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The impact of the Russia-Ukraine war in the Mediterranean region: the socio-economic consequences

edited by
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by Desirée A.L. Quagliarotti and Stefania Toraldo

Introduction

Over the last decade and a half, the Mediterranean region has been affected by several destabilizing events, including the financial crisis; the 2007-08 and 2010-11 food crises; the «Arab Spring» popular uprisings, influenced by soaring food prices; the civil war in Syria; the migration emergency; and, more recently, the COVID-19 pandemic. Moreover, the current global crisis triggered by Russia's military invasion of Ukraine in February 2022 poses additional critical challenges for the region. From a security perspective, the war has already caused extensive damage and loss of life in key population centres, leading to political tensions and confrontation between states. Along with the complex security implications, the conflict has also induced soft security impacts, affecting many components of human security and exacerbating the negative socio-economic trends that emerged in the years of the COVID-19 pandemic.

The interaction between these present and future risks results in a comprehensive «polycrisis», a cluster of related global risks with compounding effects, such that the overall impact exceeds the sum of each part[1]. Considering, among other things, that the physical consequences of climate change primarily impact the water, energy and food (WEF) sectors simultaneously, a multi-resource crisis is particularly emerging alongside global market disruption, political instability and economic growth.

[1] First coined in the 1970s, the term «polycrisis» has been popularized by Financial Times contributing editor and Columbia University economic historian Adam Tooze to describe a situation where disparate crises interact such that the overall impact far exceeds the sum of each part [Tooze 2022].

Since Russia and Ukraine are central players in global commodity markets, the ongoing war and accompanying sanctions are dramatically unsettling energy and food markets, with ripple effects on WEF resources and bringing about a setback, at least in the short term, in climate change actions.

Reliable and cheap access to WEF resources underpins the critical functioning of societies in the Mediterranean region. Supply crises, associated with increasing demand for WEF resources, can be highly destabilizing, exposing the fragility of states and leading to loss of well-being, widespread violence, political upheaval and involuntary migration. This awareness calls for a paradigm shift by adopting measures to reduce exposure, but also by cultivating a mindset, capabilities and partnerships to strengthen resilience at national and regional levels.

This chapter highlights the effects of the Ukraine war on the WEF resources in the Mediterranean region, considering both the sectoral and the nexus levels. Starting from presenting the WEF nexus concept and exploring the impact of the Russia-Ukraine war on the WEF resources, our study aims to detect the barriers and the opportunities to turn the WEF nexus from a vicious circle of trade-offs into a virtuous circle of synergies that feed each other. To overcome this challenge, several actions are identified and specific recommendations are made for the way forward.

1. The Russia-Ukraine war and the global economy

Russia's invasion of Ukraine on February 24, 2022 and the choice of the West to support Ukraine by introducing economic sanctions against Russia, have prompted a series of changes in the global order, exacerbating the negative socio-economic trends triggered by the COVID-19 pandemic.

Among its many perturbing impacts, a first and immediate consequence has been what can be considered the first truly energy crisis on a world scale. The current global energy crisis did not start with the Ukraine war, but in the late summer of 2021, when the economic rebound prompted by the ending of the global COVID-19 lockdowns spurred global energy consumption, and escalated in 2022, when the prices of natural gas and oil reached their highest level since 2008. The conflict-energy

TAB. 1. *Share of global exports in Ukraine and Russia in 2021 (%)*

Commodity	Ukraine	Russia	Russia and Ukraine
Wheat	10	24	34
Maize	15	2	17
Barley	13	14	27
Sunflower oil	31	24	55
Sunflower cake	61	20	81
Vegetable oils	–	–	10
White fish (Alaska Pollock)	–	16	–
Fertiliser mineral intermediates (ammonia, phosphate rock, sulphur)	–	13	–
Finished fertilisers	–	16	–
Food calories traded globally	6	5.8	11.8

Source: Glauber, Laborde [2022].

crisis equation is strictly related to the fact that Russia plays a key role in the global energy market, with world leadership in both oil (12.3 per cent of global supply in 2021) and gas (23.6 per cent of global supply in 2021) exports (tab. 1).

The current energy crisis shares several parallels with the oil shocks of the 1970s triggered by the oil embargo imposed by Arab members of the Organization of Petroleum Exporting Countries (OPEC). At the same time, it also shows important differences for two orders of reasons. While the 1970s price shocks were primarily limited to oil, today's crisis involves all fossil fuels.

Furthermore, the energy crisis has occurred in a very different global scenario from that of the oil crisis in the last century. The present crisis erupted in the presence of:

1. inflation levels that in many economies already reached the peak of the last 40 years;
2. unprecedented global debt, both in absolute and in relative terms, as countries launched different aid programmes to react to the COVID-19 economic crisis;
3. an increasingly interconnected and globalized world, which has quickly spread the consequences of the conflict throughout the global energy market [IEA 2022].

In such a context, energy prices exponentially surged not only in Europe but worldwide, raising inflation and pushing a number of economies into recession [European Union 2023].

The epicentre of the conflict explicitly involves two countries, Russia and Ukraine, that are also global leaders in producing and exporting food and fertilizers. As a result, the Russia-Ukraine crisis has also posed serious food security challenges, raising widespread concern for a global food crisis similar to or even worse than those the world faced in 2007-2008 and 2010-2011. Supply interruptions in the Black Sea region, combined with export restrictions, stalled shipments and panic buying resulted in dramatic food price spikes that exacerbated hunger in the world's poorest and most vulnerable regions. The *FAO Food Price Index* (FFPI), an indicator that monitors international prices of a basket of food commodities, reached the highest level recorded since its inception in 1990 in March 2022, averaging at 159.3 points, 12.6 per cent higher than in February 2022 and 3.1 points above the previous peak in February 2011 [UNCTAD 2023] (fig. 1)[2].

IPES-FOOD, an independent international panel of experts on sustainable food systems, points out that several structural food system weaknesses allowed the Ukrainian crisis to escalate so rapidly: highly concentrated markets on both food input and output supply sides; excessive speculation in the wheat market; and the mutual and compounded consequences of conflicts and climate change impacts on food security. Global trade in food commodities is highly concentrated, with several importing countries dependent on a limited number of exporters, which amplify the repercussions of supply shocks in exporting countries[3]. In the last two decades, the Black Sea region has emerged as a major supplier of grains and oilseeds, with Russia and Ukraine exporting 34 per cent of globally traded wheat, 17 per cent of maize and 73 per cent of sunflower oil [FAO 2022]. Similarly, Russia and Ukraine together account for about 27 and 17 per

[2] The FFPI already recorded before the Russian invasion the highest level since 2008, the year in which the global food crisis had unleashed popular uprisings and political instability that would ultimately be among the triggers for the so-called Arab Spring. The increase in nominal food prices was strictly related to five structural and conjunctural factors that acted simultaneously on both food supply and demand, namely demographic trends, urbanization, climate change impact, dietary homogenization and, more recently, the COVID-19 pandemic.

