European Maritime Safety Agency

CleanSeaNet: the EU remote sensing based monitoring service for marine oil spill detection and surveillance in European waters

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Introduction

Europe has a 70,000 km coastline along two oceans and four seas: the Atlantic, the Arctic Ocean, the Baltic Sea, the North Sea, the Mediterranean Sea and the Black Sea. Besides accidental pollution caused by ships in distress, routine operations of ships and offshore platforms are probably the greatest source of marine pollution and the one that poses an insidious long term threat to the marine and coastal environment.

Directive 2005/35/EC on ship sourced pollution, and on the introduction of penalties for infringements, tasks EMSA to work with Member States to develop technical solutions and to provide technical assistance in actions such as tracing discharges by satellite monitoring and surveillance. In line with this, the Agency has set up and provides a European operational system for oil slick detection called CleanSeaNet and based on satellite sourced synthetic aperture radar (SAR) images. The service offered to authorities in all EU and EFTA states is aimed at supporting the response chain of Member States for locating polluters and mitigating the impact of accidental spills.

With CleanSeaNet, the Agency developed the first European wide operational system for marine oil slick surveillance to support improvements in terms of greater consistency, efficiency and effectiveness of pollution monitoring efforts of Member States. This trans-national approach leads to optimisation of satellite image planning decreasing overall costs and greatly improving the cost effectiveness of oil pollution monitoring.

CleanSeaNet became operational on 16 of April 2007. This paper presents:

- the implementation of the CleanSeaNet service,
- its operational use in illegal discharge response chains,
- the service results for 2008,
- the satellite monitoring support provided by EMSA for accidental spills,
- Evolution of the CleanSeaNet service

CleanSeaNet Service Implementation

Satellite surveillance for oil spill monitoring is primarily based on active Synthetic Aperture Radar (SAR) sensors detecting the presence of oil. SAR "illuminates" the ocean surface and processes the back scatter signal. This signal contains information on the level of roughness of the sea surface. The dampening effect of floating oil films enables SAR sensors to detect oil slicks. There are limitations to this process as sea roughness is driven by the local wind speed and direction. Wind speeds below 2-3 m/s mask the dampening effect whereas speeds above 15 m/s also reduce detection capability. Another limiting factor for oil detection comes from the fact that SAR sensors detect all films on the sea surface that damp out the small waves generated by the wind. Other products or even natural phenomena like algae blooms may look like oil on the image. They are called look-alikes. Despite these limitations, satellite SAR imagery has proven to be an effective tool to detect oil spills at sea as it has the capacity to cover large areas day and night and is almost unaffected by cloud cover.

