CleanSeaNet: Satellite-based monitoring service for marine oil spill detection and surveillance in European waters

Maritime transport is estimated to contribute some 12% to marine environmental pollution (GESAMP 1990 - 1993). Deliberate dumping of oil at sea represents the largest ship-source input of oil into the marine environment, with tanker and oil platform accidents only accounting for a minor share. Nevertheless, they are spectacular and have a strong impact on public opinion. Even if most regulations aimed at preventing marine pollution have been set in place as a direct consequence of major oil spills, they very often include provisions with intended to combat illegal spills resulting from routine ship operations.

The IMO convention for the prevention of pollution by ships (MAR-POL) and its amendments today constitute the main international legal basis for tackling both accidental and operational pollution. In European waters, MARPOL rules are in place, but are ignored on a daily basis by a number of ships. MARPOL implementation also shows discrepancies between the Member States, and this situation has led the Commission to initiate action at European level.

In the aftermath of the *Prestige* accident, the mandate of the European Maritime Safety Agency (EMSA) in the field of marine pollution prevention and response has been extended. In 2005, the European parliament and the Council adopted a Directive ¹aimed at incorporating international standards for ship-source pollution into Community law and at discouraging illegal discharges by ensuring that persons responsible are subject to adequate penalties.

This Directive tasks EMSA to "work with the Member States in developing technical solutions and providing technical assistance in actions such as tracing satellite discharges by satellite monitoring and surveillance." Therefore, the Agency has set up and provides a European wide operational system for oil slick detection based on satellite sourced synthetic aperture radar (SAR) images, which is called CleanSeaNet. This European service supplements existing surveillance systems at national or regional level, strengthens Member States response to illegal discharges and supports response operations to accidental spills. Support to Member States affected by accidental spills is an important and interesting aspect of the service but this article will focus mainly on the use of CleanSeaNet in illegal discharge response chains.

Strengthening illegal discharge

response chains in European waters To deal effectively with the problem of illegal discharges, deliberate spills must be detected and located across wide areas during day and night and in any weather conditions.

In the 1980's, many European coastal states developed marine pollution monitoring capabilities based on airborne surveillance systems on low flying aircraft. Side-Looking Airborne Radar (SLAR), which is able to detect a large variety of pollutants (such as oil spills) and other phenomena on the sea surface, is the main detection equipment. Its use, in combination with other sensors such as Infrared/Ultraviolet Scanners (IR/ UV), Microwave Radiometers (MWR) and Laser-Fluorescence Sensors (LFS), provides the spectral signature of detected substances. It is possible to distinguish, not only mineral oil from other substances, but also to differentiate between different types of oil, and to estimate the oil spill thickness and thus the volume of the spill.

It is interesting to note that, despite progress made on developing remote sensing equipment, visual detection by experienced operators remains a key element. The Bonn Agreement Oil Appearance Code, which correlates apparent oil colour and slick thickness, is used by many European countries. In some Member States visual observation is considered sufficient for bringing a suspected vessel into port for further investigation, and is accepted in court as the main piece of evidence.

Satellite SAR imagery became available in the 1990's². SAR sensors detect the dampening effect of oil on the sea surface. A smooth surface will appear as a black pattern on the SAR image, whereas a rough surface will be much brighter. Even very thin oil films can be detected from space. This process is, to a large extent, independent of weather and visual conditions and allows the detection of oil pollution through cloud cover.

The development of satellite oil detection and monitoring techniques offered new possibilities to monitor wide areas at regular time intervals in a cost efficient way.

In the mid 2000's, only a few European countries had integrated the satellite component in their national response chains to complement aerial surveillance. With CleanSeaNet, EMSA set up the first European wide satellite oil detection and monitoring service.

CleanSeaNet uses three polar orbiting SAR satellites: ENVISAT, RADARSAT1 and RA-DARSAT2. ENVISAT provides 405 km swath coverage and RADARSAT 300 km, with the swath being the width of the land strip covered by the radar at each overpass. The frequency of observations for polar orbiting satellites is significantly greater at higher latitudes than at the equator. Therefore, having access to three wide swath capable satellites mitigates orbit constraints and increases CleanSeaNet flexibility for surveillance operations in support of illegal discharge response chains. European waters can be covered several times per day according to the needs of each individual Member State.

Although only aerial surveillance can identify the type and thickness of pollution, observations from satellites complement and optimise the use of air assets by passing slick positions to aircraft for further investigation. Therefore, CleanSeaNet, like any satellite based oil pollution monitoring service, should not be considered separately, but as an element that strengthens national operational response chains.

Catching polluters

Time is critical for catching polluters in the act. The shortest possible delay between satellite detection and alert is essential for a rapid response by coastal states. CleanSeaNet is a near real time service, and when ENVISAT or RADARSAT satellite passes over European waters, it is always within range of the ground stations in the CleanSeaNet network. As a result, data can be regularly acquired and simultaneously downloaded to the receiving station.

SAR data requires complex processing before it can be used for oil detection. Being



Twelve possible spills located between the Balearic Islands and the Spanish continental coast were detected on this ENVISAT image. All slicks were confirmed by SASEMAR as being mineral oil.



Ongoing discharge in the Adriatic detected on an ENVISAT image in December 2008. The ship visible on the satellite image has been identified using AIS information. A Port State Control inspection in Russia confirmed a sun flower oil discharge.

able to deliver analysed SAR images in near real time and to quickly inform Member States of the location of potential spills, is a real challenge.

