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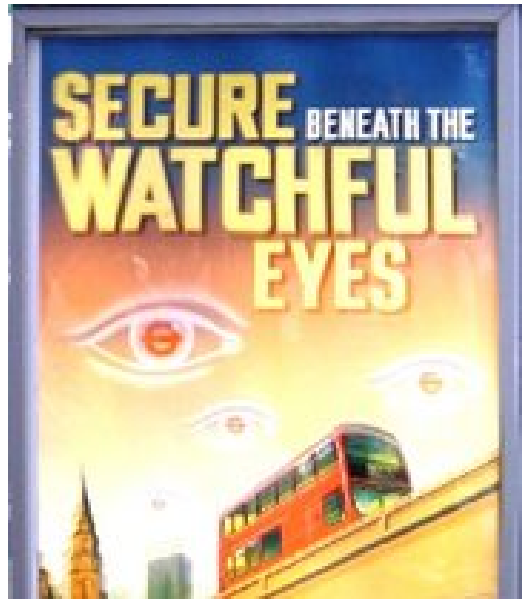
Use of surveillance technology to support response decision making and impact assessment

J Huisman RWS – Water Management North Sea



The expression “surveillance technology” covers a large area and a variety of sensors and programmes.

Interspill never deals with an aerobiological surveillance network nor will it discuss the Surveillance in town areas with high criminality. Surveillance technology in the marine world means detection and monitoring techniques for the detection of pollution.

Although the word surveillance literally means (in French) "to watch from above" (i.e. a God's-eye view looking down from on-high) the term is often used for all forms of observation or monitoring, not just visual observation.

Systems Surveillance is the process of monitoring the behavior of people, objects or processes within systems for conformity to expected or desired norms in trusted systems for security or social control.

In the framework of Interspill 2006 surveillance means the application of systems to detect and monitor pollution and their source. This paper will deal with surveillance using:
- satellite surveillance,
- aerial surveillance (sensors),
- shipborne surveillance,
- visual surveillance or observation,
- integration of sensor data and information obtained from other sources,
- requirements and
- conclusions

The presentation will be a co-presentation with Dr. Carlo Marucci who will inform the audience about the application of the ship borne radar technique, SeadarQ, in a real incident.

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Definition:

In a common explanation surveillance means "looking" at an object from a distance without touching it and also Radar detection means measuring an object relative to it's environment (surrounding area).

1. Satellite Surveillance.
   By definition a Satellite, airborne or ship borne Radar can not detect oil! What it will do is detect the differences in a wave pattern at sea surface. This should be crystal clear. Radar is a passive instrument, that transmits waves and collects the reflected waves thus building an image. What we can "see" is that in an area where there is a uniform wave pattern a specific part shows a different pattern or now pattern at all. This could be caused by a sandbank, a ship, a platform, a field of algea or a pollution. Surface tension variations will be detected.
   Satellites (SAR) have increased the capabilities to monitor a vast sea area (in respect to the Conference I refer to Marine issues). Footprints of 400 by 400 kilometers are normal. The satellite image will just give an indication that there is something which might be considered worth investigating applying another platform.
   The frequency of passes is still something to improve. However when authorities wish to have a 24 hour surveillance system over the North Sea. A geo stationary satellite over the North Sea seems to be not possible. For the moment we have to live with Envisat and Radarsat. Both ERS satellites are still orbiting but not in use for our application.

   Unfortunately in the recent major incidents involving oil, e.g. Sea Empress, Erika and Prestige the satellite imagery was of little to now use for the response organizations.
   I am confident that with the increasing cooperation between European Member States, in a coming incident through the Joint Research Centre (JRC) and the arrangements that have been made, imagery will be available and processed by JRC. The group of experts under auspices of EU puts effort in a combined approach and the development of specific processing software aiming at efficient use of the satellite's capabilities and also the financial resources.
   One has to be in the network of the EU community, know the right ways but then if satellite SLAR images are available, authorities will be provided with those images.