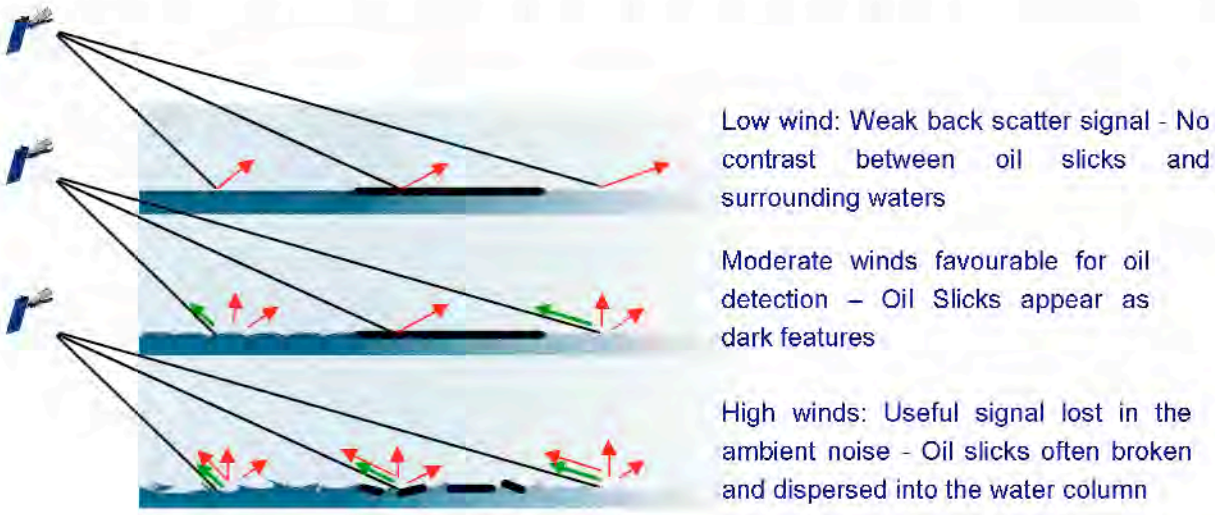


Figure 1: Oil slick detection in satellite SAR images

CleanSeaNet supplies Synthetic Aperture Radar (SAR) analysed images from data provided by the European Space Agency's ENVISAT and Canada Space Agency's RADARSAT satellites. The downloading, processing and analysis of the data has been contracted out to a consortium of European companies (KSAT, Telespazio, Edisoft). Satellite data are acquired via a network of receiving stations in Norway, Italy and in the near future the Azores. They are processed and analysed in near-real-time – less than 30 minutes. Operators assess the images, together with supporting meteorological, oceanographic and ancillary information (AIS, vessel detection) where available, to identify possible pollution events and to assist in identifying the source of the pollution. If a possible spill is detected, the affected Coastal State is alerted without delay.

The shortest delay between detection and alert is essential for a rapid response by the Coastal State and if this is the case, to catch a polluter in the act. It is a CleanSeaNet contractual obligation that SAR images, results of oil spill analysis and ancillary information are made available to Coastal States through a customer tailored web-browser and simultaneously delivered to EMSA in less than 30 minutes after satellite acquisition time.

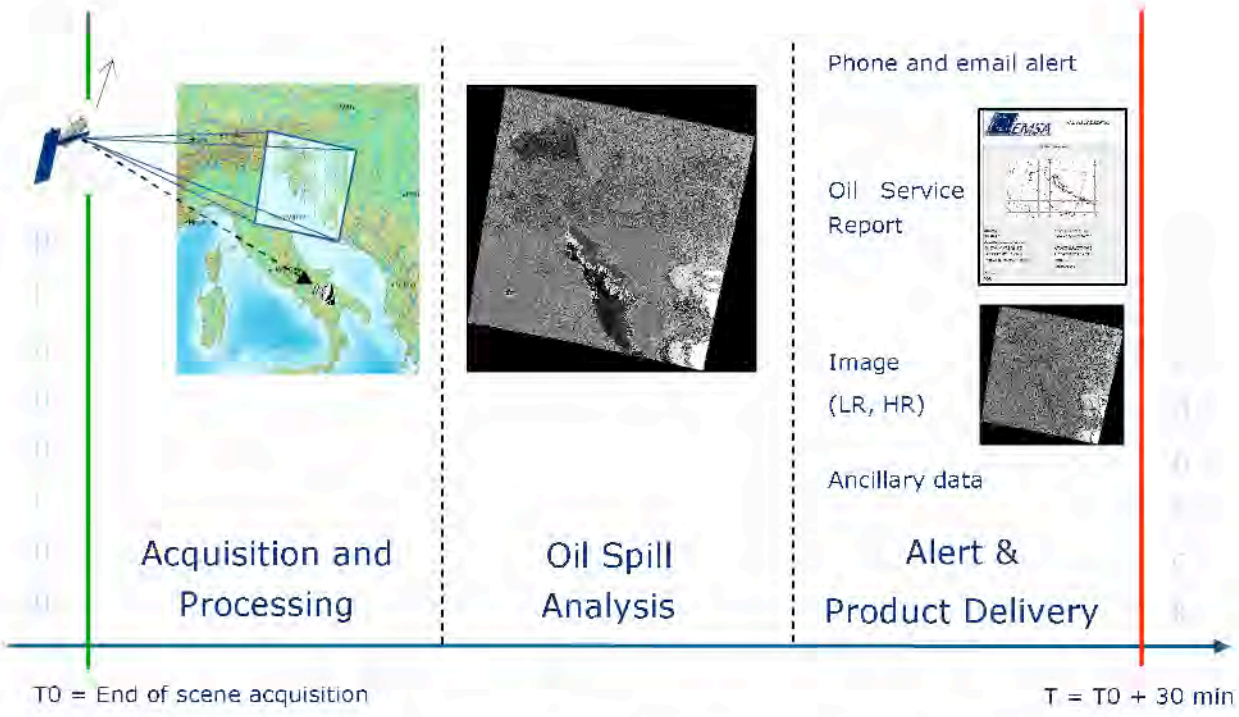


Figure 2: CleanSeaNet – A near real time service

Images are planned and ordered according to European Coastal States coverage requirements.

