European Maritime Safety Agency

EMSA's Integrated Maritime Services: Improving Operational Maritime Awareness at EU level

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Abstract

Getting a comprehensive overview of activity at sea is a challenge for most countries. To implement maritime policies effectively, governments and authorities need detailed, reliable knowledge about what happens at sea, in real time. The European Maritime Safety Agency (EMSA) has the ability to tailor maritime information according to unique operational requirements. Precise services can be provided responding directly to the specific needs of diverse maritime users across Europe. EMSA's Integrated Maritime Services (IMS) are offered based on advanced maritime data processing, combining information from all of the agency's maritime applications as well as other external sources. EMSA's expertise and availability in the processing and use of remote sensing Earth Observation products is a key element to the successful provision of these services, specifically in the case of CleanSeaNet the EU oil spill and vessel detection monitoring service.

1. Introduction

Recognising the benefits of exchanging information between different government entities and ensuring more effective integration of maritime information is a key element within the European Commission's (EC) Integrated Maritime Policy. EMSA is uniquely positioned to help the European Member States, EU bodies and organisations, and the EC achieve this aim.

EMSA operates and manages a suite of systems which receive, process, and distribute information on vessel traffic reports (LRIT, SafeSeaNet), satellite monitoring (CleanSeaNet), and Port State Control (Thetis). The services produced by these systems are shared with Member States and the Commission, to supplement and enhance national capacity for vessel traffic monitoring, Port State Control, and maritime pollution preparedness and response. EMSA has developed a platform to ensure the performance, availability and reliability of all the maritime information systems it hosts. This platform can also integrate and combine different types of data, including data provided by the end user, to produce customised services tailored to user requirements. These services are used by European authorities to obtain a clearer picture of a broad range of activities in the maritime domain, building a common picture across EU maritime interests. Enabling governmental and institutional organisations to make use of EMSA's systems avoids duplication of effort, overlapping infrastructures and unnecessary expenditure

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Services are offered directly to EU Member States and organisations, sparing them the cost and complexity of buying and managing the underlying hardware and software, and hosting separate data integration systems. Users have full operational support, 24 hours a day, 7 days a week, through EMSA's Maritime Support Services (MSS).

2. Integrated Maritime Services

EMSA provides a range of operational services to EU organisations and Member States. These Integrated Maritime Services (IMS) aim to deliver relevant, complete and up-to-date information at the right time. Services are offered to all EU and EFTA Member States in accordance with existing access rights, and provide enhanced features for, among others, environmental monitoring, search and rescue, and traffic monitoring purposes. IMS allow Member States to make full use of the integrated vessel reporting position information, such as: terrestrial and satellite Automatic Identification System (AIS), Long Range Identification & Tracking (LRIT), Vessel Monitoring System (VMS), as well as national vessel position data such as coastal radar, patrol assets, and leisure craft. The service also includes meteorological and oceanographic data, as well as automated behaviour algorithms. These configurable algorithms provide alerts responding to user defined policies. In addition, the service allows users to display, share and exchange additional information.

EMSA's IMS platform facilitates data exchange and distribution, through the promotion and implementation of both standard and semantic services. Information can be shared easily and selectively based on a set of unique capabilities:

- **Types of data**: User tailored services have a unique capacity to process, integrate, correlate and distribute many different types of maritime data and information.
- **Scale and geographical coverage:** Different levels of detail can be shared at different geographical scales. Users can choose to receive a general overview or specific data covering the areas of most interest to them.
- **Data serving different functions:** Integrated maritime services respond to the needs of users from a wide range of different functions: maritime security; maritime safety; fisheries control; law enforcement; and environmental protection. Users can share relevant and function-specific information with others carrying out the same tasks.
- **Data from users:** Users may also provide their own data which can be correlated with other data, then sent back to them, and to those with whom they choose to share it.
- **Access rights management:** Distribution policies are set by the data and information owners, complying with complex landscapes of access rights management.

