Socio-Economic Evaluation of Oil and Gas Activities in the Mediterranean Sea

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1 INTRODUCTION AND JUSTIFICATION

The Mediterranean Sea is one of the world's hotspots of biodiversity, culture and economy. Despite occupying less than 6% on the surface of the planet and only 7% of the world population, it counts for 31% of the global tourism and 12% of the global GDP. [1]

In recent years, the Mediterranean Sea has seen an increase of oil activities: explorations, drilling, transportation and stocking have increased in the last years especially among non-traditional oil producing countries such as Croatia, Cyprus, Malta and Italy.

Due to the recent economic crises, there has been a great influence on the economy and unemployment. Particularly, the unemployment rate has remained high even several years after the crisis started. For example, the 2015 unemployment rate of Italy is still 12.4%, Croatia is at 15.8%, Spain is at 22.4%, and Greece is as high as 25.6%. [2] In turn, people and governments have started to look toward oil and gas as a source for jobs and opportunities.

1 United Nations Environment Programme, Regional Activity Centre for Specially Protected Areas and Mediterranean Action Plan, *The Mediterranean Sea Biodiversity: state of the ecosystems, pressures, impacts and future priorities*, 2010

2 Eurotat. Available online: ec.europa.eu/eurotat/statistics-explained/index.php/Unemployment_statistics

The increase of oil and gas related activities have produced several concerns. Populations are mainly worried about the environment and health issues, but some sectors are also worried about the economic impact that an accident can have. Tourism, fishing and aquaculture, transportation and desalinization are the sectors most threatened by an eventual accident. In several situations citizens have organized themselves into opposition groups in order to offshore oil and gas exploitation.

This study aims to identify what the main economic activities in the Mediterranean Sea are and how those activities can be undermined by oil extraction and by accident.

Because of the different economies in different areas of the Mediterranean basin, the study also analyzes three different areas within the region, where major oil and gas development projects are taking place.

It is important to consider that this kind of study is obviously not holistic. If a major spill occurs and an endemic species of crustaceous becomes extinct, how can we monetize it? Do we measure in cash the health of a local community?

Therefore, with this point of view, this study does not aim to evaluate the economic loss in terms of biodiversity but instead aims to evaluate the economic loss in terms of other major economic activities of the area.

2 STUDY AREA: THE MEDITERRANEAN SEA

2.1. Environmental Aspect of Mediterranean Sea

The Mediterranean Sea can be divided into four regions: Western Mediterranean, Adriatic Sea, Lonian Sea-Central Mediterranean and Aegean-Levantine Sea. The 22 countries and territories that border on the Mediterranean host:

- 5.7% of the planet's land mass, including a large number of desert and mountain areas;
- 10% of known higher plant species;
- 7% of marine species in less than 0.8% of its total ocean area;
- 7% of the world's population with 460 million inhabitants;
- 31% of international tourism, with 275 million visitors;
- 12% of world GDP;
- 60% of the population of the world's "water-poor" countries;
- 8% of CO_2 emissions;
- 30% of international maritime freight traffic;
- 20 to 25% of maritime oil transport. [3]

3 United Nations Environment Programme, Regional Activity Centre for Specially Protected Areas and Mediterranean Action Plan, *The Mediterranean Sea Biodiversity: state of the ecosystems, pressures, impacts and future priorities*, 2010

Currently there are 170 Marine Protected Areas (MPAs) in the Mediterranean Sea with a total area of almost 106,465 km2 occupying 4.25 % of the total Mediterranean area. [4]

The Mediterranean Sea is a semi-enclosed basin, linked to the Atlantic Ocean through the straits of Gibraltar and with the Black Sea through the Dardanelles. Because of the difference in temperature between the two adjacent seas, it determines a counterclockwise surface circulation that intensifies in correspondence with the main straits. [5] Its warm body of water, has a relatively short occupancy (~70 years) compared to the oceans (200-1000 years). The intense evaporation due to its thin cloud cover and sunshine exceeds precipitation and river runoff, draining water from the Atlantic Ocean. [6]

4 MedPAN, *The Status of Marine Protected Areas in the Mediterranean Sea*, 2012

5 A. Carillo, ENEA, *Valutazione del potenziale energetico delle correnti marine del Mar Mediterraneo*, 2011

6 A. Carillo, ENEA, *Valutazione del potenziale energetico delle correnti marine del Mar Mediterraneo*, 2011

2.2. Environmental vulnerability of the Mediterranean Sea

To understand which areas could be the most vulnerable to contamination, we have to consider some of crucial factors, among which are:

Bathymetry The shallow depths contribute to increased vulnerability and limits the turnover of water. [7]

7 ARPA. Available online: arpa.emr.it/pianetaacqua/data/inquinamento/reazione_corpi_recettori/text1.html

Vulnerable areas are any part of the coast with prevalence to the Adriatic Sea, Sicily Channel, Alboran Sea, Balearic Islands area, Gulf of Lion, Levantine Sea, and Aegean Sea.

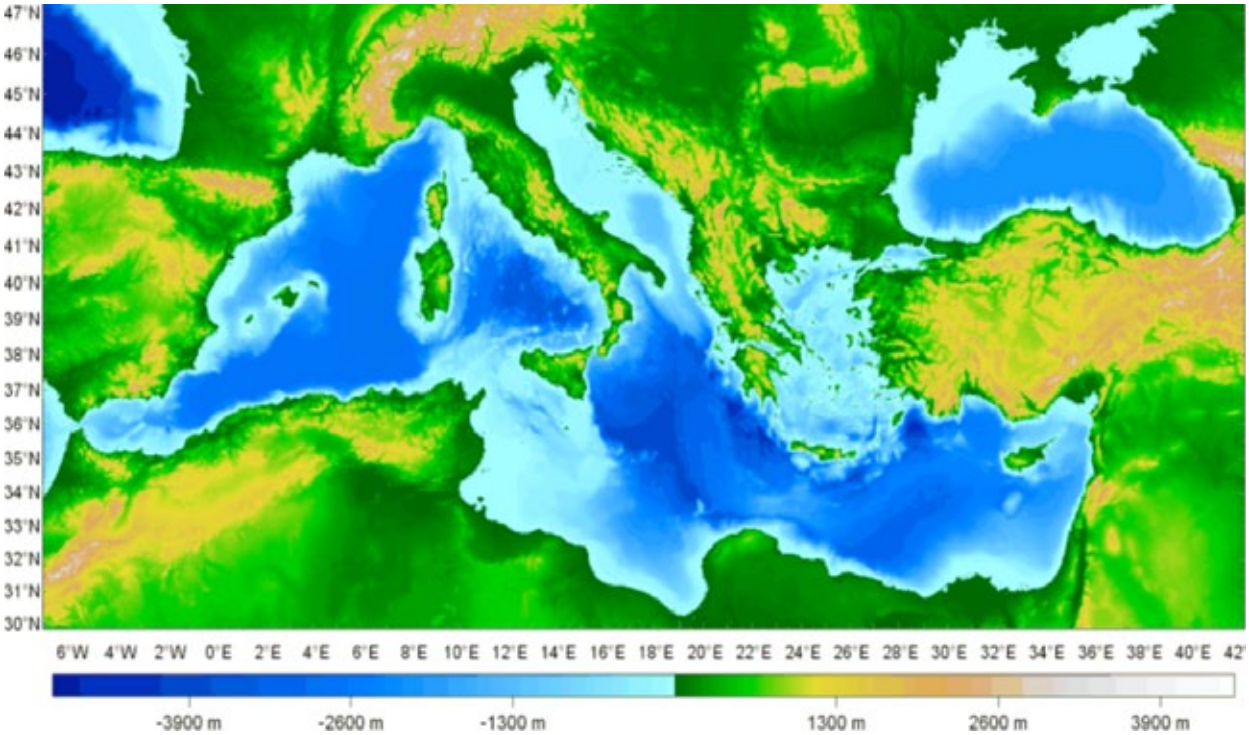


Figure.2.2.a. Bathymetry of the Mediterranean Sea.
Source: University of Pavia, Interdisciplinary Center of Bioacoustic and Environmental Research.
Available online: www3.unipv.it/cibra/edu_Mediterraneo_uk.html

Water surface temperature Hot water dissolves contaminants more quickly than the cold water due to some bacteria. Therefor, instead, the water temperatures become more vulnerable over time. The coldest waters are the Western Mediterranean Sea, Adriatic and Aegean Sea.

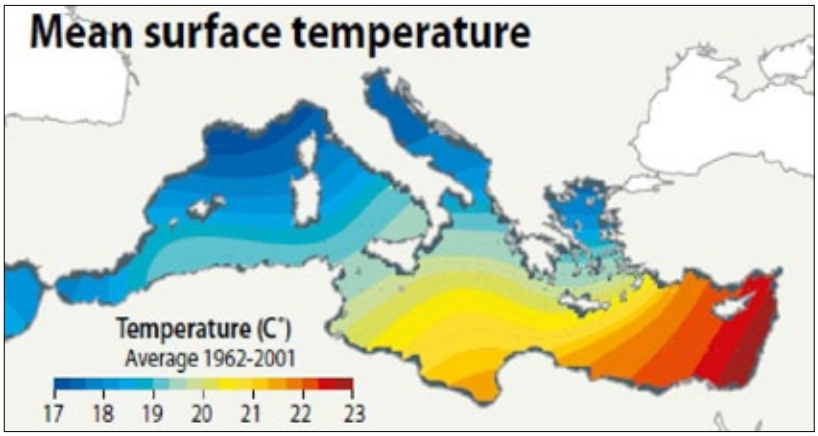


Figure.2.2.b. Surface water temperature.
Source: State of the Mediterranean Marine and Coastal Environment (UNEP/MAP- Barcelona Convention, Athens, 2012)

Marine currents Calm seas limit mixing of water and relative dilution of pollutants.[8] Considering the main motion of marine currents, the most vulnerable areas to contamination are: Adriatic Sea (for the low turnover of water), Ionian and Tyrrhenian Sea (for the cyclonic marine current), and Libyan coasts (for anticyclonic current).

8 ARPA. Available online: arpa.emr.it/pianetaacqua/data/inquinamento/reazione_corpi_recettori/text1.html

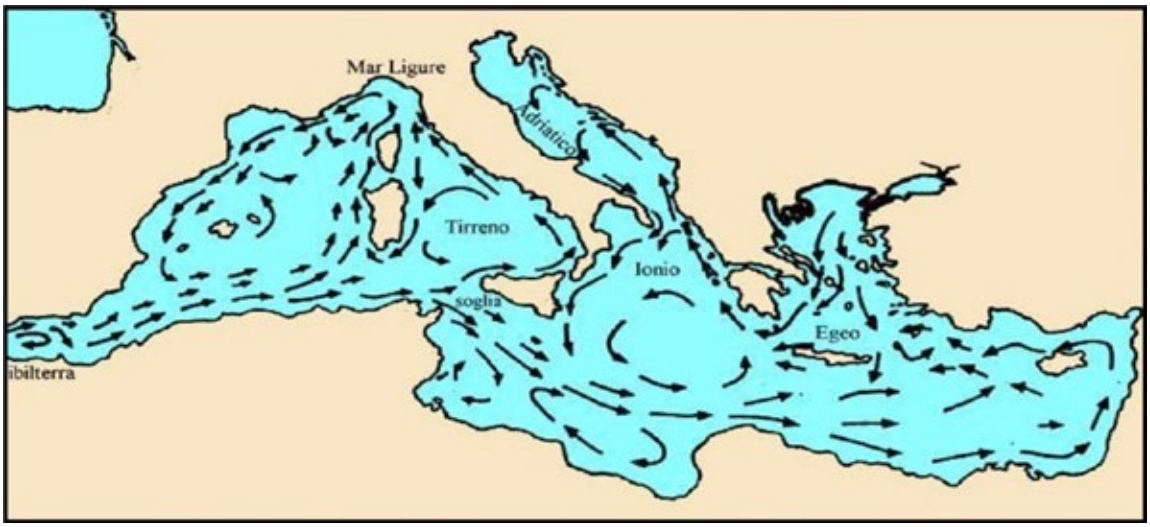


Figure. 2.2.c. Circulation in the Mediterranean Sea. Source: UNIVPM.
Available online: ginux.univpm.it/didattica/dispense/bavestrello/zoologia/pagine/1_2_1.htm

2.3. Economic aspects of Mediterranean Sea

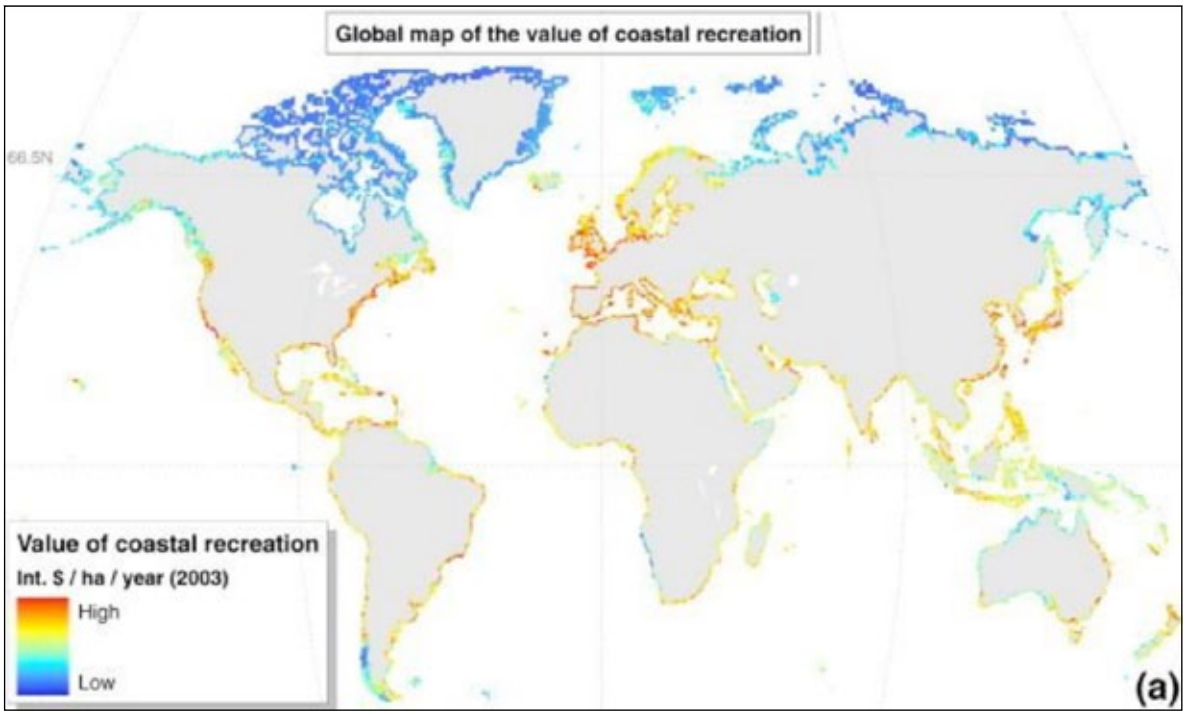


Figure 2.3. Global map of recreational values of coastal ecosystems . Source: Ghermandi & Nunes, 2013

Although it is difficult to evaluate the complete economic value of a determinate area, some economic figures can help to understand it. There is an econometric study in which the authors try to explain how the attributed values [9] to a coastal ecosystem vary according to:

1. Study variables (e.g. valuation method);
2. Site variables (e.g. protected area, ecosystem type, ecosystem service);
3. Context variables (e.g. GDP per capita, population density, anthropogenic pressure, marine biodiversity, etc.).

They elaborate this kind of data by means of a GIS software, obtaining the reported map above. With a quick look, we can see that Mediterranean coasts are among the most valuable in the world.

9 Ghermandi A, Nunes Pald, *A global map of coastal recreation values: Results from a spatially explicit meta-analysis*, 2013

2.3.1. Main socio economic activities in the Mediterranean Sea

The main economic activities of the Mediterranean Sea that threaten the Oil & Gas industry the most are tourism, fishing and aquaculture, maritime transport and desalination for freshwater provision. [10]

Tourism The Mediterranean region is the world's leading tourist destination. Tourists visit The Mediterranean especially during the summer. It has been estimated that in 2011 half of the 300 million international arrivals took place in coastal areas, accounting for about 15% of world figures. [11]

In 2014, Travel and Tourism in the Mediterranean countries [12] directly contributed to the GVA (Gross Value Added) for €289.7 billion (4.41% of total GVA) while the total contribution [13] was €730.7 billion (11.13% of GVA). Concerning employment, tourism's direct contribution amounts to 7,336,066 jobs (4.5% of total employment) to 18,366,382 jobs considering total contribution, representing 11.9% of total employment. [14] The fact that employment and GVA contributions are similar it is an index of a sector that does not generate excessive capital accumulation.

