UK Real Oil on Water Exercise – Remote Sensing Technology Tested and the Results

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Introduction

An 'oil on water exercise' is where a controlled volume of oil is released and successfully cleaned up. This oil on water exercise focuses on validating, under controlled scientific conditions, remote sensing technology for the detection of oil spills at sea.

The conduct of an oil on water exercise during 2017 was a major endeavour by OSRL and a key highlight for the year. The exercise, many months in planning, was designed to achieve multiple remote sensing objectives focussed on the validation and evaluation of the performance of remote sensing tools and techniques available in spill response in open water conditions.

The importance of surveillance has long been recognised as a critical part of oil spill response, acknowledged through the IPIECA-IOGP Joint Industry projects (JIP). Surveillance delivers accurate, relevant and timely information to facilitate strategic decision making, improving situational awareness and to allow the tactical support of operational assets to improve encounter rates. There are many different technologies that can be applied to surveillance. During a response the likelihood is that a range of sensor types and platforms will be required to monitor, track and respond to an oil spill.

A comprehensive set of exercise objectives were identified. The objectives included the validation of OSRL's UKCS surveillance aircraft sensor suite (Ultra-Violet, Infra-Red, and Visual sensors), surface and subsurface fluorometry. We also incorporated the use of Unmanned Aerial Systems (UAS) to support the tactical response of the surface vessel and evaluated the performance of autonomous systems. This enables us to understand the challenges around effective integration of these tools into response activities.

The exercise planning process and obtaining the necessary marine consents was a complex process requiring extensive stakeholder engagement and development of a robust risk mitigation strategy. The UK authorities granted a marine licence to permit the release of 500 litres of crude oil and the subsequent application of dispersant. The exercise plan was developed and submitted to the authorities, a consultation process was conducted and OSRL responded to stakeholder comments and addressed all concerns raised. Trajectory modelling conducted by OSRL was a key part of the planning process.

The exercise date and time was carefully selected to occur when multiple satellite acquisition opportunities coincided with lowest predicted tidal flows (to minimise the movement of the oil) and to maximise daylight conditions (to enable effective aerial observation). A single date in June was identified along with a backup in July in case of inclement weather conditions.

Main Results

OSRL maintains surface deployed fluorometry capability to conduct dispersant effectiveness monitoring using the established Special Monitoring of Applied Response Technologies (SMART) protocols. We conducted dispersant monitoring during this exercise using surface deployed fluorometry equipment from vessels to demonstrate the successful application of dispersant and provide a set of fluorometry data to be compared with the results from the Autonomous Underwater Vehicle's (AUV) fluorometry.

Two AUVs were deployed during the exercise, the first was a recently developed prototype micro AUV (EcoSub) designed to be easily transported and deployed in spill response situations. The second AUV (Slocum Glider) was a larger and commercially established product used for long range and endurance underwater monitoring. Both devices were equipped with multiple fluorometry sensors to detect and measure dispersed oil at different depths in the water column. These AUV's were deployed from a survey vessel to follow pre-programmed survey paths, targeting the areas where surface dispersant had been applied.

Application of AUVs to dispersant monitoring provides an opportunity to obtain increased data resolution which could expand dispersed oil monitoring above and beyond the scope the SMART protocols. One key learning from the exercise relates to the challenges associated with mission planning to ensure that the deployed device is programmed to a specific target point or path using heading and distance rather than latitude and longitude. The aim is for drift to occur at the same rate as the movement of any dispersed oil in the water column. These devices generate complex data sets, which require analyses to enable data interpretation and production of visual outputs.

The range of sensors and platforms provided data in multiple formats creating large data sets. This data required management and processing to maximise the benefit to the operation. A plan to manage the incoming data is recommended to enable the data to be utilised in the most effective manner such as displaying to a Common Operating Picture (COP) and supporting in-field response operations.

