and heating constitute the main sector of CO2 emissions due to energy use in the Western Mediterranean (41% in 2014), followed by transport (33%) (Table 2).

Table 2. CO2 emissions by sector in the Western Mediterranean, 2000-2014
(% of total fuel combustion)

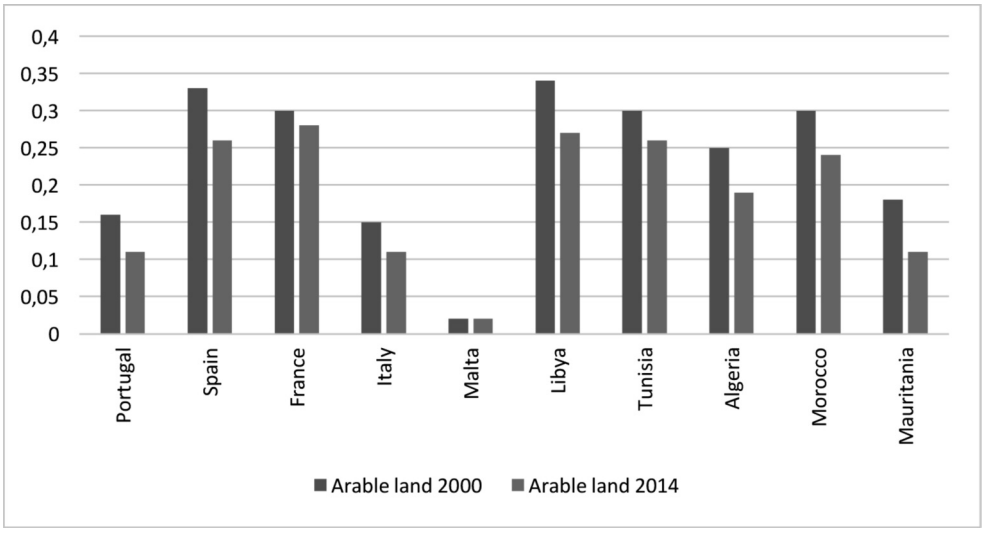
	Electricity and heat production		Manufacturing industries and construction		Residential buildings and commercial and public services		Transport		Other sectors	
Country/Region/World	**1990**	**2014**	**1990**	**2014**	**1990**	**2014**	**1990**	**2014**	**1990**	**2014**
France	18.8	13.8	20.7	15.7	24.8	23.4	32.8	42.4	3.2	4.7
Italy	36.6	35.6	19	11.2	17.2	18.1	24.7	33	2.3	2.2
Malta	76.6	68.4	0	1.3	3.9	6.4	19.5	23.1	0	0.9
Portugal	43.5	41.1	21.3	12.9	5.7	6.6	25.6	36.7	3.9	2.7
Spain	38.5	37.4	20.3	14.3	8	9.7	31.2	35.3	2.1	3.3
NWMCs	**42.8**	**39.3**	**16.3**	**11.1**	**11.9**	**12.8**	**26.8**	**34.1**	**2.3**	**2.8**
Algeria	45.1	38.8	11.1	8.3	12.9	15.2	30.9	35.5	0	2.4
Libya	63	53.2	8.1	4.1	5.1	3.4	24	39.3	0	0
Mauritania	-	-	-	-	-	-	-	-	-	-
Morocco	40.3	40.6	27.4	13.6	8.9	12.5	19.8	28.8	3.6	4.5
Tunisia	32.8	38.8	27.8	21.3	13.4	10.2	20.4	25.3	5.6	4.4
SWMCs	**45.3**	**42.8**	**18.6**	**11.8**	**10.1**	**10.3**	**23.6**	**32.2**	**2.3**	**2.8**
WM	**44**	**41**	**18**	**11.5**	**11**	**11.5**	**25**	**33**	**2.3**	**2.8**
World	**43.3**	**49**	**20**	**20**	**13.1**	**8.6**	**20**	**20.4**	**3.7**	**2**

Source: World Bank, World Development Indicators, 2018

Data analysis suggests that while NWMCs are faced with the need to immediately reduce their CO2 emissions, for SWMCs the challenge lies in the ability to contain future emissions whose entity will deeply depend on the investments capacity and on the choices made in two key sectors: electricity and transport.