From statistical evidence, it is known that almost 50% of Mediterranean tourism is concentrated in coastal zones; considering just tourism and recreational activities in coastal areas for 2012 are as following:

- More than €250 billion in total revenue;
- About €140 billion of produced GVA (Gross Value Added);
- 3.3 million in direct jobs and 8.5 million in total jobs. [15]

10 UNEP/MAP, *State of the Mediterranean Marine and Coastal Environment*, 2012; MEDSEC, *Environment and security issues in the Southern Mediterranean Region*, 2009; Plan Bleu, *Economic and social analysis of the uses of the coastal and marine waters in the Mediterranean,characterization and impacts of the Fisheries,Aquaculture, Tourism and recreational activities, Maritime transport and Offshore extraction of oil and gas sector*, 2014.

11 Plan Bleu, *Economic and social analysis of the uses of the coastal and marine waters in the Mediterranean, characterization and impacts of the Fisheries, Aquaculture, Tourism and recreational activities, Maritime transport and Offshore extraction of oil and gas sector*, 2014. Including indirect and induced effects.

12 In this case we consider the whole sector (not only coastal tourism) in the following Mediterranean countries: Albania, Algeria, Bosnia Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Libya, Malta, Montenegro, Morocco, Slovenia, Spain, Syria, Tunisia, Turkey

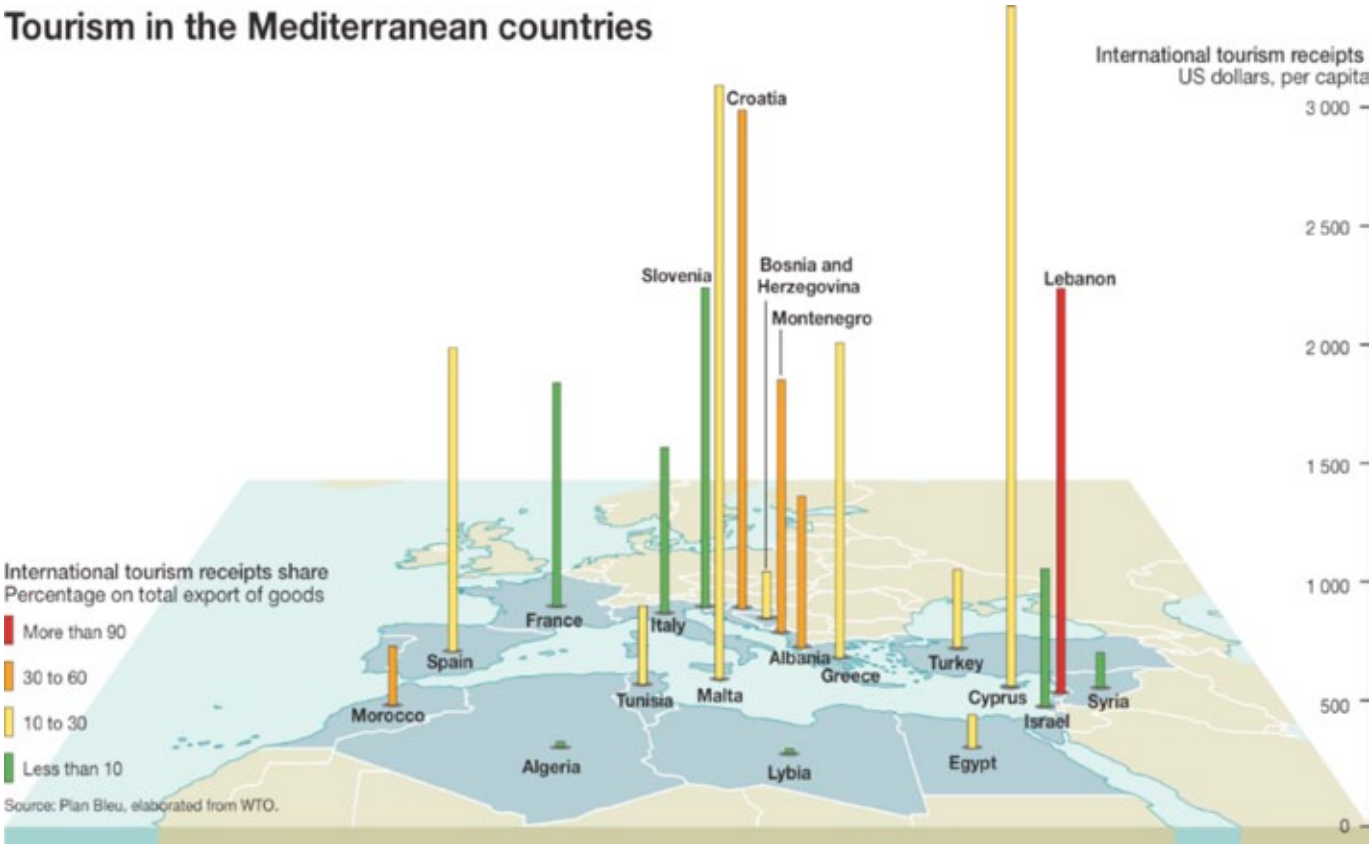
13 Including indirect and induced effects

14 World Travel & Tourism Council, *Travel & Tourism - Economic impact 2015 Mediterranean*, 2015

15 Plan Bleu, *Economic and social analysis of the uses of the coastal and marine waters in the Mediterranean,characterization and impacts of the Fisheries,Aquaculture, Tourism and recreational activities, Maritime transport and Offshore extraction of oil and gas sector*, 2014

According to WTTC (World Travel and Tourism Council) forecasts in the Mediterranean area between 2015 and 2025 in the tourism sector will have an increase of about 3% pa in direct contribution to GVA and respectively 2.2% pa and 1.8% pa in direct and total contribution to employment.

Figure 2.3.1.a. Tourism in the Mediterranean countries. Source: UNEP/MAP, 2012



Even if more than two thirds of international tourist arrivals are still concentrated in the advanced economies of Europe we have to underline that between 1995 and 2010 the Middle East, North Africa and emerging Europe have had an average growth of 9% per year. The recent political situation in the Middle East and North Africa has led to a reduction of this trend, but east Europe is still growing fast and forecasts show that this region will grow faster than mature destinations until 2030. [16]

16 UNEP/MAP, *State of the Mediterranean Marine and Coastal Environment*, 2012

Fisheries and aquaculture Data about fisheries and in particular, regarding its contribution to GVA and employment, are difficult to gather because of different levels of aggregation, and way and time of collecting.

The most recent study in this sector has been conducted by Sacchi and published in 2011 referring to 2008 data. [17] Before reporting the main results of this study it is useful to display some data series about fisheries to understand if they can represent the present situation.

As landings have slightly decreased since 2008 we can presume that the value reported in Sacchi can still approximately represent the economic performances of the fishery sector.

17 Results of this study have been synthesized in the Economic and social analysis of the uses of the coastal and marine waters in the Mediterranean (Plan Bleu, 2014)

18 Plan Bleu, *Economic and social analysis of the uses of the coastal and marine waters in the Mediterranean,characterization and impacts of the Fisheries,Aquaculture, Tourism and recreational activities, Maritime transport and Offshore extraction of oil and gas sector*, 2014

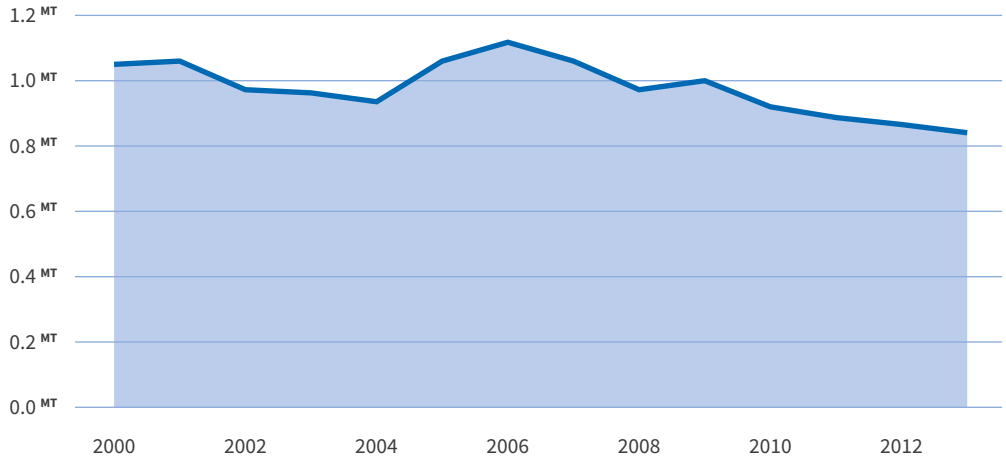
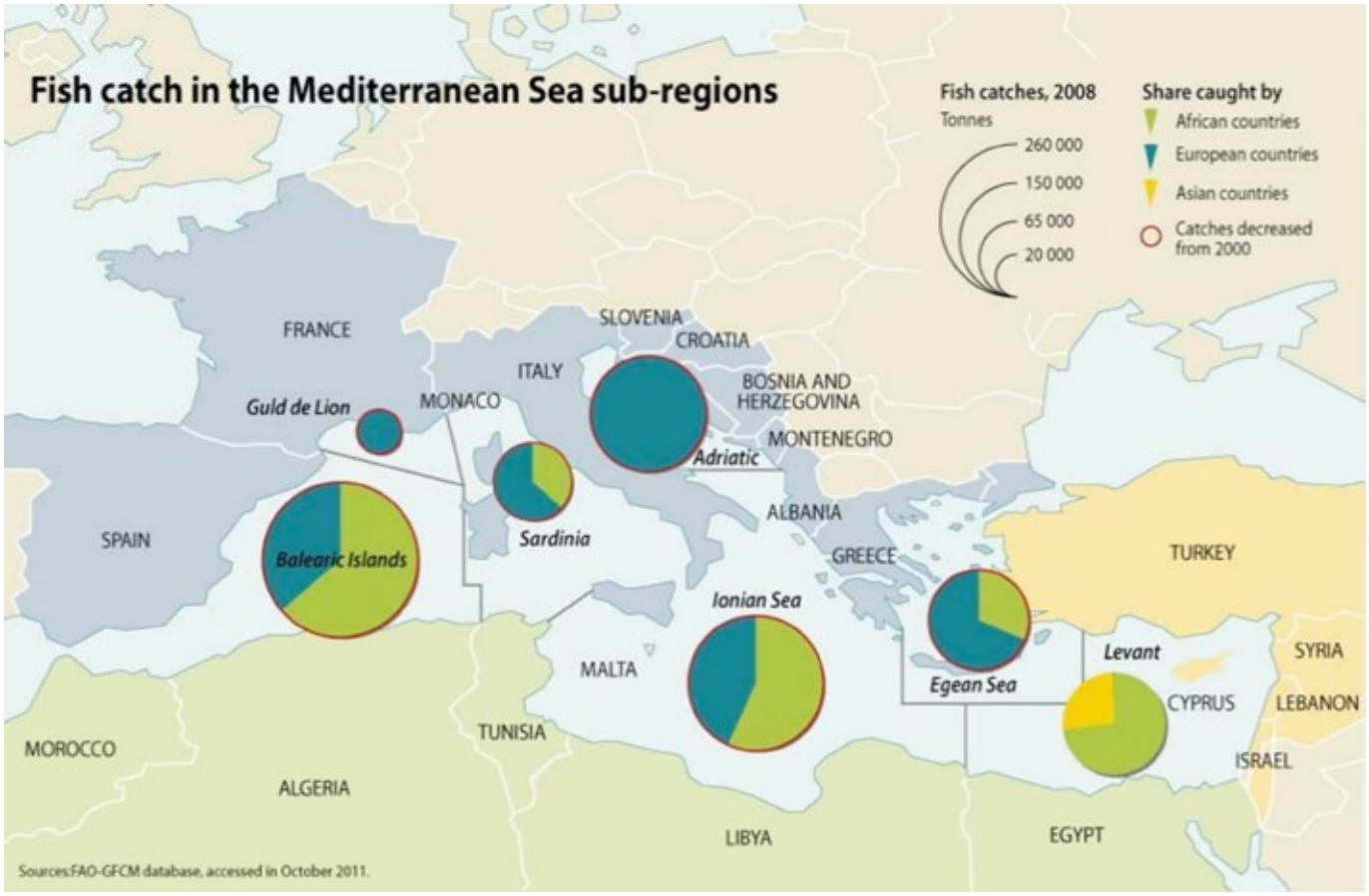


Figure 2.3.1.b. Landings in weight (million tons) in the Mediterranean Sea. Source: FAO - Fisheries and Aquaculture Information and Statistics Service

In 2008 the economic value of total fish landings was more than €3,200 million and the direct employee number was about 250,000. The economic value adjusted to 2014 should be approximately €5,000 million, but for our analysis we've used the latest official data of about €3,200 million; on this basis we have to consider that the GVA data in our further calculations on fishing are underestimated. We should also consider that even though the Mediterranean landings are just 1.24% of the world amount in weight, because of higher prices in 2008, it represented 4.6% of global values. [18]

The image below shows how fishing activities are distributed in the whole Mediterranean Sea.

Figure 2.3.1.c. Fish catch in the Mediterranean Sea sub-regions. Source: UNEP/MAP, 2012



In addition, aquaculture in the Mediterranean has an important role and is rapidly growing in last years. Production in marine and brackish water in 1990 was 543,700 tons and in it 2010 reached 1,555,800 with an average annual growth rate of 8.9%. [19]

In 2011 production value coming from marine and brackish environments in the Mediterranean Sea amounted to €2,561 million and the estimated GVA was about €1,870 million. These figures represent 6% of the world revenues in marine and brackish production and more than 70% of total aquaculture production in Mediterranean. [20] In terms of em-

19 General fisheries commission for the Mediterranean, *Trend and issues of aquaculture in the Mediterranean and Black Sea*, 2013

20 The remaining part consists of production in fresh water

ployment, in 2008 there has been an estimated 120,000 direct jobs while indirect employees were over 750,000. [21] In the following graph we can see in which countries the aquaculture sector is more developed.

21 Plan Bleu, "Economic and social analysis of the uses of the coastal and marine waters in the Mediterranean", 2014.

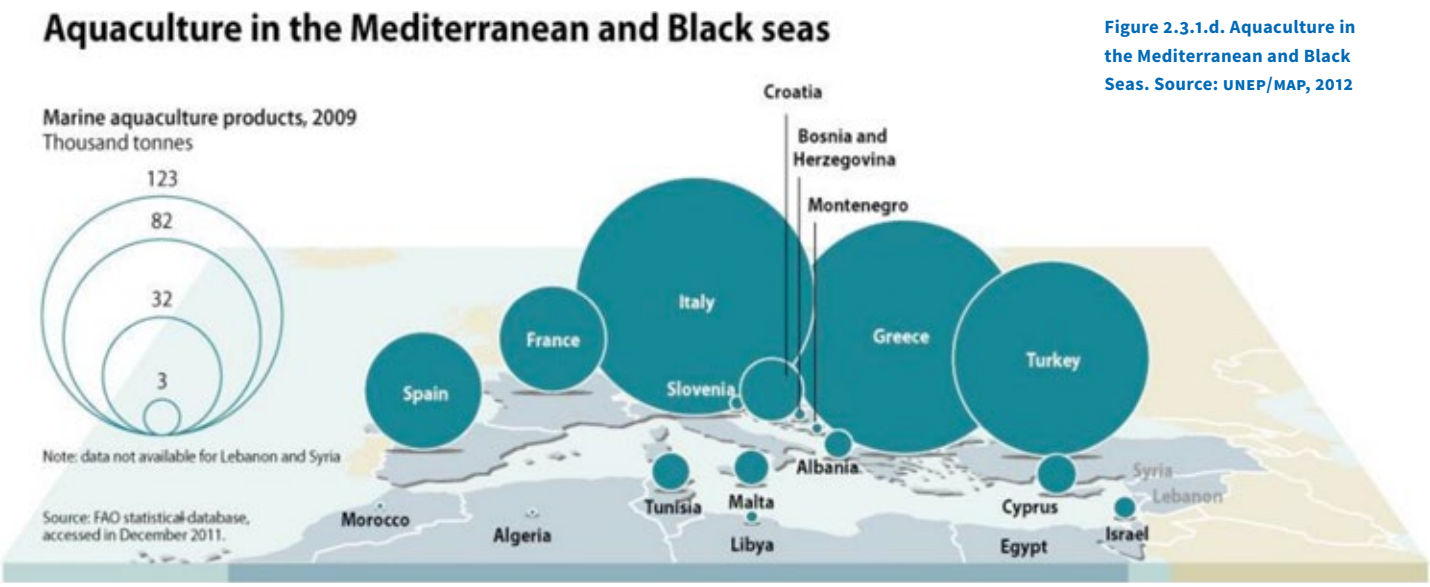


Figure 2.3.1.d. Aquaculture in the Mediterranean and Black Seas. Source: UNEP/MAP, 2012

Maritime transport Another important economic sector in the Mediterranean Sea is Maritime transport accounting for 15% of global shipping activity by number of calls and 10% by vessel deadweight tons. Most of the traffic is internal (about two-thirds) and consists of passenger ships (34%) and dry cargo ships (31%). Transportation of energetic goods is also important: about 18% of global seaborne crude oil shipments take place within or through the Mediterranean and liquefied natural gas (LNG) and liquefied petroleum gas (LPG) are a relevant part of the traffic.

