Proactive satellite-based monitoring for enhanced offshore situational awareness

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Introduction

The past decade has made it clear that offshore operations have the potential to cause significant damage to marine and coastal environments, ecosystems and communities that rely upon these resources. To this end significant effort has been directed to improving preparedness and response by those operating within the offshore environment. Whilst Earth Observation (EO) satellites currently form a key part of preparedness and response efforts, there is significant potential to exploit these instruments further.

Now, more than ever before, the amount and quality of information available from these satellites provides a practical basis for observing pollution incidents and offshore operations, and deriving further information from imagery. Satellites provide the capability to deliver regular, low risk, intelligence updates for operations in remote locations and challenging environments. New EO satellites with improved capabilities are being launched regularly; it can therefore be difficult for companies without direct knowledge of satellites to keep up with the possibilities available to them.

In the context of offshore pollution, satellite imagery can be reliably used to gather information such as slick sources, slick extents and observed trajectories. The threats presented by oil spills to marine and coastal environments and the risks associated with the process of their clean up are substantial therefore the ability to react quickly is essential, but not the whole picture. Just as we would be proactive and go for check-ups to identify health problems and build up a medical history which can be referred to in the future to help diagnose problems that continue to arise, the same can be said for offshore industry. In order to provide a comprehensive solution there must be a proactive and reactive approach. Proactive monitoring will not prevent spills from occurring, but it could contribute to minimising the impact of spills and provide information pertaining to incident liability and evidence from which lessons can be learned and improvements made for future operations.

Main Results

EO satellites offer two main approaches to observing offshore pollution; emergency tasking and routine monitoring. These approaches vary in terms of their timing, efficacy and cost.

Typically emergency tasking is the main approach taken by offshore industry, only employing satellite imagery once an incident has occurred. The benefits of this reactive approach must not be overlooked. When available, near-real-time satellite imagery provides a near-instantaneous, wide area view of offshore spills, and on this basis, is unrivalled by other methods. The observations made during a crisis can be used to inform and influence all other methods of observation and emergency response strategies. However, emergency tasking is still reliant on the ability of operators to react quickly enough to a spill incident, and the constraints of satellite orbits and satellite operators on image acquisition and delivery times. The overriding issue of key concern for industry is cost; satellite imagery acquired under emergency scenarios can be particularly costly due to the time sensitive nature of the request, the need for prioritisation and the frequency of observations required.

Routine monitoring can help to alleviate some of the disadvantages of emergency tasking without impacting the effectiveness of emergency tasking when spill scenarios arise. Furthermore routine monitoring can help to identify previously unknown problems before they become further exacerbated. Although it is impossible to completely pre-empt a spill, routine monitoring can reduce the time and cost of acquiring a satellite image early on in a spill scenario, thus allowing emergency tasking to be considered as a supplement to routine acquisition rather than the sole solution.

There is a general assumption in industry that emergency tasking is all that is necessary, but investigation has found that sentiments differ from person to person, department to department, company to company, and country to country. Further investigation by operators into the most appropriate courses of action is recommended. The benefits of routine monitoring in direct support of spill scenarios have been briefly outlined, but routine monitoring contributes in a broader sense.

Situational awareness is a key aspect of oil spill preparedness and response, which can be applied to day-to-day operations as well as emergency scenarios. Enhancing the awareness of activities around offshore infrastructure can help operators identify the slick patterns and characteristics that are considered normal in an area, thus identify deviations in benchmark conditions. These could include spills due to technical failure, pipeline leaks and illegal dumping by vessels.

Conversely, routine monitoring also ensures an evidence base is established, which can be used in a variety of ways, such as environmental auditing as proof of good practice and environmental performance, or evidence in legal disputes over slick sources. The impact satellite imagery can have can often be enhanced by combining it with collateral data sources such as, metocean data or AIS.

Routine monitoring has traditionally not been an avenue taken by offshore industry due to the costs that have been associated with running long term monitoring programs and also due to the lack of legal requirement to do so. This is not the case everywhere. Norway is an example of a country that requires operators to conduct routine satellite monitoring of offshore rigs. However, costs for satellite data are falling and in some cases, as with ESA’s Sentinel satellites, data is freely available.

The advent of Sentinel-1 has greatly increased data volumes globally. Figure 1 demonstrates the difference this has made to coverage in the North Sea over the course of a decade. Sentinel-1 is acquiring many more images than in comparable months a decade earlier by ERS and Envisat combined. Furthermore, ERS and Envisat ASAR image mode acquired data at a spatial resolution of ~30 metres with an image swath width of 100km, whereas Sentinel-1 has a spatial resolution of ~20 metres and a swath width of 250km. Therefore, the improvements are threefold; data volume, spatial resolution and spatial coverage. As with all data, free data comes with a responsibility in its use, therefore it is crucial that satellite imagery is assessed and managed by trained experts to ensure that the data is interpreted in a scientific and consistent manner. The question also arises that with the availability of free data is there now a ‘moral imperative’ to put this data to use in ways that clearly demonstrate environmental and social responsibility?

Where more frequent acquisitions are required by offshore operators, free data can be used as a foundation, which can be supplemented by commercial satellite imagery. Offshore Nigeria examples demonstrate various levels of coverage that can be achieved on a weekly basis by combining public and commercial satellite systems. The list of potential EO satellites currently in orbit to choose from, is long, thus the satellites considered in Figure 2 only represent a small sample of the resources available for exploitation. However, Figure 2 depicts the value in combining satellite systems in an intelligent manner that optimises coverage, cost and temporal frequency.

