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Agenda item 14: Review of assessments for development of three new Regional Plans in accordance with Article 15 of the LBS Protocol for the biennium 2022-2023

Assessment of agricultural practices and discharged pollutants reaching the Mediterranean marine environment

UNEP/MAP
Athens, 2021

Note by the Secretariat

The 21st Meeting of the Contracting Parties to the Barcelona Convention COP21 (Napoli, Italy, 2-5 December 2019) adopted Decision IG.24/10 which endorsed the main elements for development/ update of six new Regional Plans related to the urban wastewater treatment, sewage sludge management, agriculture management, aquaculture management, storm water management in addition to updating the current Regional Plan for Marine Litter Management in the Mediterranean. COP21 also approved the way forward proposing the time frame for the development, negotiation and adoption of the six Regional Plans. With regard to the Regional Plan on the Prevention and Reduction of Pollutant Releases in the Mediterranean Sea from Aquaculture, the Meeting approved submission of the new Regional Plan to COP 23 (December 2023). In preparation for the development of this Regional Plan, the Programme of Work (PoW) and Budget for the biennium 2020-2021, which was adopted in Decision IG.24/14, mandated MED POL in Activity 2.4.3.1(c) to undertake an "assessment of status and impacts of aquaculture on the marine environment."

The present assessment provides an overview of the agriculture sector in the Mediterranean; impacts of the agricultural sector on the marine environment; commonly applied agricultural practices in the Mediterranean including discharge of nutrients from intensive agriculture; management practices of fertilizers, pesticides and animal manure; and Best Available Techniques and Best Environmental Practices for the Agriculture Sector in the Mediterranean. The assessment includes an evaluation of current and potential level of implementation (or non-implementation) of proposed measures included in the main elements for the Regional Plan on Agriculture Management including recommendations for additional complementary measures and proposals to improve BAT and BEP for agricultural practices.

The assessment on agriculture practices in the Mediterranean and their impact on the marine environment was discussed during the Meeting on National Baseline Budget Methodologies, Assessments of new Regional Plans and Evaluation of National Action Plans under the LBS Protocol in April 2021. The Meeting agreed with the findings and recommendations of this assessment and requested the Secretariat to proceed with submission to the Meeting of the MED POL Focal Points.

The Meeting of the MED POL Focal Points is expected to review this draft assessment and to provide its comments with the aim of approval as a background information document for further elaborating the new Regional Plan for Agriculture Management in the Mediterranean during the biennium 2022-2023.

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List of Abbreviations / Acronyms

BAT	Best Available Techniques
BC	Barcelona Convention
BEP	Best Environmental Practices
EC	European Commission
EU	European Union
FAO	Food and Agriculture Organization of the United Nations Rome
GHG	Greenhouse gases
LBS	Land Based Sources
MED	Mediterranean
MEDPOL	Mediterranean Pollution Control and Assessment Programme
N	Nitrogen
P	Phosphorus
TN	Total Nitrogen
TP	Total Phosphorus
UNEP/MAP	United Nations Environment Programme /Mediterranean Action Plan

1. Overview of the Agricultural Sector in the Mediterranean

1. The Mediterranean region hosts a variety of contrasting agroecosystems, including traditional and technologically intensive irrigated agriculture, rainfed agriculture, in particular permanent crops, pastoral and agro-sylvo-pastoral systems, coastal fisheries and aquaculture. Permanent crops most typical of Mediterranean agroecosystems include olives, grapes, citrus and nuts. In addition to these typical crops, there is a strong presence of legumes, fresh vegetables, wheat, often complemented by a more extensive presence of livestock, mostly sheep and goats [1].

2. The gross agricultural production, arable land availability, precipitation and irrigation statistics in the Mediterranean are shown in Table 1. The gross agricultural production as a percentage of total GDP varies across the Mediterranean. Highest rates are found in 22.6% in Syria, 18.5% in Albania, 12.5% Morocco, whereas less than 2% are reported in the Malta, Cyprus, Slovenia, France, and Italy. It is noted that, the gross agricultural production percentage is somewhere in between depending on the natural potential in land or water. These rates are well below those of the 1960s, when they amounted to nearly 75% of GDP [1].

3. Arable land is unequally distributed across the Mediterranean, Turkey has the largest arable land with almost 23% of total Mediterranean arable lands, followed by France (20%), Spain (13%) and Italy (7%). Malta and Montenegro have the least arable land. Taking into account the population size, the ratio of arable land per person is lower than 0.05 hectares per person in Egypt, Montenegro and Palestine [12].

Table 1: Gross agricultural production, land availability, precipitation and irrigation statistics in the Mediterranean [1], [12]

