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DRONES IN
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Best Practices in UAS/RPAS Search and Rescue – use in Water and Flood Rescue Lifesaving

Author: David Lane MIFireE, AssocRINA, FRIN
Director of SAR and Water Rescue Academy, Poole, UK.
Director of Operations of SLSGB Flood Response Service.
E: prorescue@btinternet.com

Author: Gemma Alcock
Director of The SkyBound Rescuer Project – SAR UAS Research.
E: skyboundrescuer@gmail.com

BEST PRACTICES IN UAS/RPAS SEARCH AND RESCUE – USE IN WATER AND FLOOD RESCUE LIFESAVING

Picture: Irish Examiner

1. INTRODUCTION


Pictures: www.uavexpertnews.com
Gene Robinson

- Objective of this paper is to provide Emergency Services with guidance on how to employ remotely piloted aircraft system (RPAS) for water and flood search and rescue (SAR) operations.
- Highlight present areas of weakness for development considerations.
- Implemented correctly, this technology stands to offer significant value to water and flood SAR operations – but without a coherent RPAS Concept of Operations (CONOPs), maximum effectiveness cannot be achieved.
- This paper has been formed in a strategic manner; it begins by highlighting use cases, followed by a thorough technology analysis for selection, culminating in guidance for RPAS CONOPs generation.
- Emergency Services should strive to follow a similar process in reaching for effective RPAS integration.

TERMS AND DEFINITIONS


Pictures: www.uavexpertnews.com
Gene Robinson

- Terms "Unmanned Aerial Vehicle" or "UAV", and “Remotely Piloted Aircraft” or “RPA” have both become common within the industry.
- UAVs/RPAs more widely known by colloquial name of “drones.
- UAV/RPA can mostly only be operated as part of a system, so the terms "Unmanned Aerial System" or "UAS" and “Remotely Piloted Aircraft System” or “RPAS” have become widely utilised.
- Typical UAS/RPAS consists of:
- UAV/RPA, a remote pilot station – also known as a Ground Control Station (GCS), and the command and control (C2) communication links that join.
- Term “unmanned” can be misconceiving; legally speaking, the RPAS must always remain “manned”.
- Despite a proliferation of terms:
- RPAS can be defined as "a powered aerial vehicle that does not carry a human operator. It is designed to be recoverable, and can either fly autonomously or be remotely controlled." (Marketline, 2014)

CLASSIFICATIONS


Picture: Insitu

- **DISTINCT RPAS CONTROL CLASSIFICATIONS:**
- “remotely piloted” - self-explanatory and
- “autonomous” aircrafts - “an unmanned aircraft that does not allow pilot intervention in the management of the flight”. (ICAO, 2011) Aircraft is capable of taking off, landing, and flying itself but with human supervision and intervention where necessary.
- **ASSET TYPE**
- Emergency RPAS is a tactical, organic asset that will travel with response staff and thus is immediately available and used on demand.
- In contrast to what Emergency Services currently use for aerial assistance – a strategic asset, such as a Coastguard helicopter, which is deployed and tasked by an agency that then passes and filters information to the tactical teams as it becomes available.

CLASSIFICATIONS
AIRFRAME CATEGORIES


Picture: Insitu

Two categories of RPAS:

fixed wing and multi-rotor.

- FIXED WING RPAS

Fixed wing RPAS have the following characteristics:

Fixed wing RPAS have solid aerofoils and will depend on moving through the air to generate the required lift to remain airborne;

Require a means of propulsion, which may be an electric or internal combustion engine driving a propeller, or a jet engine; and

Range in size from tiny, hand-held electrics to 737-size jets. (NSARC, 2016)

