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Overview of surveillance tools in oil spill response – responders' view based on case studies

Marta Januszewska, OSRL (martajanuszewska@oilspillresponse.com)

ABSTRACT

With a growing market of new technologies in surveillance for oil spill response, it has become increasingly difficult for users to understand which surveillance tool is best suited for their requirements. Oil Spill Response Organisation's (OSROs) such as Oil Spill Response Limited (OSRL) require an easily-deployable, yet durable solution available to be utilised in a range of working conditions. The surveillance platform and type of sensor will be heavily influenced by the response scenario.

This paper provides an overview of surveillance platforms such as the surveillance kite, UAV's (Unmanned Aerial Vehicles) and tethered balloon utilised by OSRL in different response scenarios on real incidents. The examples include offshore and shoreline incidents and exercises with offshore and shoreline response elements. In each of the examples the focus will be on the advantages and disadvantages of the surveillance tool chosen for the task, and lessons learned from each case/experience.

INTRODUCTION

Following the principles of Tiered Preparedness and Response (IPIECA-OGP, 2015), surveillance, modelling and visualisation should be included in the capabilities for any response operation. Surveillance provides crucial information to the response team on the location of the oil spill, its size, type of spilled product and its trajectory. Offshore and shoreline spills are typically considered as challenging from a response perspective due to often acute weather conditions, remoteness or inaccessibility of the site. OSRL have been investigating various surveillance tools during a number of oil spills and exercises to fully understand their impact on improving situational awareness during an oil spill response.

There have been number of studies conducted on the subject of remote sensing and surveillance in oil spill response. They either focus on a specific type of surveillance platform, like satellites (Partington, 2014), UAVs (DeMicco et al., 2015) or offer a description of all tools available (API, 2013). OSRL on the other hand, has approached the subject from the end-user perspective and tested chosen tools in real-life scenarios.

METHODS

Surveillance tools were first examined considering their outputs, deployment ability during an oil spill, number of operators needed and range of weather conditions they could be operated in. Having no affiliation with manufacturers or developers of the surveillance systems, OSRL was unbiased in the choice of tools. As such, the focus was placed on matching the criteria set out by the responders, which are:

- Easy and safe deployment
- Gathering suitable data in easily readable format to support decision making
- Requirement of a small team to deploy the tool
- Adaptability to carry different sensors
- Deployment in a varying range of weather conditions

Based on these criteria, OSRL identified three tools - UAV, tethered balloon and surveillance kite. UAVs used in the Results section were all sourced locally from contractors already present in country. They were:

- Rotary UAV - DJI Phantom 4 with 4k camera for Trinidad and Tobago spill

- Rotary UAV - ARX Inspector or ARX Multirole with a range of remote sensors (42 mp camera with high definition zoom, infrared sensors (IR)) for Nigeria spill
- Tethered balloon - OCEANEYE was provided by a contractor including the deployable base unit, triple sensor unit capable of producing high resolution day and night imagery and vessel positioning with the embedded Automatic Identification System (AIS)
- The surveillance kite was purchased by OSRL as a package and consists of three kites for differing wind conditions, gyro stabilizer, action camera (GoPro HERO 4), picavet, transmitter and receiver.

RESULTS

Case studies

Inland/river oil spill in Nigeria

Location	Surveillance platform	Type of incident
Nigeria	Rotary UAV	Inland/river

In June 2019, OSRL responded to an ongoing well control incident in the proximity of Escavros, Nigeria. The exact location cannot be disclosed due to confidentiality. The well was on fire and releasing crude oil continuously. The spill site was located on low lying marshy land within the catchment area adjacent to a river, which made it accessible only with use of small vessels. Due to the fact that aerial surveillance could not be conducted for safety reasons, UAVs were the primary source of collecting surveillance data.

Figure 1 - Rotary UAV with its remote control used in Nigeria spill. The middle image shows the well blow out site.

Utilisation of UAVs provided a very valuable input without compromising the safety of personnel during the response operations. The UAVs allowed for improved proximity to the well head, permitting the well capping team to design and execute a very efficient capping plan. The information provided by UAVs also allowed for the preparation of a spill site specific booming plan.