Countries	Gross agricultural production (% GDP), 2018	Arable land (ha), 2016	Hectares per person 2017	Average precipitation (mm/year) 2014	Irrigated land as % of usable agricultural area, (2018)
Albania	18.5	615,100	0.21	1,485	30.28
Algeria	11.8	7,762,100	0.19	89	3.29
Bosnia and Herzegovina	5.8	1,029,000	0.29	1,028	0.14
Croatia	2.9	844,100	0.20	1,113	1.97
Cyprus	1.9	98,900	0.09	498	35.13
Egypt	10.9	2,895,860	0.03	51	99.66
France	1.5	18,478,700	0.28	867	9.39
Greece	3.9	2,224,000	0.21	652	25.07
Israel	1.1	297,200	0.04	435	36.1
Italy	1.9	6,601,000	0.11	832	33.24
Lebanon	4.1	132,000	0.02	661	15.81
Libya	0.7	1,720,000	0.28	56	2.61
Malta	0.9	8,970	0.02	560	35.16
Montenegro	7.4	8,700	0.01		0.92
Morocco	12.5	8,130,000	0.23	346	5.09
Palestine	7.0	64,000	0.01	402	29.37
Slovenia	2.1	184,050	0.09	1,162	1.06
Spain	2.7	12,338,000	0.27	636	14.98
Syria	22.6	4,662,000	0.25	252	9.41
Tunisia	10.0	2,900,000	0.26	207	4.89
Turkey	6.3	20,645,000	0.26	593	13.8
TOTAL		92 million ha			

4. The ensemble of the Mediterranean countries had approximately 92 million hectares of land in 2017. However, the area of arable land decreased by an average of 13% from 1995 to 2015. This decline is particularly notable in Palestine (-42%), Lebanon (-27%), and Israel (-14%). On the contrary, the number of hectares of arable land increased in Bosnia and Herzegovina (+21%) and in Albania (+ 8%), while decreasing in other countries, particularly in Greece (-24%), Croatia (-22%) and Turkey (-16%) [1].

5. The low average rainfall is another agricultural challenge facing Mediterranean agriculture, especially in Egypt, Libya and Algeria as can be inferred from Table 1. Water resources are scarce, and the expansion of irrigated land is ubiquitously limited by unsustainable farming practices and intensive use of water, resulting in groundwater depletion and soil salinization due to lack of drainage. In addition, land fragmentation with small family farms of less than 5 hectares of arable land are found in many countries such as Syria and Egypt. This triggers land abandonment and migration.

6. Precipitation over the Mediterranean region is critical to the availability of water resources. It provides the water that flows in rivers and infiltrates to recharge groundwater (blue water), as well as the water that is stored in the soil as soil moisture (green water). The latter controls the exchange of energy and water between land surfaces and the atmosphere, which impacts rainfall-runoff processes. Thus, soil moisture is vital for the ecosystem and agricultural outputs (food security). In Egypt, Libya and Algeria, soil moisture is very low due to low precipitation and high temperatures, limiting the possibility of rainfed agriculture. Since precipitation is considerably less than potential evaporation in these parts of the Mediterranean region, any future decrease in precipitation will often cause a decrease in soil moisture [1].

7. In the Mediterranean, irrigated agriculture was the most water-demanding sector and excessive abstraction of groundwater for irrigated agriculture is leading to a rapid depletion of aquifers inducing significant environmental degradation, such as land subsidence and seawater intrusion [2]. In Syria and Libya for example, irrigated agriculture is affected by limited water resources and the extension of irrigated land is limited everywhere by non-sustainable agricultural practices and intensive water usage, resulting in groundwater depletion and soil salinization due to lack of proper agricultural drainage systems.

2. Impacts of the agricultural sector on the marine environment

8. The main impacts of agriculture on the marine environment are due to runoff of nutrients and agro-chemicals to the sea. Globally, around 80% of marine pollution comes from land-based sources, mainly agriculture, industry, and municipal waste. Overall, the Mediterranean region, in terms of nitrogen (N) usage has moved towards a more unbalanced situation with most of the countries being net larger importer (see Annex I). The decoupling of the crop and livestock producing systems caused a lower nutrient efficiency and issues associated with the lack of manure in cropping area and excessive manure in livestock farms. The excessive manure production is difficult to manage, and over-application in areas close to high-density livestock systems can severely affect the environment [3].

9. As disaggregation of the impact from different sources of land-based pollution is difficult, there is no quantitative data concerning the effect of agriculture on the environment of the Mediterranean Sea. The runoff of inorganic nitrogen and phosphorus fertilizers leads to eutrophication, which in turn negatively impacts marine ecosystems [4]. Eutrophication leads to hypoxia and anoxia, reduced water quality, habitat degradation, loss of biodiversity and noxious and harmful algal blooms. In addition, coastal hypoxia contributes to ocean acidification harming the calcifying organisms for example mollusks and crustaceans. The toxins from algal blooms can also deplete local fish stocks [5].

10. The runoff and infiltration of pesticides into the sea affects the marine environment at a slower pace by bioaccumulation higher up the food chain [5]. The impact of pesticides within an aquatic environment is influenced by their water solubility and uptake ability within an organism [6]. Pesticides affect the fish food webs and impacted their vital organs, behaviours and can cause their

mortality. Another major effect of toxic contaminants is on olfaction in fishes since it can affect activities such as mating, locating food, avoiding predators, discriminating kin and homing etc For instance, simultaneous exposure of trematode parasite (Telogaster opisthorchiasis), freshwater fish (Galaxias anomalus), and snails to high glyphosate concentrations significantly reduced their survival and development [7].

3. Evaluation of currently applied agricultural practices in the Mediterranean in support of the proposed main elements for the Regional Plan

11. The 21st Meeting of the Contracting Parties to the Barcelona Convention COP21 (Napoli, Italy, 2-5 December 2019) adopted Decision IG.24/10 which endorsed the main elements for the development of the new Regional Plan on the Prevention and Reduction of Pollutant Releases in the Mediterranean Sea from Agriculture, mandating also UNEP/MAP to undertake an assessment of the the state of play of agricultural practices and discharged pollutants reaching the Mediterranean marine environment. In the following sections, common agricultural practices in the Mediterranean are presented with regard to discharge of nutrients from intensive agriculture; fertilizers management; pesticides management; and manure management. For each of the above issues, common practices related to the aspects specified in the proposed main elements for the new Regional Plan are addressed.