- MULTI-ROTOR RPAS

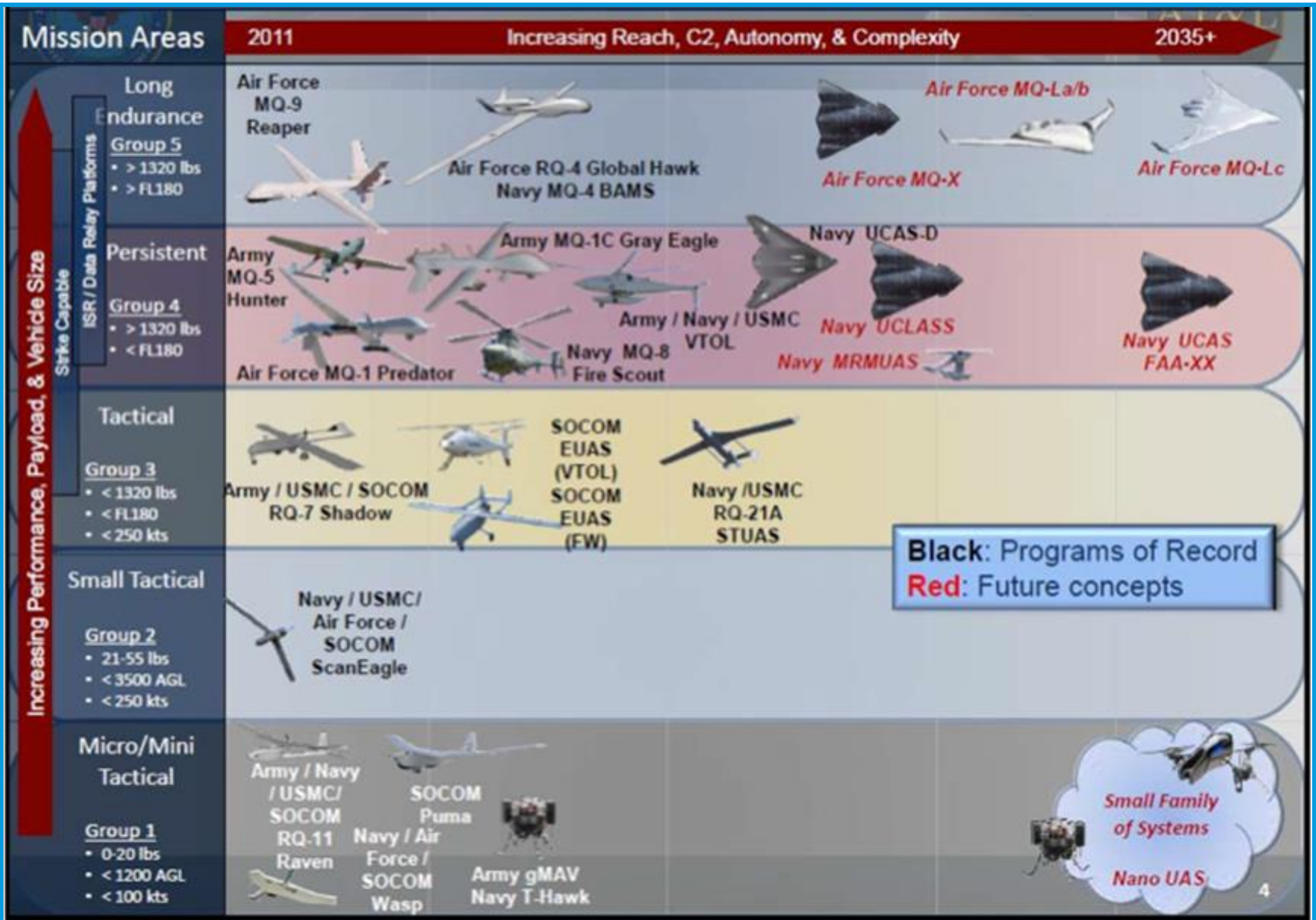
Multi-rotor RPAS have the following general characteristics:

Use multiple spinning propellers to generate lift, independent of airframe movement; and

Have the ability to hover – remain motionless – over a target area. (NSARC, 2016)

CLASSIFICATIONS
AIRFRAME CATEGORIES & SIZES


Picture: Insitu



Source: UAS SAR Addendum to the National SAR Supplement to the International Aeronautical and Maritime SAR Manual, NSARC

CHAPTER 2:
RPAS IN WATER RESCUE


Picture: Alligator Drone and UAV Technology

Higher height of eye is of the greatest advantage to search teams.

Until recently Emergency Services have been relying on the costly involvement of (SAR) helicopters for an aerial view.

Introduction of small affordable RPAS into commercial market became a game-changer to the SAR domain.

Small RPAS cannot physically conduct a rescue or casualty extrication like manned SAR helicopter can.

There can be no rescue without first locating the casualty - emphasises how RPAS capabilities can save life.

As costs fall and capability rises, RPAS technology is vastly becoming a serious contender as the go-to asset for higher height of eye advantage, the boost this technology can offer Emergency Services towards saving lives should not be underestimated.

