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Conclusions for Part II: National Case Studies

Angela Carpenter[1] and Andrey Kostianoy[2]

Abstract

This book (Part 2 of a volume on "Oil Pollution in the Mediterranean Sea") has presented a review of knowledge on oil pollution in the Mediterranean Sea, through a series of National and Regional Case Studies. Those chapters have used of a range of data on oil extraction and production activities, oil transportation, satellite technology, aerial surveillance, in-situ monitoring, for example, to present a picture of trends in oil pollution in various areas of the region over many years. A range of legislative measures are in place to protect the marine environment of the region, including the Convention for the Protection of the Mediterranean Sea Against Pollution (Barcelona Convention, 1976) and its Protocols. The Mediterranean Sea and its various regions, such as the Adriatic Sea, have Special Status for the prevention of pollution by oil from ships under International Convention for the Prevention of Pollution from Ships and its Protocols (MARPOL 73/78 Convention). National Contingency Planning (NCP) and other activities take place under the aegis of the Regional Marine Pollution Emergency Response Centre for the Mediterranean Region (REMPEC), through which countries in the region can work together to cooperate in preventing pollution from ships, for example, and work together to combat pollution in the event of an emergency. NCP and oil pollution preparedness and response activities are discussed within a number of the national case studies. By bringing together the work of scientists, legal and policy experts, academic researchers and specialists in various fields relating to marine environmental protection, satellite monitoring, oil pollution and the Mediterranean Sea, these national case studies present a picture of oil pollution from a range of sources (shipping – accidental, operational, and illegal), offshore oil and gas exploration and exploitation, and coastal refineries, to present a picture of the current situation in the Mediterranean Sea.

Keywords

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Mediterranean Sea, oil pollution, Mediterranean Quality Status Report, European Union, Barcelona Convention, MARPOL Convention, REMPEC, National contingency plan, Oil Pollution Preparedness and Response, aerial surveillance, oil spill monitoring, satellite monitoring, shipping, oil installations.

The Mediterranean Sea lies between Europe to the north, Asia to the east and Africa to the south. It is one of the most highly valued seas in the world, with coastal habitats including brackish water lagoons, estuaries, coastal plains, wetlands, rocky shore, and sea grass meadows, for example [1]. In 2010 around 472 million people lived in Mediterranean countries, mainly concentrated near the coasts of the western Mediterranean, the western shore of the Adriatic Sea, the eastern shore of the Aegean Levantine Region, and the Nile Delta [2]. The population of the region is forecast to grow to 572 million by 2030, which will increase the environmental pressures facing the region from demand for water and energy, waste generation, degradation of habitats, and impacts on coastlines, for example [2].

The Mediterranean Sea is one of the busiest in the world with around 20% of shipping trade and 10% of world container traffic moving through it, and around 200 million passenger movements annually [2], while major shipping routes are dominated by crude oil shipments coming from the eastern Black Sea, Northern Egypt, and from the Persian Gulf (via the Suez Canal) [3]. This contributes to environmental impacts including CO_2 emissions, oil pollution, and marine litter [2], while oil and gas production activities generate waste and the release of pollutants into the atmosphere [4]. There are oil and gas reserves located in Algeria, Cyprus, Egypt, Israel, Italy, Lebanon, Libya and Syria, with offshore exploration and exploitation activities taking place, particularly in the eastern Mediterranean [4], together with coastal refineries in Italian Adriatic waters and in Algeria, for example. **Figure 1** illustrates total oil and gas production by country between 1990 and 2015, with the upper black line showing the total for all countries.

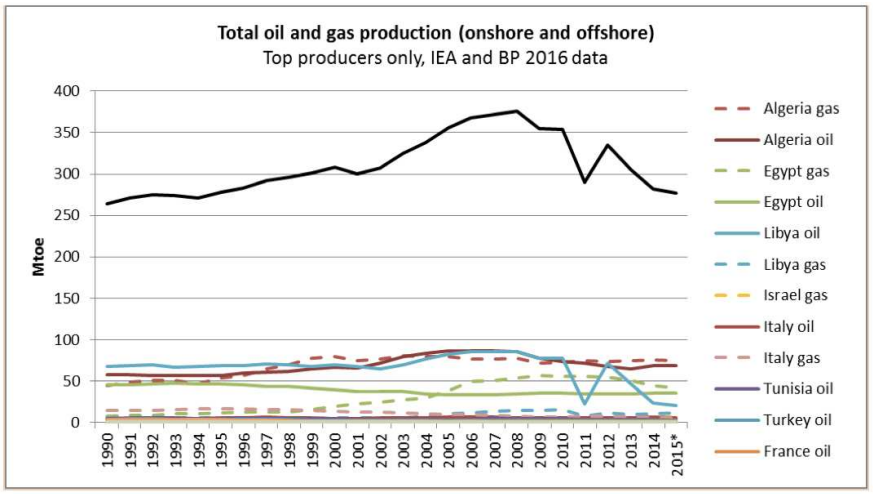

Fig. 1. Total oil and gas production (onshore and offshore) in the Mediterranean Sea Region. Source: UNEP (2017) Mediterranean Quality Status Report [4]

The majority of countries bordering the northern Mediterranean Sea are EU Member States (Spain, France, Italy, Slovenia, Croatia and Greece), and together with the Island States of Cyprus and Malta, are subject to European Union (EU) legislation relating to marine pollution. However, the Principality of Monaco, a sovereign city state on the French Riviera, together with many countries in the Adriatic (Bosnia and Herzegovina, Montenegro, and Albania), in the eastern Mediterranean (Turkey, Syria, Lebanon and Israel) and on the North African coast (Egypt, Libya, Tunisia, Algeria and Morocco), are not subject to such legislation.

In order to protect the marine environment at a regional level, the United Nations Environment Programme (UNEP) established a Regional Seas Programme in 1974. In 1975 the Mediterranean Region adopted an Action Plan (MAP) which focused on marine pollution control, and which was approved by 16 Mediterranean countries together with the European Community (now EU) [5]. Subsequently, the Convention for the Protection of the Mediterranean Sea Against Pollution (Barcelona Convention) was adopted in 1976 in order to protect the marine environment across the whole region [6] and Contracting Parties (CPs) to the Barcelona Convention includes all 21 Mediterranean coastal states together with the European Union. The Barcelona Convention has a range of protocols relating to dumping of pollutants from ships and aircraft, pollution from land based sources, and pollution from offshore exploration and exploitation, for example. **Figure 2** sets out the current status of ratification of the Convention and its Protocols which provide a legislative framework under which countries in the region can work together to prevent, combat or eliminate oil pollution from all sources.

