Operational use of satellite SAR at EMSA

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The structure of the presentation

- Introduction to European Maritime Safety Agency (EMSA) tasks
- EMSA Operational Services
- Integrated Maritime Surveillance platform
- Q&A
European Maritime Safety Agency

Background:
- Legal basis: Regulation 1406/2002/EC

Regulatory Agency of the European Community
- Own legal identity
- Technical and operational support to EC and MS
- Approximate 200 staff
- Annual budget about 50 MEURO
Objectives of EMSA

Within the fields of maritime safety, pollution prevention from ships and ship security, EMSA has the following main objectives:

• To ensure the proper **implementation of EU maritime legislation** by Member States

• To foster **technical cooperation** and development and disseminate best best practice

• To provide **technical advice** to the Commission and Member States

• To **provide assistance** to top-up Member States’ capabilities for **oil pollution response**
EMSA Operational Services

EMSA is presently offering three operational services:

- CleanSeaNet (CSN) based on SAR detection
- Long Range Identification and Tracking (EU LRIT DC) based on communication satellites
- SafeSeaNet (SSN) based on shore AIS network (727 coastal stations)
Legal framework is provided by Directive 2005/35/EC on ship sourced pollution – “EMSA should work with the Member States in developing technical solutions and providing technical assistance in relation to the implementation of this Directive, in actions such as tracing discharges by satellite monitoring and surveillance;”

- Became operational 16 April 2007

24 EU Coastal States currently users of CSN
Scope of the CleanSeaNet oil spill monitoring service

- **European system** for detecting oil slicks at sea using satellite surveillance on request of Coastal States and of the Commission.

- To achieve a system that **links into the national/regional response** chain (aerial/naval surveillance) and strengthens routine, operational pollution surveillance of illicit discharges and response for accidental spills.

- CleanSeaNet provides a **complete service chain** from the collection of coverage requirements to the provision of the final detection results.

- **Identification of potential polluters** by combining CleanSeaNet and vessel traffic information and drifting models.
Oil Slick Detection in SAR images

- SAR sensors emit electromagnetic pulses and measures the level of the backscattered signal. Doppler history along track is used for azimuth resolution and signal modulation for range resolution.

- SAR sensors provide information on the surface roughness of the ocean. Ocean’s roughness is driven by the wind which creates ripples at the sea surface.

- The presence of a film on the sea surface dampens small waves and reduces the measured backscattered energy. This results in darker areas in the SAR image.

**Low wind:** Weak backscattered signal - No contrast between oil slicks and surrounding waters

**Moderate winds:** Favorable for oil detection - Oil Slicks appear as dark features

**High winds:** Useful signal lost in the ambient noise - Oil slicks often broken and dispersed into the water column

- 2-3 m/s < WIND < 12-15 m/s
Oil Slick Detection in SAR images – Look-alikes

SAR sensors detect all films on the sea surface that damp out small waves generated by the wind.

CleanSeaNet detections are not “Oil Spills” but “Potential Oil Spills”. Discrimination between Oil Spills and Look-alikes require more information and most often in-situ verification.

How to reduce the number of false alarms?: good knowledge of local conditions (Winds, currents, vessel traffic,...), improvement of the oil detection chain by a thorough analysis of feedback and by gathering experience

Look-alikes:
- Other man-made substances: fish or vegetable oil, chemical, sewage, other...
- Natural phenomena: low wind area, algae, current front, upwelling area...

Current fronts
Low wind, rain cells and oil seepage
Algae
Land breeze
CleanSeaNet satellite Network

- ENVISAT
- RADARSAT 1
- RADARSAT 2
- Sentinel 1 (2013)
CleanSeaNet Service Flowchart

Ex- NL may require 4 scenes/month covering their waters.

1. Coverage Requirements
2. Images allocation
3. Satellite Planning
4. Oil Spill Alerts
5. User Feedback

EMSA contracted Service Provider

3. Satellite acquisition and processing
4. CleanSeaNet Products (Images, Oil Spill Reports, Ancillary products)

EMSA

Web Browser
Products delivered by CleanSeaNet

- Satellite images (both in full-resolution and in reduced-resolution) and associated image data such as acquisition date, geographic coordinates, etc...
- “Oil Spill Reports” or “Clean Sea Reports” containing the indication of the oil spill detected from that image. Reports are delivered in the email alert and are available via the web browser
- Potential oil spills are reported with 3 Confidence levels (low, medium and high)
- Associated ancillary data: meteorological wind and wave data, SAR wind and SAR swell data derived from the image
- Other ancillary data when available from external providers like AIS information
Near Real Time Service – 30 Minutes