RPAS are not a replacement for manned air units, should be considered a force multiplier, to “provide the Incident Commander with a new set of tools in order to make informed decisions”. (Kessler et al., 2015)

CHAPTER 2:
RPAS IN WATER RESCUE


Picture: Alligator Drone and UAV Technology

Ultimately, main functions of SEARCH AND RESCUE (SAR) team are to:

LOCATE – define specific location of point last seen or identify casualty location

ACCESS – establish rescue teams access to the casualty and safe EGRESS from the scene (with casualty) by appropriate transport methods e.g. walk/wade/boat/helicopter. ASSESS equipment requirements.

STABLIZE – scene environment, medical and physical stability to secure casualty

TRANSPORT – transport of casualty and rescuers to safety

RPAS technology offer many capabilities that can greatly assist the LOCATE and ACCESS functions of the SAR operation.

Emergency Services, SAR agencies, and First Responder communities all have different requirements and not all would benefit from RPAS as part of their toolkit.

We'll focus on water-related SAR practices – in both maritime and flood environments.

All other forms of SAR are out of scope for this research piece.

CHAPTER 2:
RPAS IN WATER RESCUE

Picture: Alligator Drone and UAV Technology

- ‘Search’ element of ‘search and rescue’ is a complex, arduous, time-consuming, and costly task.

  (Office of SAR US Coast Guard, 1996)
- This justifies developing more efficient search procedures, like implementing RPAS for “rapid search and clearing of large open areas to conserve ground personnel”. (NSARC, 2016)
- Uncertainty regarding the location of casualties in a marine environment increases rapidly with time, therefore faster methods will increase chances of survival.
- In resource restricted worlds where budget cuts frequent, manned aircraft and highly skilled crews they require may be otherwise tasked or unavailable.
- Report for UK’s Her Majesty’s Coastguard (HMCG) helicopter service said very few searches took place more than 3 nautical miles out to sea; 9 callouts for maritime search over a 3-month period (UK Government Department for Transport, 2016).
- Same time the Royal National Lifeboat Institution (RNLI) were tasked to over 2,000 maritime SAR incidents, in stark constant to what the HMCG statistics report suggests. (RNLI, 2015)
- HMCG helicopters rarely deployed to search only tasks due to their lengthy response time and expense, despite their inherent height of eye advantage necessary for rapid search. Into the future, RPAS may be the only aerial asset option available in a search-focused operation.

CHAPTER 2:
RPAS IN WATER RESCUE
SITUATIONAL AWARENESS

Picture: Alligator Drone and UAV Technology

In emergency situations, one of the first requirements is to gain up-to-date situational awareness information of highest quality available and as quickly as possible;

Therefore RPAS is a key strategic asset by:

- Increasing the safety of the first responders but also
- to support better decision-making by
- providing videos and images to the Incident Commander on the ground.

During severe floods, all that was known about an area prior to a flood becomes secondary data.

It may no longer be true. And until it is confirmed it cannot be reliably acted upon.

Added to the challenge of holding potentially inaccurate situational information about a flooded area are sudden gaps in information: Where are on-going hazards, such as strainers or weirs? Are there sources of contamination as a result of the flood? An RPAS could supply the IC with this crucial real-time information, before sending teams into unknown hazardous areas.

CHAPTER 2: RPAS IN WATER RESCUE

REAL CASE STUDIES


Picture: EUWatersave Project

- How RPAS can aid during water-related incidents, we examined a selection of real-life use cases where RPAS have made a difference for personnel. Here are some:

WEST MIDLANDS FIRE SERVICE: MISSING CHILD

- The UAS "negated having to put responders into a potentially dangerous situation by having to search the whole of the lake in very poor weather conditions." (NSARC, 2016)

AUBURN, MAINE FIRE DEPARTMENT: LITTLE ANDROSCOGGIN RIVER RESCUE

- A teenager and young boy tubing on the Little Androscoggin River were knocked off their tube and became stranded on rocks in the middle of a strong current. Only the boy was wearing a life jacket. A responding fire fighter used his personal drone to deliver a line attached to a lifejacket to the teenager, who was able to pull it to himself. The fire fighters used a rescue boat to recover the boy, and then the teenager. (NSARC, 2016)

THE MEMORIAL DAY FLOODS, MAY 23, 2015 – WIMBERLEY, TEXAS

- The 2015 Texas Memorial Day Floods are now being labelled a "millennial flood"; On the Blanco River in Wimberley, water rose rapidly, reaching what was described by first-hand observers as a "wall of water" estimated to be 40 feet high.
- The Wimberley unmanned aviation unit performed three different operations throughout the flood. (Kessler et al., 2015)

CHAPTER 3: RPAS SELECTION

Picture: www.service-drone.com

The RPAS model an Emergency Service purchases dictates what RPAS capabilities they have and the level of performance they can achieve, thus making RPAS selection an integral variable in establishing best practices.