Also in 1976 a Regional Oil Combatting Centre (ROCC) was established to help Mediterranean coastal states co-operate in combatting oil pollution and also deal with marine pollution emergencies. The ROCC was renamed as the Regional Marine Pollution Emergency Response Centre in the Mediterranean Region (REMPEC) in 1989 [7]. Based in Valetta on the island of Malta, it has assisted countries across the Mediterranean by, for example, helping 15 CPs to draft and adopt National Marine Pollution Contingency Plans, helped groups of countries to develop sub-regional agreements on pollution preparedness and response, and helped countries strengthen national legislation on the enforcement of the International Convention for the Prevention of Pollution from Ships (MARPOL Convention) [8] to illustrate just some of its activities over more than 4 decades.

While the roles of various bodies at different levels (regional, international, EU) as they relate to oil pollution in the Mediterranean Sea are covered in Part I (the International Context) of this Volume [9-13], the focus of Part II is on National Case Studies from around the region.

This book contains 10 chapters on “national activities”, written by experts and practitioners covering Spain, France, Italy, the Adriatic coast of Italy, Slovenia, Croatia, Turkey, Israel, Cyprus and Algeria [14-23].

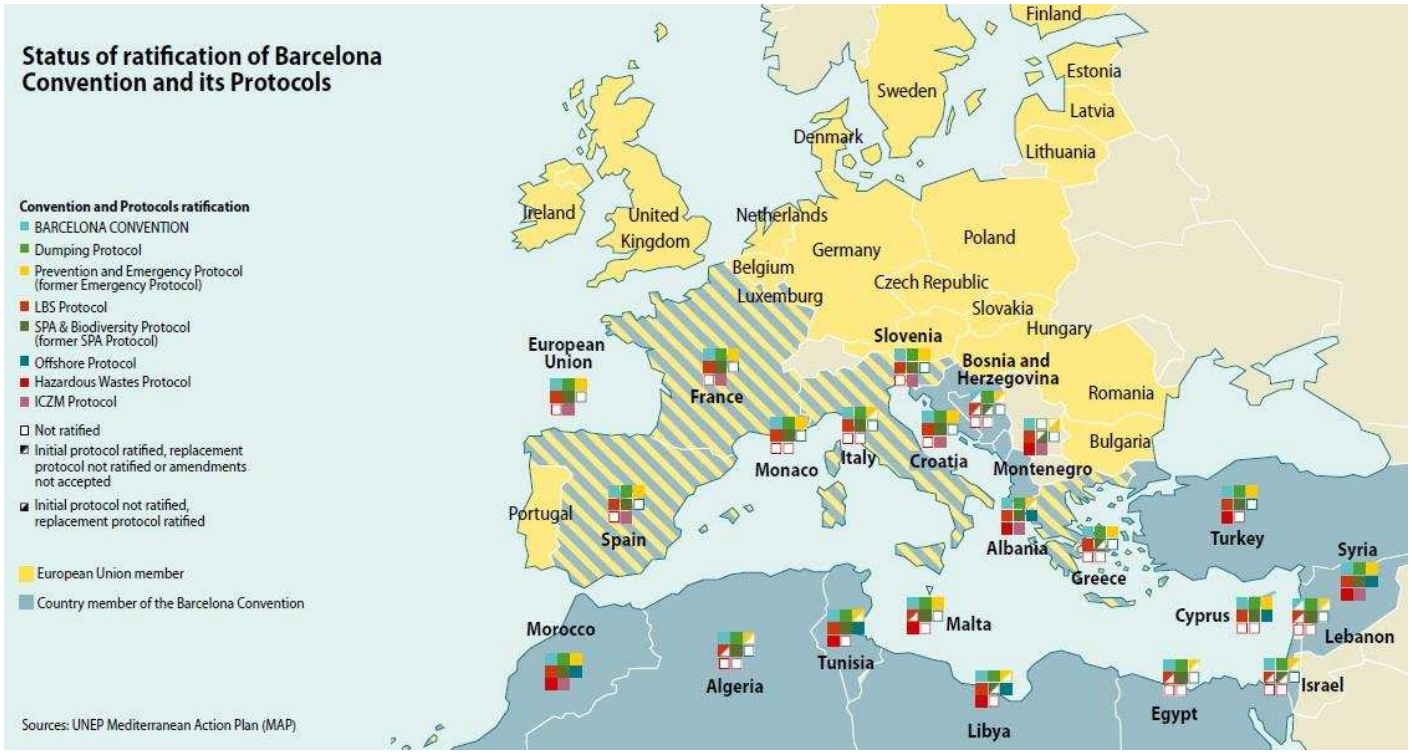

Figure 2: Map showing Status of Ratification of the Barcelona Convention and its Protocols.
Source: GRID Arendal. Available at: https://www.grida.no/resources/5911

Spain has one of the longest coastlines in Europe (approximately 8,000 km) including its Atlantic coast and Mediterranean Sea coast. Spain also has territories in the Atlantic Ocean (the Canary Islands) and the Mediterranean Sea (the Balearic Islands of Mallorca, Minorca, Ibiza and Formentera). Spanish territorial waters, at approximately 1.5 million km^2, are around three times as large as its land area (just over 500,000 km^2). Spain, the largest country in southern Europe and second largest European country, also has two cities located on the African mainland (Ceuta and Melila), giving it a land border with Morocco, and Spanish territory also includes several small islands in the Alboran Sea off the coast of Africa. Spain's Mediterranean coastline has an abundance of beaches, and is most ecologically valuable locations are its coastal wetlands, dunes, small islands and islets, and some areas of seabed [14]. The Balearic Islands have a long, rugged coastline, with beaches in small inlets and lagoons, for example, and a wide range of ecologically important environments [14]. Spanish coastal waters in the Mediterranean also have significant socio-economic importance through activities including tourism, fisheries and aquaculture, with the mainland Mediterranean coast, Canary Islands and Balearic Islands receiving 85% of all foreign tourists and 60% of domestic tourists in Spain [14]. As a result of tourism, increasing amounts of energy from oil and gas are supplied by sea, while sea trade contributes to economic prosperity in the region [14].