3.1 Discharge of nutrients from intensive agriculture

12. The Mediterranean agriculture production is characterized by a high spatial variability and differences. Annual crops include cereals (e.g., wheat, maize, barley and rice), and vegetables (e.g. potatoes and tomatoes). Together, wheat, maize, barley and rice cover, for almost all Mediterranean countries, more than 90% of the entire cereal production, with rice having a significant share (>3%) only in Egypt, Greece, North Macedonia, Portugal, Spain and Italy. Permanent crops consist of fruit, olives, grapes and dates. For cereals, France, Turkey, Egypt, Spain and Italy produce (2014-2018 average) about 66, 35, 23, 21 and 18 million tons, respectively. As for fruit and vegetable production, the highest quantities (15-22 million tons for fruit, and 13-24 million tons for vegetables) come from Egypt, Italy, Spain and Turkey [8].

13. The Mediterranean Countries show an increasing demand for different animal products linked to demographic, cultural and economic growth. These different trends impact the ecological equilibrium and socio-economic viability among the Mediterranean countries particularly with regards to the sustainable use of natural resources (soil and water) [9]. As a result of intensive crop production and livestock, the main Mediterranean coastal areas historically affected by the inputs of nutrients due to leakage or infiltration/drainage from fertilized soil, wastewater, landfills and animal feedlots are the Gulf of Lion, the Gulf of Gabès, the Adriatic, the Northern Aegean and the South East Mediterranean. Maps showing the concentration of nitrate in the Mediterranean Sea and nitrogen and phosphorus emissions by agricultural areas, shown in Figure 1, illustrate coastal and marine areas potentially affected by runoffs of agricultural emissions.

3.2 Fertilizers management

14. The average consumption of overall fertilizers of countries in the Mediterranean basin increased by 10% between 2002 and 2016, from 160 kg to 174 kg per hectare of arable land. This average is subject to significant differences, ranging from 8 kg per hectare in the Syria to 649 kg per hectare in Egypt. Around one third of Mediterranean countries show national consumptions of fertilizers above the global average of 141 kg per hectare of arable land as is shown in Figure 2 [1].

15. In terms of usage of inorganic nitrogen and phosphate fertilizers, among all Mediterranean countries, the highest nitrogen and phosphate usage per hectare is in Egypt (342,26 kg/ha of nitrogen and 68,9 kg/ha phosphorus) and in in France (117.5 kg/ha). In Cyprus and Croatia, use of phosphate fertilizers is highest at around 40 kg/ha. [12].