Although climate change is an issue affecting all Western Mediterranean countries, SWMCs are especially vulnerable due to lack of two natural resources considered strategic for agricultural production: fertile land and water. Over the years, high population growth rates associated with the scarcity of arable land have led to a decline in the per capita availability of cultivable area, contributing to deforestation and over-exploitation of structurally fragile land (Figure 1). Land degradation or desertification is on the increase in SWMCs. According to the last AFED Report, in 2012 the area threatened by desertification ranged from 9.7% in Algeria to 64% in Tunisia (Table 3).

Fig. 1 Arable land in the Western Mediterranean (ha per capita)



Source: World Bank, World Development Indicators, 2018

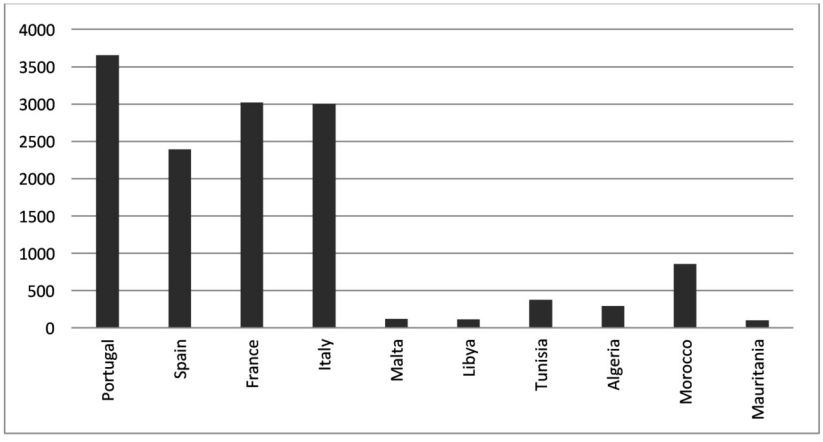
Tab. 3 Desertified area and the area threatened by desertification in South-Western Mediterranean countries, 2012

Country	Total area (000 of km2)	Desertified area (000 of km2)	Desertified area (%)	Area threatened by desertification (000 km2)	Area threatened by desertification (%)
Algeria	2,382	1,970	83	230	9.7
Libya	1,807	1,589	88	381	21.1
Mauritania	1,031	636	62	343	33.3
Morocco	711	455	64	195	27.4
Tunisia	164	-	-	105	64

Source: N. Saab (2017). Arab Environment in 10 Years

Both geo-climatic constraints and unsustainable uses of water resources amplify the gap between water demand and supply inducing a severe water crisis. All SWMCs are currently below the water poverty line of 1000 m3/capita/year (Figure 2).

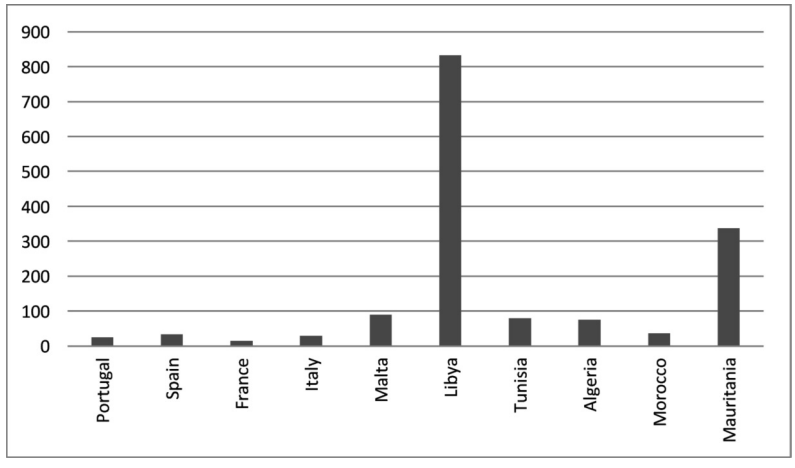
Fig. 2 Internal renewable water resources in the Western Mediterranean, 2014 (m3 per capita)



Source: World Bank, World Development Indicators, 2018

Moreover, the water exploitation index close to or above 100% suggests that in some Western Mediterranean countries more than half of current water withdrawals already exceed sustainable limits (Figure 3).