[3] According to USDA data, just seven countries plus the EU account for 90 per cent of the world's wheat exports, and only four countries account for 87 per cent of the world's maize exports [IPES-FOOD 2022].

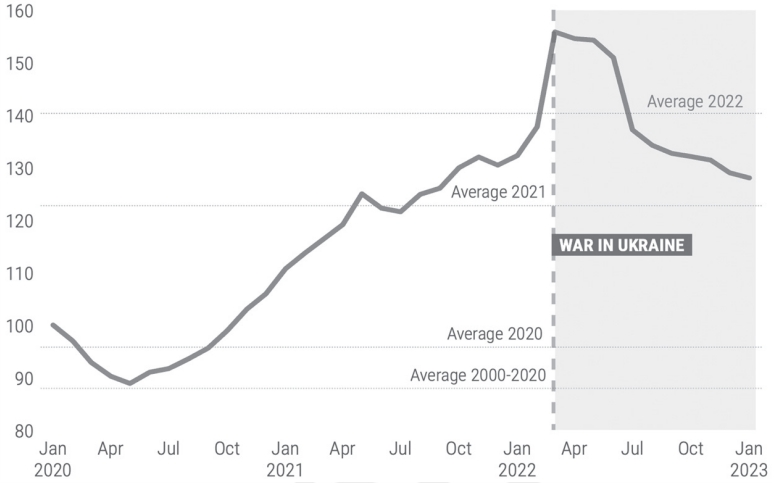

FIG. 1. FAO Food Price Index (FFPI - 100=January 2020).

Source: United Nations Conference on Trade and Development (UNCTAD) [2023].

cent of the global barley and maize trade, respectively. These exports represent a substantial share of global consumption and diets, accounting for about 12 per cent of total calories traded worldwide.

Price shocks are also being exacerbated by several dysfunctions in global grain markets linked to the impact of financial speculation. As highlighted by an *Agricultural Market Information System (AMIS) Market Monitor report* [2023], investors rushed into wheat and corn futures immediately following the invasion of Ukraine. In just a few days, the price of cereals on futures markets jumped 54 per cent, exacerbating historical volatility for agricultural commodities in both the USA and Europe. For other items, high price volatility may mean more significant gains or losses for investors; in the case of food, it translates into higher real-world prices affecting the poorest.

Furthermore, the war came at a time when the global food system struggled to feed its growing population in a sustainable way, under the pressure caused by climate change, conflicts, and the COVID-19 pandemic, which created persistent vulnerability and introduced a further layer of uncertainty into global food

markets. In its *Hunger Hotspot* report, the World Food Programme (WFP) identifies violent conflicts as the primary driver of global hunger as they can displace farmers, destroy agricultural assets and food stocks, or disrupt markets. It also describes climate change as the main factor in reducing global agricultural production by decreasing cropping frequency and yields [WFP and FAO 2022][4].

The Russia-Ukraine crisis and associated sanctions on Russia and Belarus also disrupted global fertilizer markets. Nitrogen (N), phosphate (P) and potash (K) play a key role in nourishing plants and promoting crop growth with higher yields. The fact that a small number of countries produce a large share of internationally traded fertilizers and about three quarters of all countries import at least 50 per cent of their fertilizer consumption, makes the fertilizer sector extremely vulnerable to trade shocks. Russia and Belarus are important producers of all three major fertilizer nutrients: in 2020, Russia accounted for 14 per cent of global trade in urea, 11 per cent of global trade in phosphate and, jointly with Belarus, 41 per cent of global trade in potash [Glauber and Laborde 2022].

Before the Russian invasion, fertilizer prices were already at historically high levels because of several factors that acted on demand and supply. Fertilizer demand declined during COVID-19 lockdowns and rebounded in late 2020 as restrictions were lifted and crop prices rose. On the supply side, increases in the costs of key inputs in fertilizer production, such as natural gas and coal and raw materials, also added upward pressure on prices. The economic sanctions on Russia and Belarus and disruptions in Black Sea trade routes added further uncertainty, driving fertilizer prices higher. IFPRI estimated that potash exports from Belarus and Russian urea and potash exports were at least 50 per cent lower in 2022 than in 2021 because of the sanctions and restrictions on using EU territory for transit [Glauber and Laborde 2022]. In addition, the shutdown of the Tolyatti ammonia pipeline, built to transport ammonia from Russia's Volga region to Ukraine's Black Sea port of Odessa, contributed to a dramatic decline

[4] The IPCC estimates that climate change has reduced agricultural productivity growth by 21 per cent since 1961, and by up to 34 per cent in Africa and Latin America [Quagliarotti 2023].

of Russian ammonia exports[5]. Countries heavily dependent on fertilizer imports from Russia and Belarus feared an immediate shortfall, and many had to secure alternative sources from a very tight global market. Brazil, the second largest importer of potash, increased imports from Canada to help offset the decline from Belarus; and Morocco, the fourth largest global ammonia importer, stepped up imports from Saudi Arabia and Egypt to make up for shortfalls from Russia [Glauber and Laborde 2022].

To secure the supply of food and fertilizers at home, several governments decided to modify their food trade policies by increasing export-related restrictions, including licensing requirements, taxes, and bans, as already happened in the previous crises (COVID-19 pandemic; 2007-2008 and 2010-2011 global food crises). These measures helped countries to mitigate and cope with conflict damage to their domestic economies, but they also fuelled war-related disruptions in global markets, contributing to higher prices and price volatility. As data show, since the conflict, the number of countries that implemented food export restrictions rose exponentially (lower panel of fig. 2).

In addition to Ukraine and Russia, other notable suppliers imposed trade measures, such as Indonesia (ban on palm oil exports), Argentina (ban on beef exports), and Turkey, Kyrgyzstan and Kazakhstan (bans on a variety of grain products)[6] (tab. 2).

At the peak of export restrictions in late May, almost 17 per cent of global food and feed exports on a caloric basis were affected by measures implemented by countries (upper panel of fig. 2).

Export restrictions did not only concern food products but also key agricultural inputs, especially fertilizers. To prioritize domestic farmers in a context of limited availability and amid high prices, several countries such as China and South Korea, banned fertilizers exports, furthering contributing to market instability (tab. 3).

[5] The pipeline from Russia to Odessa was designed to pump up to 2.5 million tons of ammonia per year. From Soviet times, ammonia travelled southeast along a 2,418-kilometre pipeline that crosses Ukraine for over a thousand kilometres from the Russian border to the Black Sea. From there the fertilizer reached the rest of the world by ship.

[6] While countries restricted food exports to ensure adequate supplies for their population during the conflict, Russia restricted food exports mainly to respond to the economic sanctions imposed by the European Union, United States, Canada and other countries.