22 Dry cargo ships are used to carry solid dry goods that have a higher tolerance to heat and cold, such as metal ores, coal, steel products, forest products, and grains

23 UNEP/MAP, *State of the Mediterranean Marine and Coastal Environment*, 2012

24 These data do not include Algeria, Lebanon, Libya, Palestinian Territories and Syria since there are no available information in the Plan Bleu, 2014

In economic terms, in 2010, the maritime transport sector accounted for €70 billion in total revenue and about €27 billion in Gross Value Added. Jobs directly created were about 550,000. [24]

The following map shows which are the most important routes in Mediterranean Sea.

Figure 2.3.1.e. Maritime transportation routes in the Mediterranean. Source: UNEP/MAP, 2012

Maritime transport in the year to come will probably grow because of the increase in crude oil exports from the Caspian region and Black Sea as well as for the increasing bulk cargo traffic through the Adriatic Sea due to emerging Eastern European economies. [25]

Desalination Water produced through desalination is mainly used as drinking water for communities, tourist resorts and pure water for industries. Desalinated water waste is also primarily used for irrigation.

In 2006 the total production of all desalination plants worldwide was 44.1 million m3 per day. 28 million m3 of it was produced from seawater, corresponding to 63% of total production. Between 2003 and 2008 the desalination market was growing at an average rate of 12% per year and it is expected to reach a total production of 98 million m3 by 2015. [26] The largest producers in the world are the United Arab Emirates and Saudi Arabia. The total installed capacity in the Mediterranean in 2008 was 4 million m3 per day (14% of the world's total) and Spain was the largest producer (8% of worldwide

25 UNEP/MAP, *State of the Mediterranean Marine and Coastal Environment*, 2012

26 UNEP, *Resource and Guidance Manual for Environmental Impact Assessments - Desalination*, 2008

production). In Israel the biggest plant was producing 330,000 m3 per day. [27]

27 These data do not include Algeria, Lebanon, Libya, Palestinian Territories and Syria since there are no available information in the Plan Bleu, 2014

As we can see in the figure below, big desalination plants (producing more than 50,000 m3 per day) are scattered in the whole Mediterranean Sea. It is suitable to underline that some of these big plants are located in the Levant Basin (near Cyprus and Israel) and the Sicily Channel (in particular near Malta) but also near Libya and Algeria.

Figure 2.3.1.f. Water stress in the Mediterranean basin. Source: UNEP/MAP, 2012

Since water scarcity is going to be one of the most important themes in the near future, practices like desalination will probably continue to expand as we try to satisfy water needs for economic growth, social development and human health.

3 THE OIL AND GAS SECTOR IN THE MEDITERRANEAN SEA

3.1. Oil and Gas exploration: Environmental Concern

Oil exploration can constitute a serious danger for the deep environment both for survey seismic activities and for the direct physical impact on the sea bottom. [28] Seismic exploration is the most common way of looking for oil and gas in sea. It consist in recording, processing, and interpretation of artificially induced shock waves in the earth. In marine environments, air guns fire highly compressed air bubbles into the water that transmit seismic wave energy into the subsurface rock layers.

28 United Nations Environment Programme, Regional Activity Centre for Specially Protected Areas, and Mediterranean Action Plan, *The Mediterranean Sea Biodiversity: state of the ecosystems, pressures, impacts and future priorities*, 2010

The travel times and the intensity of the returned seismic energy, consent to estimate the structure and stratigraphy of subsurface formations, and facilitate the location of prospective drilling targets.

The generation of the shock waves has several negative impacts on marine ecosystem, especially to marine mammals that have a very sensitive hearing system.

Potential biological effects of airgun noise include physical-physiological effects, behavioral disruption, and indirect effects associated with altered prey availability. Physical-physiological effects could include hearing threshold shifts and auditory damage as well as non-auditory

disruption, and can be directly caused by sound exposure or the result of behavioral changes in response to sounds, e.g. recent observations suggesting that exposure to loud noise may result in decompression sickness. Responses, including startle and fright, avoidance, and changes in behavior and vocalization patterns, have been observed in baleen whales, odontocetes, and pinnipeds and in some case these have occurred at ranges of tens or hundreds of kilometers. [29]

All the stages and operations involved in surveying and extracting petroleum entail liquid and solid waste. These volumes of waste may be as high as 5,000 m3 for every well sunk. The liquid waste consists of toxic impurities needed for the coordinated working of the drilling equipment, heavy metals which accumulate as a result of working the geological material, and also clay suspensions which increase the turbidity of the water in discharge areas. [30] Sound waves of oil prospecting affect marine species: damage and injury in fish and cetaceans, impaired breathing rates and migratory routes, or decreased up to 50% mortality of fish eggs and larvae and plankton and reduction in catches of different species. Submerged habitat affected are the seagrass *(Posidonia oceanica)*, plants with stems, leaves and fruits similar to terrestrial plants are of great importance and ecological value since the bottom structure serving as shelter, food and breeding in a diversity of plants and animals. [31]

29 Gordon, J et al.; *A Review of the Effects of Seismic Surveys on Marine Mammals Marine Technology Society Journal*, Volume 37, Number 4, Winter 2003, pp. 16-34(19)

30 Available online: bellona.no/assets/fil_Chapter_3._Environmental_risks_when_extracting_and_exporting_oil_and_gas.pdf

31 José C. Serra, *Impacto ambiental de las prospecciones petrolífera en el golfo de Valencia*

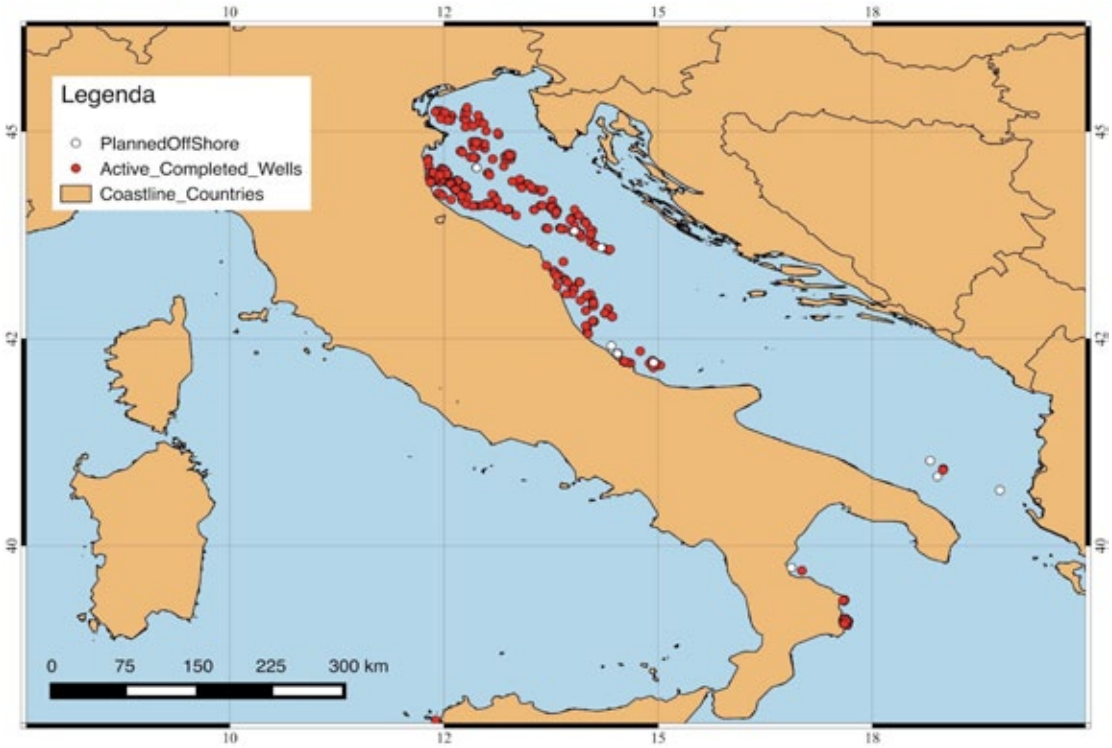
3.2. Oil and Gas extraction: Environmental Concern

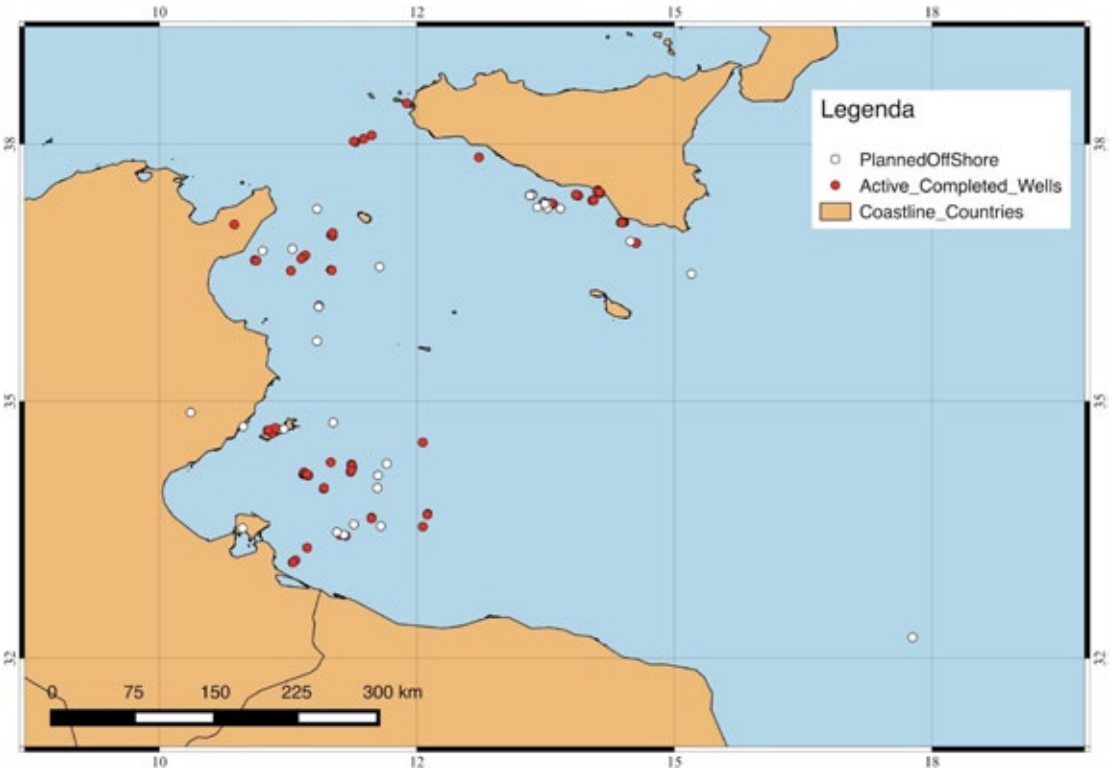
Potential environmental issues, associated with offshore O&G extraction phase, include the following:

- Air emissions (nitrogen and sulfur oxides, carbon monoxide, and products from incomplete burning of hydrocarbons);
- Wastewater discharges;
- Solid and liquid waste management (produced waters that include dissolved salts, organic compounds, oil hydrocarbons and trace metals; and drilling fluids and cutting, that contain many heavy metals and biocides);
- Noise generation;
- Oil spills. [32]

32 Stanislav Patin, *Waste discharges during the offshore oil and gas activity*, based on *Environmental Impact of the Offshore Oil and Gas Industry*

Figure 3.2.a. Map of wells (active/completed and planned) in the Sicily Channel, Adriatic Sea and Levantine Basin. Source: O&G from Drilling Info (2015) part of the Africa Land Use Planning and Monitoring System (ALES)

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PlannedOffShore
Active_Completed_Wells
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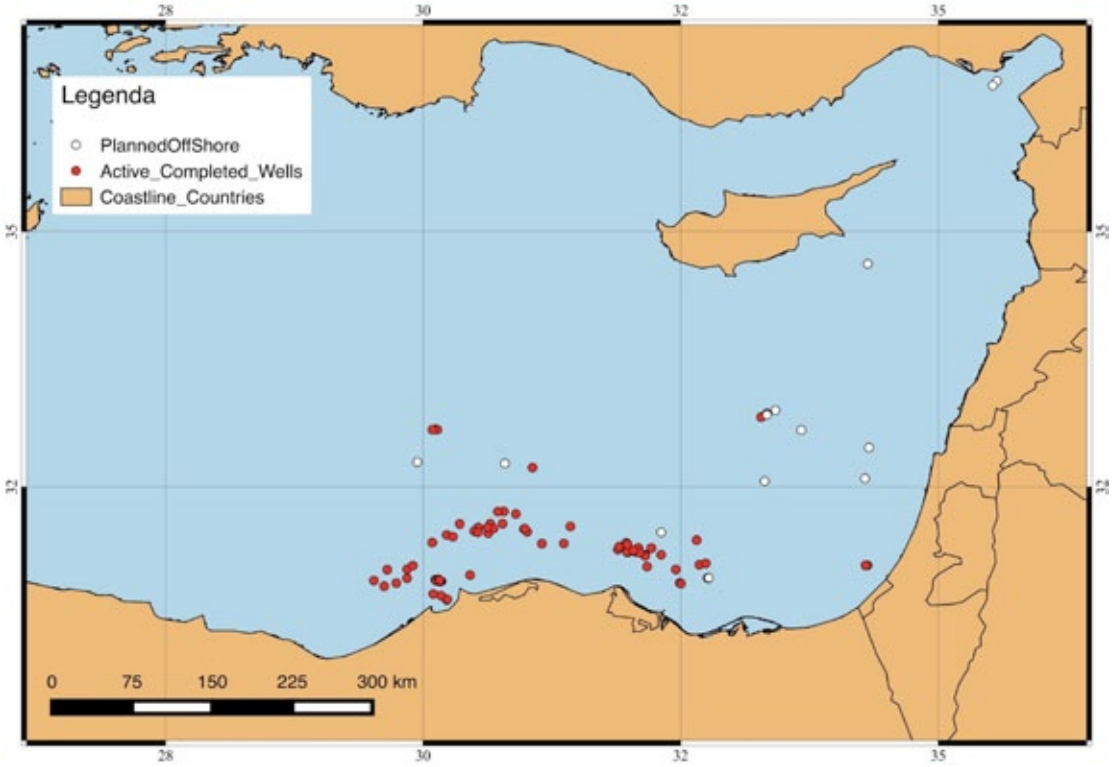
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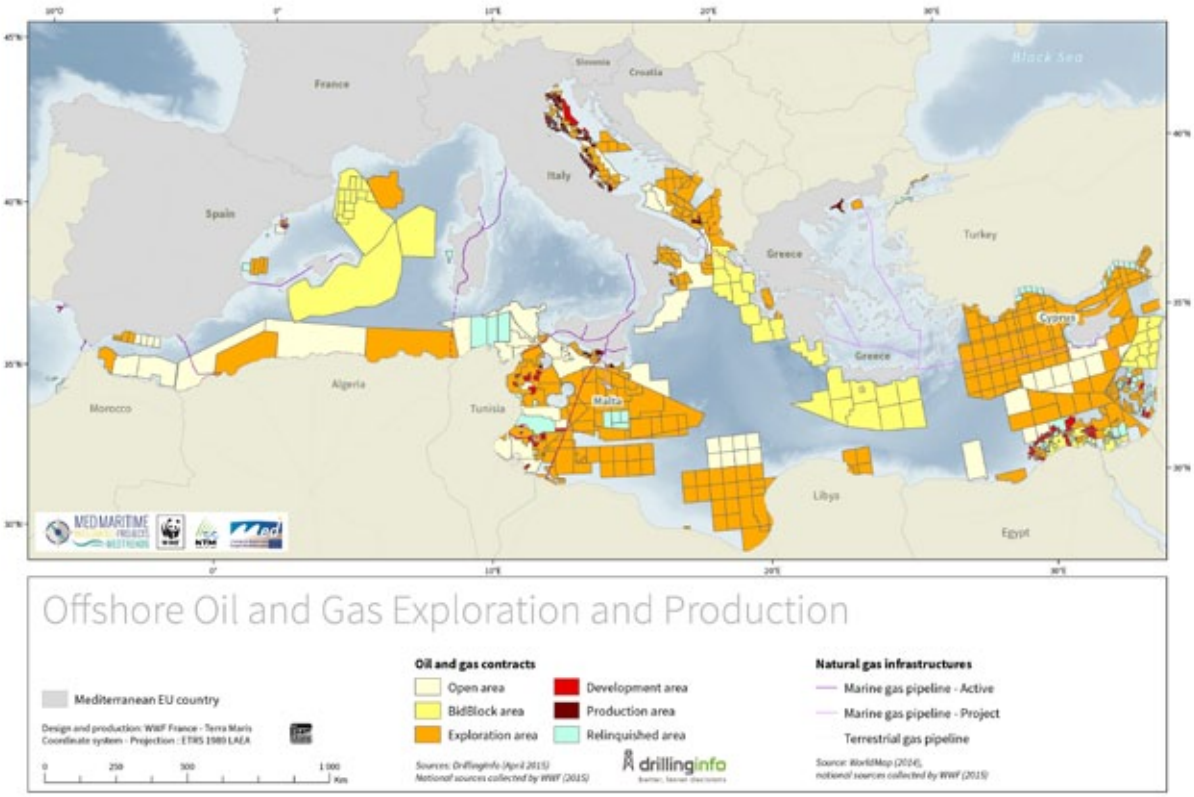
In the case of a grave ecological incident (such as the Deep Water Horizon, Gulf of Mexico), the estimated surface that the oil spill would cover is up to 20% of the total extent of the Mediterranean Sea. In terms of numbers, given that the Mediterranean Sea surface is 2.5 millions of Km^2, crude oil could cover 500,000 Km^2 in the basin's central area, causing immeasurable impact in the whole ecosystem. [33] The risk associated with an oil spill is particularly elevated in the Adriatic Sea, the Sicily Channel and Levantine Basin.