The CleanSeaNet service is contracted to a Consortium of European companies (KSAT, Telespazio and Edisoft), and it is a contractual obligation that all CleanSeaNet products are delivered in less than 30 minutes. Like any radar, SAR sensors are able to detect ships and quite often their wakes. A ship appears as a bright dot on the surface, and when a long and linear spill is detected trailing in its wake, there is little doubt about the nature of the ongoing discharge. Nevertheless, it is necessary to identify the vessel and to determine whether the observed discharge is legal under MARPOL.

By allowing the identification of vessels suspected of pollution, traffic monitoring and



This view of CleanSeaNet detections in the Atlantic approaches, the Channel, the North Sea and the Baltic Sea during 2008 shows the accumulation of possible pollution along the main traffic routes

information systems contribute to the better prevention and detection of ship-sourced pollution ³. More and more European countries are developing integrated surveillance systems of which vessel traffic information is one component. AIS coastal stations in Member States cover most of European waters and most of them are now connected to regional servers.

Since the end of 2008, CleanSeaNet has had a direct access via these regional servers to AIS based vessel traffic information. Therefore, it is now possible for CleanSeaNet to positively identify the source of possible pollution when a vessel is still connected to the slick. It is also possible to link a recent spill to a vessel if the vessel's track matches the pattern of the spill, and if there is no possible confusion between the different vessels observed in vicinity of the reported slick.

The use of hind-casting oil drift modelling tools combined with vessel traffic information further enhances the capabilities of the authorities in the Member States to identify polluters. Backtracking of spills and intersecting the trajectory with vessel tracking data limits the number of potential polluters and allows authorities to carry out more in-depth checking of suspicious vessels. This is an important element in the chain of evidence and will hopefully provide a significant deterrent effect which should lead to a decrease in illegal discharges.

Follow up on CleanSeaNet detections is the responsibility of each coastal state, but the response may vary a lot from one country to the other. In some countries, each time a satellite acquisition is planned, an aircraft is either in flight or on stand by, thus increasing the chances of catching a polluter in the act. Some European Member States are now inflicting fines of many hundreds of thousands Euros for deliberate pollution in violation of MARPOL regulations. As an example, on 18 March 2009, a French court handed the Russian-flagged general cargo ship Skulptor Anikushin a EUR 350,000 fine for deliberate pollution in the English Channel during its voyage to Saint Petersburg in July 2008. The ship had been brought into Dunkirk and detained for one week until a EUR 400,000 bail was paid by the ship operator.

A possible spill detected on a SAR satellite image may constitute a suspicion ⁴ that a ship has been engaged in a discharge. More and more Member States use CleanSeaNet detections to trigger Port State Control inspections when vessel traffic monitoring systems, AIS information, and soon LRIT information allow the clear identification of the source. A number of polluters have been fined on the basis of evidence collected during such inspections.

CleanSeaNet figures

CleanSeaNet entered into operation in April 2007 and 24 coastal states now have access to the service. From 16 April 2007 until 31 December 2008, 3679 satellite scenes (2031 ENVISAT and 1648 RADARSAT) have been acquired and analysed and more than 400,000,000 km² of sea have been monitored by the European satellite based oil pollution monitoring service. To cover the same area with aerial surveillance would have required more than 25,000 flight hours.

In most cases, each satellite scene covers more than one country's waters. The scenes ordered by CleanSeaNet have fulfilled more



This February 2009 CleanSeaNet image informed the Irish authorities of an accidental spill approximately 50 miles southeast of Fastnet Rock off the West Cork coast of Ireland involving the Russian aircraft carrier Admiral Kuznetsov (visible on both images).

than 7,000 national requests by Member States and this illustrates the economies of scale generated by having a European level service.

During this period, 4,027 possible oil slicks were detected and reported to the authorities in the coastal states., but not all of these 4,027 detections were oil. A study conducted after 18 months of operations showed that the percentage of CleanSeaNet detections checked on site by aircraft or vessels confirmed as being mineral oil may vary from one region to the other but can reach values as high as 80% (e.g. in the Western Mediterranean Sea).

Most slicks are detected by CleanSeaNet along the main maritime traffic routes. This indicates that illegal discharges from ships are still an important source of pollution that causes significant damage to the marine and coastal environment.

With CleanSeaNet, significant pollution is not likely to go unnoticed. Ship Masters have the obligation to report any observed pollution at sea, and they should be conscious that it is becoming more and more risky not to report accidental spills that they may have caused.

It is of vital importance for the preservation of marine resources that all actors engage themselves in the necessary actions to reduce marine pollution.

Notes

- Directive 2005/35/EC of the European Parliament and of the Council of 7 September 2005 on ship-source pollution and on the introduction of penalties for infringements.
- Launch of the 2 first European SAR equipped satellites ERS1 (1990) and ERS2 (1995) and of the Canadian satellite RADARSAT1 (1995).
- "Contributing to a better prevention and detection of pollution by ships" is one of the objectives of the directive 2002/59/ EC of the European Parliament and of the Council of 27 June 2002 establishing a Community vessel traffic monitoring and information system.

4. Article 6 of Directive 2005/35/EC of 7 September 2005 on ship-source pollution and on the introduction of penalties for infringements provides that if "information gives rise to a suspicion that a ship which is voluntarily within a port or at an offshore terminal of a Member State has been engaged or is engaging in a discharge of polluting substances into any of the areas referred to in Article 3 (1) that Member State shall ensure that an appropriate inspection ... is undertaken". Areas listed in the article 3 of the Directive include the high seas.

Editor's Note: Marc Journel works for the European Maritime Safety Agency in the CleanSeaNet team. He is a former French Navy officer with many years of experience in maritime surveillance.

Detailed information on the Agency can be found on www.emsa.europa.eu