The UAVs were sourced in country by the oil company and contracted for the duration of the incident to conduct daily surveys. The UAVs' company was quite well established in country, which assisted with getting necessary approvals to deploy the equipment at the spill site. Typically, availability of sourcing UAVs in country and getting necessary approvals in time, is the main obstacle for utilising this type of equipment for emergency response purpose.

Advantages	Disadvantages
• Proximity to the source of the spill • Safety of personnel not compromised	• Availability of the UAV in country • Regulatory approvals not in place

Offshore oil spill in Trinidad and Tobago

Location	Surveillance platform	Type of incident
Trinidad and Tobago	Rotary UAV	Offshore well blow out

In 2018, OSRL participated in an offshore clean-up operation located from Trinidad and Tobago. The source of the spill was an abandoned well, which lost integrity and was releasing oil and gas. Lack of available aircraft in country made surveillance with that tool impossible. The oil company responsible for the spill looked at other options for collecting surveillance data. Rotary UAV sourced in country, from a local provider, was utilised for daily surveys of the well and assisted with monitoring the trajectory of the slick.

Figure 2 - Drone footage from the spill site and an image of rotary UAV used for surveillance operations.

Containment and recovery operations were carried out every day with responders travelling to the source of the spill and searching for the slicks with thickest concentrations of oil. The response operation would carry on until the tides changed and the vessel had to alter position to continue with recovery of oil. Obtained UAV footage was primarily used by responders to establish the most efficient location to deploy resources and verify expected trajectory of the spill based on the tidal data and observations from previous days. The UAV survey was conducted once a day, so the data collected did not provide sufficient support to the changing conditions during the response operations. However, it proved very useful for planning the next day operations, and to compile a capping plan by the Incident Command.

Advantages	**Disadvantages**
• Proximity to the source of the spill	• Availability of the UAV in country

• Safety of personnel not compromised • Survey covered wide area	• Lack of ongoing support to response teams • Battery power and flight time

Offshore oil spill in India

Location	Surveillance platform	Type of incident
India	Tethered balloon	Vessel grounding

OSRL were mobilised in July 2018 for a container ship which was on fire and aground approximately 7.5 NM off the coast of Sundarbans National Park, close to the maritime border between India and Bangladesh. The vessel was carrying 350m^3 of HFO. The aerial surveillance and the response were hampered by inclement weather, meaning no overflights could be conducted until several weeks into the response phase. To aid with surveillance, tethered balloon (aerostat) has been mobilised by the polluter together with OSRL's response equipment from the UK.

Figure 3 - Deployment and the spill site image from the aerostat.

There was a significant delay in deployment of the aerostat due to lack of Ministry of Civil Aviation permits and adverse weather conditions. The aerostat was meant to assist vessels in salvage operations and oil recovery, however getting access to the spill site proved to be a challenge due to shallow water, and as such, only small and medium-sized vessels could be utilised. This also influenced the type of aerostat which could be used for the task. The response team decided to use Aerostat 100 with a smaller hoisting platform, which could be fitted on the support vessel located in the proximity of the stranded vessel. Aerostat did not provide the live feed to the Incident Command as expected. Due to this fact and the challenges in transferring the asset offshore, aerostat did not seem to be adding a lot of value to overall response and it has been stood down. The aerostat was only deployed once during the entire response.

Advantages	Disadvantages
• Easy deployment once transferred to the spill site	• Helium availability • Restricted access to the spill site (shallow water) • No live stream to the Incident Command • Weather dependent • Delay in getting permit for deployment of equipment

Offshore oil spill in the United Kingdom

Location	Surveillance platform	Type of incident
Isle of Wight, UK	Tethered balloon (aerostat)	Bunkering incident

In December 2017, OSRL was contacted regarding an incident onboard an LPG tanker during bunkering operations. The incident location was approximately 0.54 NM (1 km) from the coast of Isle of Wight, UK. Aerial surveillance was available, however the overflights were postponed due to low visibility and a low cloud base. Other assets were considered to aid with aerial surveillance and OSRL mobilised its aerostat. An aerostat was deployed from the vessel assisting the response.

	

Figure 4 - Aerostat during the deployment and oil spill identified by aerostat camera.

The primary task of aerostat was to verify the presence of oil and guide response vessels to the largest slicks. The deployment of aerostat was slightly delayed by operational decision and by the time it was deployed, the oil has mostly dispersed into small long streaks. Aerostat proved useful and an easy tool to confirm the quantities and location of oil remaining on the water surface.

