European Maritime Safety Agency Activities in the Mediterranean Sea

Angela Carpenter

Abstract The seas and oceans of the EU, together with the more than 12,000 commercial ports located in EU coastal states, play a major role in Europe's economic security. Its seas and oceans are used to transport of goods and people from within and outside the EU, to produce food from fisheries and aquaculture, and to produce energy from both non-renewable (oil and gas) and renewable (wave, wind) energy sources. In order to protect Europe's marine and coastal areas, the European Maritime Safety Agency (EMSA) plays a significant role in monitoring and protecting those maritime regions from pollution and ensuring the safety and security of ships operating in the region. EMSA has, since its establishment in 2002, developed a broad portfolio of operational and implementation services that it offers to the European Commission and EU Member States. For example, it provides a pollution prevention and response (PPR) service that provides operational assistance in the event of an oil spill at sea. It also provides an earth observation service with satellite-based oil spill detection through its *CleanSeaNet* (CSN) Service and vessel tracking through its *SafeSeaNet* (SSN) Service. This enables EMSA to support both identification of pollution at sea and potentially locate the source of that pollution. This chapter provides a broad overview of the activities of EMSA before focussing on specific activities relating to oil pollution in the Mediterranean Sea. It examines the availability of resources, ships and equipment, and different PPR activities taking place in the region. It also examines the availability of satellite imagery as a tool for oil spill detection during the period 2007–2011, for individual EU Member States in the region, together with more general observations post-2011.

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Contents

1 Introduction

The seas, oceans, and coastal regions of Europe, together with more than 12,000 commercial ports located around its coasts, provide a vital link in the transport of goods and people both within the European Union (EU) and globally [1]. Maritime transport in the Mediterranean is a strong economic sector, with 15% of global shipping activity by number of calls (10% by vessel deadweight) taking place in the region, and more than 325,000 vessel movements in 2007 [2, p. 31]. The region is also a major route for transporting oil, with around 18% if global seaborne crude oil shipments taking place within or through the region. The main oil transport route is from the Suez Canal/Dardanelles Strait in the east to the Strait of Gibraltar in the west, with traffic branching off to ports in both the northern and southern Mediterranean [2, p. 31]. The Mediterranean is an important economic resource as a source of food, with more than 800,000 tonnes of sea fish being landed in 2006 and over 1,500 tonnes of aquaculture production in 2004 [2, pp. 58–59]. Other economic activities in the region include energy production (oil and gas installations, for example) and it a major destination for tourists, including the cruise industry.

Twenty-one countries border the Mediterranean, most of which are EU Member States in the north and non-EU states in the south, including Turkey, Syria, Lebanon, and Israel in the eastern Mediterranean.

The European Maritime Safety Agency (EMSA) is the body which facilitates cooperation between EU Member States and the European Commission in a number of areas to monitor and protect Europe's marine environment, and help maintain the safety and security of maritime traffic in the region. As such it plays a major role in the region, alongside other bodies at international and regional levels.

This chapter presents a brief overview of the history of EMSA and the role it plays in the region. It examines some of EMSAs operational activities relating to maritime safety in areas such as pollution preparedness and response and the provision of oil spill response vessels and equipment around the region. It also examines the role of the EMSA Earth Observation Service through satellite imagery for tracking oil pollution at sea, using data from its *CleanSeaNet* (CSN) Service for the years 2007 to January 2011 (CSN First Generation Report [3], and subsequently from February 2011 to the end of 2013. Finally, some conclusions are presented on how levels of *CleanSeaNet* monitoring compare between the Mediterranean and other regions of the EU, and within the Mediterranean itself.

2 History of the European Maritime Safety Agency

The EMSA is based in Lisbon. It was created as a result of growing public concern about the safety of maritime transport and the issue of oil pollution entering the marine environment, particularly from shipping accidents. For example, when the single-hull oil tanker '*Erika*' broke into two and sank around 40 km off the southern tip of Brittany in December 1999, it resulted in pollution along almost 400 km of French coastline, The European Commission responded very rapidly to that event with a series of proposals for measures relating to Europe's maritime safety policy [4]. In March 2000, the Commission adopted the *Erika I* package of measures through a Communication on the Safety of the Seaborne Oil Trade (COM (2000) 142 final) [5]. The *Erika I* package included measures to: step up controls in ports such as banning or refusing entry into EU ports ships that are in poor condition; greater control of the activities of classification societies, private organizations responsible for checking the structural integrity of vessels, for example; and elimination of single-hull tankers through a proposal for a Regulation on accelerated phasing-in of double-hulled oil tankers [4]. That Regulation (No. 417/2002) entered into force in February 2002 [6].

2.1 Establishment of EMSA

The *Erika I* package was followed, in December 2000, by a second set of measures on maritime safety, the *Erika II* package, in a Commission Communication (COM (2000) 802 final) [4]. That package included measures relating to: greater safety in maritime traffic and more effective prevention of pollution by ships; improvements in existing schemes concerning liability and compensation for pollution damage; and, in relation to this chapter, to a Proposal for a Regulation establishing an EMSA [4]. That specialized agency was to provide Member States and the Commission with technical and scientific support to properly apply community legislation relating to maritime safety, and would also monitor implementation of that legislation and assess its effectiveness [7].

EMSA was established in 2002 under Regional (EC) No. 1406/2002 of the European Parliament and of the European Council [8]. Under Article 1 of that Regulation, EMSAs main purpose was to ensure uniform and effective maritime safety and prevention of pollution from ships operating in EU waters. EMSA would therefore be required to provide objective, reliable, and comparable information and data so that Member States could to take steps to improve both maritime safety and prevent marine pollution, as set out under Article 2.

