Droning On: A review of UAV use in recent spills attended by ITOPF and considerations for the future

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Introduction

As a not-for-profit organisation, ITOPF devotes efforts to developing a wide range of technical services to promote effective spill response in the marine environment. ITOPF's technical advisers have attended on site at almost 800 spills since the 1970s, which has given ITOPF first-hand experience in the application of new and existing technology during an incident, for example by clean-up contractors, government agencies, media or surveyors etc.; one such example is Unmanned Aerial Vehicles (UAVs).

The use of UAVs was originally seen in the context of aerial warfare in the 20th century. The purpose of this being to prevent the loss of pilots' lives in military conflicts. UAV usage is now widespread across many professional sectors including but not limited to scientific research, environment, engineering and media. UAVs are made up of either fixed wing or rotary wing configurations of varying capability, complexity and expense. They are able to overcome some of the limitations encountered by other means of aerial and in situ observations. For example satellite observations can be constrained by the sensor's spatial and spectral resolutions, atmospheric conditions, revisit time and cost[1]. In most cases, fixed wing UAVs are able to fly longer distances, can carry a heavier payload and usually come at a higher cost than rotary wing. Hence, rotary wing UAVs are much more accessible to small companies and the public. The European Maritime Safety Agency (EMSA) has demonstrated that a fixed wing UAV can have multiple uses, subject to the sensors on board; coupling the detection of oil with an emission sensor/sampler system to test ship emission plumes.

This paper discusses the considerations for the use of UAVs at future oil spill incidents, based on its experience with other parties who have used the technology on site over a three year period, November 2014 to November 2017.

Main Results

Between November 2014 and November 2017, ITOPF attended 55 incidents in 33 countries where oil or hazardous and noxious substances were spilled or threatened to spill into the marine environment. Throughout this three year period, an increased use of UAVs by media and/or response operators in at least a quarter of incidents was observed. Figure 1 categorises UAV usage at these incidents. In all cases, the UAVs were of rotary wing configuration, with visible imaging capabilities. The following observations were made.

The benefits associated with UAV operations, witnessed during ITOPF attendance on-site are summarised below.

- Government agencies have posted UAV footage of a casualty and associated oil spill on their websites to inform, notify and reassure the public of a response. Subsequently, the footage has been used by international media agencies and shared across social media accounts.

- Oil spill response contractors have employed UAV footage, either taken by themselves or through a UAV specialist, to enable shoreline monitoring and assessment to be performed quickly and with photographic and video evidence. This footage has been also used for their own public relations and promotional purposes.

- UAVs have proven to be highly versatile along a variety of shoreline types, including difficult to access areas, in order to perform prompt preliminary survey assessments and recurrent monitoring. Such surveys would traditionally have been performed by helicopter, by boat, or on foot.

- UAVs have been used to examine oil response equipment condition and efficiency. For example, an oil recovery skimming system (Current Buster) and booms have been monitored by UAVs to determine whether replacements, cleaning or removal is required.

- Trajectory maps have been validated with the help of UAV footage. With more precise and frequent inputs of an oil slick's position and weathering, trajectory maps can be made more accurate and therefore benefit response planning.

- During an incident where oil spilled into an area of high vessel traffic, UAVs were used by a contractor to examine and document the condition of vessels' hulls before and after passing through the slick. This main purpose of this was to identify affected vessels and anticipate claims for compensation for hull cleaning work.

- UAVs have been deployed in areas which presented significant health and safety risks. In a dangerous environment, where human health would be put at risk, for example by undertaking surveillance from a helicopter or a boat in high vapour levels, a UAV has overcome the safety concerns, allowing continued monitoring of the incident.

Notwithstanding these benefits, the use of UAVs may be disadvantageous, particularly if the equipment is not operated responsibly or with clear coordination. A number of challenges involving the use of UAVs have been observed, as discussed below.

- The limitations of the optical equipment on UAVs have prevented surveillance at night or in areas of minimal lighting. The UAVs encountered by ITOPF at spill sites have captured only visible imagery, rather than using other sensors such as hyper spectral imagers, LIDAR (LIght Detected And Ranging), synthetic aperture radar, and thermal infrared sensors. At the beginning of the three year period, these sensors were and still are being developed for use by UAVs[2] and although specialist sensors are now available they are not common within the retail and commercial markets.

- As with more traditional aerial observation, for example by helicopter, the reflection of sunlight on the sea surface also made identifying oil difficult and care must be taken to ensure that angle of incidence is optimised to improve the visibility of oil.

- A UAV was deployed to conduct aerial surveillance in a country that at the time did not have any laws or regulations regarding the equipment's use. Due to operating near an airfield, safety concerns arose and regulations were introduced ending UAV operations during that response. The legislation stated that operators of UAV's henceforth had to be commercially licenced, which then involved approvals from communication and aviation authorities.