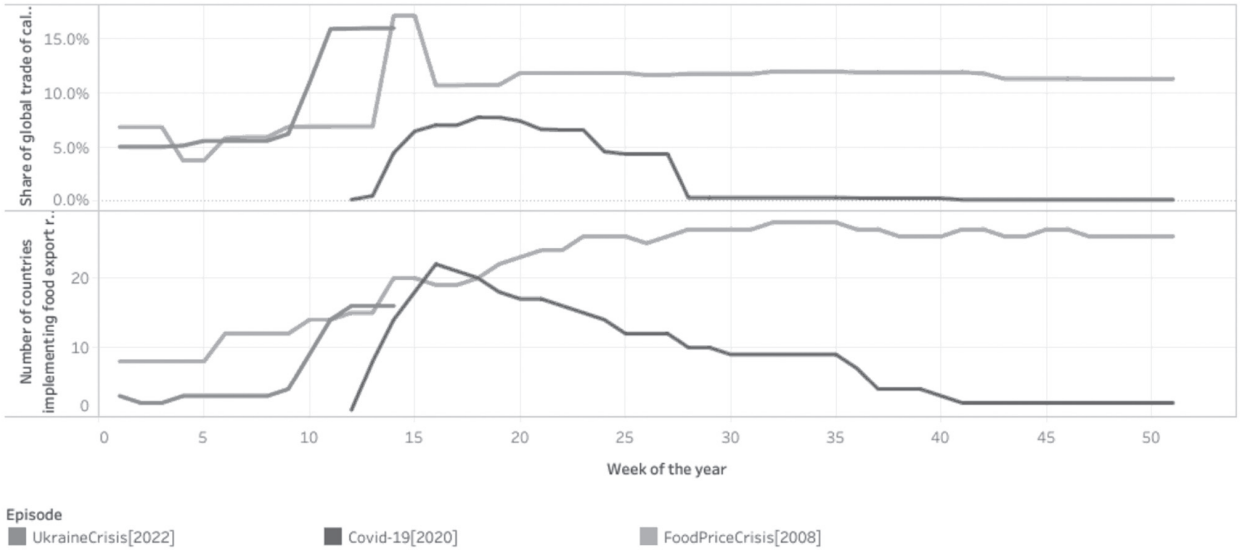

FIG. 2. Share in global trade of calories and number of countries implementing food export restrictions.

Source: Laborde and Mamun [2022].

TAB. 2. *Export restrictions on food during the Ukraine crisis*

Country	Type of food product	Ban end date
Argentina	Soybean oil, soybean meal	Dec 31, 2023
Algeria	Pasta, wheat derivatives, vegetable oil, sugar	Dec 31, 2022
Egypt	Vegetable oil, maize	June 12, 2022
Egypt	Wheat, flour, oils, lentils, pasta, beans	June 10, 2022
India	Wheat	Dec 31, 2022
Indonesia	Palm oil, palm kernel oil	Dec 31, 2022
Iran	Potatoes, eggplant, tomatoes, onion	Dec 31, 2022
Kazakhstan	Wheat, wheat flour	June 15, 2022
Kosovo	Beef, mutton, goat meat, butter, cooking oils	Dec 31, 2022
Ukraine	Wheat, oats, millet, sugar	Dec 31, 2022
Russia	Sugar, sunflower seeds	Aug 31, 2022
Russia	Wheat, meslin, rye, barley, maize	June 30, 2022
Serbia	Wheat, corn, flour, oil	Dec 31, 2022
Tunisia	Fruits, vegetables	Dec 31, 2022
Kuwait	Chicken meat products, grains, vegetable oils	Dec 31, 2022

Source: FSIN [2023].

After May, many countries partially removed trade policy measures. By mid-July, the amount of affected trade fell to 7.3 per cent, mainly remaining at that level over the rest of 2022 (tabs. 1, 2 and 3). The removal of export restrictions, in addition to several other factors, such as good summer harvests and the *Black Sea Grain Initiative* (BSGI), positively affected global markets, averting an unprecedented global food crisis. In particular, since the signing of the BSGI, ship departures from Ukrainian ports have shown a marked increase and more than half of Ukrainian grain exports have been supported by the agreement (fig. 3)[7].

[7] A widespread food global crisis has been averted only thanks to the intervention of the international community. In May 2022, the European Commission launched the *EU Solidarity Lanes Initiative* to help Ukraine to bypass the blockade of Ukrainian seaports by the Russian army and other supply chain disruption, facilitating the export of Ukrainian agricultural products to third countries using EU land routes and seaports and freeing storage capacity for the new harvest. In addition, in July 2022, two agreements were signed: the Memorandum of Understanding between the United Nations and the Russian Federation to facilitate the unimpeded access of food and fertilizers exports to global markets; the BSGI, signed by the Russian Federation, Turkey and Ukraine, and witnessed by the United Nations to allow the safe export of grain, fertilizers

TAB. 3. *Export restrictions on fertilizers during the Ukraine crisis*

Policy status	Category	Country	Product	Ending day	Share of global exports of nitrogenous impacted (%)	Share of global exports of potash impacted (%)	Share of global exports of phosphates impacted (%)
Inactive	Actual ban	China	Phsphate rock	12/31/22	0.0	0.0	0.6
Inactive	Actual ban	Korea, South	Urea fertilizer	03/31/22	0.3	0.0	0.0
Inactive	Actual ban	Russia	Fertilizer	08/31/22	10.1	18.7	8.6
Inactive	Actual ban	Ukraine	Nitrogenous	12/31/22	0.9	0.2	0.0
Inactive	Export Licensing	China	Fertilizers	12/31/22	10.6	1.2	11.4
Inactive	Export licensing	Russia	Nitrogenus fertilizers	12/31/22	10.1	2.8	8.5

Source: Laborde, Mamun [2022].

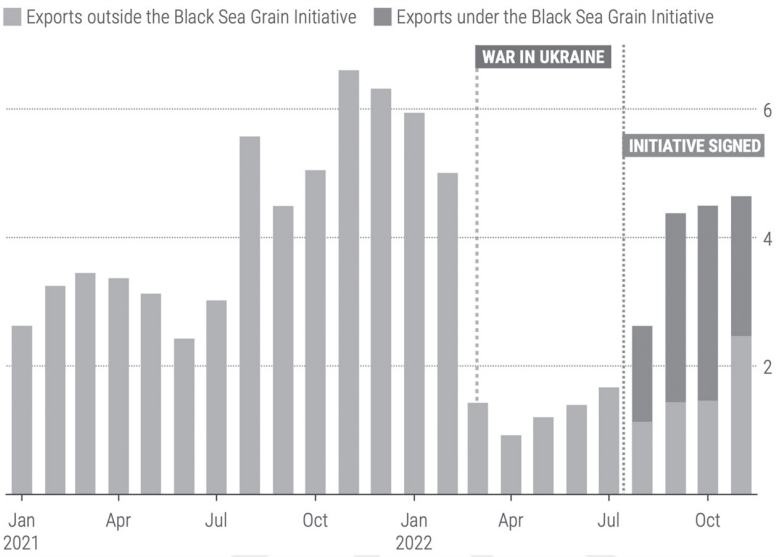

FIG. 3. Monthly Ukrainian exports of maize, wheat and barley, with and without the BSGI, in million tons.