2.2 The Developing Role of EMSA

In addition to oil pollution arising from shipping accidents, there was increasing recognition of the issue of discharges of wastes and residues to sea through operational activities of ships. It was estimated that around 20% of global discharges of wastes and residues to the sea came from shipping and the EU therefore developed a Directive on Port Reception Facilities for ship generated waste and cargo residues (Directive 2000/59/EC; PRF Directive) [9] to try and reduce such discharges. The Directive, published in 2000 with entry into force in December 2002, required ports across the EU to provide adequate reception facilities so that a lack of facilities in ports could no longer be used as an excuse to discharge oil and other substances into the sea [10]. The Directive also supported the requirement for provision of reception facilities under various Annexes of the MARPOL Convention [11].

An early responsibility of EMSA was to establish appropriate information and monitoring systems to identify ships that did not deliver their waste according to the PRF Directive. This included monitoring operational implementation of the PRF Directive, and EMSA continues to do this as one of its Implementation Tasks relating to the marine environment [12].

EMSA has a number of other general Implementation Tasks. These include the investigation of accidents in the marine transport sector as laid out in Directive 2009/19/EC of June 2011, which contains fundamental principles governing those

investigations [13]. Paragraph 22 of that Directive identifies that EMSA had the specific task of facilitating cooperation between Member States and the Commission in the development of a common methodology of maritime accident investigation [13].

The types of accidents investigated under the implementation task include capsizing and listing, collisions, fire or explosions, grounding/stranding, and hull failure, for example [14]. Data on maritime casualties and incidents is stored in the European Marine Casualty Information Platform (EMCIP). Between 2011 and 2014, there were 9,180 occurrences reported to the EMCIP, of which two third directly involved damage to a ship and one third were related to accidents to persons on board [14, p. 8]. 251 cases of pollution were reported of which 216 affecting the sea. 165 cases of sea pollution involved the release of the ship's bunkers and other pollutants (e.g. residues, lubricating, or hydraulic oils [14, p. 57].

Implementation Tasks of EMSA relating specifically to the marine environment include: sustainable shipping; air pollution (SOx and NOx; including emission abatement methods); Ballast Water; Greenhouse Gases; and Ship Recycling, for example. In the area of the environment, it has been identified that the European Commission, Member States, and EU maritime industry have to work together towards a long-term objective of 'zero-waste, zero-emission' to meet European environmental and transport policy and EMSA supports the work of the Commission in that respect [15].

EMSA also has a range of Operational Tasks and these are discussed in Sects. 3 and 4 of this chapter.

3 EMSA Operational Tasks

The Operational Tasks[1] fall under the headings of Vessel Reporting Services, Earth Observation Services, Integrated Maritime Services, and Pollution Response Services. Vessel reporting, for example, makes use of Automatic Identification System (AIS) tracking to collect data on ships travelling in European waters under the EMSA *SafeSeaNet* (SSN) maritime data exchange system [16]. SSN provides information on ship type, course, speed, destination, and any hazardous cargo on board, with that information available to all EU Member States, Norway, and Iceland (see Fig. 1). Outside European waters AIS data is also used to track vessels through the EMSA Long-Range Identification and Tracking System (LRIT).

Under the Integrated Maritime Services heading, for example, EMSA conducts a range of activities including traffic monitoring, search and rescue, fisheries monitoring, and pollution monitoring, for example, [17] and for the latter it uses data collected via satellite monitoring under *CleanSeaNet* (CSN), one of its Earth

[1] For further information on all of the Operational Tasks of EMSA, see: http://emsa.europa.eu/operations.html.

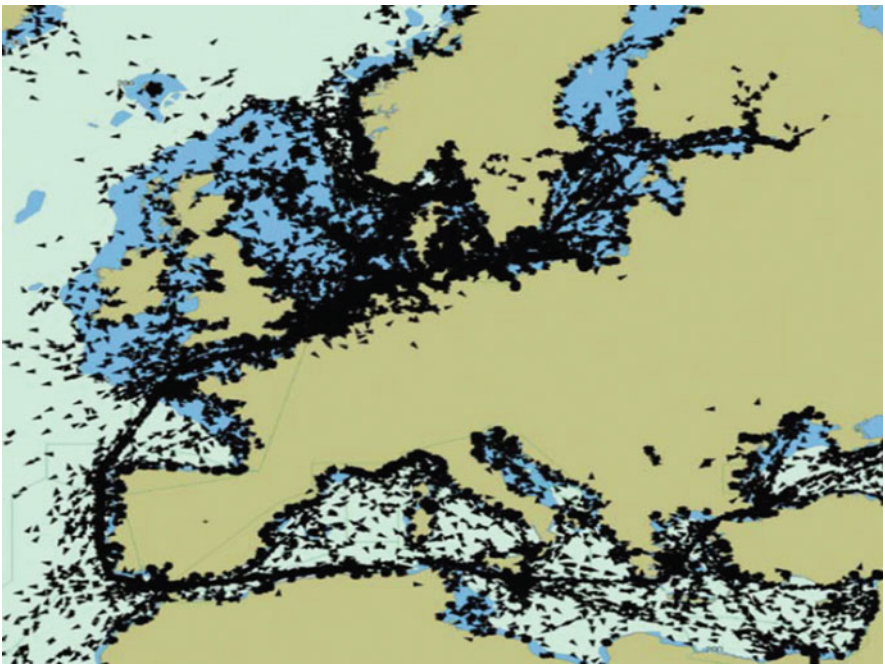

Fig. 1 SSN vessel tracking screenshot from 2011. *Source*: Adapted from [16]

Observation Services which is discussed in Sect. 4. This section focuses on EMSAs Pollution Response Services.