2. **The aerial surveillance** has been known for many decades, although it was since the beginning of the eighties that in Europe sensor were installed in aircraft, such as the Side Looking Airborne Radar. The technique of the system is not dealt with here, but basically the system provides a 80 kilometers wide image that builds up by the forward moving aircraft. Again the SLAR will provide an indication that there is something at sea surface worth investigating. Satellite SAR and Airborne SLAR are similar techniques.
   Not only SLAR is used on board aircraft. A package on board a remote sensing aircraft may comprise, next to SLAR, an UltraViolet and InfraRed line scanner (UV/IR-ls) or InfraRed camera; a microwave and a Laser Fluorescence Sensor (LFS).
   UltraViolet will give, only during daylight, an indication of the total dimensions of the surface slick. InfraRed will provide information on the relative differences in layer-

thickness of the oil slick and the Laser has the capability to identify, with a some uncertainty, the type of pollution.

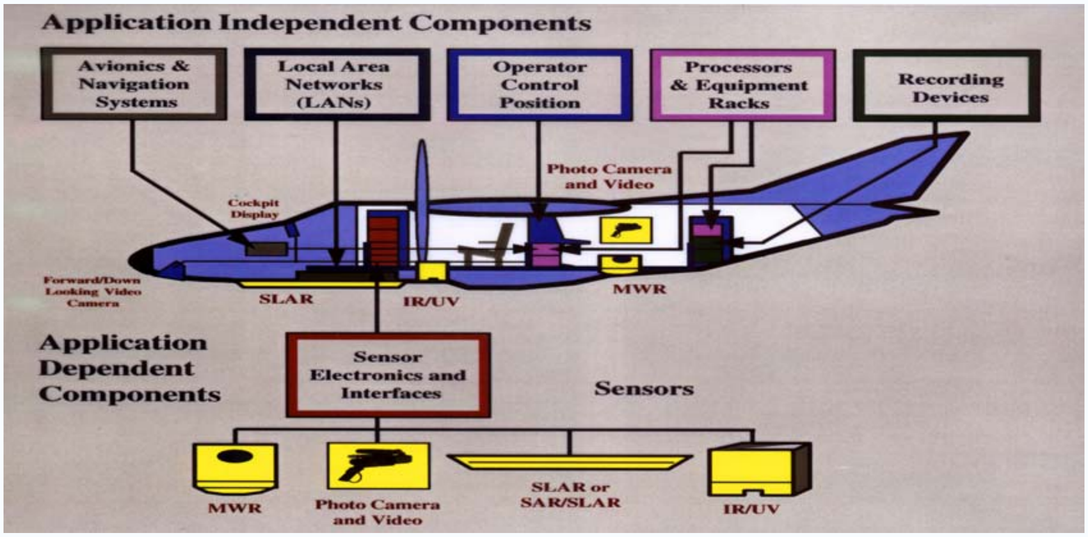


figure 1: aicraft lay-out

The operator will interpret the SLAR image and as the image in modern systems is presented on top of an electronic map one can directly check a surface slick against shipping lanes, offshore installation or a pipe-line on sea floor. A well trained operator may conclude on the shape of the "detection" whether it is worth investigating. Algae and mineral oil spilt at sea surface may appear the same at the SLAR image, as both influence the ripple waves, but still there is a difference.

Finally, the modern systems will also have a the provision to transmit all recordings to land or ship based stations in order for authorities or the response team to "see" the pollution.

3. **Shipborne radar** is in use for many years as an aid to navigation. However recently special software has been developed and in combination with the radar this provides an application to detect a phenomenon, other then a ship or platform, at sea surface.
   Again the radar technique is equal to the satellite's SAR or the aircraft SLAR.
   This SeadarQ system, as it is called in the Netherlands (designed by TNO and Tech5), has been installed on board the oil recovery vessel ARCA in the Netherlands and on board the Italian TITO and it suits the purposes (Dr. Carlo Marucci will show you). In an area of about 8 kilometers around the ship surface distortion of the ripple waves will be detected.