Approximately106,000 vessels pass through, or cross, the Strait of Gibraltar each year, posing a risk of oil or other pollution from accidents (structural damage, grounding or sinking of vessels) or operational discharges (for example during fuel transfer) [14]. While a large number of major oil spills occurred in Spanish waters over the last half century, including the Uriquiola, Aegean Sea, Khark 5 and Prestige oil spills (numbers 10, 15, 17 and 20 in **Table 1** showing the world's top 20 oil spills), no major oil spill have occurred in Spanish Mediterranean waters, and only one in the Mediterranean as a whole (the 1991 Haven oil spill off Genoa). However, a number of pollution incidents have occurred in Spanish ports, resulting in small discharges of oil products in the inner waters of harbours, generally resulting from cargo-handling, bunkering or oil transfer operations [14]. There are eight harbours that are major load and discharge centres for oil products, and which hold oil terminals of coastal refineries [14], together with two offshore oil rigs 45 km off the coast of Tarragona Province (north-east Spain), with a pipeline leading to a refinery in Tarragona, and a refinery in Murcia Province, also on the Mediterranean coast [25]. Approximately one pollution incident from rigs has occurred each year between 2006 and 2015, including all Spanish waters [14].

Table 1. World Top 20 Major Oil Spills since 1967

Rank	Ship Name	Year	Location	Spill Size (tonnes)
1	*Atlantic Empress*	1979	Off Tobago, West Indies	287,000
2	*ABT Summer*	1991	700 nautical miles off Angola	260,000
3	*Castillo De Bellver*	1983	Off Saldanha Bay, South Africa	252,000
4	*Amoco Cadiz*	1978	Off Brittany, France	223,000
5	*MT Haven*	1991	Genoa, Italy	144,000
6	*Odyssey*	1988	700 nautical miles off Nova Scotia, Canada	132,000
7	*Torrey Canyon*	1967	Scilly Isles, UK	119,000
8	*Sea Star*	1972	Gulf of Oman	115,000
9	*Irenes Serenade*	1980	Navarino Bay, Greece	100,000
10	*Uriquiola*	1976	La Coruna, Spain	100,000
11	*Hawaiian Patriot*	1977	300 nautical miles off Honolulu	95,000
12	*Independenta*	1979	Bosphorus, Turkey	94,000
13	*Jacob Maersk*	1975	Oporto, Portugal	88,000
14	*Braer*	1993	Shetland Islands, UK	85,000
15	*Aegean Sea*	1992	La Coruna, Spain	74,000
16	*Sea Empress*	1996	Milford Haven, UK	72000
17	*Khark 5*	1989	120 nautical miles off the Atlantic coast of Morocco	70,000
18	*Nova*	1985	Off Kharg Island, Gulf of Iran	70,000
19	*Katina P*	1992	Off Maputo, Mozambique	67,000
20	*Prestige*	2002	Off Galicia, Spain	63,000

Note: Quantities rounded to the nearest thousand tonnes. Spills highlighted in grey occurred in the Mediterranean Sea

Source: ITOPF (2015) [24]

Marine pollution prevention, preparedness and response is the responsibility of a number of different authorities in Spain, including the Spanish Maritime Safety Agency (SASEMAR), for example, which is the national body providing search and rescue, maritime traffic control, and pollution prevention and response services, while 20 Maritime Rescue Coordination Centres (MRCCs) are responsible for operational coordination of pollution incidents [14]. The National Rescue and Pollution Response (NPRP) Investment Plan provides the necessary resources to deal with pollution incidents, and SASEMAR owns a maritime fleet of 73 vessels

and an aerial fleet of 3 aircraft and 11 helicopters [14]. Maritime units perform mechanical recovery of oil on the sea surface, and a number of vessels are equipped for towing, search and rescue, and oil spill response purposes [14]. SASEMAR aircraft operate for approximately 1,200 hours per year for pollution control activities, around half of all surveillance activities taking place at night, and this is supported by EMSA CleanSeaNet (CSN) remote sensing surveillance [26].

There has been a declining trend over 5 years for spills and vessels being caught 'red-handed' illegally discharging bilge waters, for example [14], and oil spill forecasting and identification activities provide evidence to support enforcement activities [14]. Those activities include participating in annual Bonn-OSINet (oil spill identification network of experts within the Bonn Agreement) activities [27]. Spain therefore has a solid system for oil pollution prevention and response, a clear regulatory framework, and bilateral and regional operational plans established with neighbouring coastal states. These, together with investment action plans, aerial and satellite surveillance, and oil forecasting, source identification, and sampling systems, mean that Spanish authorities are able to respond to the medium and small oil spills occurring in Spanish waters, while at the same time enhancing maritime safety in order to reduce shipping accidents [14].

France has a coastline of around 4,853 km including all of its overseas regions and territories (including French Guiana and islands in the Atlantic, Pacific and Indian Oceans. Metropolitan France has a coastline of 3,427 km, and is bounded by the Mediterranean Sea, Atlantic Ocean, English Channel and the North Sea [28]. Metropolitan France includes the island of Corsica in the Mediterranean, and with the inclusion of all its overseas departments and territories, possesses the second largest Exclusive Economic Zone in the world covering more than 11 million km^2 [28]. The French Mediterranean coastline includes the French Riviera (Côte d'Azur) along the southeast corner of France (where it meets up with the Italian Riviera), an area that is a hotspot for tourism in the northern Mediterranean basin [15]. The French city of Marseille is also located on the Mediterranean coast, in Provence, and is the second largest city in France, Marseille is the sixth largest port in the EU (largest in the Mediterranean), and approximately 80 million tons of freight passed through the port of Marseilles in 2015 [29]. There are a small number of oil refineries located along the coast of Provence including at Fos-sur-Mer and Lavera, for example [30]. While operational spills from shipping take place weekly or even daily on some heavy traffic routes (an average of 330 spills per year during the years 2000 to 2009 in French Mediterranean waters; 115 spills in 2012), these spills are generally less than 10 m^3 of oil, there has never been a major oil spill in French Mediterranean waters [15]. The Côte d'Azur was, however, impacted by the 1991 MT Haven oil spill, when partially burnt oil from that spill was carried to the region through prevailing winds, waves and the Ligurian Current, with an estimated 10,000 tons of oil drifting into French waters [15].

The French system if oil spill prevention and response involves public services and institutions under the French Marine Pollution Organization (POLMAR). POLMAR partners include three maritime Préfectures (covering the Mediterranean, Atlantic, and the Channel and North Sea), the mayors of communes or prefects of départements impacted by a pollution incident, and CEDRE (the "Centre

de documentation, de recherche et d'expérimentations sur la pollution accidentelle des eaux") which provides an advisory service in the event of an incident. It also involves a number of French ministries together with MeteoFrance which deals with slick drift prediction modelling [15]. The French system also involves an annual 'at sea' response exercise organised by each maritime Préfecture, together with other organisations, while Cedre holds regularly updated manuals setting out information and recommendations for dealing with an emergency at sea (Polmar-sea) and on the coastline (Polmar-land) [15]. The response strategy in dealing with accidental spills has, since 2000, been that ship owners are required to pump and recover highly toxic pollutants (including crude oil and heavy fuel oil) from shipwrecks, and to release low toxicity pollutants under controlled conditions, at their own expense [15].