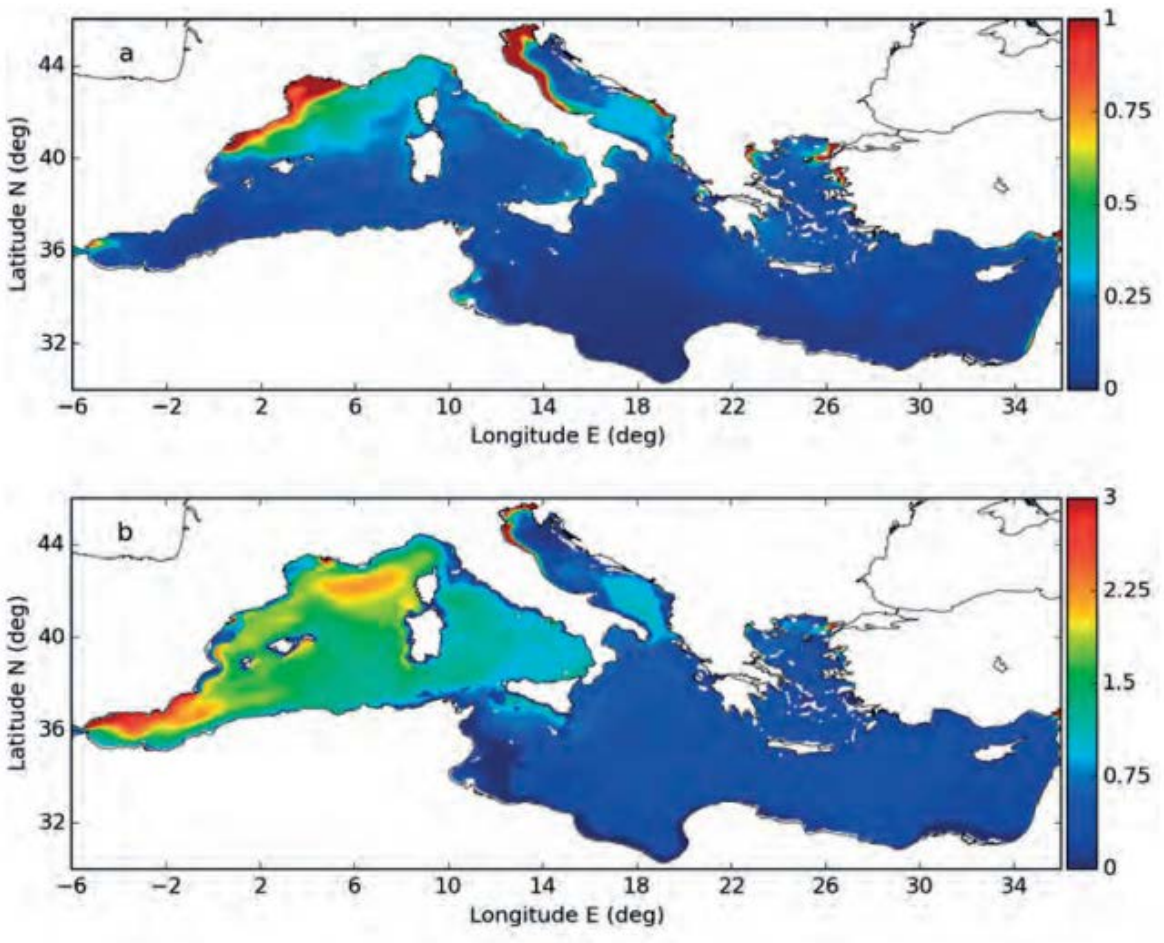

Figure 1: Surface (a) and sub-surface (b, 0-150 m) maps of nitrate (mmol/m^3) over the 2002-2014 period [1]

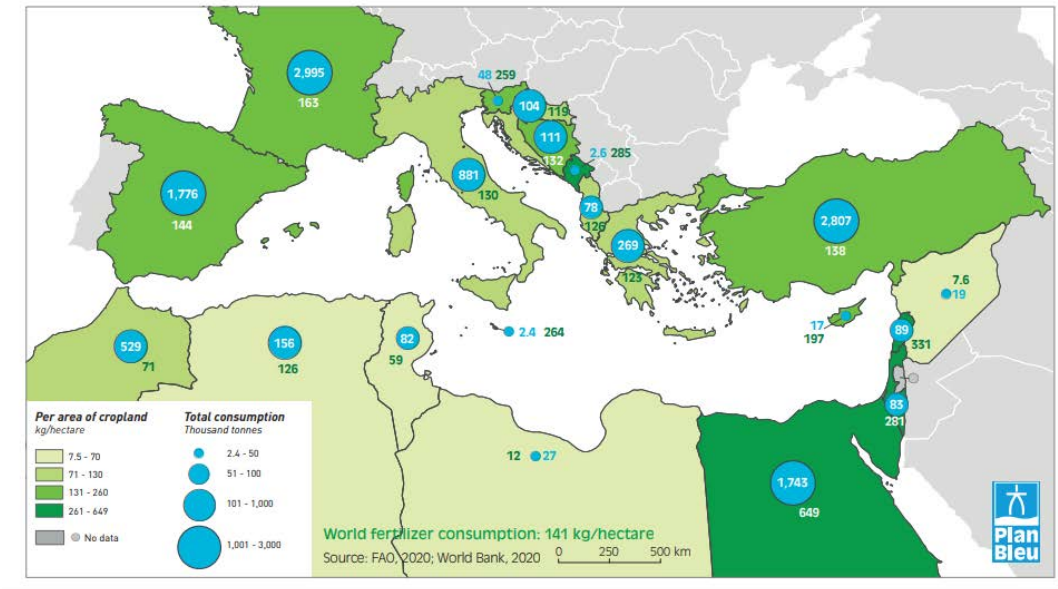

Figure 2: Agricultural use of fertilizers in Mediterranean countries, 2016 [1]

16. Existing standards and regulatory measures regarding restrictions on the use of fertilizers (according to FAOLEX Database [11]) are:

a. In Albania - Law No. 8531 regulating the Chemical Fertilizer Control Service establishes the rules and procedures for control of inorganic fertilizers, both imported and domestic, available for use in the Albanian market. Any individual or legal entity, registered according to Albanian legislation, has the right to buy and sell chemical fertilizers and is subject to this Law.

b. In Bosnia and Herzegovina, the law on mineral fertilizers prescribes all necessary conditions for the composition, quality and labelling of mineral fertilizers on the territory of the Federation of Bosnia and Herzegovina, which are placed on the market for free use/commerce, also providing concrete rules for their use and supervision over the implementation of rules aimed to defined various issues related to the safe, correct and sustainable use of mineral fertilizers.

c. In Croatia, the Regulation on Fair Agricultural Practice in the Use of Fertilizers provides general principles for good agricultural practice in the use of fertilizers that contains the period during the year when it is not allowed to use fertilizer on agricultural soils, the methods of fertilizer application near water courses, sloping terrain, water saturated soils, flooded, frozen or snow covered ground conditions.

d. In Cyprus, with Fertilizers Law 1999 (Law No. 124(I) of 1999), the Council of fertilizers control is instituted. A written authorization, issued by the Council, must be obtained before importation, preparation or packaging of any type of fertilizer. The marking of fertilizer packages must comply with prescriptions issued by this Law.

e. The European Commission envisages a replacement of the currently valid Regulation (EC) No 2003/2003, expanding its scope to secondary raw material based, i.e. recovered and bio-based fertilizing products. A new EU Fertilizing Products Regulation (EU) 2019/1009 was approved by the European Parliament and the Council of the European Union on 5 June 2019. Within this new regulation, EU fertilizing products divided into different product function categories (PFC), which should each be subject to specific safety and quality requirements adapted to their different intended uses.