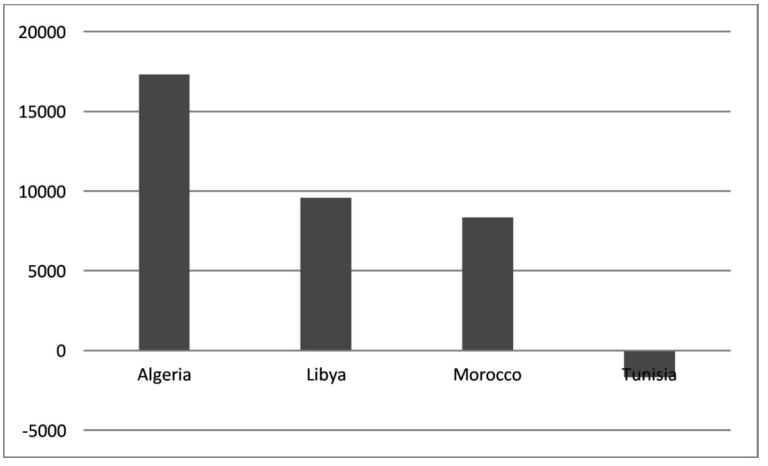
Fig. 3 Water Exploitation Index in the Western Mediterranean, 2014 (%)



Source: World Bank, World Development Indicators, 2018

The direct link between food, arable land and water limits the potential to promote food production. As a result, international trade plays a key role in achieving macro-level food security in SWMCs. As domestic production of water-intensive food is not an efficient way of using scarce natural resources, governments have generally adopted a trade-oriented food security strategy based on the neoclassical theory of international comparative advantages. In this way, they have "externalised" the pressure on nations' own water resources importing water in virtual form (Figure 4).

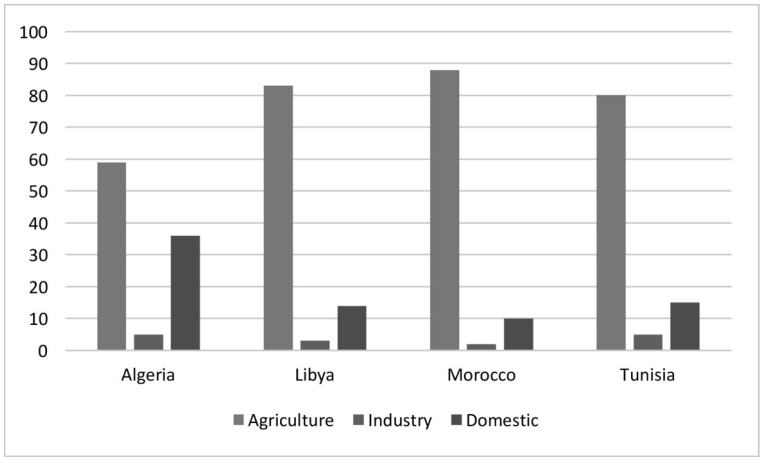
Fig. 4 Net Virtual Water Imports in some Western Mediterranean countries
(Mm3/year)