- A UAV was used by a contractor in a transboundary incident. Upon crossing the border, the UAV was taken under control and confiscated by government officials and UAV operations were ceased.

- A helicopter was mobilised to conduct aerial surveillance by a command centre at the same time a UAV had been deployed. Care had to be taken to ensure both platforms did not interfere in each other's airspace. Each platform offers distinct advantages, however unless a clear delineation of purpose and objective exists, synchronous use of both UAVs and aerial observation is an unnecessary and unreasonable duplication of effort as well as a potential increase in risk.

- Accessibility of UAV equipment may have also led to the increased media coverage through the use of UAV footage. At least eight incidents attended involved journalists mobilising their own UAV equipment and members of the public uploading footage from personal UAVs to social media accounts. Ease of access to such UAV footage allows the wider public to scrutinise response operations to a significant degree often with little time delay. This places added pressure on response agencies, particularly where the limitations and difficulties of pollution response are not widely understood, or are ignored, by the public. Furthermore, the ready availability and relative ease of operation of UAVs, has led a number of government agencies to place restrictions on their use at incidents to allow 'official' flights to operate safely and unimpeded.

- Many UAVs are unable to operate in bad weather, particularly in high winds or rain that may otherwise not prevent helicopter flights or boat operations. National restrictions may also prevent use of UAVs. Direct visual observation of oil may in some instances be preferable to viewing via UAV footage. As a consequence, a number of scenarios exist in which the more traditional forms of surveillance may be preferable.

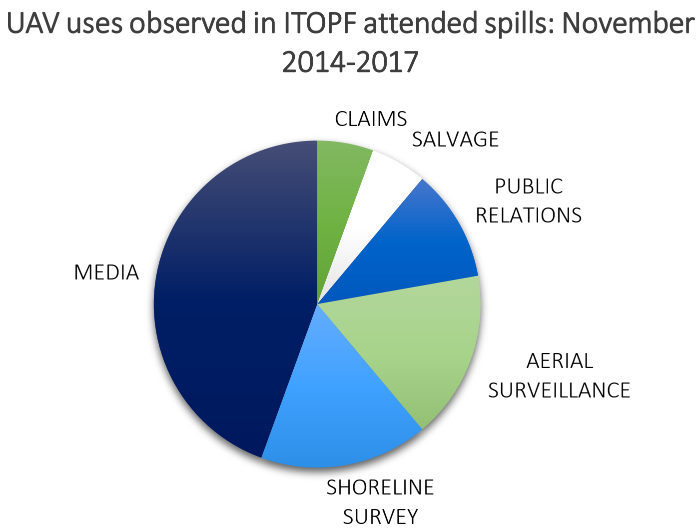

Figure 1: This figure represents the range of UAV deployment purpose ITOPF has observed onsite at oil spills around the world, between November 2014 and November 2017. Media incorporates amateur as well as professional reporting.

Conclusion

From ITOPF's experience UAVs can assist during different stages of an oil spill, from assisting with initial assessments of the extent of pollution damage, to monitoring clean-up operations and providing evidence to support subsequent claims for compensation. In particular, UAVs have proved advantageous in areas that are logistically challenging, for example due to health and safety concerns. They can offer a possible alternative to conventional manned and satellite platforms for acquiring high-resolution remote-sensing data at lower cost, increased operational flexibility, and greater versatility.

Some maritime agencies, such as the EMSA, have a well-developed range of specialised fixed wing UAV equipment available for use by European countries[5]. However, this equipment is expensive, must be used by trained professionals and is not readily available to the same extent as the consumer grade rotary wing UAV.

UAVs are used increasingly in a range of other industries, for example, rotary wing UAVs in photography. As this technology spreads globally, it may be possible to find experienced UAV operators to support a spill response, however, it is likely that some training is required to maximise the utility of their footage to the specific needs of an oil spill operation. The production of guidelines that draw on past experiences to create best practices can help facilitate this training, potentially including:

- a rapid tool for deciding the appropriateness and configuration of a UAV for the situation at hand,
- templates for flight plans,
- optimal operational parameters for different shoreline substrates,
- guidelines to assist in interpreting UAV footage,
- information on different sensors and filters and,
- methods to maximise the safety standards of UAV operations.

Future Work

Future work to develop an operational field guide to emphasise considerations discussed in this paper could prove useful in the field to assist governments, field operatives and non-specialist drone pilots etc., whom are inexperienced with UAV use in oil spills. However, given the multi-faceted nature of the subject, this would best be developed in conjunction with a number of agencies, presenting an opportunity for collaboration to produce a guide that represents cross-sector opinion. Such a guide would benefit from development under the auspices of an intergovernmental association and could include cooperation between parties such as oil spill response contractors, aviation safety organisations, regulatory agencies, the International Civil Aviation Organisation (ICAO), the International Maritime Organisation (IMO) and UAV specialists.

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