3.1 Pollution Response Service

The EMSA Pollution Response Service provides operational assistance and information to Member States under five main service pillars [18]. The first two pillars, a network of Stand-by Oil Spill Response Vessels located along the European coastline and the CSN satellite-based oil spill and vessel detection monitoring service, are discussed in Sects. 3.2 and 4.2, respectively. The remaining three pillars are: the Marine-Intervention in Chemical Emergencies (MAR-ICE) Information Service which relates to chemical spills at sea; cooperation and coordination with the EU Commission, EU Member States, EFTA/EEA Coastal Countries, Candidate Countries, Acceding Countries, Regional Agreements, and other relevant international organizations such as the International Maritime Organization (IMO); and the provision of information through publications and workshops [18].

Originally the EMSA pollution response service used CSN information to assist in responding to ship-source pollution (both oil pollution and hazardous and noxious substances). Since March 2013, however, EMSA has also had a mandate

to respond to marine pollution from oil and gas installations [19]. In response to that requirement, EMSA drafted an Action Plan to establish a framework for its pollution response activities relating to oil and gas installations and, following consultation with relevant stakeholders, the 'Action Plan for Response to Marine Pollution from Oil and Gas Installations' was approved by the EMSA Administrative Board in November 2013 [20, p. 39]. Specific measures were identified to adapt the existing network of Stand-by Oil Spill Response Vessels (OSRVs), to develop monitoring and evaluation tools (including adaptation of CSN), and also measures relating to the use of oil dispersants and provision of specialized equipment [20, p. 39].

3.2 Stand-by Oil Spill Response Vessels in the Mediterranean

Under the first pillar of its Pollution Response Service, EMSA provides Member States with access to a network of Stand-by OSRVs located around the EU's coasts and seas (see Fig. 2).[2] In January 2015 there were 18 OSRVs of which 8 were based in the Mediterranean region [21].

These vessels are commercially operated and can be rapidly converted to oil pollution response activities. In the Mediterranean they range from an offshore supply vessel with a tank capacity of 950 m^3 to an oil tanker with a tank capacity of 7,458 m^3. They have a wide variety of oil spill response equipment on board, including sweeping arms, booms, skimmers, and oil detection equipment. Two vessels are located in the eastern Mediterranean (one of which is based out of Algeciras and one out of Genoa – see Fig. 2), two in the central region (based out of Malta), three in the western region (two out of Piraeus and one out of Limassol), and one in the Adriatic (out of Trieste) [21]. A summary of technical specifications for vessels located in the Mediterranean is provided in Table 1.

In the event of an oil spill, requests for vessels and equipment are channeled through the Emergency Response Coordination Centre (ERCC), with EMSA then providing pollution response resources, as necessary. Those cost of those resources, the network of OSRVs and associated equipment, are covered by EMSA and funded by taxpayer contributions from EU and coastal EFTA states. In 2010, for example, the total expenditure for pollution preparedness and response activities relating to Stand-by OSRVs in the Mediterranean East, Aegean Sea, Atlantic Coast, and Mediterranean West regions (Contract 2010) was over €3,164,000 [20, p. 60]. While Member States as the main beneficiaries of these vessels, they can be made

[2] For further information on the Network of Stand-by Oil Spill Response Vessels and Equipment (Handbook 2014), which includes information sheets on individual vessels and specifications for available equipment, see: http://www.emsa.europa.eu/oil-recovery-vessels/opr-documents/opr-inventories/item/1439-network-of-stand-by-oil-spill-response-vessels-and-equipment-handbook-2014.html (Last updated 20.10.2014).

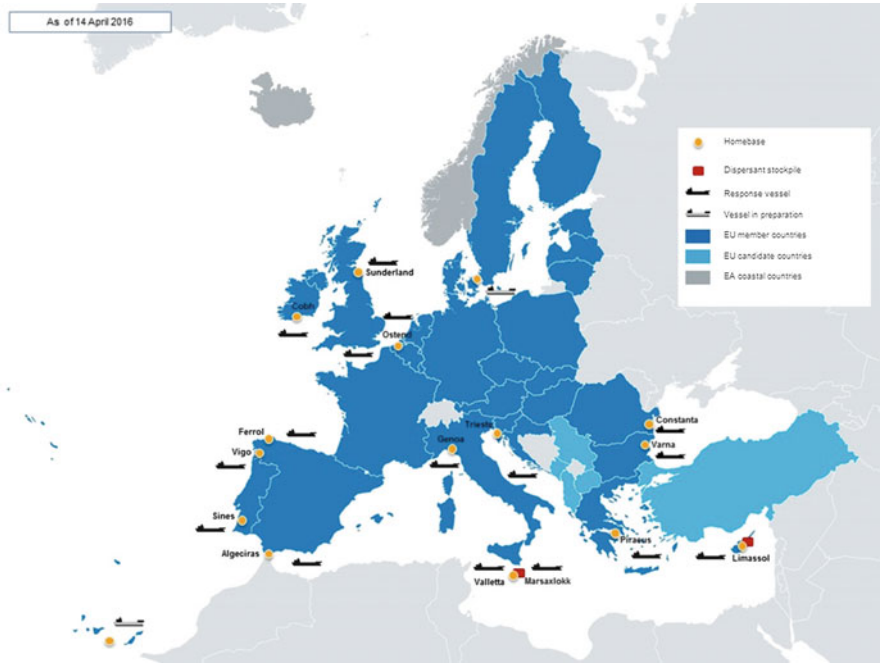

Fig. 2 Locations of EMSA oil spill response vessels and equipment as of April 2016. *Source*: Adapted from [18]. See http://www.emsa.europa.eu/operations/pollution-response-services.html

available to third parties if considered necessary, and all vessels are available to respond to spills anywhere in European waters [22].

In relation to technical cooperation on pollution preparedness and response, EMSA works with international bodies such as the International Maritime Organization (IMO) and is part of the European Commission delegation to the IMO Marine Environment Protection Committee on Oil Pollution Preparedness, Response and Cooperation – Hazardous and Noxious Substances (MEPC OPRC/HNS) [23]. It also works with regional bodies including the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC) and with the Barcelona Convention, the regional agreement for the Mediterranean Sea [23].