Source: Water Footprint Network, 2016

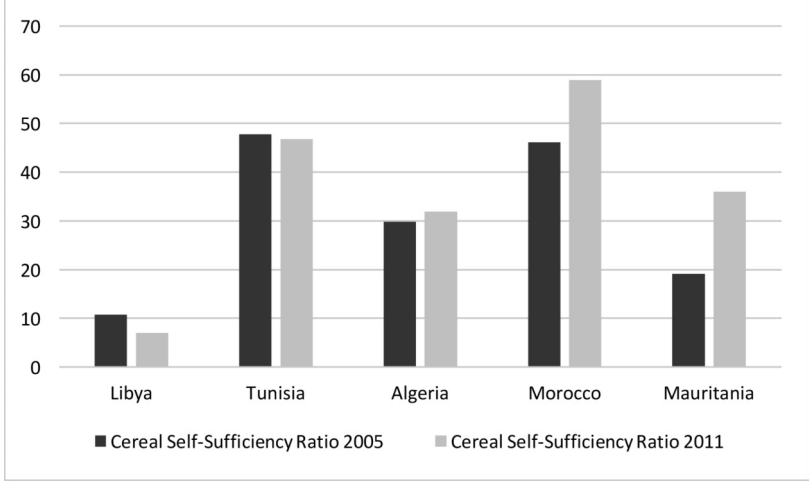
Nevertheless, achieving a certain level of food self-sufficiency has always been a national strategic goal, especially when it has been necessary to take into account considerations going beyond mere economic criteria, including geopolitical and social concerns. As a result, in SWMCs, food security has been achieved by alternating or combining food self-sufficiency and trade-based strategies depending on the greater emphasis given to economic factors or to social and geopolitical goals. There have been two consequences of these opposing policy options: an inefficient water allocation system characterised by high share of agricultural water use (Figure 5), and low level of food self-sufficiency and high vulnerability of SWMCs to the increase and volatility of international food prices (Figure 6).

Fig. 5 Water allocation by sector, 2015 (%)



Source: World Bank, World Development Indicators, 2018

Fig. 6 Cereal Self-Sufficiency Ratio (%)



Source: N. Saab (2017).

Despite contributing to food security, agriculture still plays an important role in SWMCs' economies, both in terms of employment and GDP (Table 4).

Tab. 4 Rural population, agricultural employment and agricultural contribution to GDP in the South-Western Mediterranean

Country	Rural population (% of Total) 2016	Agricultural labour force (% of Total) 2014	Agriculture (% of GDP) 2017
Algeria	29	20.1	12
Libya	20	2.5	1.9
Mauritania	48	49.6	23
Morocco	39	23.5	13
Tunisia	32	19.6	9

Source: World Bank (2018)

Challenges regarding environmental and socioeconomic systems amplify the vulnerability of SWMCs to the effects of climate change. A new study on the risks posed by climate and environmental changes in the Mediterranean basin states that the impacts of global warming have so far been underestimated because each risk within the region has been analysed independently, not taking into account the "multiplier effect" triggered by the interconnections with economic and social issues. According to the research team, average temperature in the Mediterranean has already risen by 1.4°C since the pre-industrial era, 0.4°C more than the global average. Even if future global warming will be limited by 2°C, as called for by the Paris Agreement, summer precipitation could be reduced by between 10% and 30%, threatening water availability (-2-15%) and agricultural productivity (-12-40%). Extreme weather events, such as heat waves and drought, may further contribute to yielding reductions and variability. Changes in food production and the simultaneous shift in consumption patterns towards animal-based and higher value foods will put Southern Mediterranean countries at risk of increasing their dependence on food trade.

The Conventional WEF Nexus in the Western Mediterranean

As shown in the previous paragraph, today Mediterranean countries are facing a set of complex and interrelated challenges, many of which are directly related to WEF production, distribution and use. WEF resources share many common issues, including changes in supply and demand, regional disparities, and strong interdependencies with climate change. Besides these similarities, they are intimately linked (nexus). This implies that between the respective sectors, synergies, but also trade-offs, may exist and the

prevalence of one or the other depends on the approach followed in their management. The WEF nexus in the Mediterranean region follows patterns elsewhere in the world, with resource availability, use efficiency and access closely interconnected with human securities, and critical cross-resource links. Increasing demand for WEF triggered by population growth and economic development in a scenario of resource scarcity and climate change impacts make some of these interlinkages particularly crucial, especially in SWMCs.

In the Mediterranean region energy is used in the supply chain of both water and food. Water abstraction (pumping of groundwater), purification (desalination or wastewater treatment), distribution (transport via pipelines or in urban distribution), and disposal (on-site urban or industrial wastewater) require a huge amount of energy. The current electricity needs for water management are 5% in the northern countries and 10% in the southern and eastern countries while, at global level, the food sector accounts for 30% of energy use. The increasing technification of agriculture is driving a rise in energy demand, consuming energy directly in the form of fuels for land preparation, tillage, crop management and transportation, and indirectly by the use of energy-intensive inputs, such as chemical fertilisers and pesticides. Energy is also utilised during processing, distribution, storage and preparation of food.