Shoreline survey using Shoreline Clean-up Assessment Technique (SCAT) was conducted using web enabled mobile technology. This technology enabled real time information to be sent to the incident command. The information collected was then processed and visually displayed quickly to allow real time 2-way communication to the in-field SCAT teams, for example re-tasking or reprioritising the SCAT team(s) to survey locations. Shoreline surveys were completed prior to, during and following the exercise.

We utilised two UAS and a surveillance kite fitted with a camera providing a live feed to tactically support the response activities. These systems provide a "birds eye" view of the response activities enabling the response vessel to target thickest patches of oil. These tools achieved this objective. The challenges associated with rotary UAS include limited duration flights which can be mitigated by having a large supply of charged spare batteries. The kite requires either sufficient wind speed or forward motion of the vessel to fly the kite. These tools provide an overhead constant-stare capability to the response vessels. OSRL has previously evaluated the benefits of UAS in exercises, however this was the first time that we had used them in an actual spill scenario.

Two aircraft participated in this exercise. OSRLs UK Surveillance aircraft is equipped with Infra-Red (IR), Ultra-Violet (UV) and visual sensors. One of the primary justifications for the exercise was the validation of these tools on real oil in open water conditions. The sensor manufacturers participated in the exercise and the results showed excellent performance at both identifying thicker patches of oil using the IR sensor as well as detecting very thin areas of oil using the UV sensor. Some of which were so thin they were unable to be identified using visual observations alone.

A second aircraft was equipped with the technology to collect hyperspectral imagery. This is an evolving and novel application of this technology which offers the potential to enable the derivation of oil characteristics based upon unique spectral signatures. The results of this part of the exercise demonstrate the potential of the equipment to add value in response. There remains a challenge to enable the image processing to be completed in a timeframe which is useful in a response. To safely conduct multiple aerial operations simultaneously in the same area, including surveillance aircraft and UAS, a detailed aerial deconfliction plan was developed and agreed in advance.

Satellite imagery is an established tool for detecting marine oil spills. Both Synthetic Aperture Radar (SAR) and optical satellites were tasked with acquiring images. Multiple images were acquired and analysed over the course of the exercise. Radar detection of marine oil spills relies on detecting a reduction in the reflected signal to the satellite caused by increased backscatter due to oil dampening capillary waves. Very low wind speeds on the day of the exercise resulted in exceptionally calm water conditions and so the radar satellites were not able to detect the presence of the spilled oil. Some detections were successful late in the day when the weather conditions had changed. The optical imagery was acquired between mid morning and early afternoon by which point most of the oil had been successfully dispersed.

During the exercise, multiple trajectory model simulations were completed using the actual weather and most up to date forecasts and compared to the observations of the day of the exercise. These models correlated strongly with the actual trajectory of the released oil.

500 litres of oil is a relatively small volume to release in an exercise in open water conditions. A maximum amount of 25 litres of dispersant was applied, targeting the spill after a one-hour monitoring window. As anticipated, the levels of dispersed oil in the water column were not high and the area affected limited. It was therefore challenging to position the AUV's to detect dispersed oil due to the limited volume of dispersant utilised. It was also challenging to differentiate between naturally dispersed and chemically dispersed oil. Nevertheless, the fluorometry data indicated increased fluorescence and the exercise demonstrated that the AUVs have the potential to provide significant benefits, which are more likely to be realised in spills of greater magnitude.