3.3 Pollution Preparedness and Response Exercises in the Mediterranean

A further element of the EMSA Pollution Response Service is the conducting of drills and training exercises for Stand-by OSRVs and their crew. For example,

Table 1 EMSA stand-by oil spill response vessels – technical specifications (at 2015) [21]

Name	Area of operations and equipment depot	Tank capacity (m^3)	Flash point	Oil spill response equipment
Monte Anaga	Mediterranean West Algeciras/Spain	4,096	>60°C	2 × 12 m RSA; 2 × 250 m SPIB; W/BHM; Brush Skimmer; OSDS
Brezzamare	Mediterranean West Genoa/Italy	3,288	<60°C	2 × 12 m RSA; 2 × 250 m SPIB; Weir/Brush/Disc Skimmer; OSDS
Balluta Bay	Mediterranean Central Valletta/Malta	2,800	<60°C	2 × 12 m RSA; 1 × 300 m SPIB; Weir Skimmer; OSDS; DSS
Santa Maria	Mediterranean Central Marsaxlokk/Malta	2,421	<60°C	2 × 15 m RSA; 2 × 250 m Heavy Duty Boom; W/BHM; Weir Skimmer; OSDS
Marisa N	Adriatic Sea Trieste/Italy	1,562	<60°C	2 × 12 m RSA; 2 × 250 m SPIB; W/BHM; Brush Skimmer; OSDS
Aktea OSRV	Mediterranean East Piraeus/Greece	3,000	<60°C	2 × 15 m RSA; 2 × 250 m SPIB; W/BHM; Weir Skimmer; OSDS
Aegis 1 (backup vessel)	Mediterranean East Piraeus/Greece	950	>60°C	2 × 250 m Heavy Duty Boom; Weir/Brush Skimmer
Alexandria	Mediterranean East Limassol/Cyprus	7,458	<60°C	2 × 15 m RSA; 2 × 250 m Heavy Duty SPIB; W/BHM; OSDS; DSS

RSA rigid sweeping arm, *SPIB* single point inflation boom, *W/BHM* weir/brush high-capacity multiskimmer, *OSDS* oil slick detection system, *DSS* dispersant spraying system
Note: All vessels are oil tankers except the *Aegis 1* which is an offshore supply vessel
Source: EMSA – http://www.emsa.europa.eu/oil-recovery-vessels/vessel-technical-specifications.html

acceptance drills take place when a vessel is newly contracted, as was the case of the *Alexandria* which was newly contracted in 2011 and for the *Balluta Bay* and its backup vessel, *Aegis 1* which replaced the *Mistra Bay* and *Aktea OSRV* in the same year [24, p. 13]. Similarly, the *Brezzamare* was newly contracted in 2013 while the *Santa Maria* was re-contracted in the same year [20, p. 16]. In addition to these drills, a series of at-sea operational exercises take place annually and the exercises for 2011 to 2013 are outlined in Table 2 [20, pp. 24–25].

RAMOGEPOL 2013 [20, pp. 30–31] was the largest at-sea training exercise in the Mediterranean between 2011 and 2013, and was the only exercise with participation by multiple countries. The exercise took place in Ajaccio and was organized by the Préfecture Maritime de la Médirerranée. The main goals of the exercise included training staff at the French and Italian Maritime headquarters, verifying and improving national procedures, and improving international cooperation between RAMOGE (an agreement between France, Italy, and Monaco), REMPEC, and EMSA. Under a scenario of a ship collision, with one ship adrift with main

Table 2 At-sea operational exercises in the Mediterranean, 2011 to 2013

Exercise name	Date, location	Participating parties	EMSA vessels
MALTEX 2011	14/09/2011 La Valetta, Malta	Malta, EMSA	*Balluta Bay*
NIRIIS 2011	06.10.2011 Limassol, Cyprus	Cyprus, EMSA	*Alexandria*
NIREAS 2012	06/07/2012 Athens, France	Greece, EMSA	*Aktea OSRV Aegis 1*
MALTEX 2012	14/09/2012 La Valetta, Malta	Malta, EMSA	*Santa Maria Balluta Bay*
NIRIIS 2012	14/09/2012 Limassol, Cyprus	Cyprus, EMSA	*Aktea OSRV Alexandria*
MALTEX 2013	18/09/2013	Malta, EMSA	*Balluta Bay*
RAMOGEPOL 2013	10/10/2013 Corsica, France	France, Italy, Monaco, Spain, EMSA	Monte Anaga

engine and steering gear failure, air and sea assets were mobilized to localize and monitor fuel slicks, while the Stand-by OSRV *Monte Anaga* undertook simulates oil recovery operations. The exercise, which took place in adverse weather conditions, tested the performance of both the *Monte Anaga* and the equipment on board [20, p. 31].

Such exercises, funded through annual vessel contacts between EMSA and commercial operators, provide a valuable tool in maintaining an appropriate level of readiness to deal with a pollution incident at sea. This supports the first pillar of the EMSA Pollution Response Service, an Operational Task of EMSA, which was discussed at Sect. 3.1.

4 EMSA Earth Observation Services

Another Operational Task of EMSA is its Earth Observation Service, which comprises of two elements:

1. Earth Observation for Integrated Maritime Services which includes vessel detection and target activity detection in support of EU maritime border control activities undertaken by FRONTEX, the agency which coordinates and develops European border management, including its maritime borders [25] and anti-piracy activities undertaken by EU Naval Forces (EU NAVFOR) outside of European waters [26]; and

2. *CleanSeaNet,* the European satellite-based oil spill and detection service, which is discussed in more detail in Sect. 4.1.