Operational spills as part of a ship's normal operation, whether resulting from a human decision, human error, or a technical failure, are generally illegal within the Mediterranean Sea given its special status under the MARPOL Convention [8][1], and in 2001 a law on operational spills established a court in Marseilles (together with two courts on the Atlantic side of France) to deal with legal aspects of operational pollution [15]. As soon as any spill occurs a response plan is activated to mobilise at-sea detection, satellite and aerial observations, slick drift modelling to predict the path of a spill, and determine priorities for pollution response [15]. Statistics for the years 2000 to 2015 covering both the Atlantic and Mediterranean that 67% of spills identified by Marine Pollution Reports (POLREP) were oil, of which only one tenth could be linked to a source [15]. While it was only in 2003 that the Mediterranean maritime préfecture started arresting and prosecuting ships suspected of illegal operational spills these prosecutions, this has, in combination with surveillance activities, led to a reduction in the number of operational spills in French waters [15], Through joint exercises conducted through bilateral agreements under the Barcelona Convention [6] and participation in the activities of REMPEC [7], France is a major regional player in co-operation to deal with oil pollution in the Mediterranean [15].

Italy is surrounded by the Adriatic Sea in the east, the Ionian Sea in the southeast, the Tyrrhenian Sea in the southwest and the Ligurian Sea in the northwest [16], and its land border with France is the meeting point of the French and Italian Riviera. Italy has a coastline of 7,600 km, and its territory includes the islands of Sardinia and Sicily, together with a number of smaller islands. Around 30% of the Italian population of around 60 million people live in 646 coastal towns [16], Large volumes of crude oil are transported by tanker to Italy from the Middle East and Russia, while tanker trades represent around 60% of trade between littoral States in the Mediterranean, with the main Italian discharge ports being Trieste in the Adriatic, Augusta in the Ionian, and Genoa in the Ligurian seas [16]. There are offshore oilfields south of Sicily and in the Adriatic Sea [16, Figure 8] with 139 offshore installations, 119 of which are production platforms, 8 support platforms

[1] The Mediterranean Sea is a special zone under MARPOL, with strict limits on the volume of oil that can be legally discharged. See: http://www.imo.org/en/OurWork/Environment/SpecialAreasUnderMARPOL/Pages/Default.aspx

and 9 non-production platforms, together with 13 sub-sea wellheads [16], and around 14 oil refineries in Italy (many located on the coastline) [30]. Although oil pollution risk is high, there has been only one major oil spill in Italian waters, that of the MT Haven off Genoa in 1991. As noted previously, around 144,000 tonnes of crude oil was spilled in that accident, some of which was transported as far as the Côte d'Azur of France on the prevailing currents.

Italy's pollution response activities fall under the direction of the Ministry of Environment at the strategic level, the Coast Guard branch of the Italian Navy for operational activities at national and local levels, and the Civil Protection department in the event of a large and catastrophic event. The response system has three levels: (1) for small spills far from the coast incidents, (2) for small or medium oil spills in coastal or protected areas, and (3) for large oil spills requiring resources in addition to those available from the Ministry of Environment, with Level 2 and 3 spills over 100 m^3 being reported to the Regional Centre [16]. The Italian Coast Guard has around 600 vessels spread across 100 harbours to deal with a range of incidents, and have access to a large number of vessels available from a contracting company to participate in spill clean-up activities [16]. The Italian Coast Guard also has a fleet of aircraft equipped with sensors (including Side Looking Airborne Radar; SLAR) to detect pollution at sea [16]. In recent years much of Italian oil pollution monitoring has included satellite imagery, partly provided by COSMO-SkyMed data and partly by EMSA CSN data.

Italy has been involved in a range of remote sensing programmes including with European Space Agency and NASA [16] Its largest investment has been in space systems for earth observation and COSMO-SkyMed, a constellation of four SAR satellites, together with ground based activities, provides data for risk management, civil and defence needs, and marine monitoring (including monitoring for oil pollution) [16]. Oil Spill Monitoring is the main focus of the Italian chapter [16] which considers a range of issues associated with the use of SAR for operational use of satellite imagery. It considers the history of Italy's contribution to such operational use, and a range of benefits to be gained from it which include acting against oil pollution, helping to identify offenders, monitoring oil rigs and offshore pipelines, detecting natural seeps, and search and rescue operations [16]. Images of potential oil spills can be sent to the Ministry of Environment and the Coast Guard from the Matera Remote Sensing Centre, which assists them in identifying vessels responsible for pollution and, where necessary, taking operational measures to deal with and mitigate the effects of such pollution [16]. The Italian National (Marine Pollution) Contingency Plan, a requirement of Article 4 of the Barcelona Convention [6, 11], and supported by REMPEC [12] has been developed over time to include the use of satellite and other new technologies and this approach is considered to discourage operational oil spills which represent the major source of pollution in Italian waters [16].

Three chapters examine oil pollution in the Adriatic Sea sub-basin of the Mediterranean [17-19]. The Adriatic Sea lies is a semi-enclosed water body occupying the northern part of the Mediterranean Central Basin and lying between the Apennine Peninsula on southern Europe in the west, and the Balkan Peninsula in the east [31]. It measures around 770 km from southwest to northeast, and has a width

of between 93 and 248 km, and a coastline of 3,707 km (6,200 km with the addition of all the approximately 1,300 islands, mostly along the eastern shores of the Adriatic) [31]. There are six states with a coastline on the Adriatic – Italy in the west , with a coastline of 1,249 km, and (from north to south on the Balkan Peninsula), Slovenia (coastline of 47 km), Croatia (1,777 km), Bosnia and Herzegovina (23 km), Montenegro (298 km), and Albania (362 km) in the east (see **Figure 3)** [31].

Fig. 3 The Adriatic Sea
(http://www.worldatlas.com/aatlas/infopage/adracsea.gif)

The Adriatic Sea is home to 7,000 species of flora and fauna, including around 750 species of algae, a range of gastropods and molluscs, and more than 400 species and sub-species of fish [31], The region is highly productive for fisheries and is an important area for tourism in the region, with a range of historic locations (including underwater cities and major archaeological sites on land), seaside resorts and beaches, and many on- and in-water activities (diving, windsurfing, yachting, leisure fishing, for example) [31]. The region has a population of more than 3.5 million people living in coastal areas. The Adriatic has fifteen Marine

Protected Areas (four in Italy, seven in Croatia, three in Slovenia and one in Albania) [31] where human activities are restricted in order to protect the natural and cultural resources of the region. There are around 100 oil and gas platforms in the Adriatic along the coast of Emilia-Romagna (Italy), together with a number of liquefied natural gas terminals [31]. Platforms and rigs are allowed to discharge higher concentrations of oil in water (monthly average concentration of 40 parts per million (ppm) and a single incident maximum of 100 ppm) than is the case for shipping under MARPOL Special Area status, where any visible and/or detectable oil spills (deemed to be above the 15 ppm) are illegal [17].