Supporting Images

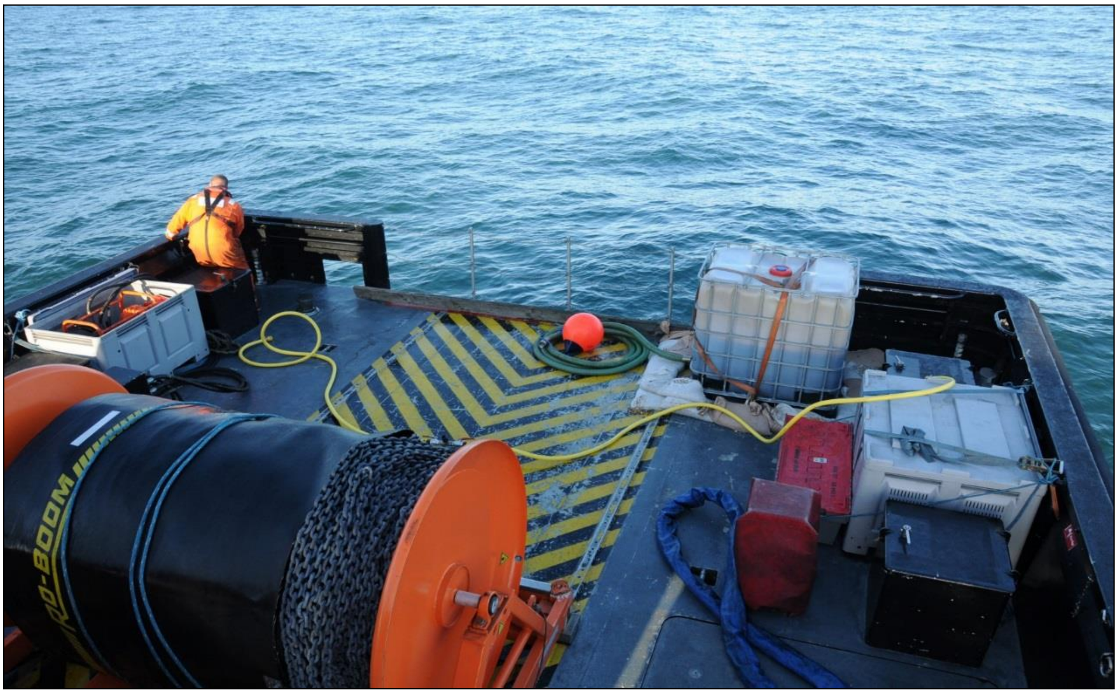

Figure 1 - Earl 2 Deck Preparation

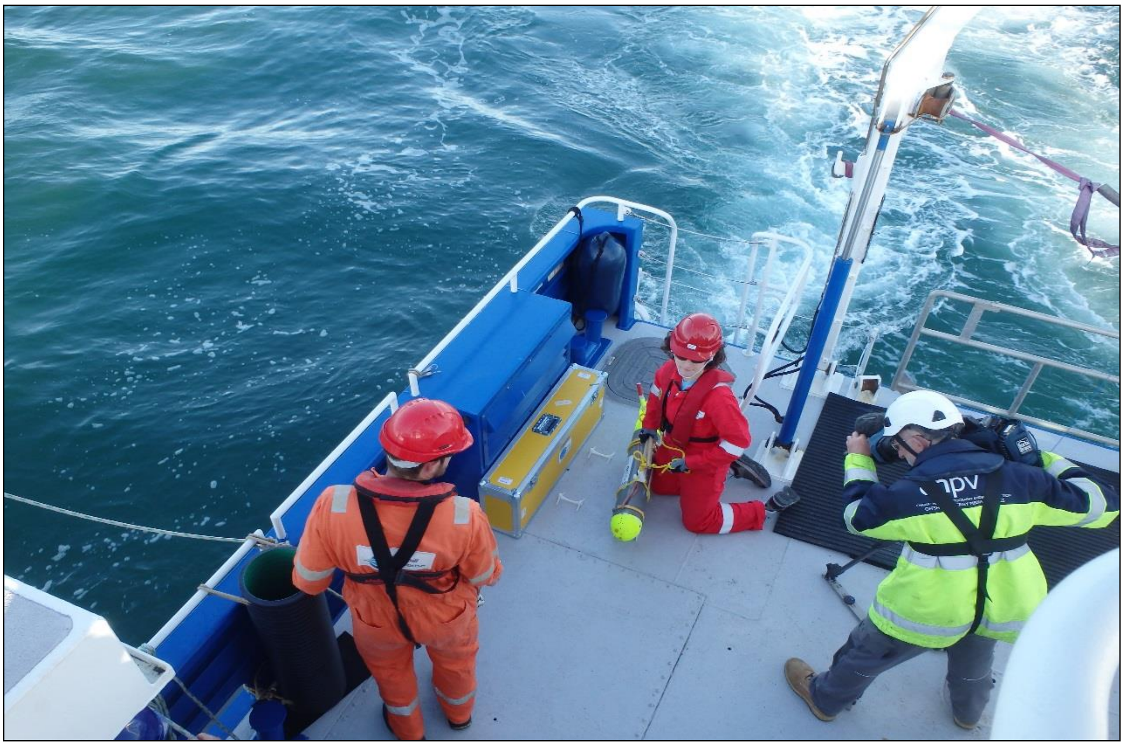

Figure 2 – Solent Guardian Autonomous Underwater Vehicle (AUV) launch preparation