Since ENVISAT and RADARSAT satellite orbit track spacing varies with latitude (the spacing at 60° latitude is half that at the equator), the density of observations and/or revisit rate is significantly greater at higher latitudes than at the equator. As a result, one satellite can acquire images covering the same location as frequently as once a day in high latitudes but only every five days at the equator. Increasing the number of satellites and/or the swath width helps to mitigate the effects of this constraint inherent to satellite remote sensing. With the entry into operation of RADARSAT 2, CleanSeaNet has now access to three radar satellites. This greatly improves the flexibility of the service to the Member States in support of their illegal discharge response chains as well as the capacity to provide assistance with respect to accidental pollution incidents.

In addition to the implementation of the contracted system, EMSA put in place a number of technical elements. An in-house Oracle database was developed by the Agency to

store all data and information products and associated metadata generated by the service for further analysis and production of statistics. The Agency also provides the CleanSeaNet web portal which serves as an access point for information on the EMSA service and includes the secure log-on function to the CleanSeaNet web browser. The web-browser is hosted by the service provider. The browser is the interface used by the coastal states to access the service and allows the user to see detailed information on all the satellite images planned and already acquired. All data products can be viewed and downloaded from the browser and an interactive map viewer can be used to locate the image on a GIS map and view additional data such as wind, wave and vessel information.