Between 70 and 80 million tons of crude oil, petroleum products and liquid chemical cargos and transported within the Adriatic Sea each year [17], and there are 19 Adriatic Sea ports that handle more than a million tons of cargo per year: the largest cargo port is located in Trieste in Italy; the largest passenger port is Split in Croatia [31]. The main ports handling crude oil are Trieste (41 million tons discharged in 2015), Venice in Italy (10 million tons imported in 2015), Omišalj, north-west of the island of Krk in Croatia (between 7 and 9 million tons in 2015), and the Port of Koper in Slovenia (more than 3 million tons in 2015) [17]. Large vessel traffic is dense, and likely to continue to grow in volume, resulting in the constant threat of both operational and accidental pollution.

A system using satellite images to detect pollution and backtrack it to its source has been developed in the region to minimise ship-generated pollution [17]. Despite the use of satellite surveillance systems and aerial surveillance, illegal discharging and dumping by commercial vessels remains commonplace [17] and the frequency of accidental spills in the Adriatic is estimated to be more than five times higher than the world average [17]. 174 accidents occurred between 1995 and 2005 of which only eight spills exceeded 10 m^3 quantity of oil released: the largest of these was the MT Baba Gurgur spill in February 1989 which released 100 m^3 [17]. Operational pollution, for example as a result of tank washing by oil tankers, is far more common and in breach of the discharge limits set out for the region [17]. Around 100 to 200 commercial vessels sail in the Adriatic at any given time and it is estimated that seven to ten of those vessels are polluting [17]. Between 1999 and 2004 there were 1,049 possible oil spills identified in the Adriatic from ERS-1 and ERS-2 SAR satellite images [17]. Between 2005 and 2006, the AESOP (Aerial and Satellite Surveillance of Operational Pollution in the Adriatic Sea) Project was developed to test the capability of providing satellite near real-time operations for marine oil pollution and monitoring shipping routes in the region [17]. 66 possible spills being detected in the Adriatic in the summer of 2005 from 69 images, with a response activated by the Italian Coast Guard to deal with a significant operational release on 25 August 2005 off San Cataldo Point in Puglia in the southern Adriatic [17]. In September 2005 three slicks (out of four) were successfully connected with potential polluters [17]. AESOP was a predecessor of the EMSA CSN service established in 2007 [26], a service which has confirmed that oil is still illicitly discharged across all European seas, and which detected 250 probable oil spills in the Adriatic Sea between 2011 and 2015 [17].

Despite the frequency of detections by satellite imagery (including EMSA CSN and images from the new sensor Sentinel-1), and subsequent confirmation using

surveillance vessels and aircraft, it can concluded that oil pollution is much reduced from levels in the early 2000s, with just under 3,000 m^3 being discharged each year [17]. Case studies are presented on pollution from shipping and from rigs in the Adriatic Sea to illustrate how pollution has been successfully attributed to the polluter [17], At the same time, it is necessary to model marine seeps from six crude oil seeps in the Adriatic Sea (natural springs where liquid and gaseous hydrocarbons leak from underground oil and gas accumulations) to ensure that natural seepages are not attributed to human activities [17]. Pollution can also come from other sources including fishing activities (for example oil in bilge water or leaks from hydraulic systems on board), from land-based sources entering the marine environment through rivers and streams, and there are also ten wrecks in the northern Adriatic Sea that pose a potential pollution threat due to the nature of their cargos and bunker fuel oil left on board [17], As a result of advances in satellite imagery and aerial surveillance, for example, there has been some reduction in oil pollution, the Adriatic Sea still faces the threat of pollution from a range of sources [17]. That threat is seen as posing a significant threat to the Slovenian coast, its environment as a particularly sensitive shallow sea, and Slovenia cultural heritage sites [18].

While the Slovenian coast is only 46.6 km long, with several bays and peninsulas, its 180 km^2 shallow sea area is the location of two salt pans, mussel and fish farms, has a wide variety of marine flora and fauna, and contains five marine protected areas including nature reserves and natural monuments [18]. An area of particular concern and high vulnerability is the Secovlje salt pans in the Bay of Piran [18]. Much of the salt pans are below sea level and are protected by embankments; a risk is posed to millennia of heritage in the event of an oil spill occurring at the same time as elevated sea levels, high tides and strong winds from the southwest [18]. In addition, there are 36 areas with cultural remains which already face danger from fishing trawlers and anchoring procedures, and which would be at serious risk of permanent damage in the event of a major oil pollution incident [18]. Hazard identification and analysis is therefore very important in the region, in order to identify all the potential or likely hazards of an oil or chemical spill, and determine the sensitivity of an area to such an incident (including factors such as type of coast, presence of natural resources, amenity values etc.) [18].

A high level of preparedness and response would be necessary to deal with marine pollution in Slovenian waters and a sub-regional contingency plan has been drawn up between Italy, Croatia and Slovenia, has been presented to the Barcelona Convention, and is awaiting final adoption [32]. Slovenia has also established a simulation based oil spill crisis management centre which provides training, acts as an active centre in the event of a real emergency, and has already been used in such cases [18]. Vessel traffic surveillance, metocean buoys and high frequency radar have been installed to help cooperation between the three countries if the sub-regional contingency plan is activated [18] while Traffic Separation Schemes are in use in the Adriatic Sea as a whole. Solvenian waters host the majority of shipping traffic in the Adriatic in the port of Koper which receives around 6,000 vessels per year, with around 45 million tons (out of total traffic of 70 million tons)

being crude oil, its derivatives, and liquid chemical cargos [18]. Commercial maritime traffic in the northern Adriatic (through Koper, Trieste, Venice, Ravenna and Rijeka) grew by 7% per year between 1990 and 2013, while Koper has seen average annual growth of 8% between 2010 and 2015 for cargo throughput (nearly 16% yearly for container growth), with dredging and pier extension leading to larger vessels being able to operate in the port, and 93 cases of oil pollution took place in the port of Koper between 2007 and 2015 (about one third of all cases of pollution) [18].