At the same time, water is required to produce energy and food. In most energy production processes, water is a key input. Fossil fuel production requires water for extraction, transport and processing; thermoelectric generation needs water for cooling; hydropower uses blue water available in rivers and artificial reservoirs; feedstock production for biofuels, such as ethanol, depends on irrigation water; and renewable energy resources such as solar require water for cooling and cleaning panels or collectors for improved efficiency. The impacts of energy on water withdrawal, consumption and quality depend on the technology choice, source of water and fuel type. At present, energy production accounts for nearly 15% of global freshwater withdrawals or 580 billion m3 of water every year. Agriculture is the largest user of water in the Western Mediterranean, accounting for 70-90% of freshwater withdrawals. Water is also used throughout the agri-food chain, including processing, distribution, retailing and consumption.

Climate change both affects and is affected by the WEF nexus through multiple bidirectional interactions that intertwine within the web of WEF interconnections. Western Mediterranean countries contribute to climate change primarily by burning of fossil fuels for transport and energy production, together with industrial activity. At the

same time, climate change drives a series of phenomena that have negative impacts on WEF security, exacerbating nexus conflicts in SWMCs. In addition, policies and strategies aiming to cope with climate change may amplify rather than reduce negative externalities and trade-offs within the nexus. Low carbon transition, the shift to non-conventional water resources and agricultural intensification, all implemented to mitigate and adapt to climate change, are not always nexus-smart.[1]

In addition to the external drivers, several key internal political and economic factors influence the WEF nexus in the Western Mediterranean.

Despite the extreme resource scarcity in SWMCs, which would require important improvements in resource use efficiency, cross-resource use efficiency is generally low. Conventional sectoral approaches and the lack of integration and coordination between WEF policies constitute the main drivers for inefficient resource management and cross-inefficiencies between sectors, fostering conflicts among users and the unsustainable use of natural resources. Traditionally, WEF have been considered separately in planning investments. For each sector, regulatory frameworks, organisations and infrastructures address specific sectoral goals and challenges, neglecting the interdependence between demands and policy choices made in each sector.

Furthermore, in SWMCs, the prices of energy, water and food are strongly affected by subsidies, which do not reflect the relative scarcity of the resource, the cost of the service, and the true economic relationship between resources. These market distortions encourage higher consumption, inefficiencies, loss and waste, and prevent cost recovery from infrastructure investments and operation. When subsidies within each WEF system are connected across the nexus, negative externalities and distortions can be multiplied.

Integrated Solutions to Manage the WEF Nexus

In the Western Mediterranean, the extreme vulnerability of SWMCs to the impact of climate change, the significant contribution of NWMCs in terms of GHG emissions, and the target agreed during the Cop 21 to keep the increase in global average temperature to well below 2°C above pre-industrial levels imply that greater efforts should be focused on mitigation and adaptation to climate change. Since energy represents a critical input along different stages of the water and food supply chain, renewable energy technologies could provide integrated solutions able to enhance security and sustainability across all three sectors, while supporting global climate ambitions.

[1] For instance, the adoption of so-called “low or lower carbon technologies”, such as hydropower, first generation biofuels and thermal power coupled to carbon capture and storage (CCS) systems, has important water and food trade-offs; the production of unconventional water is usually energy-intensive; intensive increasing of agricultural output requires a greater use of inputs such as water and chemical fertilisers.

In NWMCs, the development of the renewable energy sector has been growing rapidly in recent years thanks to the launch of Directive 2009/28/EC, which aims to ensure greater energy security at European level and reduce GHG emissions related to the use of fossil fuels. New incentives in terms of reduction of GHG emissions emerged during the Paris Agreement, when the European Union adopted new targets for 2030: a reduction of 40% emissions compared to 1990 and a share of at least 27% of renewable energy sources in final energy consumption.

SWMCs have a high development potential in renewable energy, especially in the solar sector, due to the presence of vast desert areas with a solar radiation density between 1,300 and 2,500 kWh/m2 per year. In SWMCs, the development of renewable energy sources has increased rapidly in the last few years. In 2015, renewable energy accounted for 13% of the region's total power generation capacity, mostly in the form of hydropower, wind and solar energy (Table 4). Morocco continues to lead the region in terms of total installed renewable generation capacity with an increase of its share of solar from 35 MW in 2014 to 198 MW in 2015, and wind from 290 MW in 2012 to around 790 MW early 2016.