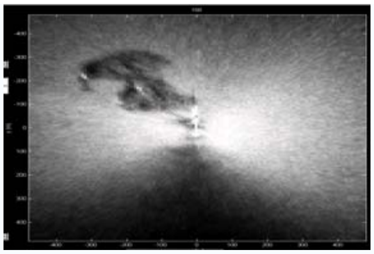


foto 2. SeadarQ: oil slick detection

foto 3. SeadarQ

4. **Visual observation**, the human eye is a very low cost instrument to monitor and observe an object. It is the aircraft that could make an operation costly. There are other reasons why visual observation is important. The operator can check his finding with the MARPOL regulations. Assuming he has detected a discharge and visually observes a ship with a pollution in its wake, the operator will then note additional characteristics. Not only about the type of pollution, but also of the ship. Name and flag, type and other remarks. However he will also check the position relative to the coastline or EEZ boundaries. It is especially worth mentioning that whereas discharges of mineral oil are dealt with in MARPOL Annex 1, discharges of Annex 2 substances are also frequently observed. Some of the substances may look like mineral oil.
   Here it is, the main difficulty (challenge if you like). A radar can certainly not discriminate between a Marpol Annex 1 or 2 discharge. A trained operator may well be in a position to judge the discharge.

   When an incident occurs, colliding ships or a broken pipeline, a remote sensing aircraft is directed to investigate the situation. The operator will, based on his experience gained during the routine monitoring flights, take collect all kind of data using all his instruments. He will also use the OIL VOLUME ASSESSMENT CODE, originally developed by the BONN AGREEMENT, in order to inform authorities about the total volume of oil at sea and to advise on response.

5. **Integration of sensor data** and information obtained from other sources will make the collected data useful to authorities responsible for maintaining maritime law.
   Providers of satellite imagery have developed software tools to analyze the radar data. Also they combine information on the weather (sea) conditions in the area covered in order to have a realistic image. It is known that at very low wind speeds (less then 8 knots), the absence of the ripple waves may create an area that looks like an enormous oil slick. Also at very high wind speeds (more then 33 knots) the discharged oil, especially the bilge discharges, will mix rapidly with the waves and it will therefore be unlikely that the radar will detect something that is an oil slick.

   Including tidal information in a satellite image is necessary to understand specific shaped phenomena. For instance if an offshore installation that is permitted to discharge production water carrying a minor quantity of, lets say 10 ppm, oil is “monitored” by the satellite during a period of calm weather the image may show a very artistic shape surface phenomenon (an oil slick) because of tidal currents and the absence of sea state.

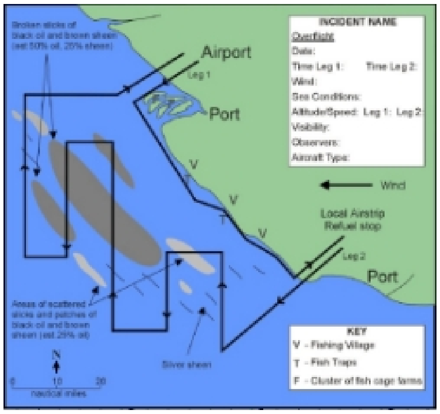
Programs aiming at comparing satellite radar (SAR) data and airborne radar (SLAR) provided a means to software programmers to built tools applied to process the satellite data and to reduce to a minimum or exclude the so-called false positives.

Recently the AIS (Automatic Identification System) has become very effective. Again when a possible oil slick or other surface phenomenon has been detected by means of satellite or aircraft and the AIS shows a vessel in the vicinity of this detection, the name and other data can be obtained from the AIS. The identified vessel can be inspected in the next port of call or even at sea.

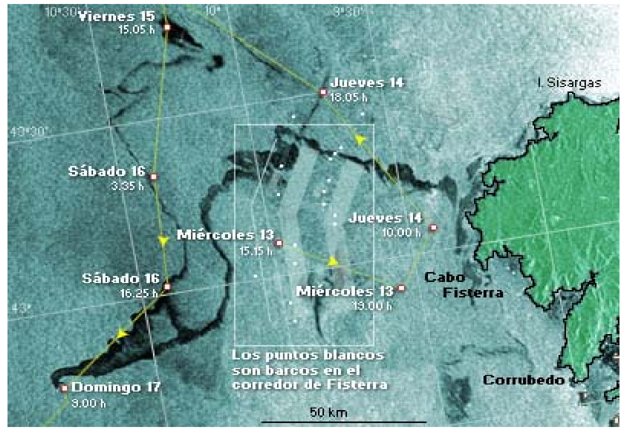
Finally if an oil spill drift model is integrated into the other data a prediction can be made in what direction the oil slick will drift. As most of the drift models also will take into account the physical and chemical behavior of the oil an estimation will be obtained on evaporation, spreading and dissolution of the oil.
However, with regard to the latter, the more detailed the information on the oil type is available the better the estimation.