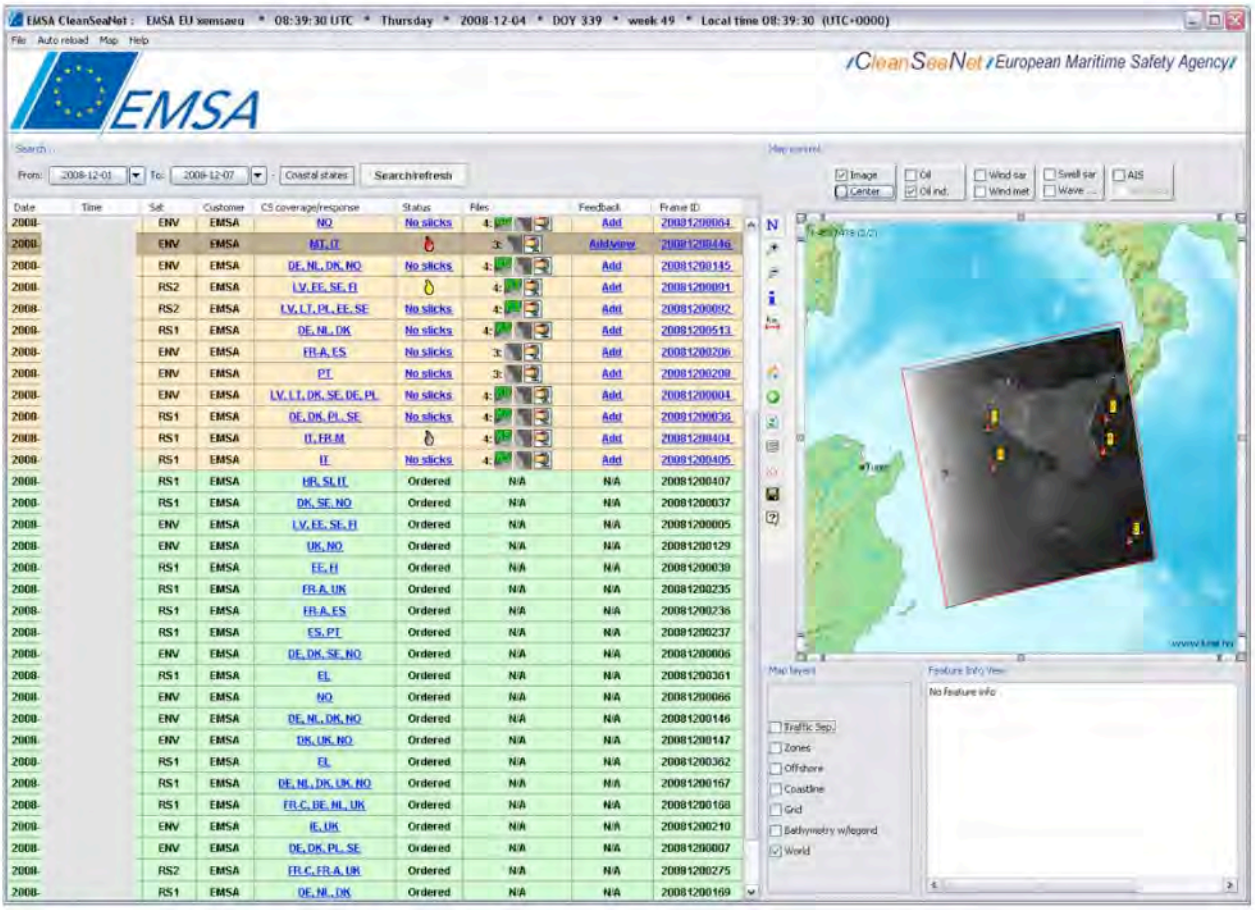


Figure 3: The CleanSeaNet browser

The Operational Use of CleanSeaNet in Illegal Discharge Response Chains

The way CleanSeaNet is implemented in each national operational chain may differ. Some Member States plan aerial or vessel support each time a scene covers their waters, some make a case-by-case evaluation of the need to send resources on site. Planning aerial or vessel support for ordered scenes is part of the national response chain and taken independently from EMSA. It is important to remember that CleanSeaNet detections are not "oil spills" but "possible oil spills". Discrimination

between oil spills and look-alikes require more information and most often on site verification. Therefore the oil pollution monitoring service should not be considered separately but as one element that strengthens national operational response chains. On site verification by the Member States is and remains a key element.

Nevertheless, when a clear and linear potential spill is connected to a vessel and when AIS information or vessel traffic monitoring systems allow a clear identification of the source, there are sufficient grounds to trigger a Port State Control inspection. It is worth noting that some Member States have successfully fined polluters based on evidence collected during such an inspection.