EENA / DJI Pilot Project Report highlighted the following as the minimum RPAS configuration for first responders:

1. Reliable platform with redundant system; i.e. dual IMUs (Inertial Measurement Unit, an electronic device that measures and reports a body's specific force and angular rate and allows a RPAS to work when there is no GPS), dual compass, dual battery etc.

2. GPS and GLONNAS (satellite-based radio navigation system run by the Russian Ministry of Defence) systems

3. Integrated camera systems, preferably modular, with live downstream capabilities in HD format

4. Able fly in moderate winds and light rain

5. Integrated SDK (Software Development Kit) so specific apps can be written to help operators. E.G. the DJI/DroneSAR Search and Rescue app, DroneDeploy for 2D and 3D mapping etc. (EENA, 2016)

Several organisations claim to offer "search and rescue drones", yet seem to be simply transferring a consumer or commercial RPAS into the SAR market without any or very little adaptation. SAR RPAS needs to be more than just a consumer/commercial RPAS with a thermal camera attached to it; its SAR capabilities need to extend further than its payload. For this reason, airframes have been analysed for their SAR use separately to payloads.

CHAPTER 3: RPAS SELECTION

AIRFRAME SELECTION

Picture: www.service-drone.com

Most Emergency Services seem to have converged on small multi-rotor RPAS as the default platform, fixed wing models should not be dismissed.

This section examines both airframe categories for use in water and flood SAR applications:

Picture: Pinterest

Fixed wing strengths:

- Will generally have longer range, higher speed, and greater payload capability than a similarly sized multi-rotor RPAS; and
- Will usually be able to fly at a higher altitude.

Fixed wing weaknesses:

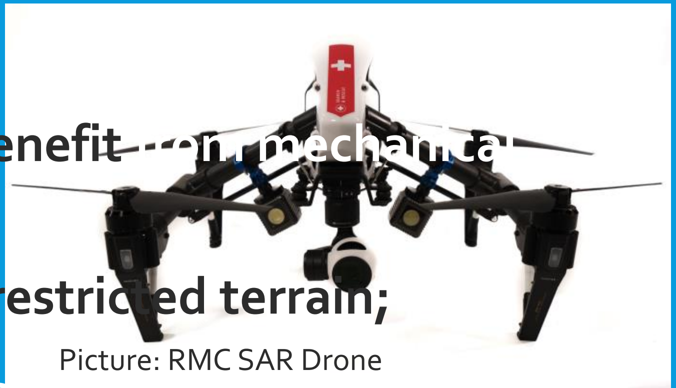
- Most are limited by the need to take-off and land laterally, so terrain will affect launch and recovery sites;
- Cannot be used in restricted or congested areas because of their requirement to move through the air to generate lift; and
- Without a stabilised camera, video imagery from a fixed wing RPAS can be difficult to interpret due to the constant airframe motion.

CHAPTER 3: RPAS SELECTION
AIRFRAME SELECTION

Picture: www.service-drone.com

Multi-rotor strengths:

- Multi-rotors, with three, four, six, eight, or more powered rotors, benefit from mechanical simplicity and redundancy in higher-number configurations;
- Have the ability to launch from, manoeuvre in, and recover to very restricted terrain;
- Can provide a steady video picture from a stationary, top-down perspective.


Picture: RMC SAR Drone

Multi-rotor weaknesses:

- Hovering requires more power than fixed wing flight, so multi-rotor platforms will have shorter flight-times, lower top speed, and lower altitude limits than equivalently-sized fixed wing airframes.

Given Emergency Services' clear preference towards small multi-rotor RPAS, the ability to hover and ease of launch/recovery must outweigh the requirement of long endurance.