33 NiKolaos Nikolopoulos, *Natural Disaster prevention and management in the Mediterranean marine space caused by oil and gas leakage*

Figure 3.2.b. O&G from DrillingInfo (2015) part of the Africa Land Use Planning and Monitoring System (ALES)



Ecosystem Impacts Oil spills can provoke tremendous environmental disasters. Deep Water Horizon, Exxon Valdez and Prestige are just some of the latest disasters provoked by oil spills. Oil spills affects all aspects of the ecosystem:

- Blocking the light on the surface;
- Depositing to the bottom affecting plants and benthic animals;
- Depositing coat the feathers of seabirds and fur of some marine mammals;
- Dissolving several toxic compounds that affect sea ecosystem even after the emergency;
- Compounding bioaccumulate in fish and plants and then affect human health.

In the Deep Water Horizon case, the U.S. Fish and Wildlife Service reported that up to 32 National Wildlife Refuges were potentially affected by the spill, [34] 600 Gulf species were reduced in numbers, and 10 species are at risk of extinction. Along with manatees and batfish species becoming more extinct:

- All sea turtles species in the Gulf are at risk of possible extinction, but none are as threatened as the **Kemp's Ridley** *(Lepidochelys kempii)*.
- The oil spill has the potential to erase the entire U.S. population of the **North Atlantic Bluefin Tuna** *(Thunnus thynnus)* because most of the fish use the Gulf of Mexico as their spawning ground.
- Only 71 individuals of **Snowy Plover** *(Charadrius nivosus)* remain of this critically endangered population of shorebirds.
- The entire year's spawn of **Elkhorn Coral** *(Acropora palmata)* could potentially be wiped out.
- Removed from the Endangered Species List just months before the oil spill, the **Brown Pelican** *(Pelecanus occidentalis)* may soon be added back to the list.
- Two species of **Sawfish** that inhabit the Gulf, the smalltooth and largetooth, are greatly threatened by encroaching oil.
- If the Gulf oil spill kills a mere three individuals of **Sperm Whale** *(Physeter macrocephalus)*, the entire population could crash, according to a 2009 stock assessment report by the NOAA.
- The **Gulf Sturgeon** *(Acipenser oxyrinchus desotoi)* is just one of hundreds of fish species threatened by the oil spill. Already considered a species at risk, the oil slick could potentially cover what remains of this animal's remaining habitat.

34 Cutler J. Cleveland, *Deepwater Horizon oil spill*, 2013

In addition to the 14 species protected by U.S. law, the IUCN Red List identifies a further 39 species in the Gulf belonging to one of three threatened categories: critically endangered, endangered, or vulnerable. [35]

Figure 3.2.c. Column of oil 16 km deep in the Gulf of Mexico. Source: earthfirstjournal.org/.

At the moment (July 2015) BP set the ultimate cost associated with the spill at nearly €49 billion (US $54 billion), though there are still some unknown expenses to come, [36] increasing the costs of the spill higher than all the profits it has earned since 2012. [37] U.S. officials has estimated the size of the spill at 4.09 million barrels, which would raise BP's maximum fine of €16 billions (US$ 17.6 billion) for clean up costs. BP has set aside €3.1 billion (US$ 3.5 billion) to cover penalties related to the Clean Water Act. So far, the company has incurred more than €38 billion in costs for the spill, including for cleanup and compensation for victims. Only about 810,000 barrels of oil were collected following the accident. [38]

The Exxon Valdez (Gulf of Alaska) oil spill killed between 350,000 and 600,000 birds, along with thousands of sea otters and other marine animals; [39] after the spill, the local herring fishery collapsed and it took three years before it came back to the pre-spill situation. [40]

In 2007, two decades after the oil spill, NOAA reported that the impacts still linger: the orca pod affected by the spill never recovered. Sea otters and ducks, who forage for food in the beaches, need only scratch the sur-

35 Mother nature network, *10 animals at risk of extinction from the Gulf oil spill*

36 The New York Times. Available online: nytimes.com/2015/07/03/us/bp-to-pay-gulf-coast-states-18-7-billion-for-deepwater-horizon-oil-spill.html?_r=0

37 The Wall Street Journal. Available online: wsj.com/articles/bp-agrees-to-pay-18-7-billion-to-settle-deepwater-horizon-oil-spill-claims-1435842739

38 International Business Time. Available online: ibtimes.com/bp-says-gulf-mexico-recovering-2010-oil-spill-federal-scientists-dispute-companys-1849546

39 Cutler J. Cleveland, *Deepwater Horizon oil spill*, 2013

40 David Biello, Scientific American, *How Did the bp Oil Spill Affect Gulf Coast Wildlife?*, 2011

face to find layers of oil soaked into the sand. The oil remains toxic to these animals. Oceana, a conservation organization, reports that some species of loons, salmon, seals, ducks, herrings, pigeons, mussel and clam populations have never fully recovered. Commercial fishing, a €260 million (US$ 286 mln) industry, has not completely resumed in the area. [41]

19 of the 32 monitored wildlife populations, habitats and resource services that were injured in the spill are still listed today as "not recovering". [42]

In the case of Prestige (Spain), several marine organisms (particularly mollusks) were nearly extinct at a local scale. [43] The spill may have contributed to extinction of the rare Iberian breeding population of common murre *Uria aalge.* [44] The total number of birds affected by the Prestige oil spill was expected to be between 115,000 and 230,000 some of them raptors. [45]

After the MT Haven accident in 1991, occurring only seven miles from the coast of Genoa (Italy), there was an estimated 43% reduction in fish populations. [46] For the next twelve years, the coasts of Italy and France were polluted, especially near Genoa and Southern France. [47]

A study [48] carried out in 1994, demonstrated that the contamination of the trophic nets contribute to the alteration of the ecosystem equilibria, leading to exposure of carcinogenic, teratogenic and mutagenic tar, particularly polycyclic aromatic hydrocarbons (PAHs), presenting strong concentrations. Studies aimed at the evaluation of genotoxic damage and hepatic tissue alterations in demersal fish species were sampled in the area. [49] 50 thousand tons covered the seabed at a depth between 60 and 500 meters as a layer of tar a meter thick and 250 km^2 wide. [50] Long-term ecological effects has meant a decrease in biodiversity and modification of the ecosystem.

41 Demand Media, Michelle A. Riviera, *The effects of Exxon Valdez oil spill on Alaska wildlife*.

42 CNN, Marybeth Holleman, *After 25 years, Exxon Valdez oil spill hasn't ended*, 2014.

43 Piñeira J, Quesada H, Rolán-Alvarez E, Caballero A, *Genetic impact of the Prestige oil spill in wild populations of a poor dispersal marine snail from intertidal rocky shores*, 2007

44 Birdlife International, *Oil spill significantly populations of seabirds and area costly to clean up*

45 Iñigo Zuberogoitia et al., *Short-term effects of the prestige oil spill on the peregrine falcon (Falco peregrinus)*, 2015

46 MT Haven. Available online: joyeresearchgroup.uga.edu

47 David Scherer and Bret Barattini, MT *Haven oil spill*

48 Amato E., Ausili A., Giannì A., Vacchi M., *Sunken Heavy Oil Residuals In A Bathyal Ecosystem. Proceedings of the U. N. International Maritime Organization Third R&D Forum on High-density Oil Spill Response*, 2002

49 Pietrapiana D., Modena M., Guidetti P., Falugi C., Vacchi M., *Evaluating the genotoxic damage and hepatic tissue alterations in demersal fish species: a case study in the Ligurian Sea (NW-Mediterranean)*, 2002

50 Corriere della Sera, *Haven: bomba ecologica in fondo al mare*, 1992

The European average cleanup cost per ton of crude oil spilt is €9,818 (US $10,800), the half of the costs applied in North America €18,012.72 (US $19,814.63). [51]

Human Health impacts In the case of oils spills people may be unable to consume shellfish and other seafood that continue to be affected for many years after a spill. Consumers eating contaminated fish are exposed to chemicals and acute health effects from the evaporation of volatile oil components. These causes include headaches, nausea, vomiting, eye irritation, worsened asthma symptoms, upper respiratory tract irritation, vertigo, leg and back pains and psychological problems. Air pollution (flaring, venting) from oil rigs also pose a health threat to people who live near oil platforms. This process releases more than 250 different chemicals into the atmosphere that are known to cause lung and heart disorders, cancers, asthma, and reproductive problems. Those who suffer from lung and cardiovascular disease are at greater risk and these pollutants can affect people and animals living within 300 km from the drilling platform. [52]

For example, those exposed to the Exxon Valdez oil spill and the cleanup efforts which followed were 3.6 times more likely to have general anxiety disorder and 2.1 times more likely to have developed post traumatic stress disorder (PTSD) than those who were not exposed. [53] Exposures to oil spills and clean-up activities were also associated with increased use of mental health services, as indicated by an increase in the number of mental health visits to the Seward Life Action Council in Seward, Alaska. In addition to the psychological outcomes, there are significant associations with alcohol and drug abuse, domestic violence, as well as declines in traditional social relations. [54] The clean up costs of Exxon Valdez was about €6.3 billion (US $ 7) to recover only 10% of the oil it spilled. [55]

Studies on Prestige health impacts (acute ocular, respiratory, dermal, psychological and neurological symptoms) found that toxic symptoms were higher among seamen but injuries were greater among bird cleaners. [56]

51 Andrea Bigano and Paul Sheehan, *Assessing the risk of oil spill in the Mediterranean: the case of the route from the Black Sea to Italy*, 2006

52 OCEANA, *Toxic Legacy: long term effects of offshore oil on wildlife & public health*, 2009

53 OCEANA, *Toxic Legacy: long term effects of offshore oil on wildlife & public health*, 2009

54 Palinkas et al., *Social, cultural, and psychological impacts of the Exxon Valdez oil spill*, 1993

55 Available online: concernedengineers.org/paying-for-a-spill

56 Suarez et al., *Acute health problems among subjects involved in the cleanup operation following the Prestige oil spill in Asturias and Cantabria (Spain)*, 2005

After the Sea Empress oil spill (UK, 1996), exposed residents were more likely to report symptoms of acute toxicity, including neurological, ocular, and respiratory symptoms, than unexposed residents. [57]

The Gulf of Mexico's oil spill impacts are wide-reaching and will likely have long-lasting effects on the physical, psychological, social, and economic health of populations in the affected regions. [58]

3.3. Oil and Gas transportation: Environmental Concern

Underwater pipelines and tankers cross important Mediterranean marine areas like the Sicily Channel and the Adriatic Sea: both Priority Conservation Areas and Ecologically-Biologically Significant Areas identified by the Regional Activity Centre for Specially Protected Areas RAC/SPA. Moreover along the routes, in the Sicily Channel and in the North-Central Adriatic Sea are presently crucial habitats for cetaceans, monk seals, seabirds, turtles, sharks and bluefin tuna.

Transport by tankers Tanker accidents are among the most harmful accidents in the marine industries. [59] The dimensions of the vessels has increased constantly during the year and today some vessels can carry more than 500 million liter of oil. [60] Although this has led to a decrease of price transportation in oil, it has increased the risks of serious disaster in the case of accidents.

An amounted 370 million tons of petroleum oil are transported annually in the Mediterranean Sea (18% of the world's total), and 250-300 oil tankers cross the Sea every day. In 2006, 4,224 laden oil tanker movements carried 421 million tons of crude oil: 457 of these were transits, involving tankers carrying 72 million tons of crude oil in route between non-Mediterranean ports. [61]

57 Lyons, et al., *Acute health effects of the Sea Empress oil spill*, 1999

58 Margaret A. McCoy and Judith A. Salerno, *Assessing the Effects of the Gulf of Mexico Oil Spill on Human Health*, 2010

59 Cristina Gómez, David R. Green,European Parliament-Policy Departement, *The impact of oil and gas drilling accidents on EU fisheries*, 2013

60 Tankers International LCC. Avalaible online: tankersinternational.com., 2008

61 UNEP/MAP, *New study highlights present and future maritime traffic flows in the Mediterranean*, 2008

Ship-related operational discharges of oil include the discharge of bilge water from machinery spaces, fuel oil sludge, and oily ballast water from fuel tanks. Also, commercial vessels other than tankers contribute operational discharges of oil from machinery spaces to the sea. Cargo-related operational discharges from tankers include the discharge of tank-washing residues and oily ballast water.

Considering solely estimates (reported in the final report of the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea -REMPEC-), [62] the volume of oil bilge water per year generated from oil tanker operations of the main southern Mediterranean oil terminals (Algeria, Cyprus, Egypt, Lebanon, Malta, Turkey, Syria, Israel, Morocco and Tunisia), calculated the volume of oil bilge water corresponding to 73,222 m^3 per year.