Source: UNCTAD [2023].

Almost a year after Russia invade Ukraine, global market prices for key food items have returned to pre-war levels. Nevertheless, it is too early to declare the crisis over: food prices were on the rise before the war began, and they remain high compared to mid-2021 levels; global food stock levels also remain tight, and with no immediate prospect for peace in Ukraine and extreme weather events affecting many parts of the world, prices are likely to remain volatile [Caprile and Pichon 2022].

Global increase and volatility in food, energy and fertilizer prices entail heterogeneous consequences for countries depending on their underlying conditions and vulnerabilities.

and other foodstuff from Ukrainian ports in the Black Sea. Before the war, more than 90 per cent of ships had departed from seaports. Between the onset of the war and the implementation of the BSGI, this share abruptly dropped to 20 per cent and rivers became the main shipping routes for Ukrainian exports. After the signing of the BSGI, the share almost doubled. The agreement helped to bring down the cost of food, stabilize global markets and keep them open.

To understand the impacts of the Ukraine crisis on the Mediterranean region, it is important to identify the nature and degree of countries' vulnerability regarding both the WEF nexus and components. A first step towards this direction is introducing the WEF nexus concept to describe the causal linkages and trade-off relationships between WEF resources, focusing on the MENA region.

2. The Water-Energy-Food (WEF) nexus in the Mediterranean region

According to the Food and Agriculture Organisation of the United Nations (FAO), the WEF nexus indicates that water, energy and food security are very much linked, meaning that the actions in one sector can often affect one other sector or both [FAO 2014][8]. The interactions among WEF are numerous and significant: energy depends on water for power generation, the extraction, transport and processing of fossil fuels, and the irrigation of biofuel crops [IRENA 2015]; water provision depends on energy for its abstraction, purification and distribution; and food production needs water and energy to produce, process and transport food [FAO 2014]. It then follows as a corollary that impacts on one resource, whether from the demand or supply side, affect all other WEF resources and thereby the entire production or consumption chain. Recognising this, the policies that govern these resources are also interrelated. Nevertheless, the management of these interlinked resources is usually handled by separate institutions to facilitate decision-making in addressing sector-specific challenges and demands. This approach overlooks the interdependences between resources, triggering

[8] Water security has been defined as «the reliable availability of an acceptable quantity and quality of water for health, livelihoods and production, coupled with an acceptable level of water-related risks»; energy security has been defined as «access to clean, reliable and affordable energy services for cooking and heating, lighting, communications and productive uses», and as «uninterrupted physical availability [of energy] at a price which is affordable, while respecting environment concerns»; food security is defined as «availability and access to sufficient, safe and nutritious food to meet the dietary needs and food preferences for an active and healthy life». Adequate food has also been defined as a human right [FAO 2014].

inefficiencies and trade-offs throughout the nexus [Giordano and Quagliarotti 2020].

The term nexus is bi-dimensional, contemporarily describing a conceptual and a governance framework [Harwood 2018]. As a conceptual framework, it provides a systemic understanding of the interconnections of WEF resources; as a governance framework, it draws attention to the interdependencies between the management of different resources and raises questions on the limits of single-resource governance models.

The WEF nexus is particular evident in the Mediterranean region, especially in the MENA countries, where it is driven by many natural, demographic, socio-economic and political factors that intensify the nexus interlinkages.

Several nexus studies point out that in the MENA region, the need to meet the growing demand for water, energy and food in a climate change and increasingly resource-constrained scenario, associated with resources inefficiency and WEF sectoral policy, has fuelled a vicious circle that has ended up favouring trade-offs rather than amplifying synergies between sectors, with significant implications at the domestic, international and global scale [FAO 2014; Borgomeo *et al*. 2018].

At the domestic level, in the last three decades, the MENA region has experienced rapid population growth and accelerated socio-economic development, which have contributed to increased water, energy, and food demands. However, raising demands are not only associated with demographic and socio-economic trends, but also to low efficiency throughout the WEF nexus. The prices of energy, water and food are strongly affected by subsidies, which do not reflect changes in resources scarcity, 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. To make essential energy services available to low-income users, fuels and electricity are subsidized at rates averaging in excess of 50 per cent of the supply cost, with energy subsidies representing more than 9 per cent of GDP in many countries [IRENA 2015]. However, energy subsidies tend to promote unsustainable consumer behaviour, send the wrong signals to consumers and suppliers, affect the economic viability of sustainable energy sources, contribute to

environmental pollution and greenhouse gases (GHG) emissions, and worsen governments' finances. In addition, due to perceived cultural and religious considerations, the average price charged for water in the MENA region is about 35 per cent of the cost of production. In the case of desalinated water, it is only 10 per cent [IRENA 2015].

The availability of inexpensive and heavily subsidized water has led to overuse and waste in the agricultural and municipal sectors. Yet water remains a scarce resource in almost every country.

Moreover, Arab governments maintain their obligations to the social contract by providing low-priced food to the population, creating a dangerous bidirectional link between internal stability and the price of primary commodities. When subsidies within each WEF system are connected across the nexus, negative externalities and distortions can be multiplied, triggering inefficiencies and trade-offs throughout the nexus.

Inefficiencies, market distortions and high negative externalities are particular evident in fossil fuel-producing countries, where the WEF nexus is heavily oil-dominated. Here, the relative abundance of energy sources helps to support many of the basic resources, in terms of both availability and affordability, obscuring any shortages in the other components of the nexus. The ability to increase water supply as well as support domestic agricultural production is strongly dependent on the rent from oil, which allows countries to finance the production of non-conventional water (i.e., seawater and brackish groundwater desalination, and treated wastewater) and agricultural goods (i.e., using highly controlled environmental conditions in closed agricultural systems) overcoming the internal geoclimatic constraints.