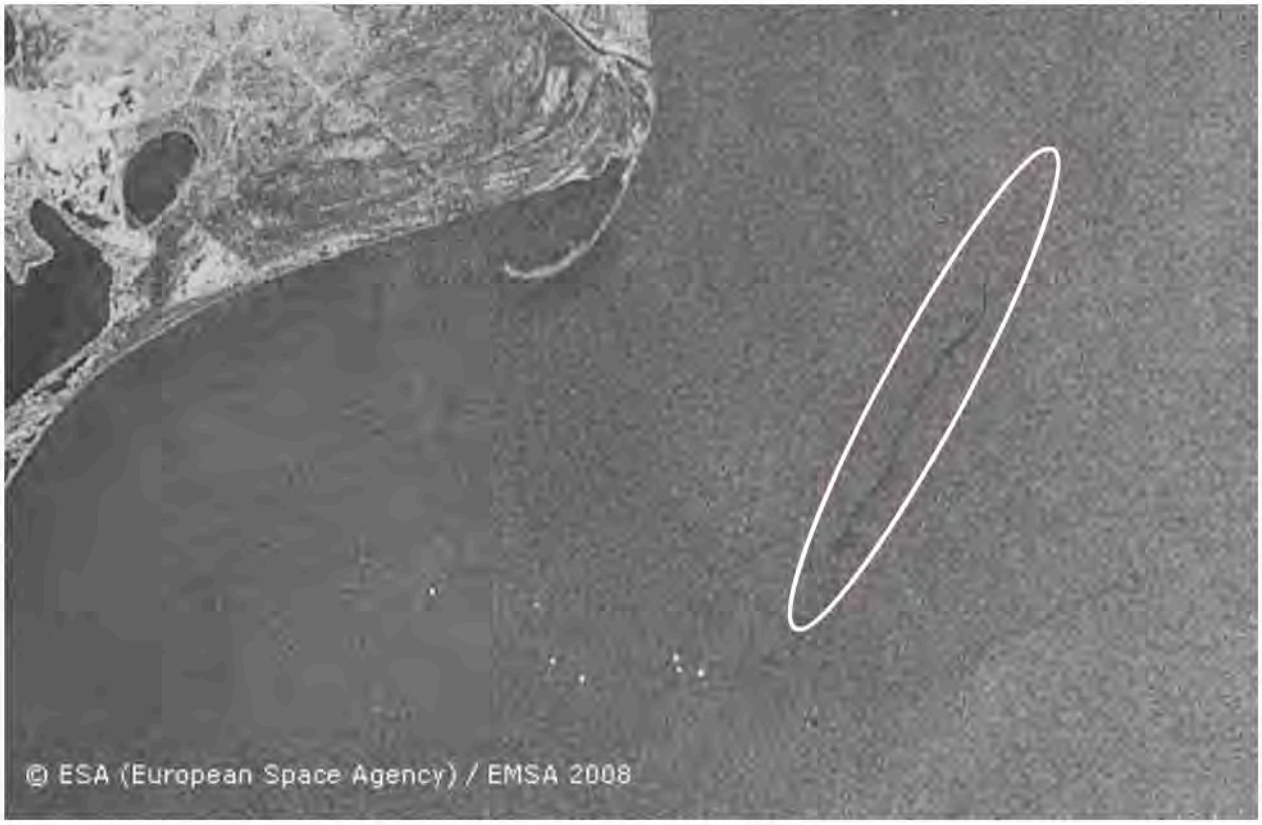


Figure 4: ENVISAT CleanSeaNet image - 3 November 2008

On this 3 November 2008 ENVISAT CleanSeaNet image, a 20 Km long oil slick in Romanian waters was reported by CleanSeaNet. The potential polluter was identified by Romanian authorities by using vessel traffic information system and fined as the result of a Port State Control inspection in Galati.

In addition to routine surveillance tasks, the Agency supports special oil spill monitoring campaigns organised by Member States and/or Regional Agreements in the seas surrounding Europe.

CleanSeaNet results for 2008

From 1 January until 31 December 2008, 2603 satellite scenes have been ordered for the Coastal States users of CleanSeaNet. This number of images corresponds with 4306 country allocations. This means that 2603 images cover 4306 requests from the Member States illustrating the economy of scale of a service at European level. The orders included 1394 ENVISAT ASAR scenes, 1042 RADARSAT-1 scenes and 167 RADARSAT-2 scenes. A total of 2335 scenes were delivered to the users of the CleanSeaNet service. Some of the ordered but not delivered scenes were cancelled due to conflicts with other orders and some were not delivered due to technical problems with the satellite, data downloading or data processing. The percentage of successfully delivered scenes has reached 90%.

A total of 3296 possible oil slicks were detected on the delivered satellite scenes. On average 1.41 possible oil spill was detected on each SAR image. Most potential spills reported were detected along main maritime traffic routes. Nevertheless some of these possible oil spills were look-alikes. Therefore, it is important to take a closer look at the results of on site verifications carried out by the Member States.