4.1 CleanSeaNet Service

CSN is the second element of the Earth Observation Service [27]. CSN is a European satellite-based oil spill and vessel detection service which assists participating States in: identifying and tracing oil pollution on the sea surface; monitoring accidental pollution during emergencies; and contributing to the identification of polluters. These tasks are requirements of Article 10 of the 2005 EU Directive on ship-source pollution [28].

A number of satellites including the European Space Agency's ENVISAT and the Canadian Space Agency's RADARSAT's 1 and 2, with their on-board sensors, have provided wide-area surveillance across over 1,000 million km^2 of the EU's maritime area. Satellite imagery has been used to identify potential oil spills at sea, approximately 2,000 satellite images being analysed through the CSN service each year. Once a potential oil spill has been detected, an alert is sent to the country in whose waters it is located.

Between 16 April 2007 and 31 January 2011 the EMSA CSN First Generation service was based on 3 polar orbiting SAR (synthetic aperture radar) satellites (ENVISAT and RADARSAT's 1 and 2) [3]. More recently, images from other satellites (COSMO-SkyMed, for example) have also been used (see Sect. 5.1). 8,866 possible spills were detected between April 2007 and January 2011 with 2,828 possible spills being checked on site and 50% of those checks taking place within 3 h of satellite acquisition. Of the 745 confirmed spills, 80% were mineral oil and 20% were other substances [3]. In 2011 there were 72 authorized users of the CSN service in the 24 coastal states of Europe which included Croatia, Cyprus, France, Greece, Italy, Malta, Slovenia, and Spain in the Mediterranean [3]. Each country has a designated alert area covering its national waters. If a spill is detected on a satellite image the relevant country is alerted and the analysed images are made available to national contact points within 30 min of the satellite passing overhead [3, p. 4].

4.2 CleanSeaNet in the Mediterranean

The western-most limit of the Mediterranean is at 5°50′W while the eastern-most limit is at 36°13′E. Fig. 3 illustrates the CSN satellite coverage for that area with green squares representing satellite detections. Yellow squares are detections checked using aerial surveillance, for example, and red squares are confirmed detections. Only two countries, France and Spain, undertook verification by aircraft less 3 h after detection of a potential oil spill, with one such verification also for

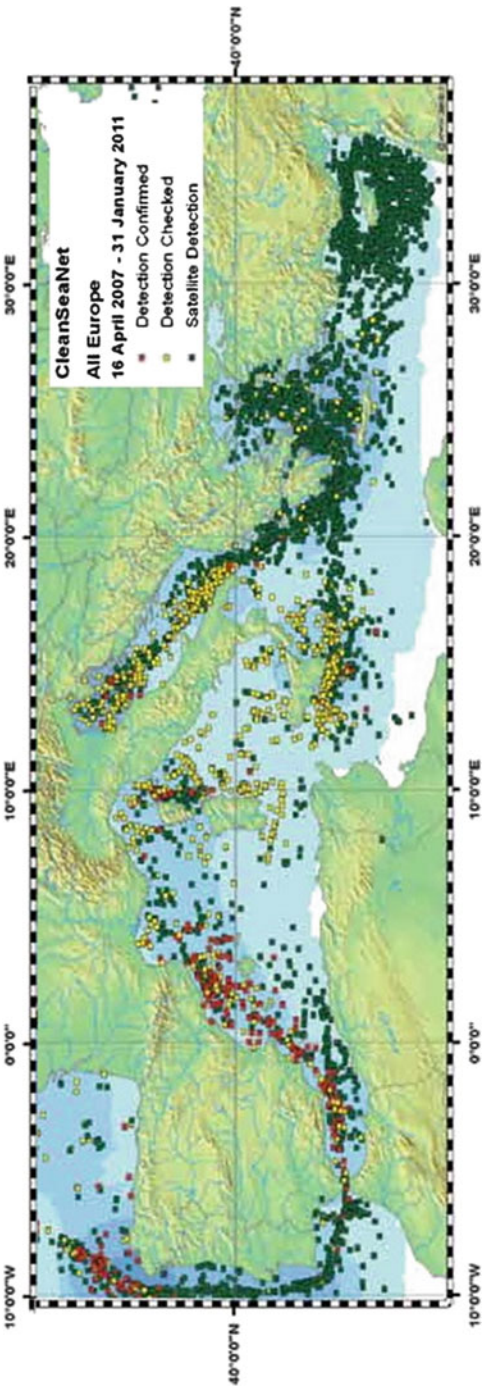

Fig. 3 Sea area coverage of EMSA CleanSeaNet for EU countries bordering the Mediterranean Sea. This figure has been adapted to show the area bordered by Mediterranean Sea states. *Source*: Adapted from [3, p. 8]

Malta. For other countries the confirmed detections (red squared) took place outside that limit.

As can be seen in Fig. 3, the highest proportion of confirmed detections (red squares) is in the western Mediterranean, from the Strait of Gibraltar and around the coasts of Spain and France. The highest concentration of satellite detections which have not been checked (green squares) is in the eastern Mediterranean, around the coasts of Greece and in the Aegean Sea, and also around Cyprus (particularly south of that island).

The highest concentrations of checked detections (yellow squares) are in the Adriatic, around southern Italy and Sicily, and also in the central Mediterranean. In these areas there are very few confirmed detections. A more detailed examination of data by country is presented in Sect. 5.2.

Figure 3 also illustrates that satellite imagery extends into the waters of southern Turkey, Syria, Lebanon, and Israel, with all areas showing high levels of satellite detections. However, for those countries, no information is available on the numbers of detections checked or confirmed.

Table 3 identifies the number of satellite images acquired via CSN annually [3] in each country's alert area. In the case of France and Spain, data on image acquisition covers both the Mediterranean and Atlantic alert areas. In the case of Spain CSN data also includes the area around the Canary Islands in the Atlantic. Slovenia, with a coastline 43 km in length and a single port (Koper), is not included in Table 3 or the subsequent analysis as, from a total of 203 image acquisitions (some of which may have been requested by Italy or Croatia), there were no satellite detections in the Slovenian alert area from the CSN data [3, p. 27].