Tab. 5 Renewable power: Installed capacity in South-Western Mediterranean countries, 2015

Country	Wind (MW)	PV (MW)	CSP (MW)	Hydro (MW)	Renewable excluding hydro (MW)	Renewable excluding hydro (%)	Renewable including hydro (MW)	Renewable including hydro (%)
Algeria	10	270	25	288	305	2.2	533	4.1
Libya	-	5	-	-	5	0.05	5	0.05
Mauritania	34.4	18	-	30	52.4	12.38	82.4	19.46
Morocco	790.5	15	183	1770	988.5	12.05	2758.5	33.63
Tunisia	245	20	-	66	265	5.82	331	7.37
SWMCs	1079.9	328	208	2154	1615.9	6.5	3709.9	12.9

Source: IRENA, 2016

In SWMCs, the development of renewable energy not only may satisfy the growing demand for energy in those countries with a lack of oil reserves, but also improve the resilience and adaptive capacity of countries that, due to the scarcity of two strategic resources for human survival – water and food – are more vulnerable to the impact of climate change. Generally, renewable energy technologies are less water intensive than conventional options. Water needs for solar photovoltaics (PV) and wind are negligible

compared to conventional thermoelectric generation, withdrawing up to 200 times less water to produce the same amount of electricity. In addition to contributing to significant water savings, renewable energy can be used to increase non-conventional water supply, such as desalinated water, whose production is still affected by high economic and environmental costs, due to the considerable amount of fossil energy necessary to feed the reverse osmosis.

Regarding integrated solutions that simultaneously enhance WEF security by addressing trade-offs and leveraging on synergies between sectors, several best practices are found in SWMCs. In 2012, Tunisia opened a plant for desalinating groundwater in the Ben Guardane region to increase water supply in desert areas and provide the local population with about 1.8 million litres of drinking water per day. Morocco has recently inaugurated the first phase of the Noor-Ouarzazate solar plan, which aims to increase the share of renewable energy to 42% in 2020 and 52% in 2030 and use the energy to produce desalinated water and meet the country's growing energy and water demand. In 2013, in Mauritania, the government together with the OPEC Fund for International Development and the Islamic Solidarity Fund for Development decided to co-finance a project in the Aftout El Chargui region for the production of solar energy in order to improve the access to energy in rural areas. A wind power mini-grid project and a grid-connected hybrid solar, wind and hydro project were approved for funding by the Abu Dhabi Fund for Development in 2014 and 2015, respectively. These multi-sectoral projects aim to provide access to clean energy to local communities, produce desalinated water and meet electricity needs for fish refrigeration for fishing villages along the coastal area. In Algeria, the government is implementing an ambitious Renewable Energy and Energy Efficiency Programme, which aims to produce 22,000 MW of power from renewable sources between 2011 and 2030 for domestic consumption and export. Algeria has also joined the Desertec Industrial Initiative, whose goal is to use solar and wind power to supply 15% of Europe's electricity needs by 2050.

In the last few years, a new era of green projects, based on the circular economy model, has been inaugurated in several Middle East and North Africa (MENA) countries. They aim to produce food, drinking water and zero-emission energy in desert areas through the simultaneous use of two different technologies: concentrating solar power and saltwater-cooled greenhouses. An example is the Sahara Forest Project, whose goal is to exploit the relative abundant resources in coastal desert areas (saltwater, sunlight and CO2) to produce scarce resources (food, water and clean energy) through a system able to integrate sustainable cultivation, solar energy production and desalination

process. The first country to embark on this new model of production has been Qatar, followed by Jordan and, more recently, Tunisia with a pilot of 10 hectares.