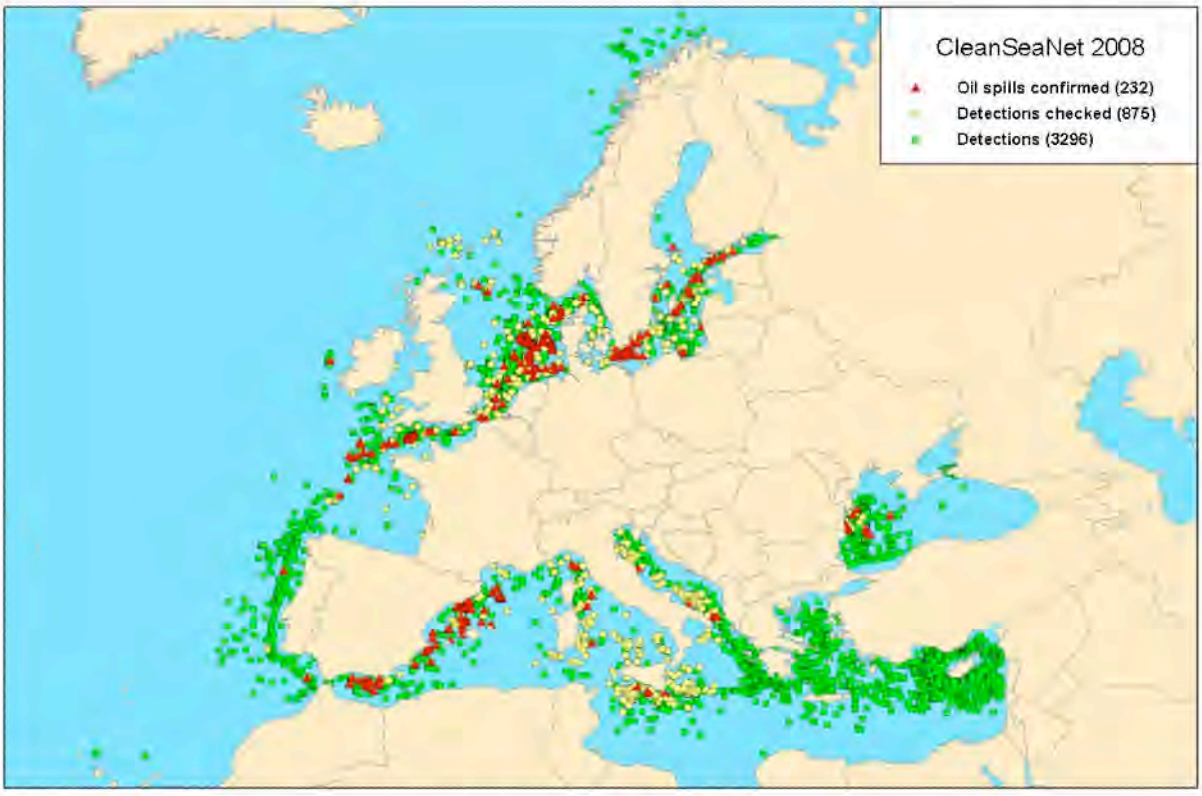


Figure 5: CleanSeaNet results - 2008

In 2008, out of the 3296 potential spills, EMSA has received feedback for 875 checked indications of which 232 have been confirmed as being mineral oil. The average rate of confirmation for all European areas is around 27%. This percentage should be considered with caution. Verification results very much depend on the means used for verification and on the delay between detection and verification. We can illustrate this

point with two opposite scenarios: some of the 875 feedback reports submitted by the Member States are flight observations from aircraft specialised in marine pollution detection flying over the reported position shortly after satellite acquisition time; other come from MRCCs having asked merchant vessels passing in vicinity of the CleanSeaNet detection to report their observations. For some areas where systematic aerial verification is conducted, confirmation rates may peak at more than 80%. The general performance of the service for detecting oil is probably not so high but there is no doubt that this performance is significantly higher than 30%.

Figure 6 CleanSeaNet detection checked and confirmed by the Swedish CoastGuard

EMSA's Satellite Monitoring Support for Accidental Spills

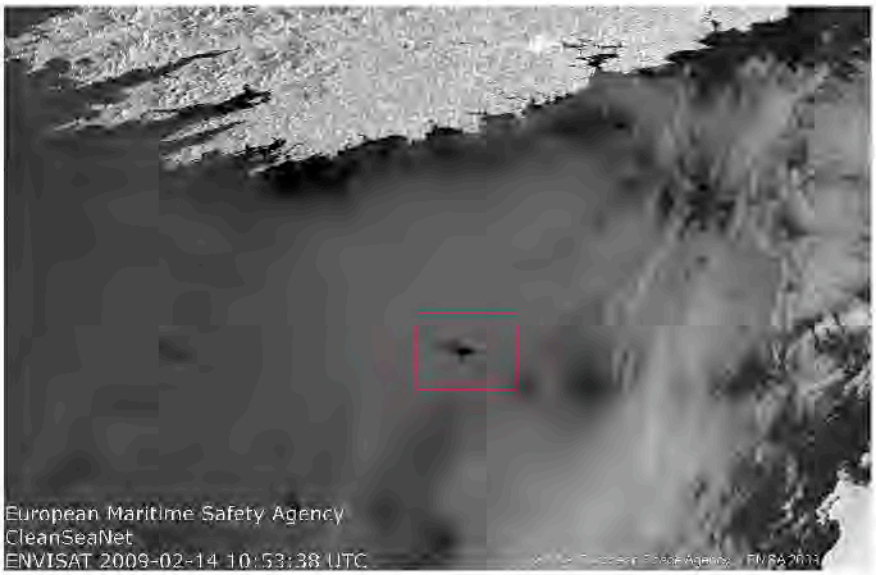
EMSA also has an important role to play in case an accidental oil spill occurs in EU or adjacent waters. The Agency's Maritime Support Services offer a single point of contact available 24/7 for responding to emergency satellite monitoring requests from the Member States or from the European Commission's Monitoring and Information Centre (MIC).

In case of accidental oil spills, the CleanSeaNet service will rapidly respond by providing analysed satellite radar images of the affected area. For major pollution additional satellite sensors or images over areas outside the service coverage can be acquired via the activation of the International Charter for Space and Major Disasters. The charter mechanism will be explained below.