3. Data Sources

One of the main attributes of EMSA's Integrated Maritime Services is the ability to combine information from a range of different data sources, and as such greatly enrich the maritime domain awareness picture. These include data and operational functionalities directly contracted by EMSA:

- **Automatic Identification System (AIS):** AIS is a maritime broadcast system, based on the transmission of very high frequency radio signals. Ships send reports with ship identification, position, and course, as well as information on cargo. In Europe, the exchange of AIS messages is done through the SafeSeaNet system.
- **Satellite-AIS:** New systems are being developed to enable satellites to receive AIS position messages. This extends the geographical range over which ships can be tracked using the AIS system.
- **Long Range Identification and Tracking (LRIT):** LRIT is a global ship identification and tracking system based on communications satellites. Under IMO regulations, passenger ships, cargo ships (300 gross tonnage and above), and mobile offshore drilling units on international voyages send mandatory position reports once every six hours.
- **Synthetic Aperture Radar (SAR) Satellite Imagery:** Satellite radar sensors measure the roughness of the sea surface independent of weather and sunlight conditions. On the satellite image, oil spills appear as dark areas, and vessels and platforms as bright spots. This is used in vessel detection systems (VDS) as well as pollution monitoring.
- **Optical Satellite Imagery:** Earth observation imagery from satellite sensors operating in the optical spectrum, providing high resolution images of vessels or coastal areas.
- **Additional Ship and Voyage Information:** Member States also exchange a range of additional data through the SafeSeaNet system, including: port notifications (e.g. arrival and departure times), Hazmat notifications (carriage of dangerous and polluting goods), ship notifications (additional information sent in mandatory reporting areas), and incident reports (e.g. pollution reports).
- **Meteorological-Oceanographic Data:** This is under development and will include a range of fields: wind speed and direction, wave height and direction, wave period, etc.

Other data sources from national systems can also be integrated:

- **Vessel Monitoring System (VMS):** VMS uses communications satellites for tracking commercial fishing vessels. Vessels are equipped with on-board transceiver units which transmit messages every two hours.
- **Coastal Radar:** Member State vessel traffic services constantly track vessels movements along their coastline with the aid of local radar.
- **User Specific Data:** EMSA can also process other varied forms of national data provided by users. To date, this has included encrypted position reports from patrolling vessels, position reports from leisure crafts, and additional meteorological-oceanographic data provided by buoys.

4. Oil spill monitoring and vessel detection from space

4.1 Background

In September 2005 the European Parliament and the Council adopted Directive 2005/35/EC (since amended by Directive 2009/123/EC) on ship-source pollution and on the introduction of penalties for pollution offences. The Directive tasks EMSA to "work with the member states in developing technical solutions and providing technical assistance in actions such as tracing discharges by satellite monitoring and surveillance." Following a preparation period, the service, known as CleanSeaNet, became

operational in April 2007. It is available to all EU Member States, EFTA/EEA Contracting Parties as well as Acceding and Candidate Countries territories (hereafter referred to as Coastal States). Territorial waters of coastal Member States, and overseas countries and may also be monitored. CleanSeaNet is now the most comprehensive oil spill monitoring and vessel detection service in Europe,

4.2 How it works

The CleanSeaNet service supplies over 2000 images a year to participating Coastal States. EMSA provides a state-of-the-art oil spill monitoring service, which can be integrated into national oil spill response chains. CleanSeaNet supplements existing surveillance systems at national or regional level, strengthens the responses to illegal discharges, and supports response operations to accidental spills. The service, based on the near real time analysis of Synthetic Aperture Radar (SAR) satellite imagery, is currently made available to 27 Coastal States, including all European Union coastal states, as well as Turkey, Iceland, Norway and Montenegro.

Coastal States define their coverage (i.e. monitoring) requirements, which can also include support to specific operational aerial surveillance activities (e.g. SUPER-CEPCOs), and thereafter EMSA plans and orders satellite imagery accordingly. Satellite data are acquired and processed via a network of outsourced ground stations around Europe. The images are then assessed, together with supporting meteorological, oceanographic and ancillary information (e.g. AIS position data), to identify possible/probable incidences of pollution, to determine the likelihood of the presence of oil on the sea surface and therefore to assist in identifying the source of the pollution.

When a potential spill is detected, an alert is sent to the relevant national authority. These alerts are sent within 30 minutes of the satellite acquiring the image. The national authority then decides how to respond to the alert e.g. a patrol aircraft or vessel may be sent to survey the area and verify the oil spill detection. As time is critical for confirming a possible spill and catching polluters in the act, the shortest possible delay between satellite detection and alert is essential for a rapid response by coastal states.

In addition to the regular monitoring service, the Agency also provides assistance to all EU/EFTA/EEA Member States during emergency situations. This is usually requested by Member States through the Emergency Response Coordination Centre (ERCC), operating within the European Commission's Humanitarian Aid and Civil Protection department (DG ECHO). In relation to CleanSeaNet, such assistance usually takes the form of acquiring additional images and associated services over an area where an incident or accident has occurred. This can support the monitoring of the extent of a spill and its evolution over time (e.g. direction of drift).