While there have been a number of explosions/serious fires and collisions on ships operating in the Gulf of Venice / northern Adriatic, there were only two incidents causing serious pollution between 1985 and 2008: the release of 90 m^3 of bunker oil from the Ledenice in 1983 at the Izola Shipyard, and a spill of >10 m^3 of sludge or bunker oil from an unknown source in the Bay of Koper in 1990, with oil spreading beyond Slovenian waters into the Gulf of Trieste [18]. A range of accidents have taken place including the grounding of a 220 m long fully loaded Chinese bulk carrier which ran aground in fog, but fortunately did not release any pollution, for example [18]. No operational spill has occurred in Slovenian territorial waters, although some have been close enough to pose a risk, including the 6 August 2008 case of an operational discharge of oil which resulted in a 2 NM long and 1/2 NM wide oil slick and tar balls being discovered along the Istrian Coast and just outside the Bay of Piran, near to the Secovlje salt pans [18]. While measures were taken to deal with the spill, it was not considered to pose a threat to the Italian or Slovenian coasts and so they were not informed of the incident and, following a violent storm, oil came ashore around Savudrija Cape [18]. HF radars and satellite images were used in this case to hindcast and to progressively simulate this incident and can provide valuable tools in both predicting where a spill will spread to, and for polluter identification [18]. This is particularly important in an area of high natural and cultural risk in the event of a catastrophic spill, particularly with more and larger ships operating in the north-eastern Adriatic Sea [18].

Croatia, with around one million people living around its coasts and islands, has an economy that is dependent on tourism, fisheries, aquaculture, shipping and marinas, for example [19]. Croatia has a number of marine protected areas, national parks, special reserves and areas of ecological significance it its waters, while the EU's Natura 2000 ecological network includes 16.4% of Croatia's marine area (5,205 km^2) [19]. Aquaculture ponds are located in many coastal areas and on the southern sides of many Adriatic islands, making them vulnerable to oil and other pollution from shipping traffic such as tankers and cargo ships; the main transport routes used by those ships are crossed by fishing vessels and also cruise ships [19]. Oil exploration activities are also being agreed by Croatia, Albania and Montenegro, and this will pose a risk of pollution if oil deposits are located in the eastern Adriatic [19]. However, Croatia has a number of undefined marine borders with Montenegro and with Bosnia and Herzegovina, and agreement is still pending with Slovenia for the marine border by the Bay of Piran, and this has implications for protection of the marine area, search and rescue activities, and for exploration and exploitation of underwater oil and gas reserves [19].

SAR has been used for operational oil spill detection and monitoring in the region for many years, and a high number of images have been analysed to identify oil slicks from natural, accidental and intentional sources [19], Examples of oil slicks identified from Envisat and Radarsat-1 satellites for the period 2003 to 2016 have been examined to identify the main causes of oil pollution (size, shape and prevailing locations) in the Adriatic Sea (Envisat images were available from ESA and Radarsat-1 through a pilot project with Russian collaboration with the Canadian Space Agency) [19]. The main sources of oil pollution are identified as routine tank washing operations and illegal discharges, generally coming from small vessels and fishing boats, and either being caused by accidents or by dumping of oily wastes [19]. Slicks/spills of between 9–108 km^2 have been identified in SAR images, potentially from routine tank washing operations and illegal discharges, and most of these oil spills were intentionally released during night, since they were detected on SAR images acquired during morning passes of the satellites [19]. These spills are generally located in the open sea at the boundary between Italian and Croatian waters, and along the main shipping routes [19]. Although AIS vessel tracking can be used to potentially identify the source of such pollution, it is not possible to use this information as evidence for a prosecution in court [19]. The use of continuous SAR observations has, however, contributed new knowledge on oil pollution in the Adriatic including size of slicks, and time and seasonal data, and identification of new and previously unknown sources in the region [19].

At the easternmost part of the Mediterranean Sea are the waters of Turkey in the north Levantine sub-basin, where the Mediterranean and Black Seas are connected via the Turkish Straits System, an extremely busy natural channels for national and international maritime traffic [20]. Turkish waters are under heavy use by petroleum tankers from Russia and the Middle East, and these pose a threat to the Turkish coastline, along which there are many harbours, marinas and coastal facilities [20]. There are also two refineries on Turkey's eastern Mediterranean coast (at Îzmir and in Ïskenderun), together with the Baku–Tbilisi–Ceyhan (BTC) pipeline passes which passes through Ïskenderun City, that also pose a high pollution risk in the region [20]. At a national level, there are two Turkish ministries with responsibility for pollution response, the Ministry of Transport Maritime Affairs and Communication (TM-TMAC) and the Ministry of Environment and Urbanization (TM-EU), which are regulated under national legislation for the protection of the seas from oil and other harmful substances pollution, for example [33]. Contingency plans for coastal facilities, together with regional and national Contingency Plans (NCP) have been prepared by TM-EU, which include the roles of other ministries, regional governments, NGOs and experts [20]. Preparedness activities are carried out and coordinated by TM-TMAC, while emergency response facilities are based on a three tier approach: Tier 1 – small scale pollution from coastal facilities and ships; Tier 2 – middle size pollution events; and Tier 3 – large scale pollution requiring national capabilities [20]. Regional and National Emergency Action Plans are in place to deal with oil spills and other hazardous substances, and an emergency response centre is located in Antalya, and a GIS-based decision support system (YAKAMOS) is in place for decision makers to determine the best course of action during a pollution incident [20]. Natural protected areas,

important cultural areas, habitats of species such as monk seal and sea turtle, and important economic areas (fisheries, tourism areas, beaches, industrial facilities etc. have been identified, and the risks from accidents analysed on the basis of factors including maritime traffic levels, previous accidents, importance of the coastline etc. have been determined [20]. There are also 10 stockpiles of equipment in various locations to deal with the impacts of a pollution incident [20]. Regional exercises are carried out twice yearly for coastal facilities, and there is a national exercise every 3 years to ensure that representatives of the various organisations and institutions are familiar with how to deal with a pollution incident under the Contingency Plans [20]. City-based Contingency Plans are in place for seven cities located on the south-east Mediterranean Sea and the Aegean Sea coasts and guidelines based on contingency plans include information on response systems and clean-up methods, the use of dispersants in emergency situations, communication among teams and the public in emergency situations, for example [20].