In terms of total acquisitions, the figures for 2008–2010, the years where 12 months of data is available, show some variability within each country. For example, Cyprus, Greece, and Italy all received around one third less image acquisitions in 2009 compared to 2008, with some increases for Greece and Italy in 2010. For all 7 countries there was a drop in the number of image acquisitions of 31% between 2008 and 2009, before the numbers recovered towards 2008 levels in

Table 3 Annual number of image acquisitions for Mediterranean EU Member States, 16 April 2007 to 31 January 2011

Year / Country	2007	2008	2009	2010	2011	Totals by country: 16.04.07 to 31.01.11
Croatia	3	79	90	102	8	282
Cyprus	77	97	33	24	0	231
France	245	436	371	454	30	1,536
Greece	136	271	191	200	17	815
Italy	58	298	200	249	22	827
Malta	13	73	75	63	4	228
Spain	151	304	332	378	25	1,190
Total acquisitions	683	1,558	1,292	1,471	122	

2010. One problem drawing any clear conclusions here is, however, the lack of specific geographical information on image acquisitions for France and Spain.

Regarding country-specific information, it should also be noted that images ordered by one country may partially cover the alert area of a country bordering it; for example, between Spain and France. An image may therefore be included in the total for a country that did not request it. There is, as a result, the potential for some cross-coverage of image acquisitions presented in Table 3.

France, closely followed by Spain, had the highest number of image acquisitions in all years and for the total period covered by CSN First Generation data [3]. As noted above, however, this is in part explained by those figures also including their Atlantic alert areas. Greece had the third highest number of acquisitions in 2007, but in subsequent years Italy had the third highest number with that data covering both its Mediterranean and Adriatic alert areas. Malta had the lowest number for the first full year of data, 2008, while Cyprus had the lowest in 2009 and 2010, with less than half the number of acquisitions for Malta.

4.3 Satellite Imagery and CSN Post-2011

Only limited information is available on the operational use of CSN for the period since February 2011. No more recent country-specific or region-specific data has been generated by EMSA post the CSN First Generation Report [3].

While the EMSA Pollution Preparedness and Response Reports for covering the years 2011–2013 [19, 23, 24] do make some brief mention of satellite image acquisition, all data is provided for the whole of the EU. For example, 1,641 images were ordered from ENVISAT with 1,456 being delivered between 1 February and 31 December 2011 [23, p. 26]. For RADARSAT-1 the figures were 175 ordered and 129 delivered and for RADARSAT-2 there were 589 images ordered and 524 delivered. Between February and December 2011 there were 2,143 delivered images showing 2,048 possible oil spills detected. 749 of those spills were identified as Class A – most probably oil (mineral or vegetable/fish oil) and 1,299 were identified as Class B – less probably oil [23, p. 28]. Prior to this spills had not been classified.

Similar information was provided for 2012, the main change being that EMSA signed a contract for delivery of COSMO-SkyMed images in 2012 and 14 images were subsequently ordered and 9 delivered that year [29, p. 24]. COSMO-SkyMed discussed elsewhere in this volume [30] comprises of a constellation of four radar satellites with synthetic aperture radar (SAR) sensors on board which can be used for Earth Observation and has been developed by the Italian Space Agency and Italian Ministries of Research and of Defense [31, p. 4].

In 2013, 245 COSMO-SkyMed images were ordered and 137 were delivered [20, p. 41]. Further developments in the availability of satellite images were anticipated with the launch of the European Space Agency's SAR satellite

Sentinel-1 which was expected to launch in 2014 [20, p. 41]. Sentinel-1A subsequently launched on 3 April 2014 and Sentinel-1B on 25 April 2016 [32].

5 EMSA CSN First Generation Data by Mediterranean EU Member State, 2007–2011

This section examines EMSA CSN First Generation data for the individual Mediterranean Sea EU Member states covering the period 16 April 2007 to 31 January 2011 [3]. Table 4 shows the number of satellite detections by Mediterranean EU Member States for the period 16 April 2007 to 31 January 2011 and the average number of spills per image (figure in brackets).

The average number of detections per image by country, for the period 1 January 2008 to 31 December 2010, for the 3 years for which 12 months data is available, is approximated as follows: Croatia 0.45; Cyprus 2.38; France 0.25; Greece 1.51; Italy 1.03; Malta 0.41; and Spain 0.52. For all countries in those years the average number of detections per image is 0.93 in 2008, 0.69 in 2009, and 0.57 in 2010, suggestive of a reducing trend over time.

As noted previously, however, the data for France and Spain includes acquisitions for their territorial waters in the Atlantic as well as the Mediterranean. From maps provided by country, it is possible to draw some conclusions about the Mediterranean detections and spill confirmations for those countries. The CSN

Table 4 Annual number of satellite detections for Mediterranean EU Member States and average number per image, 16 April 2007 to 31 January 2011

Year / Country	2007	2008	2009	2010	2011	Totals by country: 16.04.07 to 31.01.11
Croatia	0 *(0.00)*	42 *(0.53)*	36 *(0.40)*	44 *(0.43)*	0	123
Cyprus	139 *(1.81)*	243 *(2.51)*	67 *(2.03)*	56 *(2.33)*	0	505
France	62 *(0.25)*	131 *(0.30)*	92 *(0.25)*	86 *(0.19)*	1	372
Greece	290 *(2.13)*	425 *(1.57)*	303 *(1.59)*	270 *(1.35)*	16	1,304
Italy	25 *(0.43)*	374 *(1.26)*	180 *(0.90)*	218 *(0.88)*	16	813
Malta	0 *(0.00)*	33 *(0.45)*	30 *(0.40)*	23 *(0.37)*	1	87
Spain	135 *(0.89)*	204 *(0.67)*	184 *(0.55)*	136 *(0.34)*	6	659
Total observations	651	1,452	892	833	40	

Note: As the figures for 2011 are for 1 month only, no average number of detections per image is provided. There is also no average number provided for the Totals by country

results by EU Member State in the Mediterranean are presented below, from Cyprus in the east to Spain in the west.