At the international level, the trade dimension of the WEF nexus appears an effective solution to tackle domestic nexus challenges. The MENA countries are faced with serious challenges in their objective to achieve food security locally due to several constraining factors, including high aridity, limited cultivable land, scarce water resources and serious implications of climate change. 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 advantage. In

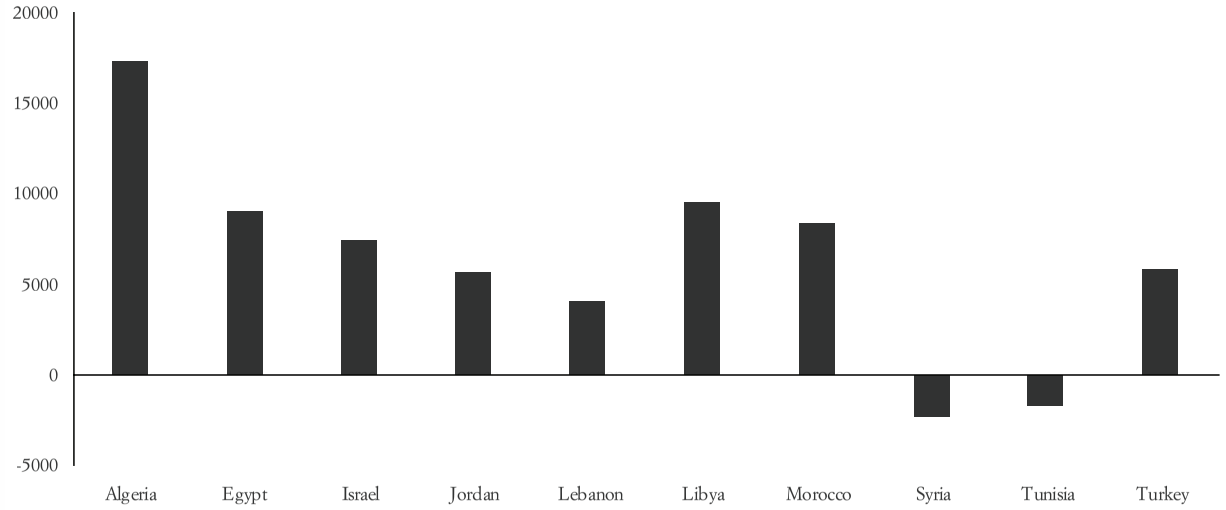

FIG. 4. Net virtual water imports in several MENA countries.

Source: Saab [2017].

TAB. 4. *Self-sufficiency ratio in total food commodities and cereals in several MENA countries*

Country/Sub-Region	Food self-sufficiency ratio (%)			Cereal self-sufficiency ratio (%)		
	2005	2011	2014	2005	2011	2014
Jordan	56.26	53.09	66.6	5.05	3.66	3.7
Lebanon	73.23	61.03	74.7	18.05	10.96	13.8
Syria	85.23	80.62	84.3	74	57.98	47.86
Palestine	81.55	72.26	79.3	19.69	10	9.48
West Asia	74.0675	66.75	76.225	29.1975	20.65	18.71
Algeria	53.48	70.04	75.2	29.88	31.96	21.65
Egypt	83.68	78.96	88	69.63	56.3	66.04
Libya	44.95	43.09	38.3	10.79	7.06	9.49
Morocco	89.6	80.4	100	46.09	58.96	68
Tunisia	71.78	68.49	89.5	47.82	46.79	42.42
North Africa	68.698	68.196	78.2	40.842	40.214	41.52
Total	71.38275	67.473	77.2125	35.01975	30.432	30.115

Source: Saab [2017].

this way, they have «externalised» the pressure on their nations' own water resources by importing water in virtual form (fig. 4)[9].

As a result, international trade plays a key role in achieving macro-level water and food security but, at the same time, it increases the vulnerability of the MENA countries to the increase and volatility of international food prices (tab. 4).

The international dimension of the WEF nexus is particularly evident in oil-producing countries, where revenues from oil exports allow them to quickly offset low food production and scarce water availability through virtual water imports. However, this dependency is dynamic over time, increasing when oil prices are low and/or food prices are high[10].

[9] The virtual water concept was coined by Tony Allan in 1993 to describe the hidden flow of water in food or other commodities that are traded from one place to another. For example, cereal grains have been major carriers of virtual water in countries where water resources are scarce. Therefore, cereal imports can play a crucial role in offsetting local water deficit [Allan 1998].

[10] Keulertz and Woertz [2016] explicitly underline the importance that energy exports have for steering the Gulf States towards food imports as an alternative to improving their WEF resource management, but they also highlight how reducing domestic trade-offs can lead to higher exposure internationally.

The challenges of meeting the growing demand for WEF resources are expected to be further compounded by the impacts of climate change, which links the domestic WEF nexus to the global scale. As the demand for WEF resources increases in the context of climate change impacts, not only do the nexus interlinkages intensify, but also direct competition or trade-offs between sectors increase, limiting countries' ability to meet the growing demand sustainably [Markantonis *et al*. 2019]. Notably, climate change is a global challenge that both affects and is affected by the WEF nexus through multiple bidirectional interactions that intertwine within the web of WEF interconnections. Climate change drives a series of phenomena that have negative effects on water, energy and food security, exacerbating nexus conflicts within the region: rising temperatures, changes in precipitation patterns, extreme weather events and sea-level rise may gradually alter the balance between the nexus resources, and even the nature of their interactions [Cramer *et al*. 2018]. At the same time, water, energy and food production may increase GHG emissions, thereby contributing to global warming. Furthermore, current sectoral approaches to climate change mitigation and adaptation may amplify rather than reduce negative externalities and trade-offs within the nexus. While some sector-oriented mitigation and adaptation measures may have the potential to trigger synergistic «win-win» opportunities across one or more of the nexus sectors, other measures, such as hydropower, first generation biofuels, the shift to non-conventional water resources and agricultural intensification, are not always nexus-smart. In addition, attempts to reduce GHG emissions in order to achieve ambitions to combat climate change as expressed in the Paris Agreement or to account for the social cost of carbon may influence demand for oil and/or its price, reducing the oil and gas revenues available to import food and desalinate water in oil-exporting countries.

What emerges is a rather dramatic picture, which outlines a WEF nexus fuelled by a vicious cycle and particularly vulnerable to the impact of climate change. As we seek to explain in the next section, the war in Ukraine, due to its repercussions in the main global commodity markets, is further jeopardizing all components of the nexus, both directly and indirectly.

3. The impact of the Ukraine war on WEF resources in the Mediterranean region

Russia's unjustified and unprovoked war against Ukraine has greatly impacted markets for both global energy and food, entailing disparate consequences for countries according to their underlying conditions and vulnerabilities.

Focusing on the European level, before the outbreak of war, the EU was heavily dependent on Russia: 40 per cent of its gas and nearly a third of its oil supplies were of Russian origin [European Union 2023]. In March 2022, in light of the Russian invasion of Ukraine, EU leaders agreed to phase out European dependency on Russian fossil fuels, with important implications in terms of access to energy sources in the member states. The energy crisis has posed several key challenges, especially as it is strongly intertwined with wider climate, economic and societal considerations. It entails trade-offs between short-term energy security goals versus long-term climate-mitigation targets, or security of supply versus energy costs.

The transition towards a climate-neutral economy is high on the agenda at both the EU and member state levels. The EU aims to become a global leader in the fight against climate change by establishing a new model of energy security, stable over the long term and in line with its ambitious climate goals, as pointed out in the European Green Deal and the Fit for 55 package.