Advantages	Disadvantages
• Low cloud coverage did not obstruct the use of Aerostat • The only tool available for surveillance	• Limited view • Personnel need basic training to deploy

Oil on Water offshore exercise in the United Kingdom

Location	Surveillance platform	Type of incident
Isle of Wight, UK	Surveillance kite UAV	Exercise

In 2017, OSRL organised an Oil on Water exercise off the Isle of Wight, UK, testing four main surveillance tools for the detection of oil spills at sea. These included satellites, manned aircraft, UAVs and Autonomous Underwater Vehicles (AUVs). The aims of the exercise were to ensure safe and coordinated practice, undertake the effective release of 500l of crude oil at the designated location, conduct vessel dispersant spraying, ensure the testing of various technologies were completed and that specified outputs were generated, keep stakeholders informed of exercise activities and compile results from the exercise informing internally and externally. To better showcase the technology used at the exercise, a visualisation centre was set up in OSRL’s base located in Southampton. The visualisation centre enabled a live viewing feed from the exercise location via body cameras and near real time data feeds from the surveillance kite.

Figure 5 - Surveillance kite used at the exercise and the image produced by the camera suspended on the kite.

The deployment of the kite was successful and showed that it can be utilised in a spill scenario with a minimum Beaufort wind scale of 2. The live feed provided by the kite camera was used by the vessel captain to steer the vessel toward the thickest patches of oil. Surveillance kite is a good alternative to other surveillance platforms such as aerostats or UAVs and do not have additional restrictions of permissions to fly, supply of helium or finite power source. In order to safely use kites, training, risk assessment and safe systems of work still need to be developed. However, they are relatively easy to use.

Advantages	Disadvantages
• Easy deployment • No permits required • No power source required	• Limited view • Weather dependent • Safety procedures need to be developed

The main role of UAV during the exercise was to tactically support operations on scene by targeting the biggest concentrations of oil for dispersant spraying or prop washing and improving encounter rates for recovery of oil.

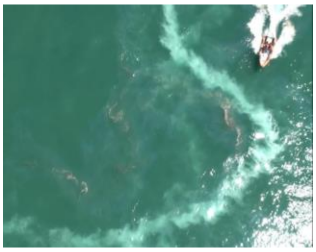

Figure 6 - Rotary UAV used on the exercise. Right hand side image is a photo taken by the UAV showing thick patches of oil. Left hand side photo shows the oil as captured by the IR camera mounted on the UAV.

The use of UAV during the exercise proved to be successful and greatly improved the communication and decision making between the responders and vessel captain. One of the main challenges for the UAV was battery life, which was overcome with a larger quantity of batteries available during the exercise. However, this caused a short period of downtime for the UAV to change batteries. Also highlighted during the exercise is the requirement for establishing pre-set location (home point) for the UAV in the event of losing the control link. One of the vessels was chosen as a pre-set location for the UAV, which meant that during the deployment of the UAV, it had to remain stationary and not participate in the recovery operations.

Advantages	Disadvantages
• Easy deployment • Variety of sensors available to be mounted on the platform • Good quality imagery	• Limited battery life • Requirement to establish home point • Permissions to fly • Limited flight time

CONCLUSIONS

Case studies provided a good overview of using different surveillance platforms in a variety of scenarios. It was noted that some of the tools performed with different results in the similar response scenario. UAVs seemed to be the most versatile and easiest to use among the tools. However, certain considerations have to be made before planning for utilising UAV during a response scenario. They are; the availability of UAV in country of response or possibility of bringing the UAV from abroad and the flight permissions. Aerostat and surveillance kite perform well in the scenario where responders can deploy them from the proximity of the spill site. All three tools will face challenges during the deployment in inclement weather conditions. The case studies have proven that in certain scenarios, having access to the variety of different tools in the response may prove to be very beneficial to fully understand their potential in improving situational awareness.

The next steps in advancing the use of surveillance tools in oil spill response should be creating a safe system of work and working procedures for deployment and handling of equipment. Efforts should also be made in integrating the tools and sensors in order to achieve the desired results in the short time frame, in an easily interpreted format.

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