5.1 Cyprus

Cyprus [3, pp. 18–19] had one of the lowest numbers for image acquisitions, but had the greatest number of detections per image with an average of 2.51 detections per image in 2008, according to Tables 3 and 4. In all years apart from 2007, when Greece had a higher average than Cyprus, the data suggests that there is a high incidence of detections in Cypriot waters, from a low of just under 2 per image in 2007 to a high of 2.51 in 2008, and remaining over 2 in 2009 and 2010.

While no verification by aircraft less than 3 h after a satellite pass took place in any of the years for which data was available, monthly data identifies 3 detections checked in July 2007 and 2 in July 2009. This is the lowest level of flights to check detections of any EU Member State being examined in Sect. 5. From the map of the Cypriot alert area all of the checked detections were to the south of the island although detections were observed across the whole alert area, apart from a small area to the north of the island at its western end, and the satellite coverage averaged at approximately 1–2 images per month. There were no confirmed detections at any time.

5.2 Croatia

CSN data for Croatia [3, pp. 16–17] identifies that the number of image acquisitions annually is low and the average number of detections per image is less than 0.5 (1 every 2 images) in most years; there was a high of 0.53 in 2008. There were 123 detections in total of which more than half were checked, all checks outside the 3 h limit. Monthly data indicates that in most months from August 2008 onward verification activities took place for a large number of satellite detections.

To illustrate the type of monthly data available in the CSN report [3], the Croatia map and data identify confirmed spills as follows: June and October 2009 (1 and 2 respectively); 1 in each of February and September 2009 and 2 in November that year; and 1 in March 2010. The map shows that 7 of those spills were in northern waters, of which 4 were close to the border with the Italian alert area, and 1 was confirmed in the south. Along most of the Croatian coastline there are large numbers of islands and the majority of detections were located away from coastal waters. Only in the north of the alert area, which received a monthly average of 2–4 images (4–6 in one area), do detections appear closer in to land. In its southern waters, the average number of satellite images was 1–2 per month.

5.3 Greece

For Greece [3, pp. 30–31] there were 1,304 total detections with no confirmations within the 3 h limit. The highest average number of detections per image was 2.13 in 2007, falling to a low of 1.35 in 2010. Monthly data for Greece indicates that a small number of detections were checked in most months from November 2008 onwards (5 or less per month; outside the time limit) and were generally distributed across the entire Greek alert area.

Greece received an average of 1–2 satellite images per month at the southern-most and western-most borders of its alert area. There were higher concentrations averages of (2–4 or 4–6 images per month) closer to the mainland. The highest concentration (6–8 images per month) was in the area south and east of Athens and north of Crete (southern Aegean and Sea of Crete area).

There were only 2 confirmed spills in Greek waters, 1 in March 2009 and 1 in February 2010. There was 1 confirmed spill off eastern Greece in the Ionian Sea and 1 to the north of Crete. It is not possible to link time and location for these spills on the basis of available data. However, it can be concluded that the number of confirmed spills would be much higher if the number of flights to check detections were increased, since only Cyprus undertook less flights.

5.4 Italy

Data for Italy [3, pp. 34–35] indicates that no detections were confirmed within the 3 h limit for 2008–2010. However, it is apparent from monthly data that the vast majority of the total of 813 satellite detections for the data period were checked, from which just under 30 were confirmed as spills between October 2007 and January 2010. The highest number of confirmations was in July 2008 (5 confirmations from approximately 46 detections that month). 2008 was the only year in which the average number of detections per image was over 1 (1.26 in that year).

Almost all detections to the east of mainland Italy in the Adriatic were checked with confirmed spills in both the north and south Adriatic, areas receiving 2–4 or 4–6 satellite images monthly on average; the central Adriatic is received only 1–2. There were also a number confirmed in the waters south of Sicily, while the area to the south-east of Sicily, with 1–2 images per month and close to the Greek alert area, had the lowest level of checked detections anywhere in the Italian alert area.

To the west of mainland Italy there was one confirmed spill east of Cagliari on Sardinia, several more being clustered to the north-east of Sardinia, all locations with an average of 2–4 satellite images per month. There were also a number of confirmed detections in the area north-east of Corsica and along the border between the Italian and French alert areas. The vast majority of detections west of mainland Italy were checked and only a very small proportion of these was confirmed as a

spill. Of all the EU Member States in the Mediterranean, Italy had the highest rate of detection checks.

5.5 *Malta*

Malta [3, pp. 40–41] had one detection confirmed in its alert area of within 3 h of image acquisition, that detection being in September 2010. In total there were 6 confirmed detections to the south of Malta with a further 10 checked in that area between June 2008 and October 2010. The average number of detections per satellite image was less than 0.45, which was the highest average of any country in 2008.

As discussed previously, images ordered by other countries may partially cover the Maltese alert area and therefore may have been included in the totals for Malta. Many of the satellite detections to the north of Malta are identified on or close to the border with the Italian alert area. In the waters closest to the island an average of 2–4 images were produced each month, while the remainder of its area extending towards Tunisia in the west and bordering the south of the Greek alert area in the east, received 1–2 satellite images per month.

5.6 *France*

The data for France includes detections in both the Atlantic/English Channel and in the Mediterranean [3, pp. 26–27]. The average number of detections per image was less than 0.30 in all years with only 372 detections from a total of 1,536 image acquisitions between April 2007 and the end of January 2011. In 2008 there were 131 detections of which 11 were checked and 8 were confirmed as spills. However it is not identified how quickly those checks took place.