Simultaneously, the oil crisis triggered by the Ukraine war has revealed the fragility of the EU countries with respect to their energy security, demonstrating the important role still played by fossil fuels in the current energy mix and highlighting the limits of the slow pace of the energy transition towards renewables. In particular, the Ukrainian war and the resulting increases in energy prices have significantly affected the three pillars of the energy trilemma (energy reliability, affordability and sustainability), underscoring that the energy transition is neither easy nor immediate as naively thought[11].

[11] In Italy, the effects of the significant reduction in Russian supply have been particularly pronounced due to the high percentage of gas in Italy's energy supply (45 per cent), combined with its dependence on imports in the energy sector (75 per cent in 2021), due to the country's scarcity of gas fields and the environmental concerns and legal constraints that have hindered gas extraction in the past [Caprile and Pichon 2022].

From the climate change standpoint, the war is contributing to two countervailing dynamics [Mecklin 2023]. Firstly, many European countries are rushing to find alternative sources of fossil fuels, re-opening coal-burning plants and investing in oil and gas abroad. Thus, in the short run, one of the dimensions of the energy trilemma, sustainability, seems destined to be shelved in favour of energy security. At the same time, the shock waves in global energy markets have strengthened the urgency of the energy transition and the need to reduce dependency on fossil fuel supplies.

Consequently, sufficient hydrocarbon resources and investments will still have to be made available to satisfy energy needs while countries progress toward transitioning to carbon-neutral power generation. So, the EU should find a way to achieve a balance between mitigating short-term critical impacts and a significantly accelerated energy transition.

As regards food security, food availability has not been at stake. The EU is self-sufficient mainly in essential agricultural products. However, the EU is a considerable net importer of specific products that may be difficult to substitute in the short term, such as sunflower oil and seafood [European Union 2023]. If roughly the availability of food necessary for the European countries is not at risk thanks to the good stability of the Single Market, the surge in energy and fertilizer prices has caused an increase in agricultural production costs, with negative consequences on farm incomes and the purchasing power of consumers. In particular, the EU's vulnerability to market distortions in the fertilizer trade may be especially acute, since fertilizers represents 18 per cent of input costs for arable crops. The EU relies on Belarus and Russia for 59 per cent of its potassium fertilizer imports, while 31 per cent of its nitrogen fertilizer imports comes from Russia [European Union 2023]. As a result, food affordability for low-income households, already affected by the pandemic, may be further jeopardised.

In the MENA region as a whole, the impact of the Ukraine crisis in terms of WEF resources is strictly related to its socio-economic and agro-ecological profile. However, when the analysis moves from a regional to a national level, it emerges that the global increases in food, energy and fertilizer prices triggered by the war entail heterogeneous consequences for countries

depending on their underlying specific conditions, which imply varying degrees of vulnerability.

The MENA region is generally described as energy-intensive, water-scarce, food-deficient and highly vulnerable to the impacts of climate change [Al-Zubari 2016]. It is one of the wealthiest regions of energy resources such as oil and gas, holding about 57 per cent of world's oil reserves and 41 per cent of natural gas resources [IRENA 2015]. Consequently, the region is bound to take advantage of higher oil and gas prices. In addition, raising oil production in line with OPEC+ announced quotas ensures that MENA oil exporters also benefit from a positive quantity effect[12].

Gas demand is also expected to remain high given the willingness of European economies to reduce dependence on Russian gas imports in the next years. Rising energy prices and output translates into higher petrodollar inflows for MENA, to the point that the International Monetary Fund (IMF) has had to revise its forecast for growth in the region as a whole by 0.9 percentage points to 5 per cent [IMF 2022]. However, this positive outcome masks several negative effects within the region. Higher oil and gas prices might push governments in oil-exporting countries to delay the introduction of the necessary structural fiscal reforms aimed at diversifying the revenue base and reducing heavy subsidies, neglecting the opportunity to take advantage of higher energy prices to implement long-awaited reforms towards economic diversification and energy transition in line with the Paris Agreement's goals. In addition, while MENA oil and gas exporters, most notably Saudi Arabia, the United Arab Emirates, Qatar, Kuwait, Bahrain, Oman, Iraq, Iran, Algeria and Libya, benefit from rising oil export revenues, which translates into ameliorating external accounts, MENA non-oil-importing economies suffer from rising energy import bills, which, in contrast, contributes to inflation and loss of purchasing power.

The fallout from the war in Ukraine also affects other components of the WEF nexus as the MENA is one of the world's most water-scarce regions. While its population represents about 6 per cent of the world population, its share of freshwater is limited to only 2 per cent [IRENA 2015].

[12] OPEC+ is a group of 23 oil-exporting countries which meets regularly to decide how much crude oil to sell on the world market.

Water scarcity, associated with constraints on agriculture land and productivity, makes the region one of the most food import-dependent areas in the world. Indeed, MENA countries have acutely felt the impact of disruption from the Ukraine conflict to global food production and exports. However, fiscal disparities between oil exporting and importing countries are equally marked also in terms of food security, with oil-rich states enjoying far greater purchasing power than their regional peers. Although oil-rich countries, such as the Gulf States, import between 80-90 per cent of all the calories they consume, and in some food categories, like cereals, they import 100 per cent of their needs, higher energy prices have largely cushioned them from food price spikes, allowing them to buy agricultural commodities at any cost, without placing an excessive burden on public finances. In contrast, in the energy importers, dramatic inflation in both their food and fuel import bills has penalized them significantly in terms of food accessibility and affordability [Saab 2017]. Not only do they have to pay for more expensive food imports, but their heavy dependence on wheat imports from Russia and Ukraine makes them especially vulnerable to the collapse of food exports from the Black Sea region. Before the war, Egypt, Lebanon and Tunisia imported respectively 80, 70 and 50 per cent of their wheat needs from Russia and Ukraine [Laborde and Mamun 2022]. Other MENA countries that are reliant on imports of key food products from Russia and Ukraine include Turkey, Syria and Libya.

Although the MENA countries are looking for alternative markets for their cereal supply, particularly India, the USA, Canada, Argentina and Uruguay, the shift is not immediate and free of costs due to longer shipping distances and the rise in fuel prices.

Soaring costs for food staples have threatened household-level food security in several import-dependent MENA countries, putting people's resilience at «breaking point», as the UN's World Food Programme has pointed out [WFP 2022]. In Egypt, the world's largest importer of wheat, this is especially true. The country consumes around 21 million tons of wheat every year, 13 million of which are imported. Egypt heavily relies on wheat to provide subsidized bread to more than 60 million people, and higher food and energy prices undermine the government's ability to pay for the $5.5 bn in food subsidies that keep the price of bread within the reach of Egypt's poor [WFP 2022].

Guaranteeing food affordability is a matter of food security and political stability since food subsidies have historically helped governments strengthen the legitimacy of their rule in the absence of meaningful political participation. Today, many analysts fear current food inflation and the consequential impact on the State's budget risk destabilising the country, as a considerable share of the population would be affected directly or indirectly by higher prices.