Emergency planning and ordering procedures have been set up in CleanSeaNet to provide the quickest possible response over the affected area but the satellite has to be re-tasked. Technical delays for re-tasking the satellite can vary from three working days

for ENVISAT to less than 12 hours for RADARSAT 2. As a result, unless an image is already scheduled in the CleanSeaNet routine planning, the delay between the alert and the first acquisition will be a combination of satellite planning, satellite programming delay and satellite revisit time as explained earlier. Then, the monitoring capacity will depend only on the number of satellites available and of their revisit time.

The following example illustrates the type of support the Agency is capable to provide in support of accidental spills. On 14 February 2009, the Irish authorities received a CleanSeaNet alert reporting a spill 50 nautical miles (80 km) southeast of Fastnet Rock off the West Cork coast of Ireland detected in one of the routine images acquired by CleanSeaNet for EU Member States. An Irish Coast Guard helicopter confirmed the spill and that it was probably due to a refuelling at sea incident involving the Russian aircraft carrier Admiral Kuznetsov. Initial estimates assessed the spill at around 1,000 tonnes but further aerial surveillance by the Irish and British maritime authorities concluded that it was in the region of 400-500 tonnes. On 17th February, a CleanSeaNet image showed the slick to have expanded to 8 x 1 km and to have drifted around 30 km NE-E of the original position. At the request of Irish authorities, EMSA mobilised and placed on stand-by at Cork one of the 11 EMSA-contracted oil pollution response vessels: The Galway Fisher. Additional CleanSeaNet images have also been ordered to monitor the situation. The spill has been closely monitored until it naturally dispersed without hitting the coastline. 15 SAR images have been acquired between 14 February and 8 March 2009 to monitor the affected area.



The International Charter for Space and Major Disasters provides a unified system of space data acquisition and delivery to those affected by disasters including marine pollutions. Space agencies members of the Charter are mobilised through its activation at the request of authorised users. Those are usually civil protection, rescue, defence or security bodies from the country of a Charter member. The Monitoring and Information Centre (MIC) operated by the European Commission in Brussels is one of the authorised users and may request the activation of the Charter in support of a major marine pollution. In that case, EMSA is likely to become Project Manager. The Project Manager ensures required satellite data are sent to the end user and coordinates when required the delivery of value-added products and information. He must have the ability to interpret data. In December 2007, EMSA was appointed PM following a spill of

approximately 3,850 tonnes of Brent crude oil from the Statfjord Alpha platform in the Norwegian EEZ.

Evolution of the CleanSeaNet service

In 2009, a new platform will be created for the second generation of CleanSeaNet. The service offered to the Member States will be more flexible to include new satellite sources and new applications. One of the improvements should be that vessel position data from the Agency's SafeSeaNet project (AIS and LRIT data) should be available on a structural basis in CleanSeaNet to help identify suspected polluters. Where possible, existing regional and local fore- and hind-cast models will be connected to CleanSeaNet. This will provide the capability to link an individual illegal discharge with an individual ship track.

Statistics will be provided to illustrate the occurrence of illegal discharges at a European, regional and national level. This will help the Member States with their reporting obligations.

Existing valuable co-operation with external organisations such as the European Space Agency (ESA) and the Joint Research Centre (JRC) will advance in 2009 in support of new CleanSeaNet developments.

EMSA's involvement in Europe's Global Monitoring for Environment and Security (GMES) programme is essential to ensure the continuous availability of SAR satellite information and the ability to provide a sustainable and mature service to Member States. The ESA GMES Sentinel-1 SAR satellite is expected to be launched in 2011 and will ensure the continuity of C-band Synthetic Aperture Radar (SAR) data. GMES will allow an optimised access to limited satellite resources through an increased coordination and cooperation between the European users of SAR satellite imagery for surveillance purposes and environment monitoring as well.

Conclusions

EMSA has developed with the indispensable help of its contracted companies, the first European wide operational SAR satellite oil spill detection and monitoring service. This service should not be considered in isolation but as strengthening national operational pollution response chains. Results since CleanSeaNet entry into operations in April 2007 show that illegal discharges are still a serious and recurrent problem in European waters. CleanSeaNet next developments shall bring more flexibility for the end user and facilitate polluter identification and follow-up actions to satellite detections. Efficiency in fighting illegal discharges will be increased by finding synergies between existing surveillance and control chains from satellite and aerial surveillance to vessel traffic monitoring and port state control, by linking related systems and by fostering cooperation between different organisations.