SAR imagery, results of oil spill and vessel detection analysis, and relevant auxiliary data (wind and swell detection, vessel traffic information, nautical charts, meteorological, oceanographic information and oil drift models) are made available to Coastal States through the web based and user tailored CleanSeaNet user portal.

While at present the CleanSeaNet service is provided mainly through the Canadian Space Agency's RADARSAT-2 satellite, European Space Agency's (ESA) Sentinel-1 satellite will be integrated later this year and will become the major workhorse of the service.

5. Operational results

In 2014, a total of 2,521 images have been delivered. Within these 2,630 possible oil spills were detected (1,565 Class A spills and 1,065 Class B spills). Given the limitations of radar detection for the identification of spills, it is important to note that CleanSeaNet does not detect “oil spills” but “possible oil spills”. Other substances with a similar effect include, for example, fish or vegetable oil, ice, algae, or other look-alikes will be detected as well. CleanSeaNet detections are therefore separated into the following two classes:

- Class A: the detected spill is most probably oil (mineral or vegetable/fish oil) or a chemical product;
- Class B: the detected spill is possibly oil (mineral/vegetable/fish oil) or a chemical product.

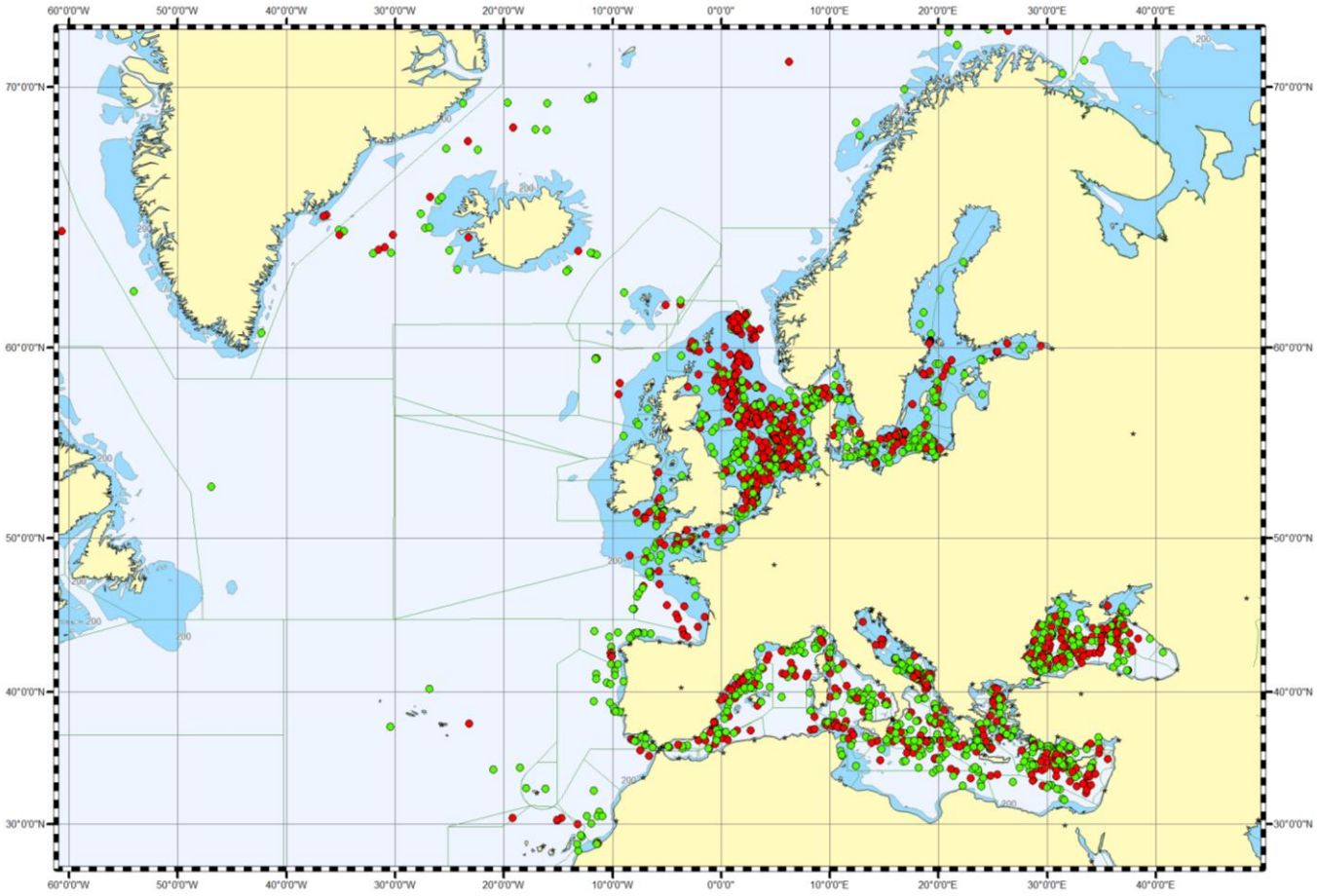


Figure 1: Map of possible spills detected by CleanSeaNet in 2014.

Over the course of the years where CleanSeaNet has been operation, the overall trend has been a reduction in the number of possible spills detected per million km2 (1,000 km x 1,000 km) monitored. The decrease was sharp from 2008 to 2010 and continued steadily between 2010 and 2013. There has

been a slight increase in 2014 as 4.26 possible spills were detected per million km2 (1,000 km x 1,000 km) monitored.

It should be noted that a high number of possible spills are detected in the North Sea (see map above) many of which are from platforms. Regulations regarding discharges from vessels and from ships differ, and while a radar detection of ship-source pollution indicates a breach of law, this is not necessarily the case for discharges from platforms.

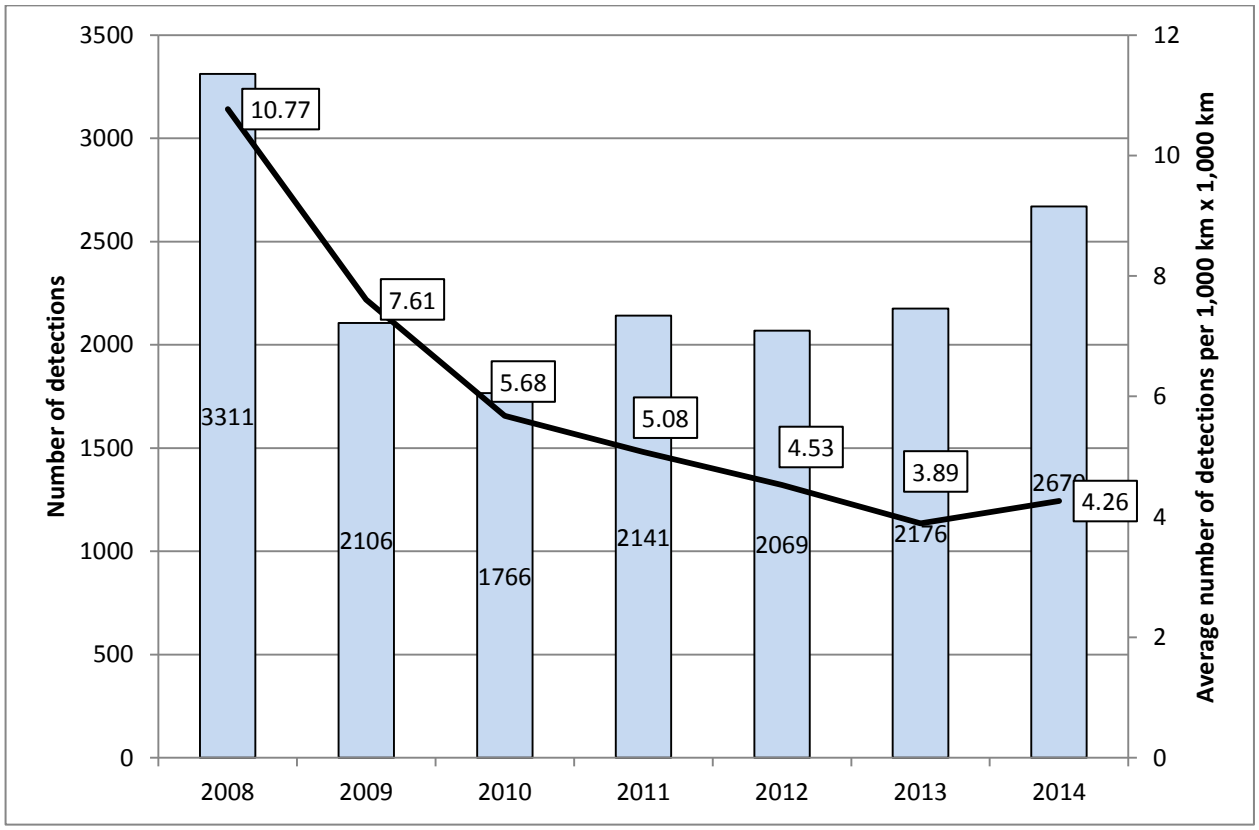


Figure 2: Comparison of Number of Possible CleanSeaNet Detections: 2008-2014

6. Examples

Two recent examples illustrate the contribution of the CleanSeaNet service to the detection and pursuit of ships discharging illegally.