With the global food crisis set to worsen in 2023 and, above all, in a scenario of increasing climate variability, which portends the spectre of multiple breadbasket failures, MENA governments perceive the dangers of the region's dependence on food imports and the urgency of adopting effective measures to address food insecurity at its roots. In the first instance, this will require diversifying away from a concentration of grain imports from any single region, notably the Black Sea. Furthermore, in response to food security concerns, several countries may be driven to abandon a trade-based food security strategy by increasing their share in food self-sufficiency, neglecting the principles of environmental sustainability and amplifying the trade-off within the WEF nexus.

4. WEF policy options to minimize repercussions in the Mediterranean region

As shown above, the Ukraine war, associated with climate change impacts, is significantly affecting energy and food security with direct and indirect consequences also for water resources.

Several policy responses to tackle the Ukraine crisis have contributed to severe market distortions, exacerbating global price increase and instability. Indeed, as countries take action to respond to high prices and other fallout from the war, they should take care to avoid exacerbating the impacts for others. As previous food price spikes have taught us, the best way to deal with market shocks is to allow markets to work by removing distortions and support the most vulnerable countries and households via social safety nets and, where most needed, through humanitarian assistance.

Furthermore, since water, energy and food security are inextricably linked and the WEF nexus includes the sectors mostly affected by the Ukraine war, policy response in «silo» to ensure

the supply of one nexus resource without considering the interdependence of water, energy and food security may amplify rather than reduce negative externalities, risking fuelling a vicious circle that ends up favouring trade-offs rather than amplifying synergies between sectors. Consequently, effective solutions able to guarantee the supply of such resources, minimizing repercussions throughout the nexus, should be envisaged.

The MENA countries have responded differently to the food security challenges posed by the Russian-Ukraine war depending on existing environmental, socio-economic and institutional contexts. In addition to some of the instruments that have already been implemented, there are additional short, mid, and long-term measures that countries should consider both on the supply and demand sides.

In the very short run, protecting vulnerable households against food price hikes is crucial. Social safety nets can be practical tools to support low-income people against this crisis and several countries are expanding existing social protection programmes to cover more households [WFP 2022]. In particular, a cash transfer system to poor households, which is proven to be effective and more cost-efficient than food subsidies and in-kind food distribution as successful Egypt's Takaful and Karama programmes have shown, should be reintroduced [Breisinger *et al.* 2018].

In the short term, countries should diversify their wheat supply, carefully weighing the costs and benefits of such an «insurance» mechanism since wheat supply from the Black Sea usually comes at lower costs compared to other regions such as Europe or the USA. In Egypt, for example, the General Authority for Supply Commodities (GASC) is actively exploring the diversification of import sources[13].

[13] GASC is an Egyptian economic body affiliated to the Ministry of Supply and Home Trade established by Republican Decree No 1189/1968 to overcome the crises arising in the Egyptian market during 1967 and in subsequent years. It aims to activate the local and international market mechanism in order to procure the strategic commodities needed by the state so as to achieve the following targets: improve productivity and raise agricultural production efficiency; develop marketing and promotional services; establish strategic governmental food stocks; achieve structural suitability within the state marketing system; create competitiveness, prohibit monopoly and make the local market balanced (http://www.gasc.gov.eg).

In the longer term, countries need to explore food security strategies to balance the benefits of trade openness with the potential costs of vulnerability to trade shocks. In a scenario of increasing food market instabilities, MENA governments may start to consider greater levels of domestic food production as part of their national aggregate food security policies. Although from a political and strategic point of view such an approach may be justified in that it can help stabilise domestic food prices and reduce vulnerability to international markets and reliance on other countries, it comes at an economic cost. This is because the resource endowments of most MENA countries are not well suited to food production, particularly cereal production, and their comparative advantages lie in other economic activities. To overcome such barriers, countries should focus on what could be called «macro food sovereignty» by combining self-sufficiency and trade-based food security strategies incentivizing the cultivation of local species of crops more suited to their geoclimatic condition [Quagliarotti 2023]. Countries could thus help build more sustainable and diverse food systems, enhancing levels of agrobiodiversity and improving nutritional outcomes while helping diminish MENA region's over-dependence on food imports. However, boosting domestic crop production may be challenging even in countries with opportunities to expand arable areas because agricultural systems must adapt to address water shortages and climate change. This suggests the need for additional research and efforts to increase the production of alternatives to wheat, including drought-tolerant sorghum, millet and high value export crops, and to support climate-resilient farming systems such as drip irrigation and solar-powered irrigation systems [Abay *et al*. 2023].

On the demand side, there are important differences among countries in terms of their potential to reduce reliance on wheat. Reducing the high consumption of wheat has significant potential in Egypt where the average annual consumption is about 145 kg per capita, double the global average. Shifting consumption from wheat to a more diverse set of food products can serve a dual purpose: improving Egypt's wheat self-sufficiency and addressing malnutrition [FAO 2022][14]. Another threat to food

[14] Egypt has high rates of overweight and obesity, which are linked to food subsidies and associated consumption of energy-dense foods.

security for the MENA region is food loss and waste. Reducing food loss and waste across the entire value chain, from the early stages (production, handling, processing and distribution) to the consumer and retail levels, would help reduce expensive food imports, freeing up fiscal resources to fund social safety nets for the most vulnerable households.

Since energy represents both a critical input along different stages of the water and food supply chain and the largest source of GHG emissions, the energy transition should be considered the first step towards sustainable integrated solutions able to enhance security and sustainability across WEF sectors, while supporting global climate ambitions. The joint development of non-conventional water and energy sources, i.e., desalinated water and renewable energy, could address water and energy security challenges by combining economic efficiency and social equity under the constraint of environmental protection [Giordano and Quagliarotti 2020].

In the MENA countries, renewable energy may provide access to a cost-effective, secure and environmentally sustainable supply of energy, simultaneously triggering spill-over effects throughout the WEF nexus. The MENA region has a high potential in renewable energy development, especially solar, due to the presence of vast desert lands with a solar radiation density ranging between 1,300 and 2,500 kWh/m^2 per year [IRENA 2015]. Generally, renewable energy technologies are less water-intensive than conventional options: water needs for solar photovoltaics (PV) is negligible compared to conventional thermoelectric generation, withdrawing up to 200 times less water to produce the same amount of electricity [IRENA 2016]. In addition to contributing to significant water savings, clean energy can be used to increase non-conventional water supply more sustainably, especially desalinated water, whose production is still affected by high economic and environmental costs due to the considerable amount of fossil energy required to feed the reverse osmosis. Therefore, the use of renewables may not only satisfy the energy demand of countries that do not have sufficient oil reserves, but also improve the resilience and adaptive capacity of those countries that, due to environmental constraints and the scarcity of two strategic resources for human well-being – water and food, are more vulnerable to the impact of climate change.