62 Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC), *Port Receptions Facilities for collecting ship-generated garbage, bilge water and oily waste*, 2003

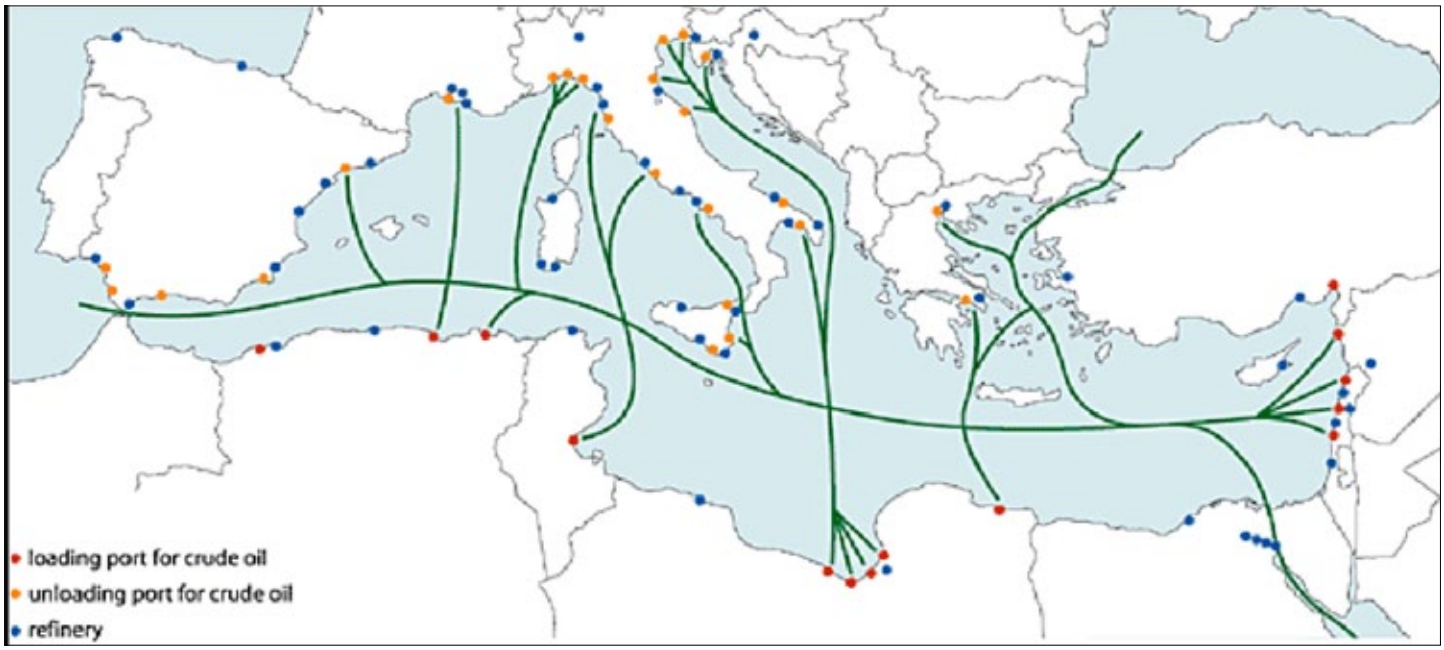


Figure 3.3.a. The major shipping routes for transport oil by tanker.
Source: Athanasios Valavanidis, "The Most Important Problems of Environmental Pollution in the Mediterranean Sea", 2014

Transport by underwater pipelines Natural hazards leading with marine landslides, earthquakes, geological faults, subsidence, deep currents, chemical-physical composition of water imply risk, compromising the stability of the pipelines with consequent spillage of hydrocarbons.

Though there are no oil pipeline crossings in the Mediterranean basin, there are several pipelines that reach coastal areas and their impacts. In the case of a spillage, it can effect the continental land and can also pose a risk to coastal marine ecosystems and human health. Four different gas pipelines across the Mediterranean Sea. While an oil spill is more "visibly" impacting, a gas spill can have serious impacts on environmental and health issues as it can be very dangerous due to the high explosivity of gas.

3.4. Oil and Gas Storage: Environmental Concern

Underwater reservoirs for storing liquid hydrocarbons (oil, oil water mixtures, and gas condensate) are a necessary element of many oil and gas developments. Underwater storage tanks with capacities of up to 50,000 m^3 are either built near the platform foundations or are anchored in the semi-submerged position in the areas of development and near the onshore terminals. There are risks with underwater storage tank damage as content is released, especially during tanker loading operations or under severe weather conditions. There is an increase in the probability of accidents on tanks and pipelines offshore in locations where natural phenomena occur such as, seismic activities, faults, subsidence, and tsunamis. [63]

Even in the absence of oil and gas accidents, storages have serious impacts on environment. Compress gas produce noise and gas emissions. Moreover, the re-injection operation of gas requires energy that generally increases as the reservoir becomes full because the reservoir pressure increases. [64]

63 Petrolio e Gas, *Sistemi di produzione offshore*. Available online: petrolioegas.it/sistemi-di-produzione-offshore

64 Centrica Storage, *Environmental impact*, centrica-sl.co.uk

Crude oil is stored in or under the platform in the sea and is loaded on to the shuttle tanker through a loading boye. With modern technology, crude oil is stored in a floating storage vessel and loaded on to the shuttle tanker from the floating storage vessel. Emission of VOC occurs both during storage in storing vessels, and during loading on to shuttle tankers. [65] Water and other contaminants in the crude can accelerate erosion of the structure and systems resulting in premature failure and, potentially, spills of hydrocarbons to the environment. Hydrogen-Sulphide (H_2S), if present in the crude, may disassociate as a gas and presents a hazard to personnel both on the "floating production storage and offtake vessels" (FPSO) and on the offtake tanker. [66]

65 Norwegian contribution to EGTEI under the pilot phase. Available online: citepa.org

66 International Association of Oil & Gas Producers, *Guideline for managing marine risks associated with* FPSOs, 2006

4 ECONOMIC COSTS AND BENEFITS OF OIL AND GAS ACTIVITIES

4.1. Overview of the Oil and Gas sector

During the last year, significant changes have occurred in the hydrocarbon world. First of all, the United States has been promoting practices like "fracking", increasing their production and decreasing importation. As a response, OPEC countries have increased their oil production in order to undermine the U.S. production. As a final consequence the oil price on the market has decreased drastically in the past two years.

Mediterranean areas in which attention to O&G activities are centralizing are:

67 Italian Ministry of Economic Development, *The sea – second edition*, 2015

- Malta and Sicily Channel: In February, 2015 Malta signed an agreement with "Ratio Malta limited" for an exploratory license in the south west of the island;
- Levant Basin: In the Eastern Mediterranean (in particular Cyprus and Israel) considerable discoveries have been made estimating non-proved reserves for 1,689 million oil barrels and 3,456,359 million Scm of natural gas;
- Croatia: Defining 29 blocks in the Adriatic Sea territorial waters have opened a first round license. In January 2015 the government has granted 10 licenses for exploration and exploitation of hydrocarbons in the Adriatic after evaluating bids from 6 companies regarding 15 blocks. In the Adriatic there are already 1,358 drilled wells in Italy's territorial waters and 133 in Croatian waters. [67]

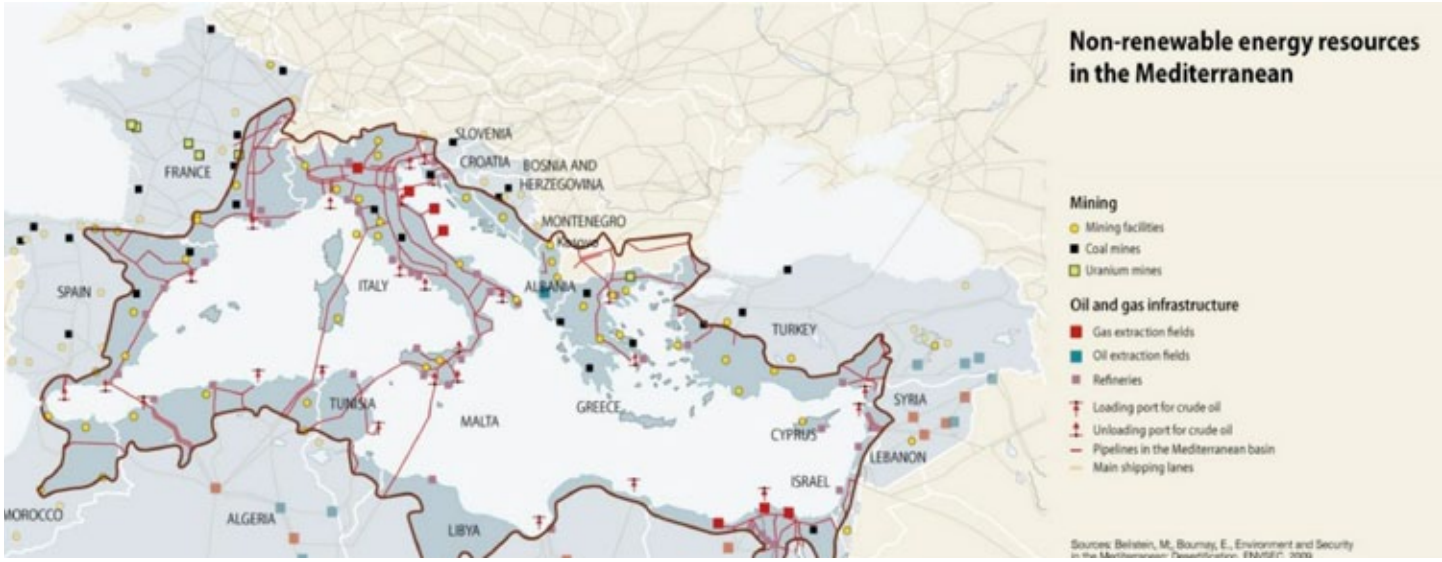


Figure 4.1.a. Non-renewable energy resources in the Mediterranean. Source: UNEP/MAP, 2012.

It is not easy to quantify in economic terms the value of these reserves and how much they are worth considering their contribution to Gross Domestic Product or number of employees, however we can describe what is the current dimension of the oil and gas sector in the Mediterranean Sea and what is predicted for the future.

The situation in 2011 in the Mediterranean region was as following: [68]

- 67 billion barrels of proven oil reserves (4.6% of the world's proven oil reserves);
- Libya, Algeria and Egypt hold 94% of oil reserves (Libya alone: 69%);
- Oil production in 2010 was slightly over 5 million barrels per day (6.1% of world oil production);
- 86% of oil production was concentrated in Algeria, Libya and Egypt;
- 4.7% of global natural gas reserves (92% of them held by Algeria, Libya and Egypt);
- Natural gas production in 2010 increased of 41% in respect of 2000 reaching 194 billion cubic meters.

68 Observatoire Méditerranéen de l'Energie, *Mediterranean Energy Perspectives 2011*, 2011

69 The only exception is Italy for which we collected real data about offshore production in 2013

70 Plan Bleu, *Economic and social analysis of the uses of the coastal and marine waters in the Mediterranean*, 2010

71 Serbutoviez S., *Offshore hydrocarbons: Panorama 2012*, 2012

To understand the economic value of the sector, in particular the offshore activity, we have conducted an analysis on available data utilizing some approximations and estimations. Our methodological analysis is carefully described in Appendix 1, however we essentially operated as following: we gathered data from the Eurotat database and BP Statistical Review of World Energy. We then considered that offshore production is respectively 12% of the total oil production and 32% of total natural gas production (since no specific data is available about offshore production in each country [69] we utilised the ratios estimated by Plan Bleu [70] on the basis of data reported in the article "Offshore Hydrocarbons" [71] and referred to the year 2011); on the basis of 2013 prices of one oil barrel and one million btu of natural gas we calculated the total revenues of the O&G sector; then determined GVA a total amount and total jobs according to available data for the O&G sector in United Kingdom. In this section we reported the most important results.

The following table contains data on oil and natural gas production in last years expressed (in thousands of tons).

	2011		2012		2013	
	OIL	NATURAL GAS	OIL	NATURAL GAS	OIL	NATURAL GAS
Greece	98,9	6,4	95,5	6,9	70,5	5,8
Spain	100,5	45,5	142,3	51,8	368,7	49,8
France	938,5	505,7	846,8	451,9	826,2	289,3
Croatia	705,9	2.007,0	628,5	1.634,8	609,6	1.507,3
Italy	5.370,0	6.919,7	5.490,8	7.047,5	5.602,6	6.335,0
Slovenia	-	1,7	-	1,7	-	2,6
Albania	876,2	12,0	986,7	13,2	1.135,1	14,6
Turkey	2.405,2	625,5	2.438,4	520,7	2.483,6	442,6
Syria	16.300,0	6.400,0	8.500,0	4.800,0	2.800,0	4.000,0
Algeria	71.700,0	74.400,0	67.200,0	73.400,0	68.900,0	70.700,0
Libya	22.500,0	7.100,0	71.100,0	11.000,0	46.500,0	10.800,0
Egypt	34.600,0	55.300,0	34.700,0	54.800,0	34.500,0	50.500,0
Tunisia	3.200,0	-	3.200,0	-	3.000,0	-
TOTAL (000 toe)	**158.795,2**	**153.323,5**	**195.329,0**	**153.728,50**	**166.796,3**	**144.647,0**

Table 4.1.c. Oil and natural gas production in Mediterranean countries (Eurostat and BP Statistical Review of World Energy)

As the table shows, most parts of oil and gas production derives from North Africa. In this study, it is important to understand the economic role and importance of this sector. In the next table we report the most significant data from this point of view:

Total Oil Production (000 Toe) *	166.796
Total Natural Gas Production (000 Toe)	144.647
Offshore Oil Production (000 Toe) †	20.083
Offshore Natural Gas Production (000 Toe)	48.599
Total Offshore revenues (000 Euros) ‡	27.738.323
Total Offshore GVA (000 Euros) ^	19.139.443
Total number of employees	301.514

* Data from Eurostat and BP Statistical Review of World Energy (June 2014).
† Estimation rate for offshore figures are from Plan Bleu (2014) for the year 2011.
‡ Calculated on the basis of the 2013 average cost of oil barrel and natural gas btu as reported in BP Statistical Review of World Energy.
^ GVA and Employment are estimated on the basis of UK Oil & Gas production data.

Table 4.1.d. Oil and Gas sector 2013

To conclude this section it is opportune to briefly describe what the present perspectives are for the O&G sector in the near future. We have already described what the "hot zones" are for future exploration and production activities, but now our aim is to analyze which areas are the most relevant in quantitative terms. Regarding oil, projections show that production should increase another million barrels per day by 2020 reaching to a total production of 6 million barrels. The main part of this increase will come from North Africa and in particular from Libya. The production should continue to increase until 2030; however after 2020, production will stabilize at around 6 million barrels due to the decrease of other Mediterranean oil fields (mostly Algeria). [72] It is important to clarify that these projections were made in 2010, due to the geopolitical situation of North Africa and the Middle East (especially Libya and Syria). These situations can change very quickly, and the projection may not be accurate.

Concerning natural gas, production should almost double within 2030 reaching 364 billion cubic meters, representing more than 8% of the global amount. Projections say that production increases in natural gas will essentially come from North Africa: Algeria and Egypt will almost double their production while Libya will more than triple. As for the oil, these projections were made in 2010 and can be different now, especially the Libyan ones.

72 Observatoire Méditerranéen de l'Energie, *Mediterranean Energy Perspectives 2011*, 2011

73 Cirer-Costa, Cirer-Costa, J. C., *Tourism and its hypersensitivity to oil spills*, 2015

An important share of natural gas should derive from Israel according to last discoveries; its total production is expected to reach 25 billion cubic meters in 2030 against about 3 billion cubic meters produced in 2010. [73]

Considering the high sensitivity of the main economic activities of Mediterranean region, it is reasonable to expect that many conflicts could arise from the expansion of O&G industry. In this chapter we will summarize the possible effect of O&G on the above described economic activities. It is important to underline that it is difficult to conduct a precise and complete analysis in economic terms of the impacts deriving from an oil spill or just from regular O&G activity. However, we can at least identify the aspects of the other economic sectors affected by the O&G activity.

We can distinguish different impacts on coastal tourism according to the O&G production context:

- Visual impacts consists of the landscape deterioration caused by the installation of drilling platforms (during normal activity) or by the effects of an accident;
- Direct oil spill impacts, namely beaches closing and other tourist related service interruptions (e.g. touristic cruises and excursions);
- Negative image impacts, that is the negative perception of a potential customer about a destination interested by O&G activities. In particular, in the case of accidents, after a complete restoration it is difficult to "clean" the touristic image of the locations affected by the oil spill; this is also true for places not directly affected by the oil spill but due to the proximity of the accident there are also minor damages.