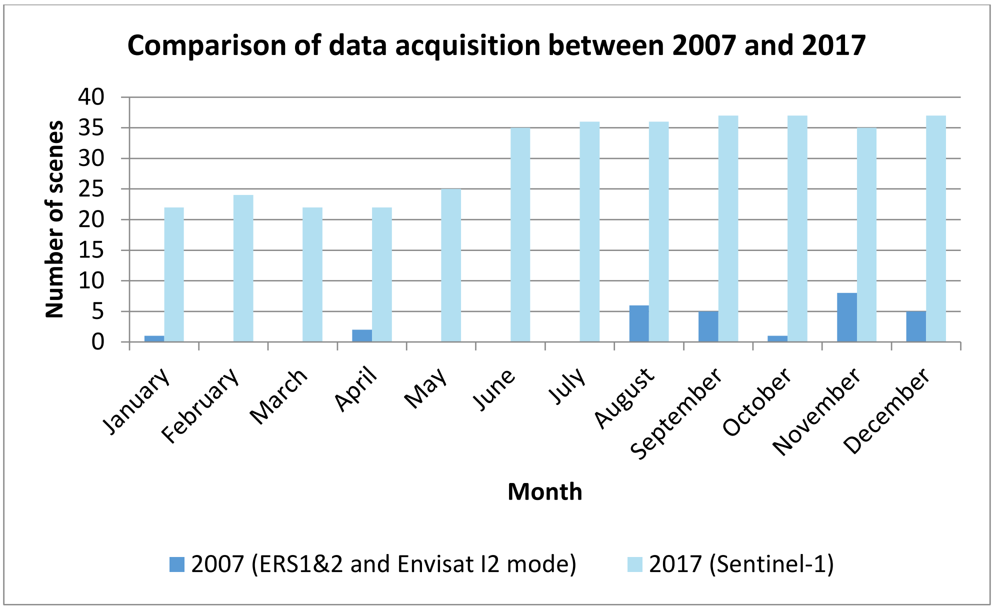

Figure 1 Comparison demonstrates the large increase in data acquisition due to ESA's Sentinel-1 mission (AOI – 56-57°N, 1-2°E)

In addition to free data and existing commercial systems, technological advancements are continuously broadening the capabilities of available satellite systems. A good example of this is ICEYE, the world's first microsatellite SAR. Due to its size it can be manufactured at a fraction of the cost of conventional satellites and thus more satellites can make up the constellation allowing very frequent revisits over the same location several times a day.

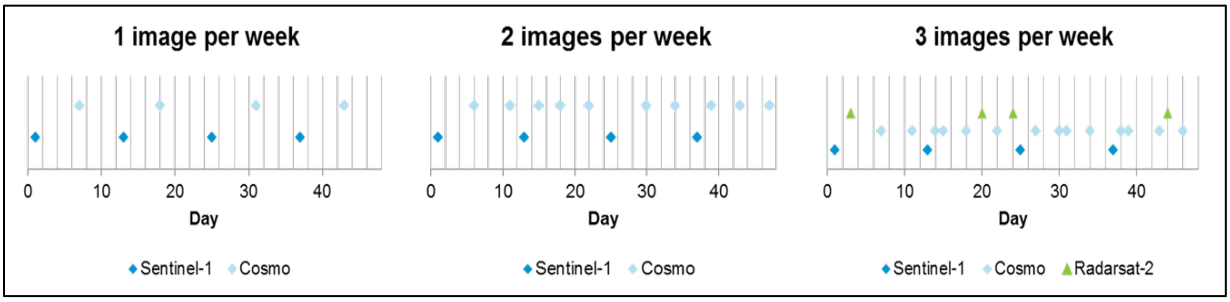

Figure 2 Example satellite acquisition scenarios using a mix of public and commercial systems to obtain varying levels of coverage per week

These disruptive Earth Observation technologies in the space sector provide step changes to the way in which industry can use data and the information it can provide throughout the oil and gas lifecycle; pre-operational environmental benchmarking, operational monitoring and evidence gathering, decommissioning and post decommissioning. Decommissioning of offshore oil and gas infrastructure is currently a very pertinent topic facing the North Sea area. Aging platforms and unprofitable fields are forcing wells into retirement, and various solutions have been circulated, concerning how much of the rig structure should be removed/left in-situ. Regardless of the final solution, an operators liability for the well will continue after it is decommissioned and abandoned, therefore routine monitoring programs need to be tailored to a level that will ensure ongoing environmental protection at a reasonable level of cost.

ESA's Sentinels operate on predefined observation scenarios that reliably acquire data around the world, and therefore may be sufficient for lower frequency, but consistent, observations. Conversely, many of the commercial satellites do not operate routine background acquisitions; therefore obtaining imagery over a particular area may only be possible if a routine monitoring schedule is set up. Incidents such as tanker spills are almost impossible to pre-empt in terms of their timing and locations, therefore routine monitoring is unlikely to be a beneficial or sensible option unless particular attention is paid to ports or narrow straits where volumes of marine traffic are high, and the risks of incident are elevated, or in environmentally sensitive regions where a spill incident could cause significant damage, such as the Great Barrier Reef. Offshore oil and gas operators could benefit from routine monitoring because the location of infrastructure is known, and although the timing of incidents are unpredictable, this proactive approach can provide a database of good practice, record events involving third parties, draw attention to potential technical problems, and provide a reliable existing plan that can support emergency scenarios when necessary.

Conclusion

The scope for using EO satellites for routine monitoring of offshore operations is continually expanding in ways that make factors of cost and time more feasible than ever before. Near-real-time processing and delivery remain the most appropriate solution for emergency scenarios; however, proactive monitoring programs can be undertaken to routinely acquire imagery over offshore infrastructure and environmentally sensitive areas, thus enhancing situational awareness for all interested parties. Increased awareness of activities and incidents occurring around offshore infrastructure can be compiled into a continually growing database to demonstrate good practise, provide an historical account of incidents, and feed into response scenarios.