Acquisition and Processing

Oil Spill Analysis

Alert & Product Delivery (Web Browser, EMSA)

Phone and email alert

Oil Service Report

Image (LR, HR)

Ancillary data

T0 = End of scene acquisition

T = T0 + 30 min
The EMSA CleanSeaNet Web Browser

This centralised interface allows:

- Viewing the acquisition plan
- Viewing and downloading CSN products
- Providing Feedback
CleanSeaNet Results – All European areas
CleanSeaNet results – Identifying polluters

ENVISAT image acquired over the Canary Islands on 15 September 2009 by the Azores ground station

possible spill reported by CSN and confirmed by aircraft as being mineral oil - 42 km long

polluter identified using AIS information
Support in case of accidental spills

In case of accidental spills, EMSA has the capacity to support the affected Coastal State with additional satellite coverage:

– Envisat and Radarsat 1 and 2 images: emergency planning and ordering via CleanSeaNet.

– Other SAR or optical data: in case of major disasters via the activation of the "International Charter for Space and Major Disasters".

A close cooperation between the CleanSeaNet team and the affected Coastal State allows optimising satellite planning and ordering.

For each accidental situation, EMSA issues tailor-made products, briefings, reports... to better fulfil Coastal States authorities expectations.
Emergency support examples

Grounding of the MS Fedra off Gibraltar in October 2008

CleanSeaNet Quick Look Report no. 1

EMSA CleanSeaNet satellite monitoring of the Bay of Gibraltar: Report no. 1 (14/10/2008)

Satellite: ESA ENVISAT
Sensor: Advanced Synthetic Aperture Radar (ASAR)
Mode: ScanSAR Wide
Date: 2008-10-13
Time: 22:00:06 UTC

CleanSeaNet Quick Look Report no. 6

EMSA CleanSeaNet satellite monitoring of the Bay of Gibraltar: Report no. 6 (22/10/2008)

Satellite: RADARSAT-1
Sensor: Synthetic Aperture Radar
Mode: Standard Image 53
Date: 2008-10-22
Time: 08:22:17 UTC

No major oil pollution could be identified.

This Synthetic Aperture Radar image (ASAR, 15 m pixel resolution) shows several dark patches, with the easterly wind with a force of around 5 m/s allows a good detection of possible oil spills.

Blue (1): The lee effect of Gibraltar introduces reduced surface wave heading to the dark patches. However in this area could be oil originated from the tanker, but there is no specific contrast, which allows the identification of oil.

Yellow (2): This feature could be potentially seen oil released from MS Fedra, as the origin of this patch is linked to the Europa Point. However due to it vicinity to the shore line this information is of low confidence and has to be verified by local authorities.

Green (3): According to the pattern structure, this feature could be oil, but due to the
CSN 2nd generation: a complete approach

- An integrated maritime surveillance platform: comprehensive, flexible and advanced system; providing
  - meteorological and sea state information, SST, algae, ...
  - vessel traffic information (AIS, LRIT)
  - Oil drift modelling: links to forecast and backtracking models tailored for specific sea areas
  - Static information (Nautical charts, bathymetry, borders, ...)
  - Optical and multispectral images
  - Satellite vessel detection

- Fusion of data
  - Vessel tracking with backtracking data for polluter identification
  - wind and wave for improving the confidence
Vision for the CSN integrated system

Integrated system to strengthen the national/regional response chain for accidental spills and deliberate discharges from ships.

**MS-bodies:**
- Coastguard,
- Border control, ...

**Early warnings, response & clean-up operations**

**Satellites**

**Models**

**Tracking**

**Efficiency**

**Real time**

**Response support**

**Collecting evidence**

**Prosecution, Deterrence**
What is LRIT?

- **Long-Range Identification & Tracking System**
  - initiated by IMO to cover maritime security
  - based on satellite communication

- The IMO Long-Range Identification and Tracking (LRIT) is covered by SOLAS V/19-1 and requires that:
  - All passenger ships including high speed craft,
  - Cargo ships of 300 gross tonnage and above
  - Mobile offshore drilling units.