f. In Egypt, Ministerial Resolution No. 918 of 1996 defining all sectors involved in agricultural activities including use of fertilizers and Ministerial Decree No. 2225 of 2004 on forms and issues related to fertilization provides for the use of the forms of fertilization schedules in the annexes No. 1,2,3,4,5 authorized by the Principal Bank for Development and Agricultural credit Exchange. Farmers are able to receive additional amounts if the grace period of the situation of fertilizers allows.

g. In France, the Legislative Part of Rural and Maritime Fisheries Code/ 2019 regulates use of fertilizers, the additives for fertilizers and growing media; rules relating to equipment intended for the application of plant protection products; and the control of the primary production of foodstuffs and products intended for animal feed or animal feed of plant origin.

h. In Greece, Ministerial Decree No. 394199/5224 on licenses of fertilizers establishes the conditions and administrative procedures for issuing licenses for provisional placement on the market of fertilizers not carrying the indication "fertilizer E.C.", import of fertilizers from third countries and quality control of fertilizers carrying the indication "fertilizer E.C."

i. In Italy, Legislative Decree No. 75 revising and rearranging provisions on fertilizers, as per article 13 of Act No. 88 of 7 July 2009 sets out a revised legislative framework applicable to products placed on the market as fertilizers, in compliance with European Union legislation. Fertilizers may be placed on the market as long as they fulfill the

prescribed requirements. Rules on packaging, labelling, identification and traceability are set out. A special commission is set up according to article 9.

j. In Israel, Agriculture Fertilizer Regulation/1938 of 19 sections and two Annexes, concerns the dealing with agricultural fertilizers before their utilization by the farmer. Registration of a fertilizers stock should be accompanied by two samples of 250g each. A registration certificate is valid till the 31 December of the current year and can be annually renewed, re-inspection can be ordered to be done on a fertilizer stock older than one year. Its paragraph 19 lists the name of fertilizers on which this regulation does not apply.

k. In Lebanon, Food Safety Act No.35 of 2015 consisting of 47 articles aims at ensuring the safety of food throughout its stages, from the farm to its consumption by humans, and establishing mechanisms to ensure the effective application of these rules. Must comply with it any person engaged in any activity dealing with food or animal feed intended for human consumption or agricultural products. The Act deals with (i) requirement for farmers, such as use of fertilizers or feed, safety and quality of plant or animal production, obtainment of the necessary licenses to carry out their activities.

l. In Malta, the Fertilizers Regulations, 2002 (L.N. No. 363 of 2002) lay down requirements with respect to labelling and packing of fertilizers and with respect to their content. They shall apply to products which are marketed as fertilizers and designated as “EC fertilizer”. The designation “EC fertilizer” which may only be used for fertilizers listed in the first schedule and complying with the conditions laid down by these regulations and their schedules.

m. In Montenegro, regulation on the principles of good agricultural practice for the application of fertilizers lays down the principles of good agricultural practice and detailed guidelines for Good agricultural practice for the application of fertilizers is reflected to the needs of plants, soil characteristics, climate characteristics, conditions for sowing and planting, method of application of the machinery and also regards the elated environmental protection issues. This text transposes the rules contained in the Annex II part of the Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources.

n. In Palestine, Project Law No. 7 of 1999 on the environment creates a framework for the protection of the environment, public health and biodiversity in Palestine including marine areas. Its Title II, Chapter 1 includes provisions regarding the manufacturing, importation, distribution, use and storage of pesticides and fertilizers, and provisions that deal with desertification and drifting of land. Specialized agencies (not defined), in coordination with the Ministry of Environmental Affairs shall devise a public policy for land use (art. 6).

o. In Spain, Law No. 1/2018 is to adopt urgent measures for the management and sustainability of agricultural activities and to guarantee their application in the surroundings of the Mar Menor and the protection of its natural resources, by eliminating or reducing the conditions caused by spills, sediment carry-overs, fertilizers and any other elements that may contain harmful pollutants for the recovery of their ecological status. The application of all types of fertilizers in the area of protection easement is prohibited in maritime terrestrial public domain (100 meters measured inland from the inner limit of the seashore).

p. In Syria, the Resolution No. 99/T issuing the Implementing Regulation of Law No. 18 concerning the trade, production and handling of plant growth regulators, and organic and mineral fertilizers.

q. In Turkey, the Regulation on Organic, Mineral and Microbial Fertilizers Used in Agriculture amends Article 7 of the Principal Regulation regarding the application procedures for real and legal persons engaged in production in the scope of the Regulation

on the principles of organic farming and their implementation. Furthermore, this Regulation amends Article 9 regarding prior consent for import, Article 11 regarding licensing for production and export, and Article 12 regarding the obligation for registration of every product before placing into the market.

17. In conclusion, it is found that the regulations related to use of fertilizers in line with EU directives are adopted not only by EU member states but also by Turkey and the Balkans. In contrast, the overuse of chemical fertilizers still occurs in many southern countries such as Egypt. This situation is driven by:

a. Use of fertilizers is not standardized with plants types, nitrogen needs, soil properties, quality and quantity of irrigation water, and climate conditions;
b. Gaps in the restrictions to the use of fertilizers near water bodies;
c. Contamination due to inappropriate storage of fertilizers (not addressing distance from water bodies, packaging, waterproof storages, etc.);
d. Need to maintain control of records of farmers' use of fertilizers;
e. Limited use of organic farming and agro-ecological practices which can reduce the environmental impact of chemical fertilizers and support the improvement of soil nutrient balance and carbon sequestration.