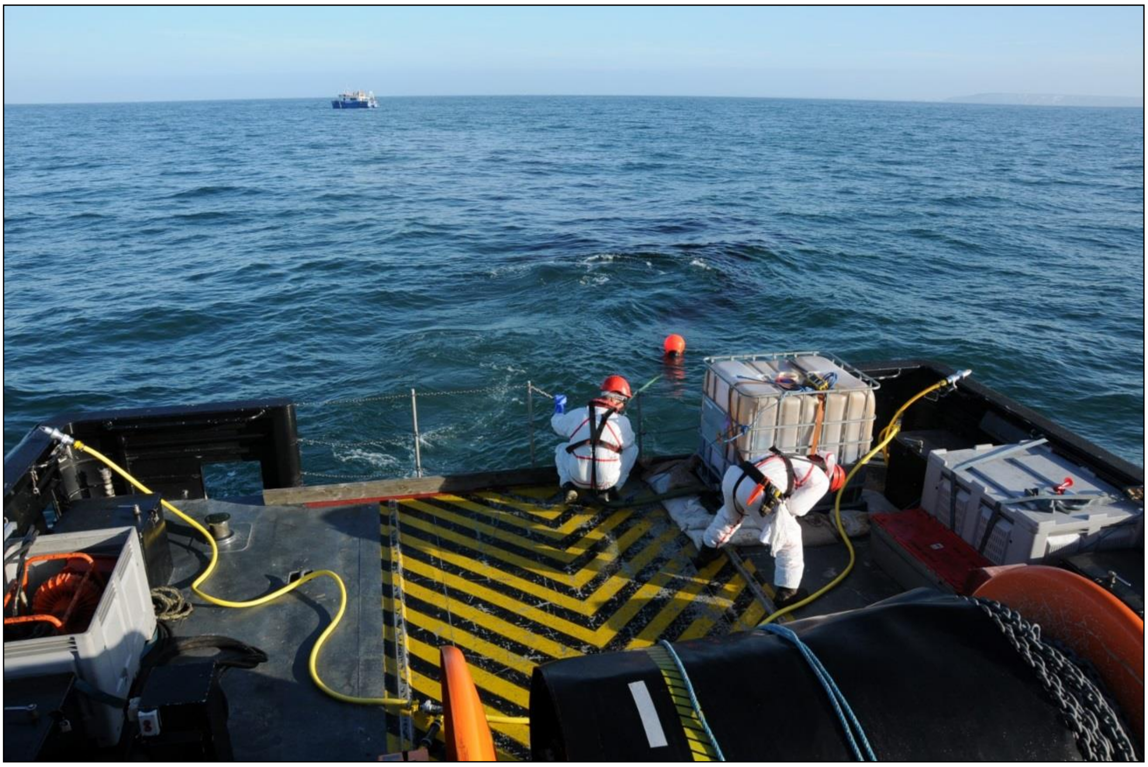

Figure 3 – 0650 Oil Release from Earl 2

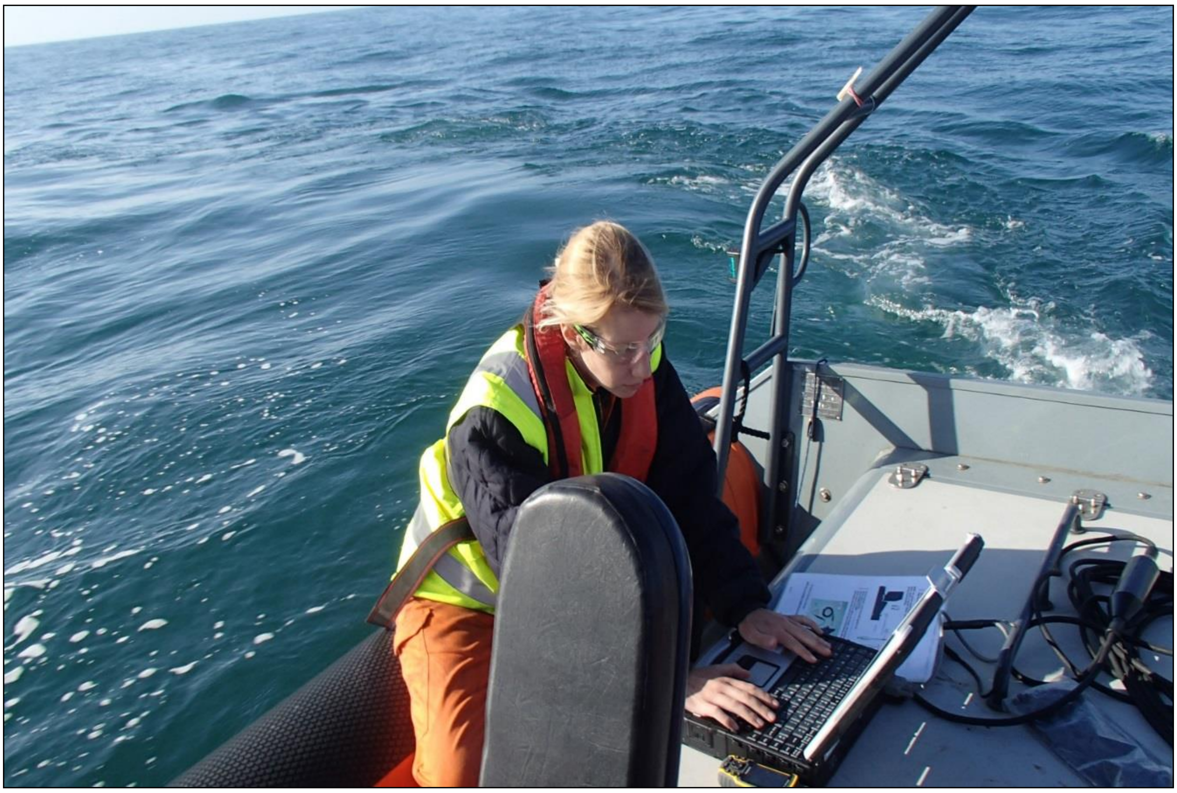

Figure 4 – Fluorometry from the Tigershark RIB

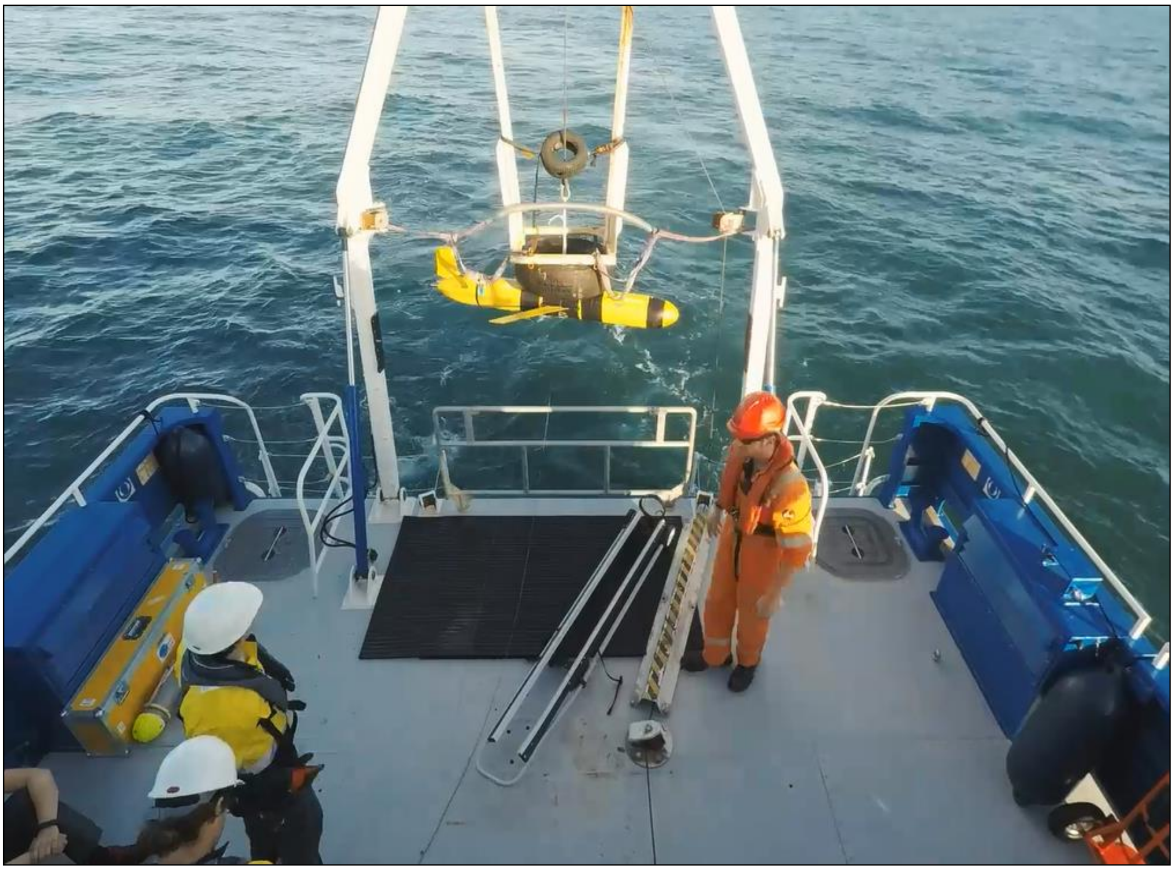

Figure 5 – The Slocum Glider AUV launching from the Solent Guardian

Figure 6 – The EcoSub AUV transiting through oil

Conclusion

The exercise highlighted the importance of retaining access to many different surveillance technologies rather than relying on any one tool. The exercise highlighted how the different surveillance tools provide information which, when collated and visually displayed helps to improve situational awareness. The exercise demonstrated the benefits and challenges with the different surveillance technologies and highlighted the importance of understanding how to apply and integrate these systems into a response to gain maximum benefit.

The exercise also demonstrated the importance of conducting this type of exercise. Whilst a real oil exercise is far more complex than a simulation where no oil is released, the opportunities presented to evaluate the performance of the different technologies against each other in open water conditions using a controlled, known volume release, are exceedingly valuable.

OSRL is continually ‘horizon-scanning’ available and emerging technology that has a potential to improve response to oil spills. This includes equipment being developed specifically to support oil spill monitoring and response as well as considering technology being developed for other markets which could be applied or re-purposed to oil spill response activities. This exercise provided a fantastic opportunity to evaluate and compare the performance of a range of existing and new capabilities including, both strategic information tools through to more tactical surveillance technologies. In addition, we had a special focus on the application of unmanned and autonomous systems for surveillance and monitoring.

This exercise provided a beneficial collaborative opportunity for service providers to work together with OSRL to gain a deeper understanding of how we apply and integrate these evolving technologies into oil spill response.

Acknowledgements

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