Returning to the title of this presentation “the use of surveillance technology to support response decision making and impact assessment”, one has to understand that training through routine patrol or monitoring flights is essential in order to make the best use of the instruments and operator during an incident.
If the surveillance technology should really support the response decision making a disciplined flight pattern is required. Flying around at low altitudes to take photographs of floating oil will not support the decision makers.
Every day as early as possible the entire area have to be mapped. This should be repeated during the day, depending on the actual weather conditions.
On completion of this “monitoring or mapping flight”, the operator will apply his InfraRed sensor to recognize the thicker parts which make the difference in the recovery operation. Thereafter the crew can make close-up imagery of the floating oil.

Specific attention should be paid to passing ships discharging bilges. This is a proven event, also in the PRESTIGE incident more then 15 vessels were observed discharge in the vicinity of the oil slicks spilt by the PRESTIGE.



monitoring pattern



SAR image of PRESTIGE spill

Based on the data gathered, both in the first day but also during proceeding flights, recovery vessels are instructed and guided in their operation. Also remote sensing aircraft is used in combination with spraying aircraft in case an oil slick is dealt with by applying dispersant spraying.

Requirements.

In order to make full use of available sensor data as well as the capabilities of the operator new software has to be developed.

Obviously the processing of satellite or airborne radar data includes overlays showing meteorological and geographical data. AIS data should be incorporated as an overlay as is done in SeadarQ. Pixel value calculations (polygon) could provide area measurements, indicating the dimensions of the possible pollution.

Assuming AIS data is available one could know details of a ship such as the type of ship, the tank lay-out, the bunker capacity and so on.

All this information can be used in a drift model and in the same computer network sensitivity maps are stored.

One may even include a sort of standard list of possible oil layer thickness based on real tests. A bilge discharge (oil-water mixture) will only result in a thin layer at sea surface, where as a release of a tankwashing, not to mention an outflow of a ruptured tank, may result in very thick layers.

Main sticking points remain: the number of satellites available; continuity in coverage (monitoring) and volume estimation.

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Conclusion.

To start with we need to understand that 99,9% of oil transported oil is safely reaching its destination. And also that the average -if that exists - bilge discharge (so-called MARPOL violation) although it still is a pollution, consist of less then 1 m^3 of mineral oil. As a side step I would like to state here that more effort has to be put into Port Reception Facilities and a stringent policy in waste management on board ships. No ship should leave a port with waste on board. Prevention overrules repression.

Large sea areas of the European waters are covered by satellite and many European Member (coastal) States perform routine surveillance flights in order to detect and observe combatable oil slicks in an early stage. This is necessary to train operators in order for them to be skilled in case of maritime incidents, such as the PRESTIGE.
Operators have to understand what an oil slick is, how in behaves and how the make a reliable volume assessment.

Although remote sensing manufacturers and image analysts continue to improve their means to provide imagery with information, volume assessment is a lacking tool.
Visual observation, with all the known limitations, remain to be the best ***guestimation.***

The SLAR or SAR will provide dimensions and area calculation can provide the extension of the pollution; applying IR and LFS more information on layer-thickness and the substance can be obtained. Visual observation will weigh all relevant information and the operator transmits his findings and advice to the authority in charge of response. Swift action, through a strong chain of sensors and knowledge contributes to effective response and the protection of vulnerable areas.

In case of a real tanker incident I would rather rely on the judgements by a trained and skilled operator then the satellite image only.
However, I also trust that the combination of all sources of information will provide me in my role of head of response, with the necessary information on the whereabouts, drift and behaviour of the oil slick that was first detected by the satellite as something worth investigating.

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