Between 2009 and 2011, a number of detections were checked and verified by aircraft less than 3 h after image acquisition; of these 53% were confirmed as a spill. Of the 92 detections in 2009, for example, 7 were checked of which 4 were confirmed. In 2010 there were 86 detections, 9 checks, and 4 confirmations; in January 2011 there was 1 detection which was checked and confirmed as a spill. The area of French waters with the highest level of satellite images per month was around the coast of Brittany and into the English Channel, with as many as 10–12 images per month in the Channel area. The majority of the Bay of Biscay received 2–4 images per month, the same level as the French Mediterranean alert area.

Focusing on the Mediterranean [3, p. 26], satellite detections were generally distributed across the whole area. There was a fairly concentrated cluster of spills to the east of Corsica and, although the intensity of squares to the east of Corsica makes the map difficult to interpret, there were approximately 5 checked and 5 confirmed detections to the east of Corsica, all close to the border with the Italian

alert area. Additionally, there was 1 confirmed detection to the north-west of Corsica and 2 further checked detections.

Around the southern French port of Marseilles there was 1 checked and 1 confirmed detection east of the city, 3 checked south of the city, and approximately 10 checked and 1 confirmed to the west of the city. The remaining checked and confirmed detections in the French alert area were close to the border with the Spanish alert area. In that area there were approximately 6 checked and 5 confirmed detections, with 1 checked and 1 confirmed being very close to the French coastline. As with all the CSN data there is no timeline associated with it, and nor is there any available data on the nature or source of confirmed spills, or the scale of any spill.

5.7 Spain

Spain, across all its alert areas, had the second highest total number of image acquisitions in all years [3, pp. 54–55]. The highest average number of detections per image was 0.89 in 2007, falling to 0.34 in 2010. In 2009, just over 60 of the 184 detections were checked by aircraft in less than 3 h and of these just under 50 were confirmed as spills. In 2010, there were 130 detections, 50 checks and 30 confirmations, while in January 2011 there were 6 detections, 4 checks, and 2 confirmed spills. Over the period 2009 to the end of January 2011, Spain had a confirmation rate of 70%.

Focusing on the Spanish Mediterranean alert area only [3, p. 54] there were large numbers of confirmed detections along the entire southern and eastern coastlines of Spain, an area receiving 2–4 satellite images on average each month. Away from the coastal areas a much smaller proportion of satellite detections were checked and therefore the level of confirmations was also much lower. For example, there was a single confirmed spill to the south of Mallorca in the Balearic Isles, south of which there were only 1–2 satellite images received each month.

Close to the border with the French alert area, and also in Spanish waters north of Barcelona, there were no checked detections or confirmed spills. This is in contrast to France where there were a number of checked and confirmed detections close to the Spain/France border.

6 Conclusions

This chapter has briefly presented an overview of the history and development of the EMSA, the development of its role to support the European Commission and EU Member States particularly in the area of marine environmental protection.

The EMSA *CleanSeaNet* Service, in conjunction with other services such as AIS vessel tracking information provided through *SafeSeaNet*, plays a major role in helping detect oil pollution entering Europe's marine areas the source of that oil, for

example. It also supports EU Member States by providing an emergency response to oil and other spills at sea within 24 h, through a network of Stand-by Oil Spill Response Vessels. Those vessels, together with oil spill equipment on board and stockpiles of equipment located around the EU, can be used to assist in cleaning up accidental oil spills at sea. This has, since March 2013, also included cleaning up spills from oil and gas installations. In the event of an incident taking place in non-EU waters, those vessels may also be made available to third parties and so could potentially be used to support clean-up operations in the southern Mediterranean.

Satellite imagery has been shown to provide an important tool in identifying oil (and other) pollutants on the sea surface. While some satellite monitoring has taken place in the Mediterranean [33–35] there is little information available to draw conclusions about long-term trends in oil pollution, unlike other regions such as the North Sea where more than 30 years of data is available and a clear trend for a reduction levels of oil entering the marine environment has been observed [36, 37].

Very little can be concluded from the CSN images available through EMSA's Earth Observation service for the Mediterranean. For the period 16 April 2007 to 31 January 2011 it is apparent that the intensity of satellite coverage was far higher in northern European waters – English Channel, North Sea, Baltic Sea – than in the Mediterranean [3, p. 8] and that difference is particularly market between northern French waters around Brittany and into the English Channel, compared to the French alert area in the Mediterranean. The majority of the Mediterranean had satellite coverage between 1–2 and 2–4 images per month, while in the English Channel coverage was approximately 10–12 images (possibly as high as 16–20). Some areas of the Baltic Sea received more than 20 images on average each month.

Between 2008 and 2010, the years for which there is a full year's data available, the number of image acquisitions for the 7 EU Member States was quite variable, with Cyprus, Greece, and Italy all receiving around one third less acquisitions in 2009 compared to 2008 (see Table 3). The total number of acquisitions in 2008 and 2009 fell by 31%, from 1,558 to 1,292, before showing an increase to 1,471 in 2010. Since data for France and Spain include their alert areas in the Atlantic and no specific information for their Mediterranean alert areas is not available, this is a limitation of the available data.

During the same period, there was a nearly 40% reduction in the total number of observations for all 7 countries from 1,452 in 2008 to 892 in 2009, with a small additional fall in 2010 when there were 833 observations (see Table 4). As a result of a lack of geographical information for Spain and France, and the non-availability of CSN data since February 2011, it is not possible to draw any conclusions on trends in oil inputs using EMSA data.

What can be concluded, however, is that the low levels of satellite images received across the region, combined with the lack of aircraft verification of acquired images in the eastern Mediterranean, means that the number of spills is likely to be much higher than the data suggests. It is also likely to remain high unless increased satellite monitoring occurs and ships are more likely to be caught illegally discharging oil in the region, and prosecuted for doing so.

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