To enhance the transition towards a mix of renewable energy and desalinated water, several measures and actions should be undertaken, such as reforming the subsidy and tax system to «internalise» environmental and social costs [Burnett and Wada 2018]; encourage the development of renewable energy technologies with the help of international financing, develop innovative means of financing, and remove institutional, technical, regulatory and economic barriers [Halalsheh *et al.* 2018]; strengthen the nexus between non-conventional energy (renewable) and water sources (treated wastewater and desalinated water) to address both climate change mitigation and adaptation; promote cross-sectoral projects; and incorporate the key principles of green and circular economy into the WEF nexus.

In addition, given the variability in the unequal distribution of the WEF resources throughout the Mediterranean region as well as the ever-increasing pressures on them, it is necessary that the Mediterranean countries strengthen their cooperation to face WEF challenges in a complementary manner. However, there is traditionally a low level of cooperation between countries, which often express different goals, agendas and priorities in addressing the complex nexus between WEF sectors. Nevertheless, in the last decade, key regional and sub-regional institutions have expressed an interest in exploring the nexus approach, including the EU, the Regional Cooperation Council (RCC), the League of Arab States (LAS), the Union for the Mediterranean (UfM) and the Barcelona Convention (MAP/UNEP).

At the EU policy level, the WEF nexus is included in the *Renewable Energy Directive*, the *Green Infrastructure Communication*, and it is in line with the vision and the objectives of the *EU Green Deal*, which is a cross-sector reform project aiming to make the EU's economy sustainable by turning climate and environmental challenges into opportunities across all policy areas [Medinilla 2021].

In the MENA region, the WEF nexus has gained increased attention in the *Arab Strategy for Water Security in the Arab Region 2010-2030*, the *Arab Sustainable Agricultural Development Strategy 2005 to 2025*, and the *Pan-Arab Strategy for the Development of Renewable Energy Applications 2010-2030*, which suggest the need for integrated WEF and climate change solutions, identifying non-conventional water and renewable energy as key elements

for increasing nexus sustainability and efficiency [IEA-ETSAP and IRENA 2012].

Furthermore, strengthening countries' WEF nexus cooperation on different bilateral and multilateral levels is crucial to face the scarcity of, guarantee access to and affordability of food, water and energy. From this point of view, the principle of comparative advantage applied to the WEF nexus can act as an effective tool to amplify synergies and complementarities between countries. Taking into consideration countries' different factor endowments, each country should specialize in the production and exchange of that good for which it has a lower opportunity cost than other countries. All countries may gain from this WEF exchange model because the potential WEF nexus net benefits may increase when complementarities and synergies among sectors cross national borders.

This approach should be adopted at both sub-regional and regional level. At the sub-regional level, MENA countries may gain from the mutual dependencies triggered by this model of sub-regionally integrated water and energy sectors, enforcing interdependencies among countries and addressing water, energy and food security in an economically efficient and environmentally sound manner [IUCN and ROWA 2019]. The *Pre-Feasibility Study for Mid-East Water-Renewable Energy Exchanges* carried out jointly by EcoPeace Middle East and the Konrad Adenauer Foundation demonstrates the potential benefits when the nexus approach crosses national borders, allowing countries to cooperate to achieve greater economic efficiency in resources management [Katz and Shafran 2017]. To achieve this objective, the study considers three countries – Israel, Jordan, and Palestine – in a cooperation model for the concrete application of the international trade theory of comparative advantages by increasing interdependencies among states. Given the constraints in terms of energy and water security and the disparities between countries in terms of factor endowments, the project takes as a reference states' relative resources abundance to build a non-conventional water-energy exchange model among the three countries. All countries will gain from this regionally integrated water and energy sector model, enhancing common social, economic, and environmental goals.

At the regional level, great opportunities may arise from a Euro-Mediterranean partnership in the field of renewables, which

goes beyond conventional trade relations in the energy sector to realize concrete «win-win» projects of common interest. Taking into consideration the geo-climatic advantages of the MENA region in solar energy, the increased production of renewable energy may be used to feed a virtuous and integrated EU/MENA WEF system able to maximise positive externalities through the creation of a sustainable circuit powered by a North-South flow of technology, know-how, capital and agricultural products (virtual water), and a reverse flow of clean energy. As a co-product of solar power plant expansion in MENA countries, a large amount of seawater could be desalinated to overcome the projected water shortages in the region [Kennou *et al*. 2018].

Such an innovative Euro-Mediterranean cooperation model could represent a first step to facing the challenges triggered by the Ukraine and climate change crises, addressing both the growing energy demand of the European countries hungry for non-fossil energy sources and the growing water demand of the Arab countries thirsty for virtual and non-conventional water resources.

Conclusions

The Ukraine war is representative of the modern risks the world is facing, generated by global change (i.e., climate change or biodiversity loss) and increased integration between economies (i.e., globalization and market concentration) in a novel geological epoch shaped by a significant human pressure on natural systems (the Anthropocene).

The conflict has caused a massive shock to the global economy, especially to energy and food markets, decreasing supply and pushing up prices to unprecedented levels. Compared with other economic regions, the Mediterranean area has been particularly affected by the economic consequences of Russia's invasion of Ukraine. In particular, the Ukraine crisis has highlighted the extreme vulnerability of the Mediterranean countries in terms of water, energy and food security, which are inextricably linked in the region. Indeed, the WEF nexus represents a growing challenge, mainly driven by a vicious circle that amplifies trade-offs rather than synergies between sectors [Zhang *et al*. 2018].

In the European countries, the ongoing energy crisis has sent mixed signals. On the one hand, securing short-term energy needs has prompted an urgent search for readily available, conventional energy supplies, such as oil and gas; on the other, the unfolding energy security crisis has been a reminder for member states about the importance of adopting energy self-sufficiency supplies, such as renewables.

The MENA region has been affected by the conflict in Eastern Europe in several ways, primarily through the substantial surge in food and energy prices and disruptions of the global supply chains.

However, the impact of the war on these countries has been different, with oil and food importers primarily hit by the conflict's economic shockwaves. Even though food prices have receded to pre-war levels, exposure to trade disruptions remains a constant concern in this import-dependent region.

Consequently, today the main challenges are how to provide Europe with clean energy supplies and the MENA region with increasing food and water supplies.

Applying a WEF nexus approach in the Mediterranean region based on the principle of comparative advantage may create a unique opportunity to mitigate the trade-offs and address pressing water, energy and food challenges both at national and regional level.

Currently, there is no sector like that of energy where Euro-Mediterranean cooperation should be strengthened to favour WEF synergies and complementarities among countries. Building long-term WEF partnerships to feed the nexus with the exchange of renewable energy, virtual and non-conventional water means placing the Mediterranean region within a virtuous WEF nexus of trade, growth and peace. The WEF nexus approach is not a «silver bullet» aimed at solving development and environmental challenges in the Mediterranean, but it could provide an opportunity to minimize security risks and maximize opportunities, enhancing resource efficiency and equity between countries and helping the region move towards achieving the Sustainable Development Goals (SDGs) and meeting the commitments under the Paris Agreement.

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