18. Fulfilling the above-mentioned gaps on fertilizer management in the Mediterranean contributes directly to the implementation of SDGs 14.1 and 6.3. The proper application of fertilizers improves soil resource and contributes indirectly to the achievement of SDGs 2, 3, 13 and 15.

3.3 Pesticides management

19. The consumption of pesticides in the Mediterranean varies largely between countries. In 2016, the average use of pesticides in kilogram per hectare of cropland was below or around the world average in most of Mediterranean countries as illustrated in Figure 3.

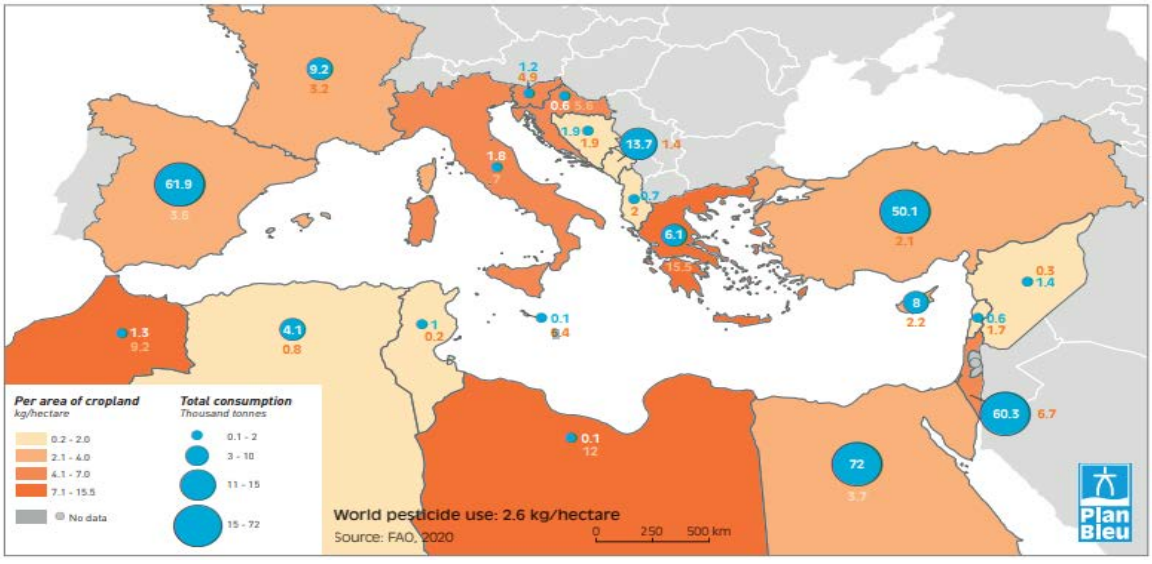

Figure 3: Agricultural use of pesticides in Mediterranean countries, 2016 [1]

20. Pesticides, especially if used irrationally, can lead to adverse impacts on animal and human health. Managing this type of pollution is particularly difficult because of its diffuse nature and largely unknown combined effects of multiple types of pesticides and their life cycles in the environment.

21. The runoff and infiltration of pesticides into the sea affects the marine environment at a slower pace by bioaccumulation higher up the food chain. Off-site impacts of erosion include diffuse pollution and eutrophication of downstream water bodies caused by eroded sediments being transported along with and the nutrients and pesticide attached to them; higher risks of flash floods transporting high loads of sediments; and reservoir siltation.

22. In this regard, the European Directive on Sustainable use of Pesticides (Directive 2009/128/EC) aims to achieve a sustainable use of pesticides in the European Union by reducing the risks and impacts of pesticide use on human health and the environment and by promoting the use of Integrated Pesticides Management (IPM) and of alternative approaches or techniques, such as non-chemical alternatives to pesticides. Specifically, Regulation (EC) 848/2008 of the European Commission resulted in a drastic reduction in the number of authorized active ingredients for olive pest control and a more limited reduction in the authorized fungicides for disease control. The EU countries have drawn up National Action Plans to implement the range of actions set out in the Directive.

23. Non-EU countries adopted rules to regulate use of pesticides. However, there are still gaps and occurrence of pesticide residues in food production. For instance, pesticide residues are often found in fruits and vegetables in the Eastern Mediterranean Region, the insecticides are often reported at levels above the Codex Maximum Residue Levels (MRLs) leading to potential exceedance of the Health Based Guidance Values established by FAO and WHO. The main cause is rapid urbanization and changes in lifestyle and consumer demands which driving farmers to apply pesticides to protect crops and increase yield.

3.4 Manure management

24. Manure has a high potential as organic fertilizer in agriculture, due to its composition of nitrogen, phosphorus, potassium and organic matter among others. However, the major intensification that livestock farming has undergone in the last few decades has generated large amounts of manure located in very specific areas, making it difficult to manage. This unbalance, combined with the bad management of the manure may cause environmental problems such as groundwater nitrate contamination, eutrophication of surface waters, accumulation of metals and phosphorous in soils [13].