The first touches on the use of CleanSeaNet images as evidence in court. Whilst it should highlighted that it is good practice to always combine satellite imagery with additional supporting information when prosecuting a maritime pollution case, the images themselves may indeed be admitted as primary evidence. On 25 February 2012, EMSA detected a possible pollution on a satellite image of the waters off the coast of Cornwall, UK. By combining the satellite image with AIS vessel position report information from SafeSeaNet, the vessel was identified as the tanker Maersk Kiera, registered to

Singapore Private, Ltd. The vessel was contacted by the UK's Maritime and Coastguard Agency, and initially denied that it was trailing a slick. It then admitted to cleaning the tank and discharging waste (palm oil and tank cleaning solution) but stated that this was outside the 12 nautical mile zone (i.e. more than 12 nautical miles from the shore, where such discharges are legal). Evidence from the satellite image showed that the slick was inside the 12 nautical mile zone, and that the discharge was illegal.

Following the court case, on 4 October 2013 the owner of the vessel was found guilty and fined. According to the investigating officer of the Maritime and Coastguard Agency's enforcement unit, it would not have been possible to lead the prosecution without the satellite evidence.

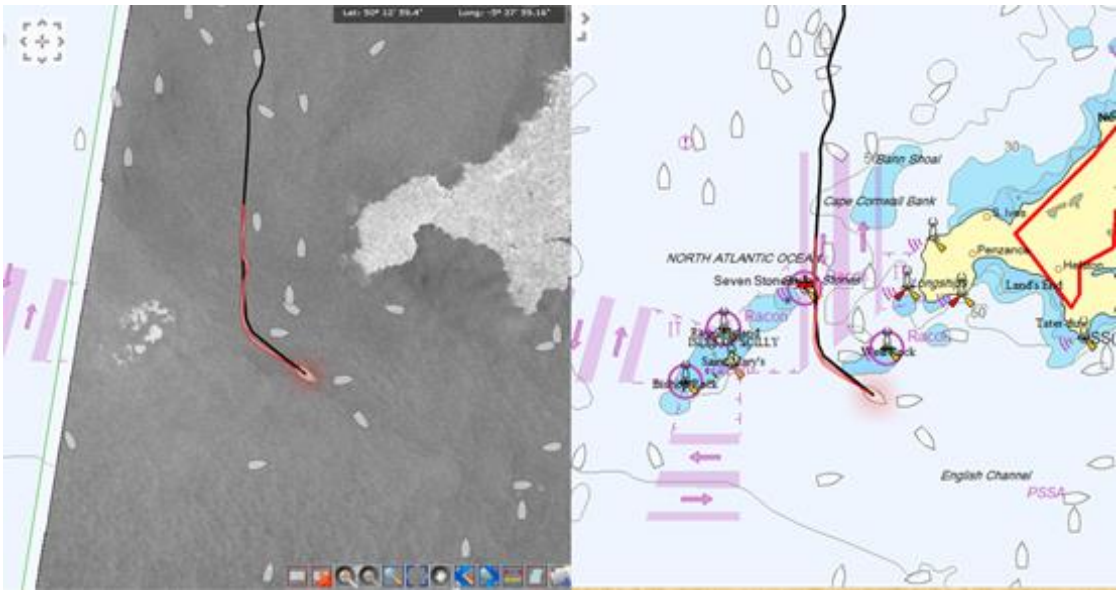
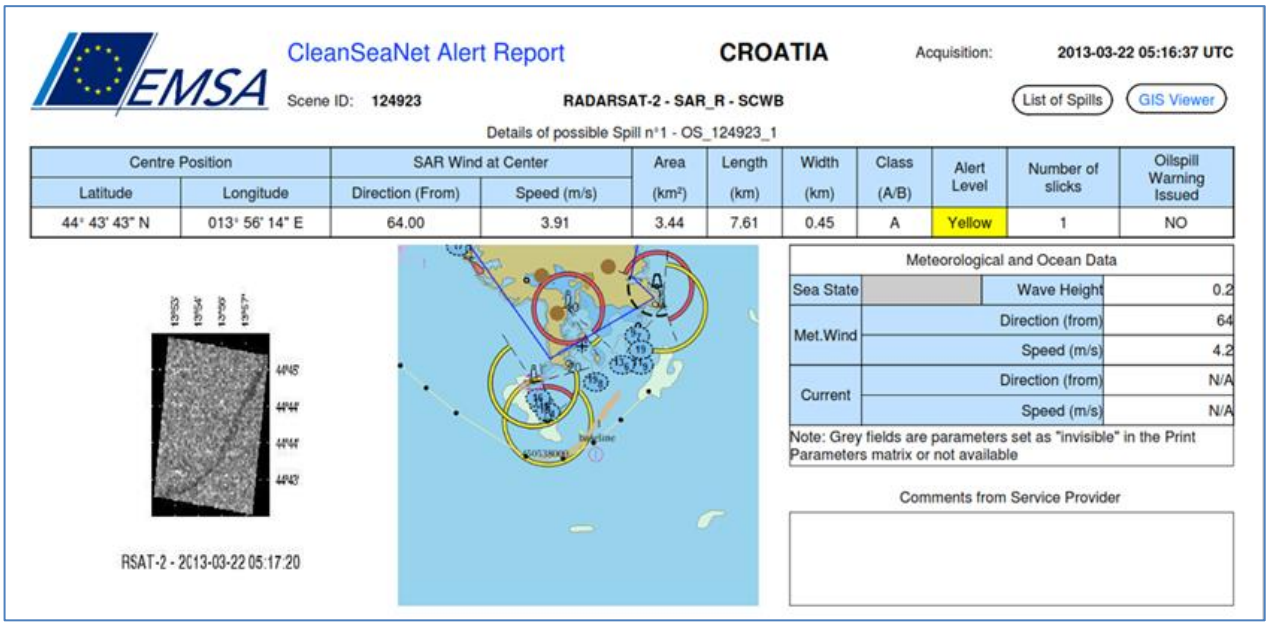