Tourism Tourisms hypersensitivity to O&G activities is proven by numerous studies. The sinking of the Don Pedro merchant ship in 2007 near the island of Ibiza shows that even a small oil spill (about 20 tons) occurred, even with a series of circumstances which significantly lessened its impact, is enough to ruin an entire season in a sun and sand tourist destination. Pointing out some of these circumstances: a big part of the fuel contained in the tanks did not escape; the rescue ship Clara Campoamor was coincidentally close to the accident location and in only three hours arrived; the accident happened at dawn so no video or photos were taken- because of this media in Europe did not talk about it due to ithe lack of spectacular images; hotels moved tourists to other beaches not affected by the oil spill since there were a lot of empty rooms during that period. In spite of everything the beaches of Talamanca, Figuretes and Platja d'en Bossa were closed for about a week; also after the reopening in Talamanca beach, bathers' feet were stained black because of tar balls half-buried in the sand. [74]

Studies on the Prestige oil spill, which took place on November 2002 off the Galician coast and consisted of about 59,000 tons of spilled oil, show that short-term economic damages on tourism can be quantified in a fall in 2003 (compared to 2002 data) of 5 million of overnight stays and 134 million euro of incomes, corresponding to about 8% in both cases.

74 Dorsett M., *Exxon Valdez oil spill continued effects on the Alaskan economy*, 2010

Another relevant accident was the Exxon Vadez oil spill: it occurred at midnight on March 24th, 1989 when the tanker ran aground on the Bligh Reef in the Prince William Sound of Alaska spilling about 42,800 tons of oil. In 1989, the loss to recreational fishing was estimated to be up to 580 millions of dollars and in 1990 the range of loss was anywhere from 3.6 and 50.5 millions of dollars. [75] During Summer 1989 visitor spending decreased 8% in South-central Alaska and 35% Southwest Alaska from previous summer spending, the two major spill-affected areas; the net result was a loss of 19 millions of dollars in visitor spending. [76]

75 Dorsett M. , *Exxon Valdez oil spill continued effects on the Alaskan economy*, 2010

76 Exxon Valdez Oil Spill Trustee Council, *An assessment of the impact of the Exxon Vadez oil spill on the Alaskan tourism industry*, 1990.

77 ITOPF, *Effects of oil pollution on fisheries and mariculture*, 2011

78 Garza-Gil, M. D., Prada-Blanco, A., & Vàzquez-Rodrìguez, M. X., *Estimating the short-term economic damages from the Prestige oil spill in the Galician fisheries and tourism*, 2006

Fishing and Aquaculture Impacts on fishing and aquaculture can be summarized as following:

- Damages on fish due to oil toxicity and smothering; seafood contamination and taste alteration;
- Lasting contamination until all gears and cultivation equipment are completely cleaned;
- Canning period for all fishing and aquaculture activities;
- Loss of market confidence even if there is no actual contamination of the product. [77]

In the Prestige oil spill it has been estimated a production decrease of about 34,000 tons and a reduction on revenues of 65 million euro as total amount for fishing and aquaculture representing respectively 10% and 17.34%; these figures have been calculated by comparing average monthly data in the period 1998 - 2002 with the monthly values in 2003 (monthly data of November and December 2002 have been compared with corresponding monthly average data in the period 1998 - 2001). [78]

In the case of the Exxon Valdez the Alaskan economy suffered severely after the oil spill because of the high importance of the fishing sector. Salmon and herring were the main species for the sector and were seriously affected by spill consequences: salmons decreased significantly and especially in 1993 beacuse billions of eggs never hatched following the spill, so there was a lack of mature fish; herring population also severe-

ly crashed in 1993. The situation after 21 years was that salmons had recovered while herring population was only 15% of what it was prior to the spill; this means that herring fishermen even 21 years later had completely lost their livelihood since herring fishery was still closed. This damage have been estimated in a loss of about 120,000 tons of herring for every year of fhishery closing. [79]

79 Dorsett M. , *Exxon Valdez oil spill continued effects on the Alaskan economy*, 2010

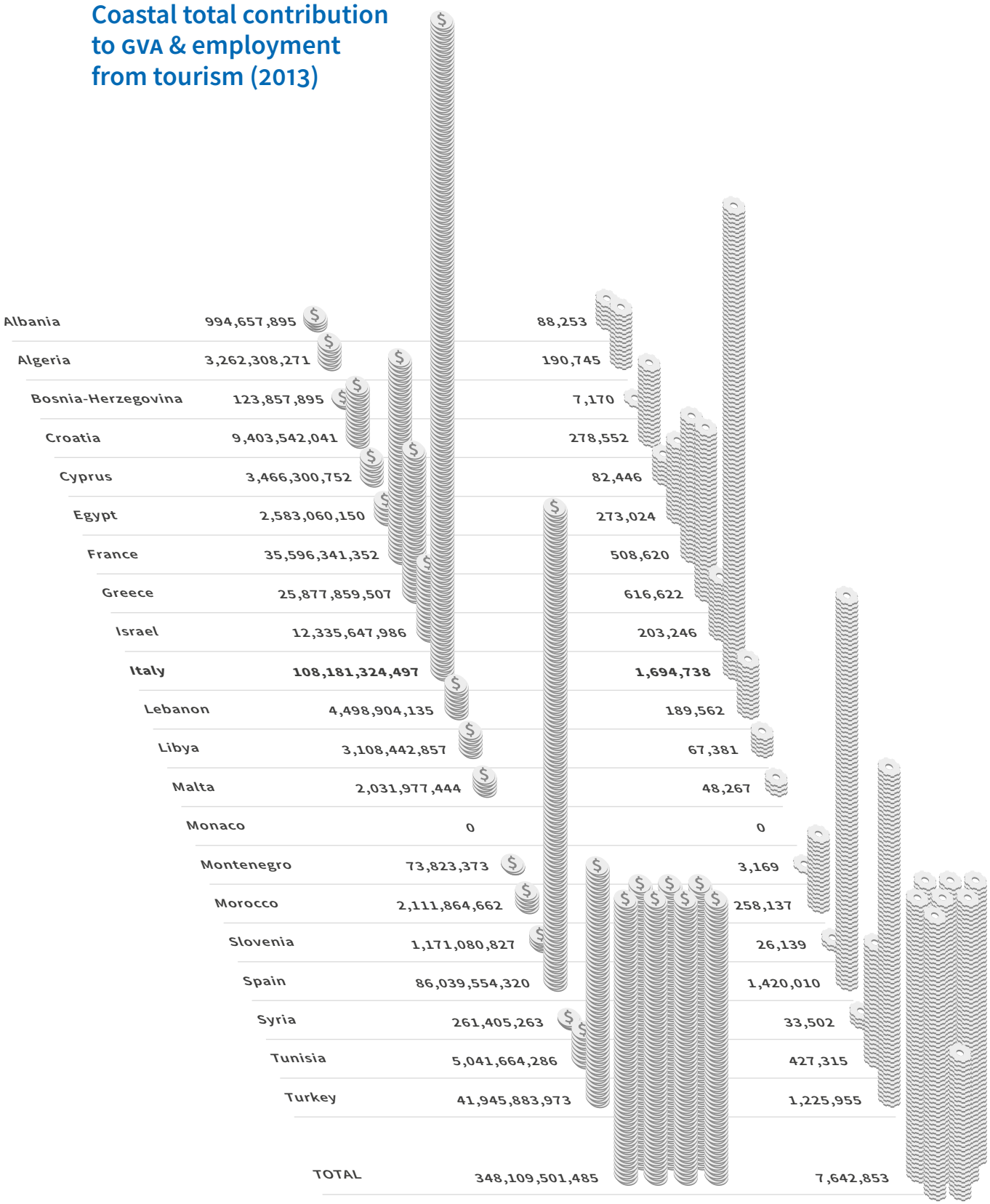
80 Malek S. A. & Mohamed A., *Environmental impact assessment of off-shore oil spill on desalination plant*, 2005

Maritime Transportations Concerning maritime transport, we can consider possible impacts eventually shipping bans, route deviations linked to the installation of oil drilling platforms or oil spills, and problems related to increased traffic due to the set up of hull cleaning stations. In our analysis, in the following part of our work, we consider GVA and employment values of this sector just for a small share of 5% (of the total amount) as a very precautionary possible value of damage in case of accident. Indeed there is evidence of impact on maritime transportation in other oil spills like Deepwater Horizon but we cannot precisely quantify their amounts.

Desalination Impacts on desalination correspond to shut down cost and plant clean-up costs. [80]

As said above, it is difficult to economically quantify these impacts so we will try to evaluate losses deriving from interruption of production in other economic sectors. We will follow an accident in the O&G activity to determine a sort of break-even point.

Coastal total contribution to GVA & employment from tourism (2013)



Albania	994,657,895	88,253
Algeria	3,262,308,271	190,745
Bosnia-Herzegovina	123,857,895	7,170
Croatia	9,403,542,041	278,552
Cyprus	3,466,300,752	82,446
Egypt	2,583,060,150	273,024
France	35,596,341,352	508,620
Greece	25,877,859,507	616,622
Israel	12,335,647,986	203,246
Italy	**108,181,324,497**	**1,694,738**
Lebanon	4,498,904,135	189,562
Libya	3,108,442,857	67,381
Malta	2,031,977,444	48,267
Monaco	0	0
Montenegro	73,823,373	3,169
Morocco	2,111,864,662	258,137
Slovenia	1,171,080,827	26,139
Spain	86,039,554,320	1,420,010
Syria	261,405,263	33,502
Tunisia	5,041,664,286	427,315
Turkey	41,945,883,973	1,225,955
TOTAL	348,109,501,485	7,642,853

Coastal total contribution to GVA & employment from oil & gas (2013)

Albania	57,412,376	618
Algeria	8,462,456,339	135,616
Bosnia-Herzegovina	0	0
Croatia	137,740,845	2,439
Cyprus	0	0
Egypt	5,313,869,576	89,117
France	61,657,203	842
Greece	3,914,703	45
Israel	0	0
Italy	**1,272,916,897**	**22,297**
Lebanon	0	0
Libya	3,079,300,752	39,668
Malta	0	0
Monaco	0	0
Montenegro	0	0
Morocco	0	0
Slovenia	185,374	4
Spain	21,861,030	264
Syria	424,244,146	7,094
Tunisia	148,986,252	1,580
Turkey	154,897,060	1,930
TOTAL	19,139,442,553	301,514

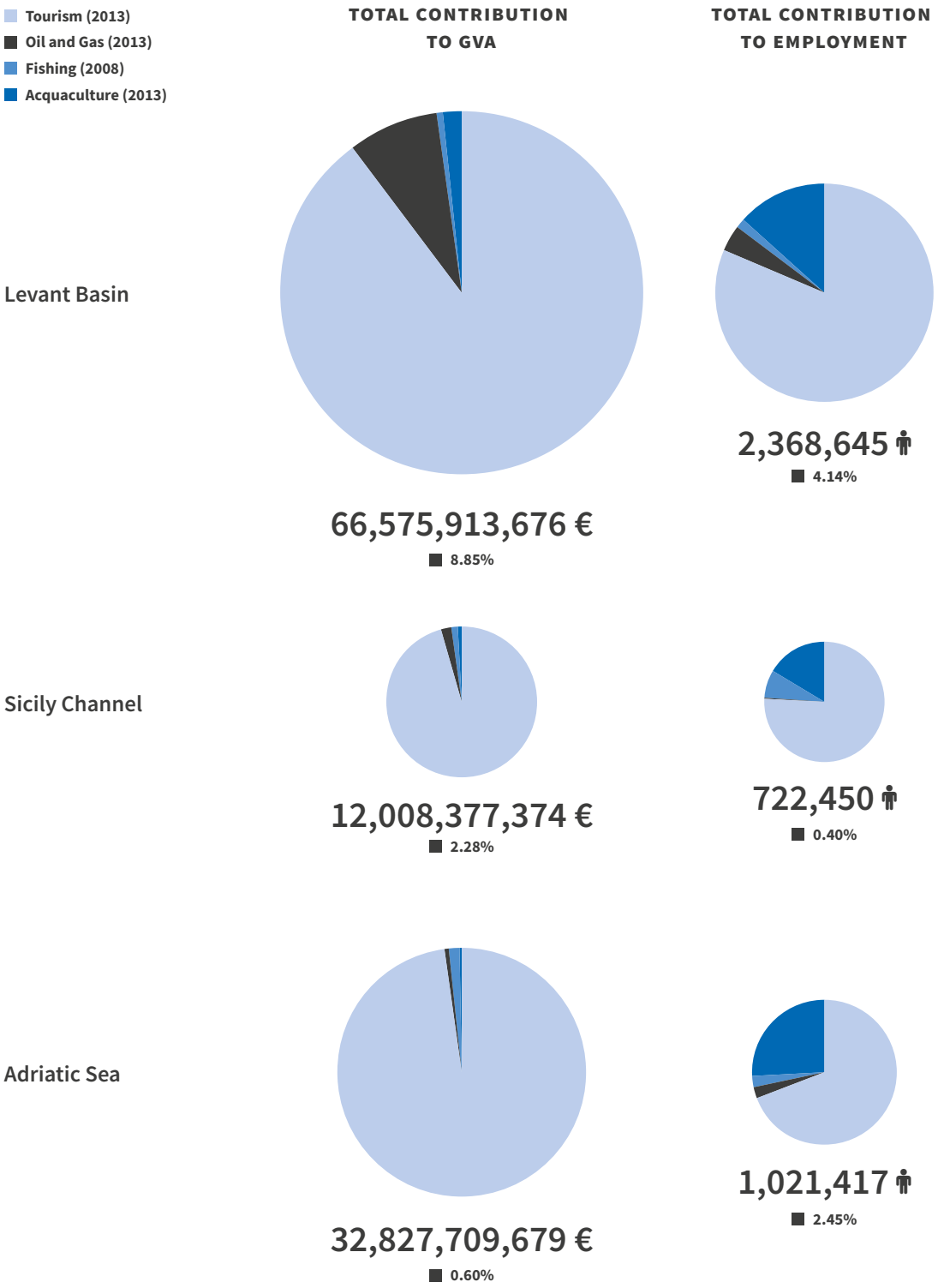
Coastal total contribution to GVA & employment from fishing (2008)

Albania	4,036,973	990
Algeria	296,488,704	39,000
Bosnia-Herzegovina	0	0
Croatia	132,994,703	15,000
Cyprus	29,952,839	930
Egypt	63,300,560	18,000
France	141,765,386	2,500
Greece	285,620,981	21,400
Israel	7,985,147	4,800
Italy	**685,404,286**	**30,500**
Lebanon	0	8,500
Libya	74,065,822	7,700
Malta	1,004,120	2,100
Monaco	0	0
Montenegro	1,694,026	510
Morocco	11,236,584	16,250
Slovenia	546,460	440
Spain	171,684,071	8,900
Syria	115,665,090	4,000
Tunisia	83,328,319	49,000
Turkey	74,591,790	1,900
TOTAL	2,181,365,859	232,420

Coastal total contribution to GVA (2013) & employment (2008) from aquacultura

Albania	1,659,902	4,100
Algeria	1,140,785	19,300
Bosnia-Herzegovina	268,436	0
Croatia	21,714,277	248,240
Cyprus	19,519,716	1,580
Egypt	838,781,310	199,000
France	34,485,234	6,620
Greece	455,096,283	44,360
Israel	17,134,636	9,400
Italy	**181,068,232**	**75,440**
Lebanon	158,139	13,300
Libya	0	11,480
Malta	3,361,737	5,220
Monaco	0	0
Montenegro	359,998	1,150
Morocco	827,318	31,310
Slovenia	186,326	1,000
Spain	95,613,217	20,720
Syria	0	46,600
Tunisia	50,348,424	97,000
Turkey	317,622,189	52,900
TOTAL	2,039,346,159	888,720

Contribution rate



	CONTRIBUTION LOSS* DAY/YEAR	EMPLOYMENT LOSS* DAY/YEAR
Levant Basin	8.85 DAYS	15.12 DAYS
Sicily Channel	8.32 DAYS	1.47 DAYS
Adriatic Sea	2.18 DAYS	8.96 DAYS

*Number of days of ban needed in order to loss all the benefits from O&G sector in one year.

5 CASE STUDIES

Analyzing the Mediterranean scenario with integrity, this gives us a comprehensive idea of the situation of the whole sea. However, if an oil spill occurred in Levant basin it would not affect in a way that is considerable to tourism dynamics on the Spanish seaside. We have focused just on certain areas in conducting this kind of analysis, taking into consideration three different oil-producing regions of the Mediterranean sea and analyzed it region by region in order to give a local perspective.