- should automatically transmit every 6 hours the following LRIT information;
  - Identity of the ship
  - Position report
  - Data and time of the position
LRIT objectives

Worldwide identification and tracking of ships for:

- Maritime security (ships in sensitive areas)
- Search and Rescue (ships within SAR operations area)
- Maritime safety (TSS, route backtracking)
- Protection marine environment (ships within pollution disaster area, identification of polluters)

4 Main Users:

- Flag State – own flag ships worldwide
- Coastal State – all ships within 1000 Nm of their coastline
- Port State – all ships coming into their ports
- SAR – all ships within their SAR area
EU LRIT SYSTEM

EU LRIT DATA CENTER

USER WEB IF

MONITORING IF

INVOICING & BILLING IF

SHIP DATABASE IF

CSP

ASP

IDE

DDP

FLAG 1

FLAG 2

FLAG 3
Significance of EU LRIT DC (34 countries)

**EU flagged ships** = 7.500 *

**Overseas Territories** = 500 *

*only vessels required to comply with the LRIT.

EU DC to cover about 20-25 % of world’s fleet
### 34 (37) participating EU/EFTA states and Overseas Territories

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**Overseas Territories**
- Greenland
- French Polynesia
- New Caledonia
- Aruba
- Netherlands Antilles
- British Virgin Islands, Falkland Islands and Gibraltar (testing)

**EFTA Countries**
- Iceland
- Norway

**Third Countries**
- Open subject to EC approval
EU LRIT DC User Web Interface

Worldwide coverage
At the required level of detail
Position reports handled by the EU DC

about 1 000 000 reports/month
Pilot Project started in September 2009: EU merchant vessel information for EUNAVFOR’s Monitoring Area

13 November 2009 area is extended to east and south due to new pirate attacks
“Anti-Piracy tool”

- Alert message (in and out)
- Automatic increase of the periodic rate of transmitting LRIT reports to the Flag State and EUNAVFOR
- 20 EU Member States participating (status Jan. 2010)

Mandatory position reports (6 hours)

Increased rate (1 hour)
PIRASAT project (3-10 December 2009)
PIRASAT situation report n°8 - 08 december 2009

Interpretation
An important number of vessels has been detected on this image.
2 possible convoys are visible.

Legend
- Vessel detection KSAT
- Vessel detection JRC
- AIS last position
- LRIT last position
- LRIT 4 hours track history
- Limit of AOI
- Fishing zone
- Corridor

Scale

Disclaimer
The land and maritime boundaries are purely indicative and don't reflect the EMSA entities views.

Image source
R52_20091208_164711_0048_SCNA_HH9HV_SCN
024339_0000_2709530
Satellite picture of skiffs; boats used for pirate attacks
1. SafeSeaNet

SafeSeaNet information sources

Data providers
- **AIS**: on board AIS and shore based networks
- **Masters /owners/ agents**: port and HAZMAT notifications
- **Local authorities (LCA)**: VTS, MRCC, Port authorities, Coast guards, Pollution survey centres for incidents or accidents
727 AIS shore stations

Coastal coverage in all MS

EU one of the most well monitored maritime region

Map of AIS shore stations
Maritime Support Services

24/7 availability as of September 2009:

- System monitoring: SSN, LRIT, CSN
- Quality of data monitoring: SSN, LRIT, CSN
- Help Desk
- Single point of contact for alerts triggering the EMSA contingency plan for:
  - Oil recovery vessels
  - CleanSeaNet support
  - Experts
2010 agenda for EMSA

- Integrate AIS, LRIT, SAR images (VD + OD)
- Explore technical capabilities for enhanced or new purposes: fishing vessels (VMS), local coastal radar
- Organise EMSA systems in such a way that it can serve other user communities (fishery control, border control)
- Focus on new technology/systems: i.a. Satellite AIS and integration with existing data. Towards a demonstration mission with ESA:
  S-AIS to become a space node of existing SafeSeaNet
- Develop collection and exchange of maritime traffic information with Neighbouring Countries (North Atlantic, Russia, Black Sea, Mediterranean countries)
Integrating maritime information systems

- EU Maritime Surveillance: to develop *common information sharing environment* SafeSeaNet as basic information platform
- At EMSA integration of data from SafeSeaNet, CleanSeaNet and EU LRIT DC within one user interface
- Challenges: access rights and user profiles, legal aspects (new purposes), data protection
Information Layers for Traffic Imagery

- AIS - National
- Radar/VTS
- AIS - Regional
- AIS - EU
- LRIT

System Coverage
Serve other user communities: EMSA as service provider for ship related information

- CFCA: fishery control
- FRONTEX/DG JLS: ship information for border control based on SafeSeaNet (GMES Border Surveillance Group)
- EUNAVFOR: LRIT anti-piracy tool and PIRASAT
- Exploratory talks with other potential users
Thank you very much!
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