Aerial surveillance by aircraft or helicopter is regularly undertaken by the Turkish Coast Guard, and satellite-based remote sensing systems are also used to identify pollution, with EMSA CSN [26] providing access to satellite images [20]. However, there have been no significant accidents resulting in marine pollution in Turkish waters, although there have been a number of accidents for Turkish flagged and foreign flagged ships in Turkish coastal waters [20]. There is also the risk of operational discharges from vessels operating in the two refineries and the many harbours and marinas around the Turkish coastline [20]. Strict laws are in place to penalise polluters for environmental damage caused by oil pollution at loading facilities, with reduced penalties if the polluter deals with cleaning up a spill; accidental spill and clean-up costs are also controlled under Turkish environmental law [20]. While Turkey does face the risk of a marine pollution incident (accidental or operational) due to the high density of shipping traffic, ait has in place the infrastructure and contingency plans necessary to deal with pollution from oil and petroleum-related products [20], and at the regional level can call upon REMPEC through its 24/7 Centre to assist in the case of an emergency (as can all Contracting Parties to REMPEC) [7].

Israel, has territorial waters of 2,264 km^2, a total marine area (EEZ plus territorial waters) of 30,000 km^2, and 195 km of coastline on the eastern Mediterranean Sea (and 14 km of coast on the Gulf of Aqaba in the Red Sea) [21]. Israel's marine area contains marine and coastal nature reserves, five major desalination plants for the production of drinking water, three major electric power stations, two main commercial ports, leisure locations, and fishing areas and developing aquaculture grounds, while 70% of Israel's population lives within 15 km of the Mediterranean coastline, where the country's main economic, commercial and tourist activities are also located [21]. Israel receives all its liquid and solid fuels (oil and gas) through its coastal ports and oil terminals [21]. Around 10 million tons of crude oil and 4 million tons of oil products are imported annually, offloaded from ocean-going vessels into onshore terminals; and about two million tons of oil products are exported annually [21]. There are two crude oil open sea terminals at Haifa and Ashkelon, two product terminals at Hadera and Ashdod, and two product terminals within closed ports at Haifa Port and Kishon Port [21]. Shipping activities within

ports produce relatively frequent small to medium oil pollution incidents, often the result of de-ballasting, bunkering, small scale collisions and from on-shore oil facilities [21]. Two offshore gas production platforms in Israel's EEZ are connected by marine pipelines to coastal facilities, and Israel also has significant offshore oil and gas exploration and exploitation activities taking place in the Levantine Basin, which includes the EEZs of Israel, Egypt, and parts of Cyprus [21] The Karish and Tanin gasfields are estimated to contain around 2.7 trillion cubic feet (Tcf) of natural gas and 41 million barrels of oil equivalent (Mboe) of light hydrocarbon liquids [34]. The Leviathan natural gas project in offshore Israeli waters is estimated to hold 22 Tcf of gross recoverable natural gas resources, and should be delivering gas ashore by the end of 2019 [35]. All findings are in ultra-deep water of 1.5 km depth or more, and there is the potential to find oil reservoirs beneath the gas fields [21]. Due to prevailing winds and currents in the Eastern Mediterranean Basin, almost oil spills tend to drift to the eastern Mediterranean coastline, posing a threat to Sinai, Gaza, Israel, Lebanon and Syria [21]. For example, in February 2005 a collision between two vessels 12 nautical miles off Damietta, Egypt resulted in a spill of around 1,500 m^3 which, after five days, washed ashore on the coastlines of Gaza and southern Israel for around 100 km [21].

Protection of Israel's seas and coasts from pollution, together with the demands of urbanisation, industrialisation, and tourism, for example, is a national priority and Israel has in place a legal framework to deal with oil pollution, derived from international agreements including the International Convention on Oil Pollution Preparedness, Response and Cooperation (OPRC 1990) [36], the Barcelona Convention [6], REMPEC [7] and MARPOL [8]. There is also a sub-regional plan for preparedness and response between Israel, Egypt and Cyprus, established in 1995 within the framework of the Barcelona Convention and with the assistance of the EU, to facilitate mutual assistance and cooperation in mobilising equipment to deal with pollution that threatens their coastlines or territorial waters [21]. A trilateral sub-regional Contingency Plan between Greece, Cyprus and Israel is also being developed [21]. A range of national laws are in place to prepare for, respond to, and combat all sources of pollution to the marine environment, and in particular oil pollution [21]. The Marine Environmental Protection Division (MEPD) of Israel's Ministry of Environmental Protection (MoEP) is the national competent authority for oil pollution preparedness and response, and is funded by the Marine Pollution Prevention Fund (created in 1983) under which ships pay fines for non-compliance and fees are levied on sea-going tankers used to import oil into Israel [21]. The MEPD has jurisdiction and oversight for all aspects of marine protection including accidental and emergency oil and chemical spills from ships and terminals, pollution from land based sources, and dumping of waste at sea [21]. Enforcement and monitoring activities are conducted by professional inspectors using a range of equipment, aided by aerial surveillance, and inspections cover vessels and oil tankers calling to Israel's ports, offshore installations handling oil, industrial plants and wastewater plants [21]. The NCP for preparedness and response to incidents of pollution of the sea (TALMAT) [37], was approved in 2008, and provides a structure for dealing with oil spill response in the case of spills up to 4,000 tons of oil; larger spills are deal with either through sub-regional conventions or at

a wider level under international conventions [21]. TALMAT requires local emergency plans at the municipality level or Facility level, and for pollution ranging from Tier 1 (small spills that can be dealt with locally) to Tier 3 (major pollution incidents requiring mobilisation of national or international resources) [21]. There are a large number of facilities requiring contingency plans, together with coastal municipalities with local emergency plans, and a range of organisations take part in preparedness and response activities including Israeli Defence Forces (air and navy), for example, while a 24/7 Rescue Coordination Centre assists with pollution incidents and a wide range of equipment (booms and skimmers, dispersants, workboats and patrol boats) are available for use in such incidents [21]. Israel is, therefore, prepared in the event of a pollution incident taking place, but consider that enhanced collaboration with other countries in the region is vital to strengthen its preparedness and response capabilities [21].

Cyprus, located in the north-eastern corner of the Mediterranean Basin, is the third largest island in the Mediterranean Sea after the islands of Sicily and Sardinia off Italy. Cyprus measures some 240 km from end to end and is 100 km wide and its' widest point, and has a coastline of 770 km, 290 km of which is under the control of the Republic of Cyprus[2]. The economy of Cyprus is heavily dependent on its marine environment for tourism and has established 6 marine Natura 2000 sites and has in place measures to monitor and protect species such as the Mediterranean monk seal and marine turtles, and to monitor sea caves [38]. The sea and coastal areas have a rich marine environmental heritage and a high level of biodiversity, making it susceptible to long term problems from even a small spill in an ecologically sensitive area [22]. In 2013 significant offshore natural gas deposits were identified in the Aphrodite gas field in its EEZ, to the south of the island, within the Levantine Basin [39]. A range of gas fields, including Israel's Tamar and Leviathan fields, and Egypt's Zohr field, have been discovered within that Basin (see **Figure 4)** [40]. The Aphrodite field has confirmed natural gas reserves of 4.54 Tcf and the potential for further discoveries [22]. The Cyprus government is seeking to move away from its energy dependence on imported petroleum towards domestically produced natural gas from the Aphrodite field, although tensions between the Republic of Cyprus and Turkey concerning the limits of the EEZ may pose problems for the development of Cyprus's mineral fuel reserves [39]. Cyprus is also looking to develop as a mineral fuel hub for the region, and there is a large oil storage terminal based in the south of the island with 28 tanks and capacity of 544,000 m^3, and having access to a deep water marine jetty and, and with expansion plans currently under evaluation [41].