25. Treatment of the solid fraction of manure comprises composting, drying and combustion. For instance, in Spain 3% of manure production is processed [14]. The liquid fraction of the manure after separation, as well as diluted slurries, can be processed with technologies to obtain a volume reduction (reverse osmosis, concentration), a more stabilized product (aeration, ozonation), and/or, a reduction of nitrogen content in the liquid (ammonia stripping and absorption, nitrification-denitrification). These treatments seem to be applied to the 3.9% of the livestock manure production in Spain, but with a relative limited number of plants while the higher number of installations are in France [15].

26. The EU Nitrates Directive [16] has represented the main driving force for adopting manure processing strategies. Manure treatment technologies can be classified on the basis of their objective (energy production, phase separation, nutrients recovery, nitrogen removal, etc.) Currently, 45 processing techniques have been identified as standalone technologies or belonging to combined treatment systems; each of them is dependent on local constraints and problems, as well as different economic, territorial, environmental, and political scenery.

27. Differing European standards exist with respect to nitrogen and phosphorus requirements for organic fertilizers. For an organic fertilizer to meet French standards, total nitrogen, potassium and phosphorus oxides must be greater than 3% in fresh weight, respectively (AFNOR: FD CR 13456 2001).

28. In Spain, legislation for fertilizers (PRE/630/2011 2011), anaerobic digestates cannot be considered balanced fertilizer products, and they must be complemented with mineral fertilizers.

29. In conclusion, the main challenge in the Mediterranean with regard to manure management is the fact that policies and regulations are not comprehensive. They do not adequately cover every important aspects of manure management.

4. Proposed additional Best Available Techniques and Best Environmental Practices for the Regional Plan

30. The Mediterranean coastline is roughly 46,000 km long and is almost equally divided into rocky and sedimentary coasts. The northern coast of the basin is especially toothed and includes big islands like Sardinia, Corsica, Crete, Cyprus, Malta and numerous small islands mostly belonging to Greece. These coasts and islands are subject to erosion, salt intrusion and flood risks due to sea-level rise. Coastal areas including wetlands are under continuous pressure from urban sprawl and infrastructure development fueled mostly by the tourism industry that brings into the region about 300 million people each year [17]. The demand of the growing population, agriculture, industry and tourism put heavy pressure on the limited natural resources of the Mediterranean region. Sustainable solutions are therefore required an integrated and holistic approaches to meet the current demand as well as to protect ecosystems.

4.1 Water resources management

31. Agriculture is the largest water consumer in the Mediterranean countries. In 2015, irrigation water consumed on average 64% of water resources (varying from 50% in the north up to 90% in some southern Mediterranean countries), followed by industry at 22% (including the energy sector and the tourism industry) and the drinking water sector at 14% [19].

32. In the Mediterranean, irrigated lands cover more than 16% of total agricultural lands. Malta ranks first for the irrigated area in percentage terms at 35%. In contrast, Slovenia irrigates only 1% while Libya covers only 2% of their total agricultural lands. Egypt tops the list in terms of irrigated lands as it literally irrigates 99% of land available for crop production (see Table 1). Expansion of irrigation has created salinity build-up problems in many countries in the Mediterranean. Over the last two decades, in Egypt for instance, about 1 million hectares have been affected by soil salinity due to inadequate irrigation water [19].

33. Special attention should therefore be given to apply BATs and/or BEPs while ensuring quality and amount of water used for irrigation and the establishment of irrigation systems that are both efficient in water use and crop productivity and that provide adequate water for the leaching of accumulated salts and drainage to avoid water logging. Farmers should both improve water use efficiency and reduce irrigation-related pollution by calibrating water consumption to actual crop-related water demands [20].

34. For instance, in a coastal area such as the Nile Delta, the productivity and efficiency of water in agriculture is being significantly improved using technologies like the construction of raised growing beds facilitating irrigation. This system reduces water inputs by 30%, while improving yield by 25% and efficiency by 72% [21].

35. In Tunisia, conservation agriculture trials were conducted with French research services and the French Development Agency (AFD). The agricultural trials showed that changes in farming practices can stop erosion and improve resilience to drought. Water does not destroy but builds because it infiltrates the soil and recharges the ground water.

36. These examples are not large-scale examples in the Mediterranean. On the other hand, securing water availability to guarantee food security is not the solution for ensuring sufficient agricultural products for the population. Efforts for adaptation of cropping systems to multiple abiotic stresses should continue to enhance sustainable soil management together with nutrient management and optimization of crops production plans while sustaining soil fertility under influence of climate change and population increases.

4.2 The WEFE Nexus

37. Delivering water, energy and food for all in a sustainable and equitable way, while preserving the health of the natural systems that form the basis of any economic activity, is one of the major challenges that the Mediterranean countries face. Traditionally, these sectors have been dealt with separately in their management and investment planning, with separate strategies, priorities, infrastructure, regulatory and institutional frameworks to address sector specific challenges and demands [22].

38. The agricultural sector and the people it employs are in urgent need of solutions that provide more resilience. The implementation of integrated approaches considering the water-food-energy nexus as an interlinked system, and Integrated Water Resources Management (IWRM) could contribute to a more efficient use of resources. Responses should also include the robust management of river runoffs, and lead to a gradual reduction in the use of fertilizers and pesticides; thus, preventing the release of nutrients and pollutants into the watersheds and reaching the coast.