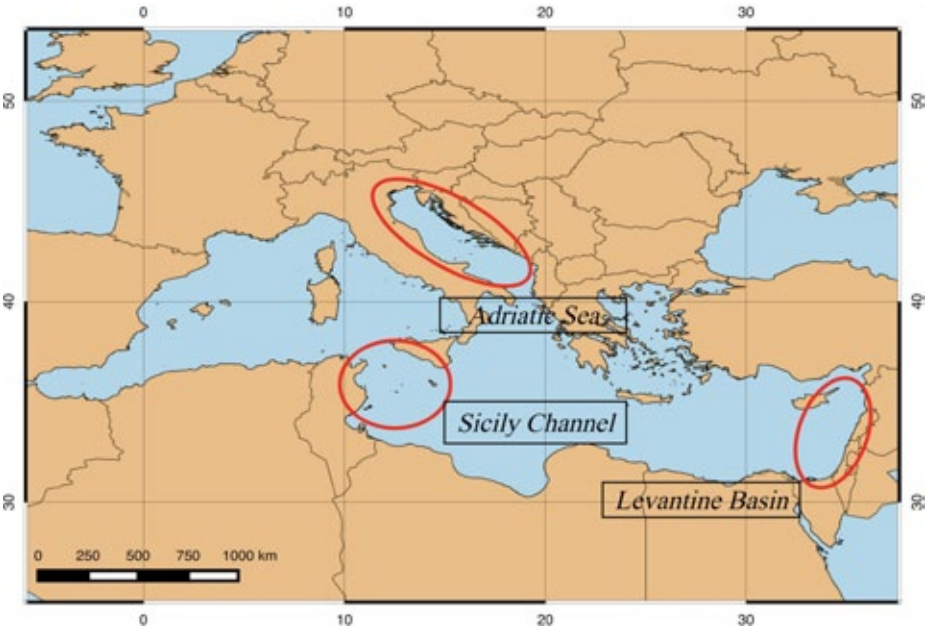


Figure 4.1.b. Focus areas: Adriatic Sea, Sicily Channel and Levantine Basin. Source: O&G from Drilling Info (2015) part of the Africa Land Use Planning and Monitoring System (ALES).

The "Others" is represented by tourism, fishing and maritime transportation. In the case of Deepwater Horizon, fishing was banned from a large portion of the sea (reaching a maximum dimension of 217,370 square kilometers) for several months. Furthermore oil reached a huge part of Louisiana, Mississippi, Alabama and Florida coastline and was unusable for tourists. Some ports were closed to prevent vessel traffic from spreading the oil and cleaning stations were set up to clean vessel hulls. [81]

Detailed data can be found in the "Appendix 5" while in this section we just show the essential results as reported in the following table. In our analysis, we considered an oil price per barrel of euro 81.69 (108.66 dollars, average brent price in 2013 according to London stock quotations) and a natural gas per million btu price of euro 8.06 (10.72 dollars, 2013 average German Import Price). [82]

81 Congressional Research Service, *Deepwater Horizon Oil Spill: Selected Issues for Congress*, 2010

82 BP Statistical Review of World Energy, June 2014

	GROSS VALUE ADDED		EMPLOYMENT	
	O&G/OTHERS	DAYS/YEAR	O&G/OTHERS	DAYS/YEAR
Adriatic	3.9%	14.1	2.5%	8.9
Levant Basin	8.8%	32.1	4.1%	15.1
Sicily channel	2.3%	8.2	0.4%	1.5

Table 5.1. a. Break-even point analysis: how many days for losing O&G GVA and jobs? Elaboration data by Source International (for more details see all Appendix).

Data contained in the "O&G/Others" columns correspond to a percentage of the oil and gas sector in relation to others major economic sectors (tourism, fisheries and aquaculture, transportation). Data reported in the "Days/year" column represent the number of days sufficient for losing all O&G GVA and employment because of the negative effects on the other economic sectors. For example, an oil spill in the Sicily channel is enough to stop other economic activities for 1.5 days in order to lose the total amount of O&G jobs along with negative impacts on tourism, fisheries, aquaculture and transportation.

This kind of evaluation is reasonable if we take the case of Don Pedro spill in Ibiza in 2007. Even if it was a very little spill (20 tons of oil) three beaches were closed for about one week.

It is important to underline that data about tourism is probably underestimated since some countries do not have accurate data about domestic arrivals (for more details see "Appendix 4"). Moreover, we considered maritime transportation of just a small share of 5%, as a highly possible precautionary value of damage in the case of an accident since there is no evidence of impacts in other oil spills like in Deepwater Horizon (in any case, this small amount does not considerably influence, the results of our analysis). Considering tourism, fisheries and aquaculture we have taken into consideration only what we call "the banning impact" but, as previously said, the image impact for these sectors is considerable. Furthermore it has not been possible to consider economic impacts on desalination activities because of the lack of data.

On this basis, we can say that less days than those reported in the table are enough to cancel the whole GVA and employment of the O&G sector as there are negative effects on the other sectors.

In the table below we reported value coming from our simulation of two price variation scenarios:

- **Price increase scenario**, in which we consider a 50% price increase of oil and gas price – oil barrel = 136 euro (150 dollars); natural gas million btu = 14.61 euro (16.08 dollars);

→ **Price decrease scenario**, in which we consider a 50% price decrease of oil and gas price – oil barrel = 45.45 euro (50 dollars); natural gas million btu = 4.87 euro (5.36 dollars).

Our starting oil price was the 2013 brent average of 81.69 euro (108.66 dollars) so the considered variation in price is approximately 50%.

In the following analysis we will consider only the value regarding GVA since results about employment are not affected by price variations as they depend only on produced quantities. Additional data is presented in "Appendix 6".

	GROSS VALUE ADDED		EMPLOYMENT	
	O&G/OTHERS	DAYS/YEAR	O&G/OTHERS	DAYS/YEAR
Adriatic	5.7%	20.9	1.9%	7.0
Levant Basin	12.9%	49.9	4.3%	15.6
Sicily channel	3.2%	11.8	1.1%	3.9

Table 5.1.b. Break-even point analysis: how many days for losing O&G GVA in two possible price scenarios? Elaboration data by Source International (for more details see all Appendix)

These values show that situations about GVA does not radically change with hypothesized price variation. For example in the case of Levant Basin for the oil and gas price increase scenario reaches 47 days instead of 32 days. We do not consider it as a significant difference because it is basically impossible to predict time duration of impacts produced by an oil spill. In the Sicily Channel case, the number of days rise to 11.8, that it is still a very low value and does not change significantly our calculations. In the Adriatic Sea the number of days rise up to 21 which is still a very low value.

In the case of the 50% reduced price (very similar to the actual, 2015 price) the number of days decreased and, for example in the Adriatic Sea, it is sufficient enough that other activities are banned for a week in order to lose all the economic benefits of oil and gas sectors in an entire year. In the Sicily channel this decrease in numbers is up to less than four days. That means that at the actual (July 2015) oil price, four days of ban in the Sicily channel are enough to break-even all the economic benefits of the oil and gas production.

Table 5.1.c. Environmental concern of the focus areas.

	EXTRACTION	TRANSPORT
Adriatic Sea	High concentration of wells in north Adriatic Sea where are identified Priority Conservation Areas, Ecologically - Biologically Significant Areas and Crucial habitats for cetaceans, seabirds, and sharks. Serious threat to large marine vertebrates, particularly Cetaceans (seismic surveying during exploration and high-intensity noise during drilling): from direct mortality to short and long term injuries (most notably to auditory system), displacement and disturbance. [83] Hazard leading with low seismic level activity with earthquakes in the south zone. [84]	Transport routes: tankers with crude oil to northern Adriatic ports and liquefied gas transported to Rovigo LNG terminal, [88] impact environmental in case of accidents because they cross Priority Conservation Areas and Ecologically-Biologically Significant Areas located in north-south zones. Gas pipeline only cross the south part. Natural hazard: Strong wind and storms with high value could compromise the safety of navigation and It implies the occurrence of accidents and following hydrocarbons spills
Sicily Channel	High concentration of wells in the Sicily Channel where are identified Priority Conservation Areas, Ecologically -Biologically Significant Areas and Crucial habitats for cetaceans, seabirds, turtles, sharks. Geological hazard as 3 major faults identified in the Sicily Strait compromise, with their activity, the stability of the platforms with following incidents and environmental impacts. Risk leading with underwater volcanoes (Like Empedocle between Sciacca and Pantelleria) [85] and pockmarks (located at the base of the northern slope of Gela) represents geo-hazard for offshore constructions and navigation. [86] Natural hazard like tsunamis could affect platforms in the Southern Italy and Greece.	Tankers: noise impact and collisions with marine mammal that abandon the areas and deviate from their usual migration routes. [89] The route of oil crude tanker and gas underwater pipeline cross the Priority Conservation Areas, Ecologically or Biologically Significant Areas and Crucial habitats (as show up).
Levantine Basin	High concentration of wells in the Levantine Basin where are identified Priority Conservation Areas, Ecologically - Biologically Significant Areas and Crucial habitats for monk seal, seabirds, turtles and sharks. Geological hazard like earthquakes and tsunamis increase hydrocarbons spills: faults in front of Cyprus and along the Syria, Lebanon and Israel coasts. Pockmark fields founded in Iskenderun Bay in Turkey near Syria, presented a potential hazard for drilling. [87] The geopolitical situation of the area make it risky to terroristic attacks or sabotages.	The continental slope is sensitive either to submarine landslides that may harm seabed installations such as pipelines, directly or via triggered tsunami. These landslides may be triggered by near as well as by remote earthquake. [90] From the Levantine Basin Coasts leave oil and LNG tankers to Europe: high traffic imply major probability of incidents and more water pollution linked with ordinary operations of upload hydrocarbons. Several gas and oil pipeline overlooking on the Levantine Basin could affect marine coastal ecosystems.

STORAGE

Adriatic Sea

Geological Hazard like earthquakes in Adriatic inland compromise stability of oil and gas storage onshore. Faults cross Adriatic western and eastern coasts.

Refineries/oil storage overlooking the Adriatic Sea: Falconara (Marche, Italy), Porto Marghera (Venice, Italy), Fier (Albania) and Rijeka (Croatia).

Gas storage: stored in exhaustive gas fields inland or in offshore terminals. LNG offshore terminal of storage/regasification in Porto Viro (Rovigo, Italy) is located at 29 m depth, 15 Km far from the coast: chemical compounds end up in the environment. [91]

Sicily Channel

Refineries/oil storage overlooking the Sicily Channel: Gela, [92] Bizerte (Tunisia), Vega A (floating storage).

Natural and geological hazard could occur in the Sicily Channel compromising stability of oil and gas storage offshore and onshore mainly in the Sicily and Tunisia coasts: earthquakes, faults, submarine volcanoes, tsunamis.

Levantine Basin

Refineries/oil storage overlooking the Levantine Basin: Ashdod and Haifa (Israel), Banias (Syria), Alexandria (Egypt).

Natural and geological hazard compromise stability of oil and gas storage: submarine landslides could affect stability of offshore construction and recovery. [93]

The geopolitical situation of the area make it risky to terroristic attacks or sabotages.

83 Avaiable online: mingo.hr/default.aspx?id=499641

84 Helen Anderson et al., *Active tectonics of the Adriatic Region*,1987

85 Centro Meteo Italiano, *Empedocle il gigantesco vulcano sottomarino che si trova sotto la Sicilia*. Available online: centrometeoitaliano.it

86 M.Taviani et al., *The Gela Basin Pockmark field in the Strait of Sicily (Mediterranean Sea): chemosymbiotic faunal and carbonate signatures of postglacial to modern cold seepage*,2013

87 Ana Garcia Garcia et al., *Geophysical evidence for gas geohazards off Iskenderun Bay, SE Turkey*, 2004

88 D. Holcer, C.M. Fortuna & P. C. Mackelworth, UNEP-MAP-RAC/SPA, *Status and Conservation of Cetaceans in the Adriatic Sea*, 2014

89 General for Maritime Affairs and Fisheries, *The potential of Maritime Spatial Planning in the Mediterranean Sea. Case Study: Malta*, 2011

90 Bella Galil and Barak Herut, *Marine environmental issues of deep-sea oil and gas exploration and exploitation activities off the coast of Israel*, 2011

91 D. Holcer, C.M. Fortuna & P. C. Mackelworth, UNEP-MAP-RAC/SPA, *Status and Conservation of Cetaceans in the Adriatic Sea*, 2014

92 ENI, *Eni refining & marketing Gela Refinery*

93 European Commission, *Gas Seeps and Submarine slides in the Eastern Mediterranean: toward comprehensive geohazard prevention*, 2012

6 OIL AND GAS EXTRACTION: MEASURING ENVIRONMENTAL COSTS

6.1. Carbon Emission Costs

Extracting, transporting, and refining crude oil account, on average, for about 18% of "well to wheels" greenhouse gas (GHG) emissions. [94] On a global scale, this equates to a very large amount of GHG emissions: about 2.8 billion metric tons of CO_2 equivalent per year. Carbon dioxide emissions impose an externality on society. This external cost is often referred to as the social cost of carbon (SCC). [95]

To calculate externalities by offshore O&G industry in the Mediterranean Basin, we started to calculate the total O&G production per toe in 2013 in all countries producing oil and gas with offshore platforms including: Spain, France, Italy, Greece, Slovenia, Croatia, Malta, Tunisia, Algeria, Egypt, Albania, Montenegro, Cyprus, Libya, Turkey and Syria. The elaboration data by Source International was made on EUROTAT data.

94 D. Holcer, C.M. Fortuna & P. C. Mackelworth, UNEP-MAP-RAC/SPA, *Status and Conservation of Cetaceans in the Adriatic Sea*, 2014

95 ENI, *Eni refining & marketing Gela Refinery*

96 European Commission, *Gas Seeps and Submarine slides in the Eastern Mediterranean: toward comprehensive geohazard prevention*, 2012

97 U.S. Environmental Protection Agency, 2009

The world average CO_2 emissions per toe by O&G extraction is 136 Kg CO_2 per toe while CO_2 emissions from using oil are much bigger: 3 tons CO_2 per toe. [96]

We estimated the Social Carbon Cost (SCC) according to the three carbon price models in euro: 9.09 euro (10 dollars), 36.36 euro (40 dollars) [97] and

200 euro (220 dollars) [98] per tons of CO_2. The total O&G production on the 2013 was 66,302.60 thousand toe (20,016 oil toe and 46,287 gas toe), which further corresponds to 9,017,153.6 tons of CO_2 emissions.

98 Robert S.Pindyck, *Pricing Carbon When We Don't Know the Right Price*, 2013

Social Carbon Cost estimated with lowest level of carbon price model used by European Union Emissions Trading System (EU ETS) fixed on 9.09 euro (per CO_2 emissions tons) is equal to 81,965,926.22 euro (90,171,536 dollars).

SCC estimated with the mainstream assessment established on 36.36 euro (per CO_2 emissions tons) is 327,863,704.8 euro (360,686,144 dollars). SCC estimated with the recently Stanford Model based on 200 euro per CO_2 emissions ton, is significantly higher than the others: 1,803,430,720 euro (1,983,773,792 dollars).

6.2. Ecological costs

Ecological Costs The value of marine and coastal ecosystems can be expressed in economic terms through the ecosystem services they provide. These include raw materials and fisheries, recreational benefits, as well as regulating services, such as climate regulation through the uptake of greenhouse gases (GHGs). In 2010, the Mediterranean marine environment was valued conservatively at €10,000 per Km^2, with most of the ben-

efits emerging from amenities and recreation. [99] The contribution of biological processes to carbon sequestration is always positive and ranges between €100 and €1500 million/year for the Mediterranean marine ecosystems. [100] The aggregated economic value of all the benefits considered by the Mediterranean marine ecosystems was estimated to over €26 billion in 2005 for all of the riparian states. Mediterranean marine ecosystem seems to produce a global benefit estimated at over €10,450/km^2/yr. Value of the benefits provided by Mediterranean marine ecosystems are:

- 2,703 million €/year by benefits relating to waste treatment (marine ecosystems have a great capacity to recycle a substantial volume of inputs from human activity);
- 527 million €/year by benefits relating to protection against coastal erosion;
- 2,219 million €/year by benefits relating to climate regulation;
- 2,871 million €/year by rent related to the provision of food resources. [101]

The economic costs of marine habitat degradation are leading with: loss and destruction of habitat for commercially harvested species (food and natural products) that can reduce food and livelihood security; decreased shoreline protection, due to habitat loss, can affect coastal communities and industries that are exposed to climatic events (e.g. storms, floods).