[2] The northern part of Cyprus is under the control of the self-declared Turkish Republic of Cyprus (36% of the island), a UN buffer zone covers a further 4% (see https://en.wikipedia.org/wiki/Cyprus). The Sovereign Base Areas of Akrotiri (in the south of Cyprus) and Dhekelia (in the south east) remain under British control (see https://en.wikipedia.org/wiki/Outline_of_Akrotiri_and_Dhekelia).

Fig. 4 Oil and gas discoveries in the Eastern Mediterranean Levantine region (International Institute for Strategic Studies) [40]

An NCP for oil spill response was developed by Cyprus in 1987, and subsequently reviewed in 1997 and 2013. As with other NCPs in the Mediterranean, in the event of a major incident an Emergency Response Centre will be established to coordinate any spill response, including co-operation at sub-regional level if required [22]. Cyprus has, as noted previously, a sub-regional agreement with Israel and Egypt to combat oil spills, and is developing a trilateral agreement with Greece and Israel [21]. Out of seven marine accidents recorded in Cyprus waters (according to the REMPEC Accident database 2004-2014), only two resulted in very small amounts of oil being spilled at sea [22]. A wide range of anti-pollution equipment and materials are available for use in the event of a pollution incident, including dispersants, booms, skimmers, and spraying units, stockpiled at various locations on the island [22]. While the Republic of Cyprus does not own any anti-pollution vessels, it does have access to them with the Department of Merchant Shipping being responsible for liaising with EMSA to contract oil recovery services including use of EMSA oil spill response vessels located around the Medi-

terranean, one such vessel being based at Limassol [42]. The Department for Fisheries and Maritime Research (DFMR) is the body responsible for authorising the use of dispersants. Cyprus participates in the majority of international conventions and their annexes including MARPOL [8] and OPRC [36] for example, together with the Barcelona Convention [6] and various protocols of that convention [11]. The Police Aviation Unit conducts aerial surveillance activities, while the Marine Police, in conjunction with the DFMR, conduct at sea surveillance and can also carry out dispersant spraying missions. Surveillance activities are supplemented by the use of EMSA CSN, while a range of data sources and tools are used to monitor the region and to forecast the transport, fate and weathering of oil spills [22]. However, it is considered that aerial surveillance could be significantly improved, potentially through the use of drones, and that long-range patrol ships could also significantly improve the naval surveillance capabilities of Cyprus.

The final national case study in Part II is that of Algeria on the North African coast [23]. As noted previously, it was not possible to obtain chapters relating to Egypt, Libya, Tunisia, or Morocco. Algeria has a coastline of 1,644 km along the Mediterranean south coast, and has six coastal terminals for the export of petroleum products located at Oran, Arzew, Algiers, Bejaia, Skikda and Annaba (from west to east) [23]. It also has five oil refineries with a total capacity of 652,000 bpd, three of which are in coastal cities (at Skikda – the largest oil refinery in Africa and third largest in the world, and in Algiers and Arzew) [23]. Algeria is the top natural gas producer in Africa, has the third largest shale gas reserve in the world, and produced about 1.7 million bpd of total petroleum products in 2015 [23]. 75% of its petroleum and petroleum products are exported by sea in oil tankers, operating out of its six coastal terminals, and it is estimated that 35% of oil that enters the sea is the due to this tanker traffic (including from illegal discharges, tanker cleaning and run-offs) [23]. Water pollution also comes from the three refineries [23]. Studies have been undertaken in the Bays of Skikda, Arzew and Algiers using field studies and remote sensing using satellite imagery, to determine oil pollution levels in each of those locations [23] with high values of hydrocarbon pollution levels being found in each of those Bays [23]. Due to its location in the Mediterranean basin, and the energetic flow of the Algerian Current [43], hydrocarbons, mercury and other pollutants can be dispersed to coastal areas in western Algeria and beyond sites have been studied using in-field and satellite [44].

Algeria is a party to the Barcelona Convention [6] and REMPEC [7] and has received approval from REMPEC for its NCP, and has a sub-regional contingency plan with Morocco and Tunisia, the first to be signed in the south-western part of the Mediterranean in June 2005 (it entered into force May 2011) [23]. Algeria has also ratified an NCP with the International Tanker Owners Pollution Federation (ITOPF) in 1994, which covers the marine districts of Alger, Oran and Jijel, overseen by a national committee led by the Ministry of the Environment [23]. These, and other plans in place at local national and regional levels, mean that Algeria has in place a range of measures to prevent and combat oil pollution and to improve the quality of the marine environment [23]. Despite the potential risks from high volumes of oil tanker traffic, and pollution in effluents from coastal refineries, there have been no major oil spills or pollution incidents in Algerian waters [23].

However, pollution levels are high in the three Bays of Skikda, Arzew and Algiers, with levels up to 250 mg/L in some locations in Skikda Bay and up to 95 mg/L in Algiers Bay. With the high level of dispersion of such pollutants across the whole of the Mediterranean, and also through the Strait of Gibraltar into the Atlantic Ocean, the monitoring of these Bays and the refineries and coastal terminals within them is clearly important [23].

While overall, it can be concluded that levels of oil pollution in the Mediterranean Sea have, from the standpoint of the individual national cases, improved significantly over recent years, particularly as there have been only a very small number of oil spills from ships over the last few years. However, the September 2017 spill from the ship-wreck of the Agia Zoni II tanker, near the port of Piraeus and off the coast of Salamina, Greece [45], illustrates that accidents cannot be considered a thing of the past and that countries need to maintain their readiness to deal with such incidents in a timely manner. Smaller operational spills also remain an issue, as highlighted in many of the chapters in this volume, and action to prevent such spills (including illegal spills) is also vital. Aerial and satellite surveillance activities provide one way of monitoring for such spills and potentially hind-casting them to their source. Oil (and less so gas) production in both the western and eastern Mediterranean, and in the Adriatic Sea, also pose a threat and here also monitoring is vital to ensure that standards are met and any spills are dealt with promptly.

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