39. Many Mediterranean countries have embarked on reforming their water sector to face the increasing stress [23]. For decades, most of the national strategies favored the supply-side, determined by the scientific and technological progress and dominated by investments and efforts to develop infrastructures and increase water storage and conveyance. They disregarded the large potential of saving water at the different scales of the chain. The focus has gradually been shifting towards sustainability, that is, the wise and responsible use of natural resources and safeguarding the rights of future generations [24].

40. Consequently, resource limitations in all sectors requires a shift towards resource use efficiency, demand management and more sustainable consumption patterns, thus saving by reducing wastage on all fronts. Policymakers need to adopt smart strategies to enhance the nexus considering the opportunities and synergies of all systems including [25], [26].

a. Applying climate-smart agricultural practices (e.g. solar pumping, precision irrigation, reduce rainfed agriculture, etc.) to reorient agricultural systems to effectively support development and ensure food security in a changing climate;
b. Increasing deployment of renewable energy technologies and increased efficiency through improvements in food production, processing and distribution;
c. Changes in lifestyles and consumption patterns can also reduce pressure on water, energy and food;
d. Increasing investments in research and innovation for water and food security and nutrition, with due attention to neglected areas;
e. Considering that the interactions between water, energy and food systems should incorporate full life-cycle assessments in terms of the mutual interaction between the three components of the full nexus;
f. Resources policies and regulations should be more based on the scientific knowledge related to the use of resources and the natural or man-induced impacts.

41. Adopting the WEFE approach in the Mediterranean as a response to prevent land-based pollution, in using BATs and BEPs will support the implementation of the SDGs especially SDG 2 (Food), SDG 6 (Water), SDG 15 (land) and SDG 7 (Energy), especially that most SDGs have elements linked to food, water, and energy in one or more ways [25].

4.3 Pesticides management

42. The greenhouse crop production has grown significantly in recent years and has become more and more intensive in the Mediterranean Basin. However, the intensification of greenhouse crop production has created favorable conditions for many devastating pests and diseases. This has significantly increased the need for pesticide applications and consequently there is strong need to

improve environmental performance of greenhouse crop productions by following the Good Agricultural Practices [27]. This includes integrated pesticides management.

43. For the pesticide management, policy makers and farmers need to give careful consideration to all available plant protection methods and subsequent integration of appropriate measures that discourage the development of populations of harmful organisms and keep the use of plant protection products and other forms of intervention to levels that are economically and ecologically justified as well as reduce or minimize risks to human health and the environment. In this regard, Integrated Pesticide Management requires the implementation of:

a. Awareness raising and capacity building of farmers;
b. Establishing a certification scheme for marketing and sale;
c. Target setting to reduce use of pesticides;
d. Restricting practices that accelerate pesticides contamination such as use of aircrafts;
e. Monitoring of effectiveness of applied pesticides management measures.

44. Widespread implementation of Integrated Pesticides Management in the Mediterranean will strongly help to minimize environmental and health impacts of pesticides and contribute the achievement of multiple SDGs such as 3, 6, 9, 14, 12 and 17.

4.4 Manure management

45. Integrated Manure Management (IMM) mainly involves improved practices in collection, treatment, storage, and application of manure to soils. Integrated manure management has no unique solution. In order to ensure its co-benefit such as reducing nitrate (N) and phosphorus (P) leaching, some common actions need to be supported among other options especially by:

a. Using adequate techniques for animal breeding, digestion and manure reuse;
b. Ensuring to extend the BATs, specifically for large farms including anaerobic digestion and bio energy to produce N rich (bio-slurry) organic fertilizer and reduce GHG emissions;
c. Turning on-farm organic waste materials into a valuable farm resource by producing liquid fertilizers from aerobic decomposition of organic waste with extending cost-effective techniques as evaporation lagoons and ensuring use of these liquid product for the improvement of soil resources;
d. Overall, ensuring the livestock breeding installations in accordance with the Best Available Techniques (BAT).

46. The increased awareness of the advantages of sustainable practices and better alternatives to disposal is expected to play a crucial role in driving future actions related to the manure management in Mediterranean, and there are several SDGs that could directly or indirectly influence positive actions in future manure management including SDG 1, 2, 3, 6, 7, 8, 10, 11, 12, 13, 14 and 15.

5. Conclusions

47. The assessment of agricultural practices in the Mediterranean shows that irrigated agriculture was the most water-demanding sector and excessive abstraction of groundwater for irrigated agriculture is leading to a rapid depletion of groundwater resources with impacts leading to significant environmental degradation. Intensive crop production and livestock affects the main Mediterranean coastal areas due to leakage and infiltration/drainage of nutrients from fertilized soil. EU Member States that are Parties to the Barcelona Convention have adopted regulations related to use of fertilizers in line with EU directives. In contrast, the overuse of chemical fertilizers still occurs in other Mediterranean countries. Regarding pesticides management, EU Member States implement the European Directive on Sustainable use of Pesticides, whereas other countries that are Parties to The Barcelona Convention do have rules in place to regulate use of pesticides; however, there are still gaps in relation to their use. Finally, with regard to manure management, the main challenge in the

Mediterranean is the fact that policies and regulations are not comprehensive; they do not adequately cover every important aspect of manure management. In response to the above, additional measures that can be classified under BATs and BEPs are provided for agricultural activities for consideration in the Regional Plan for Agricultural Management. These deal with integrated water resource management; WEFE nexus; and integrated pesticides and manure management.

Annex I
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