Offshore oil production represents a risk to marine and coastal environments and the value they hold in several aspects.

Food webs Considering the interconnectedness of food webs and nutrient cycles, a large spill would affect more than just the local environment and its inhabitants, with potential impacts for years following the incident. [102] The most fundamental source of energy in marine food webs is photosynthesis by phytoplankton, which in the case of oil pollution, would be directly affected. [103]

99 Knut Einar Rosendahl, *Norwegian oil production from a climate perspective*, 2013. Available online: umb.no

100 The climate Group, *Carbon pricing*, 2013

101 Ker Than, *Estimated social cost of climate change not accurate, Stanford scientist say*, 2015

102 Luis C. Rodrigues, *Socio-economic impacts of ocean acidification in the Mediterranean Sea*, 2012

103 Bio Science Oxford Journals, *How Were Phytoplankton Affected by the Deepwater Horizon Oil Spill?*, 2014

A modification in the food web by O&G pollution imply a loss in terms of species with repercussions on the main economic sectors of fishings and tourism, in case of commercial and recreational species, as well as a cost in terms of loss of species with important ecological roles.

Biodiversity Estimates establish the cost of biodiversity and ecosystem damages will cost 18% of the global economic output by 2050 [104] and currently at over €1.8 trillion (2 trillions of dollars) with some estimates as high as €5.4 trillion (US $6 trillion) per year. [105] The negative impacts on biodiversity by offshore O&G activities are: habitat degradation, marine life disturbance and loss of species, air and water pollution, loss of productive capacity, and degradation of ecosystem functions. [106]

Coral reef ecosystem Even if the Mediterranean Sea does not host coral reef comparable to those of the tropical zones, it presents more than 200 species of coral, and some of them are endemic. Coral reef provides many of the services that other coastal ecosystems do, as well as additional services:

- They are a major source of fisheries products for coastal residents, tourists, and export markets;
- They support high diversity that in turn supports a thriving and valuable dive tourism industry;
- They contribute to the formation of beaches; they buffer land from waves and storms and prevent beach erosion;
- They provide pharmaceutical compounds and opportunities for bio-prospecting.

The value of coral reefs has been estimated at €90,909 – 545,454 (US $100,000-600,000) per km^2. Yet the estimated annual operating costs for marine protected areas are only €704.5 (US $ 775) per square kilometer, [107] a tiny proportion of the estimated benefits of reefs.

Seagrass meadow ecosystems It produce a variety of goods (finfish and shellfish, sediment) and provide ecological services (maintenance of biodiversity, water-quality control, shore-line protection). [108] The first ap-

104 BBC news. Available online: bbc.com/news/business-11606228

105 BBC news. Available online: bbc.com/news/10103179

106 The Energy and Biodiversity, *Negative Secondary Impact from oil and gas Development*

107 Andrew Balmford et el., *The worldwide costs of marine protected areas*, 2004

108 Jens Borum, Carlos M. Duarte, Dorte Krause-Jensen, *European seagrasses: an introduction to monitoring and management*, 2004

praisal on the value of the services provided by seagrass ecosystems produced a minimum estimate of €15,837 per hectare per year, which is two orders of magnitude higher than the estimate obtained for croplands. [109]

Wetlands ecosystem It play a key role in the hydrological cycle:

- It regulates natural filtration of water and improvement of its quality when polluted;
- It regulate water flow, attenuating both the number and the intensity of extreme events;
- They are very important areas for the reproduction of birds and fishes;
- They are attractive ecosystems where several local communities are strongly connected with their environment, which has become part of their history, inherited livelihood and educational references. [110]

The total economic value of 63 million hectares of wetland around the world was estimated at €3 billion per year (US $ 3.4 billion). [111] Congaree Bottomland Hardwood Swamp wetlands in South Carolina removes a quantity of pollutants from watershed water resources equivalent to that which would be removed by a €4.5 million (US $ 5 million) water treatment plant. [112] In Georgia, 2,500 acre wetland saves €0.9 million (US $ 1 million) in water pollution control costs annually. [113] In Spain the coastal wetland of Doñana has been evaluated by the European Environmental Agency at €570.6 million, [114] which is more than the entire GVA due to the oil and gas sector in all of Spain.

Mediterranean Sea is characterized by: 35,000 km^2 of Posidonia meadows and 108,500 km^2 of corals formations. [115] Considering the minimum estimated value of seagrass meadows ecosystems of €15,837 per hectare per year, in the case of an oil spill, 10 km^2 (the smallest area considered) of seagrass meadows could be impacted. The final economic cost of this loss is indicatively equal to €15.37 million.

109 Jorge Terrados and Jens Borum, *Why are seagrasses important? Goods and services provided by seagrass meadows*, 2004

110 Mediterranean Wetlands Observatory, *Impacts and benefits*

111 L. Brander and K. Schuyt, *The economic value of the world's wetlands*, 2010

112 US EPA, 1995

113 Water sheeds, *Wetlands value*. Available online: water.ncsu.edu

114 EEA Technical Report, *Ecosystem accounting and the cost of biodiversity losses. The case of coastal Mediterranean wetlands*, 2010

115 ODEMM, *The Mediterranean Sea: Additional information on status of threatened ecological characteristics relevant to the Marine Strategy Framework Directive*, 2011.

If the same spill occurs in 10 Km^2 of coral reef ecosystem, the economic cost could be €2.7 million (US $ 3 million), considering €272,727 (US $ 300,000) as a medium value of this ecosystem evaluated between the low and high value, respectively equal to€ 90,909-545,454 per Km^2.

Moreover, in a specific analysis, we considered the economic scenario of the Sicilian Channel. This area is considered as a biodiversity hotspot within the Mediterranean and is one of the most important fishing areas in the basin. The Tunisian coastline has turtle nesting beaches, seagrass meadows, sponge communities, and represents the migratory route of large pelagic fish. [116] Seamounts and deep-sea corals are found in the channel and the area is important to fin and sperm whales as well as the great white shark. [117] The deep-water coral habitats in the Sicily Straits are rich in species diversity acting as an essential habitat for feeding and spawning. They also attract cephalopods, crustaceans and fishes. [118]

An oil spill in the Straits of Sicily, taking into consideration the marine currents in south-east direction (see chapter 2.2.), the following coral reef bank could be affected with severe consequences in the ecological systems: Nameless Bank (Pantelleria), Linosa Trough and Off Malta (Malta).

In the case that the oil pollution starts in the northern part of Pantelleria Island (Italy), it is possible to see a perturbation along 51 Km of its coast as well as in the case of Malta, with 140 Km of its coast.

Severe impacts on the Tunisian coast could affect the coastal wetland by oil pollution with loss of biodiversity and protection of this ecosystem to coastal communities. For example, the wetlands in the Gulf of Hammamet occupies 4250 ha, [119] and right in front of these coasts there are planned or active oil wells (see Sicily Channel map at section 3.2). We calculated, based on the world value of the wetlands (€3 billion per 63 millions ha), is the value of 1 ha corresponding to €47.6.

An oil accident, on this wetland area, implies an economic cost (for its 4250 ha) equal to €202,380 (US $ 229,365).

116 Oceana-MedNet, *MPA Network Proposal for the Mediterranean Sea*, 2011

117 UNEP, *Sicily Channel/Tunisian Plateau: Status of Cetaceans*, 2014

118 UNEP, *Marine and Coastal Protected Areas, including in the open seas and deep seas*, 2015

119 R.H.HUGE, *A Directory of African Wetlands*, 1992

Moreover it is important to consider the economic impact in the northern Ionian Margin along the Apulian Ridge, where the total area of coral reef covers 2,000 km^2 between 120 and 1,400 m depth, [120] and 976 km^2 are covered by the deepwater coral (Lophelia) reef in Capo Santa Maria di Leuca, in the Ionian Sea, Apulian, Italy. [121] In the case of an oil spill by oil wells in the south Adriatic Sea (three planned oil wells and one active. See map at chapter 3.2.), and considering the marine currents in the south-west direction, these coral banks could be affected with severe ecological costs. Considering the average value of coral reef at €272,727, the economic loss varies between €266 million for 976 Km^2 of coral reef off Capo Santa Maria di Leuca, and €545 million for the 2,000 Km^2 of coral reef in the Apulian Ridge.

120 Alessandra Savini et al., *Mapping Cold-Water Coral Habitats at Different Scales within the Northern Ionian Sea (Central Mediterranean): An Assessment of Coral Coverage and Associated Vulnerability*, 2014

121 UNEP, MAP, RAC/SPA, *Overview of scientific findings and criteria relevant to identifying spaMIs in the Mediterranean open seas, including the deep seas*, 2010

7 CONCLUSIONS

The Mediterranean Sea covers only 0.8% of the world's ocean surface and for centuries it has been over-exploited, nevertheless it counts 7% of all known marine species. Moreover, with less than 6% of the surface of the planet and only 7% of the world population, the Mediterranean area accounts for 12% of the global GDP and 31% of the global tourism. Tourism, transport, fishing, and aquaculture are by far the main economic activities of this sea and are very sensitive to oil and gas related activities and especially to potential accidents such as oil spills.

Apart from the enormous ecological impacts that an oil spill can have in such a fragile ecosystem as the Mediterranean Sea, it can also affect the economy in a dramatic way. Tourism would probably be the most heavily affected sector in the short term. The sinking of the Don Pedro merchant ship in 2007, near the island of Ibiza for instance showed that even a small oil spill (about 20 tons), with a series of circumstances that significantly lessened its impact, was sufficient to compromise an entire season in this "sun and sand" tourist destination. The DeepWater Horizon spill, in the Gulf of Mexico, was 40,000 times bigger. A spill of this scale could affect the tourism-related economy of entire regions of the Mediterranean Sea for years and also affect the fishing and aquaculture sectors for decades. BP has paid €49 billion to cover all the related costs of the oil spill, an amount that is 2.5 times higher than the total GVA of the entire O&G sector in the Mediterranean Sea.

The environmental damage of the 1991 TM Haven oil spill (30-50,000 tons of oil) off the coast of Genova, Italy had been estimated in the range of 620 - 1.033 Million Euro (not including the economic losses). Direct impacts included an estimated 43% reduction in fish populations in some fishing areas and 25 miles of Italian coastline impacted by 1,400 barrels of oil.

If we analyze the situation at the sub-regional level, the results are quite astonishing: an oil spill in the Adriatic Sea, resulting in the closure of the touristic income and fishing activities for nine days would eliminate all jobs created by the oil and gas sector in an entire year. In the Sicilian channel, just four days of tourism and fishing closure could be sufficient to break-even the GVA created by the O&G sector in one year. The Prestige oil spill, which took place on November 2002, twenty miles off the Galician coast in Spain and consisting in about 59,000 tons of oil spilled can also represent an important example of O&G accidents damage to the tourism sector. Studies show that short-term economic damages on tourism after the accident could be quantified in a reduction of 5 million overnight stays and a total income loss equal to €134 million, corresponding to about 8% loss in both cases. Moreover, the spill was relatively small (compared with a possible spill from a well), it occurred during a non-touristic season (November) and in an area with a moderate coastal touristic potential and in the Atlantic Ocean which has a major self-cleaning potential compared to a closed sea such the Mediterranean.

Another important example is represented by the 1993 Exxon Valdez oil spill that heavily affected the herring population in the region, which did not recover even after 21 years from the accident with population numbers reduced to 15% of the original population size prior to the spill. As a consequence, thousands of fishermen have lost their livelihood since the accident resulting in a damage that has been estimated in a loss of about 120,000 tons of herring for every year of fishery closing, totaling 2.5 million tons of herring.

The loss of ecosystem services also needs to be added to the economic losses potentially resulting from an oil accident. The economic value of seagrass meadows, for instance, is quantified in €15,837 per hectare per year which means that a relatively small oil spill affecting 10 km^2 of seagrass meadows could result in a final economic cost equal to €15.37 million. Considering that the DeepWater Horizon spill in the Gulf of Mexico has affected an area of 75,000 km^2 a similar accident in the Mediterranean Sea would result in €115 billion loss per year: equal to six times the total GVA of the entire O&G sector in one year.

If we consider the potential impacts of the oil & gas sector to ecosystem services, tourism, fishing and aquaculture, the economic evaluation of oil and gas activities in the Mediterranean Sea is clearly negative. Considering the impacts of previous spills (Exxon Valdez, DeepWater Horizon, Prestige and MT Haven), we can assume that new similar spills in the Mediterranean Sea could have an economic impact that will easily overcome the oil and gas sector by ten-fifteen times. The results from the present study clearly show that, from a mere economic point of view, oil and gas activities in the Mediterranean Sea present more risks than benefits.

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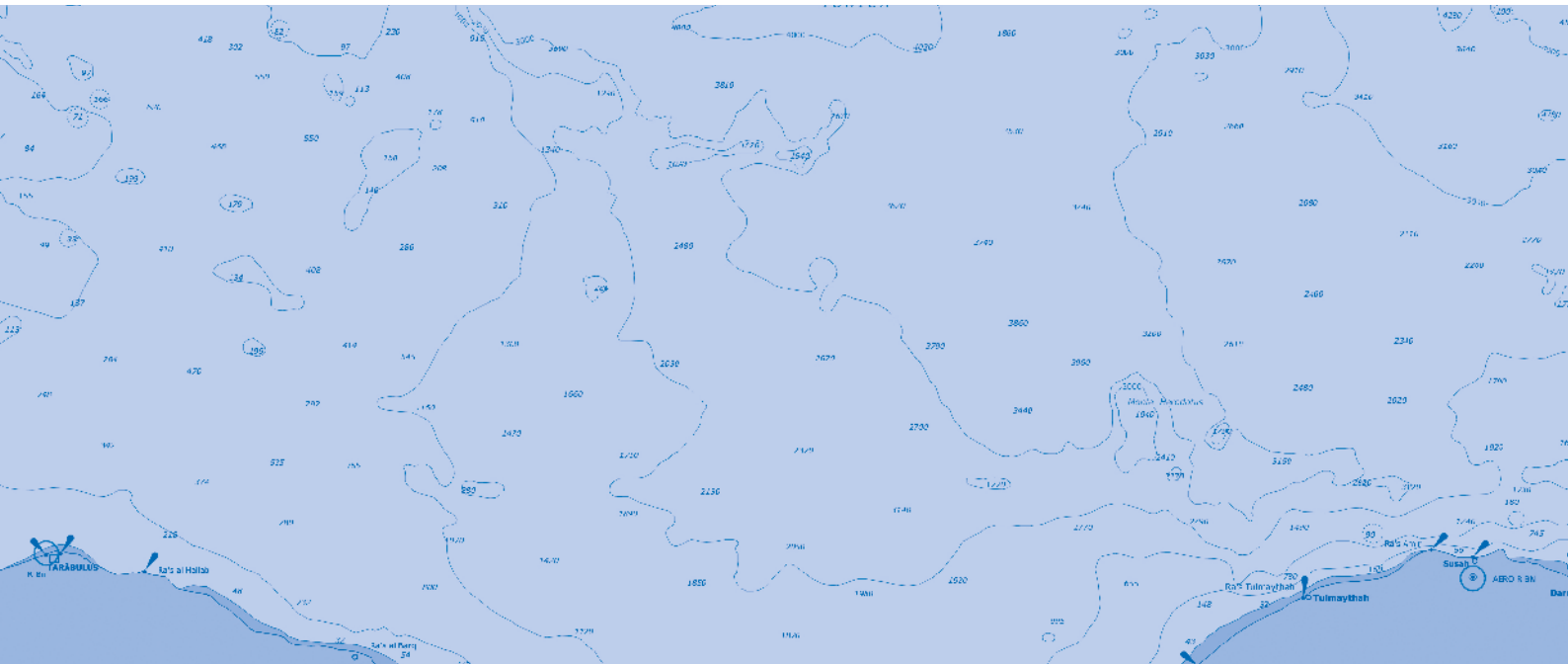
28 July 2015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