Figure 3: Maersk Kiera trailing a spill.

The second example illustrates the advantages of combining CleanSeaNet satellite imagery with data from other EMSA services. On the 22 March 2013, a possible pollution was detected by CleanSeaNet in Croatian territorial waters. Based on information available in SafeSeaNet, the possible source was identified (MMSI number), and vessel track generated. This information was added to THETIS, the EMSA information system that supports the new Port State Control inspection regime system. This made an inspection in the next port of call (identified in THETIS based on SafeSeaNet information) mandatory. The inspection found evidence that illegal discharge of oily waste had taken place (oil residues in the Oil Water Separator, and oil spots on starboard side hull), and imposed a fine on the vessel.



CleanSeaNet Alert Report — CROATIA — Acquisition: 2013-03-22 05:16:37 UTC

Scene ID: 124923 — RADARSAT-2 - SAR_R - SCWB — List of Spills — GIS Viewer

Details of possible Spill n°1 - OS_124923_1

Centre Position		SAR Wind at Center		Area	Length	Width	Class	Alert Level	Number of slicks	Oilspill Warning Issued
Latitude	Longitude	Direction (From)	Speed (m/s)	(km²)	(km)	(km)	(A/B)			
44° 43' 43" N	013° 56' 14" E	64.00	3.91	3.44	7.61	0.45	A	Yellow	1	NO

RSAT-2 - 2013-03-22 05:17:20

Meteorological and Ocean Data			
Sea State		Wave Height	0.2
Met.Wind		Direction (from)	64
		Speed (m/s)	4.2
Current		Direction (from)	N/A
		Speed (m/s)	N/A

Note: Grey fields are parameters set as "invisible" in the Print Parameters matrix or not available

Comments from Service Provider

Figure 4: CleanSeaNet Alert Report, 22 March 2013, showing spill detected in Croatian waters.

7. Looking forward

As the range and quantity of CleanSeaNet users continues to increase (Mediterranean and Black Sea countries are expected to start utilising the service through the European Neighbourhood Policy Programme), EMSA portfolio of satellites, sensors and services is also growing. The introduction of Sentinel-1 data will provide both a higher volume and better quality of satellite imagery data, and the recent agreements with a number of oil spill backtracking and forecasting model providers, will ensure additional instruments to users for a better analysis and overall management of oil spill incidents at sea.