In order to exploit the potential offered by the development of renewable energy and minimise the weaknesses that still affect the sector, great opportunities arise from Euro-Mediterranean cooperation both in terms of exchange of technology and knowledge, and transfer and distribution of renewable energy. The Mediterranean Solar Plan, Desertec and MedGrid projects all aim to increase the use of solar energy and other renewable technologies for the production, by 2020, of 20 GW of electricity in order to meet the growing energy demand of South-Eastern Mediterranean countries and export the energy surplus to European countries through the creation of a long-distance transport network. Strengthening cooperation in the field of renewable energy within the Western Mediterranean, as hoped during the 1st Ministerial Conference on the Environment and Renewable Energy in 2010, would accelerate the transition towards a low-carbon economic model, meet the climate change mitigation targets set by European policies and the Paris Agreement, satisfy Priority 6 and 9 of the Water Strategy in the Western Mediterranean, and is in line with the PRIMA goals for the development of innovative solutions to optimise the management and use of water resources for food production and ensure food security.

Conclusion

- Evidence shows that the WEF nexus in the Western Mediterranean follows the patterns elsewhere in the world, but given the extreme scarcity in water and arable land, which mainly affects SWMCs, and the increasing impacts of climate change, some of these interlinkages are becoming particularly critical. In addition, conventional sectoral approaches and very high “perverse” subsidies on resource use have entailed significant trade-offs and negative externalities in WEF sectors.

- Hence, a nexus approach that integrates management and governance across these three sectors can simultaneously enhance WEF security by minimising trade-offs and maximising synergies between sectors, while renewable energy development offers the opportunity to decouple water and food production from fossil fuel supply, leading to several advantages from both a socioeconomic and environmental point of view.

- Through the development of alternative energy sources and the optimisation of the WEF nexus in the Western Mediterranean, it is possible to reduce GHG and limit

the vulnerability of those socioeconomic systems that are more exposed to the effects of global warming.

- In such a context, great opportunities arise from Euro-Mediterranean cooperation. Particularly, the Western Mediterranean can be regarded as a kind of "Energy District" from a Marshallian point of view, able to maximise the positive externalities through the creation of networks to increase renewable energy flows and investments and knowledge transfers between the two rims.

- Cooperation between the Western Mediterranean countries in the field of renewables can meet both the growing energy demand of a northern rim hungry for non-fossil energy sources and the growing water demand of a southern rim thirsty for non-conventional water resources.

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IEMed.

The European Institute of the Mediterranean (IEMed), founded in 1989, is a consortium comprising the Catalan Government, the Spanish Ministry of Foreign Affairs and Cooperation and Barcelona City Council. It incorporates civil society through its Board of Trustees and its Advisory Council formed by Mediterranean universities, companies, organisations and personalities of renowned prestige.

In accordance with the principles of the Euro-Mediterra nean Partnership's Barcelona Process, and today with the objectives of the Union for the Mediterranean the aim of the IEMed is to foster actions and projects which contribute to mutual understanding, Exchange and cooperation between the different Mediterranean countries, societies and cultures as well as to promote the progressive construction of a space of peace and stability, shared prosperity and dialogue between cultures and civilisations in the Mediterranean.

Adopting a clear role as a think tank specialised in Mediterranean relations based on a multidisciplinary and networking approach, the IEMed encourages analysis, understanding and cooperation through the organisation of seminars, research projects, debates, conferences and publications, in addition to a broad cultural programme.

Medthink 5+5

The Med Think 5+5 is a sub-regional network of think tanks that was established in May 2016 with the support of more than thirty institutions from the ten Western Mediterranean countries of the 5+5 Dialogue: Portugal, Spain, France, Italy, Malta, Morocco, Mauritania, Algeria, Libya and Tunisia.

The 5+5 Dialogue is an informal sub-regional and intergovernmental forum established in 1990, that was created with the aim of fostering cooperation in the fields of political dialogue, defense, security, migration, transport, water, research and education, renewable energies and environment, trade, investment, health and tourism.

The Med Think 5+5 works around the Western Mediterranean Forum and its ministerial format and high-level working groups by cementing a useful partnership with regional cooperation organisations and civil society with the goal of serving as a practical model for grater regional integration.

The network aims to respond to basic needs within the system of the 5+5 Dialogue by working to enable dialogue though the organization of conferences, seminars and symposia with key players in the region. It also serves as a platform of joint research and dissemination in order to provide output to the policy-making leadership of the Western Mediterranean Forum.