CHAPTER 3: RPAS SELECTION

PAYLOAD SELECTION

Picture: www.service-drone.com

RPAS have evolved from a flying device to become a data collection device, and the type of data that it can collect is defined by the choice of payload.

RPAS technology currently lacks adversarial compatibility, i.e. the airframe selected is highly likely to significantly restrict the payload choice. Therefore, choose payload prior to selecting an airframe, as the payload is the component of the system that adds the most value.

USA's National Search and Rescue Committee (NSARC) have divided remote sensing into four functions, each requiring greater resolution to accomplish:

1 Surveillance: Wide-area observation of an area, providing general awareness of terrain or environment;

2 Detection: The ability to distinguish an object from the background (e.g. heat source, white/orange object);

3 Classification or Recognition: The ability to determine what type of object has been detected (e.g. person, bird, buoy, etc.); and

4 Identification: The ability to determine the exact identification of the object (e.g. vessel characteristics, car make and model). (NSARC, 2016)

CHAPTER 3: RPAS SELECTION
PAYLOAD SELECTION

Picture: www.service-drone.com

Essential functions for the conduct of SAR operations are **detection** and **recognition**. (NSARC, 2016)

Given this relatively high level of remote sensing required for SAR, a given RPAS and its sensors' specifications may limit its applicability for this application.

It may not be able to look closely enough to identify a search object, or may not be able to sweep large areas with sufficient resolution to detect an object.

Therefore, it is vital for SAR personnel to be able to decipher RPAS payload specifications.

Only the specifications of the two most commonly used payloads amongst response staff will be explained within our paper – **visual cameras and thermal cameras** – but Emergency Services should strive to achieve a similar level of understanding should they choose to purchase one of the many other payload options available, e.g. LiDAR, low-light cameras, multi-spectral sensors, etc.

Picture: www.service-drone.com

CHAPTER 3: RPAS SELECTION

PAYLOAD SELECTION

In our paper we attempt to explain the theory of both visual and thermal cameras in sufficient detail to provide the general reader with a practical understanding of the subject, but the level of the mathematics and science used was kept to the minimum required to achieve a pragmatic appreciation of the necessary concepts.

Mathematical and scientific rigor may be found in the references provided in the bibliography for readers who require it.

CHAPTER 3: RPAS SELECTION

PAYLOAD SELECTION - VISUAL CAMERA - CONSIDERATIONS

Picture: www.service-drone.com

Electro-optical (EO) sensor sensor's size has a direct impact on quality.

Many Emergency Services use the DJI's Inspire and Zenmuse X3 combo.

Yes considered a professional level videography RPAS.

However, their sensor is a mere 6.17mm in contrast to a professional standard DSLR that wields a 35mm sensor size.

Megapixels figure – also considerably influences image quality.

More is more, is better!

CHAPTER 3: RPAS SELECTION

PAYLOAD SELECTION - VISUAL CAMERA - CONSIDERATIONS

Picture: www.service-drone.com

Camera's optical lens system will define a FOV in degrees, which at a given range will span over a calculable distance. Imagine a camera with 5 degrees FOV that spans 175 metres, using Pythagoras' Theorem its range of 2km can be calculated.

For example, a 1920 x 1080 HD image with a 5 degrees FOV that spans 175 metres wide means each pixel accounts for 9.1cm across of the scene.

Whereas a 1080 x 720 HD image with the same setup means each pixel represents 16.2cm across.

In both examples, this is the minimum detail that can be observed, and will affect the ability of the operator to spot objects in a scene. Each pixel is the recorded light, contrast, etc., which adds to detail; therefore the smaller the area covered per pixel, the better the captured detail.

Furthermore, the effective resolution available to the viewer will be further affected by the viewing system. A HD sensor is only SD if viewed on an SD screen, not only this, FPV screen size will also effect detection and recognition capabilities.

CHAPTER 3: RPAS SELECTION

PAYLOAD SELECTION - VISUAL CAMERA - CONSIDERATIONS

Picture: www.service-drone.com

Aperture also plays a part in capturing sufficient detail.

Aperture controls how much light enters the camera.

In sunny conditions, a wide aperture will cause overexposed footage. Overexposure removes all detail and gives a very white image, which will obviously impact performance of emergency RPAS use, and this effect will be augmented further by reflection off the water. While aperture can often be adjusted on handheld cameras, RPAS visual spectrum cameras usually come with a fixed aperture to minimise weight and size.

Solution is neutral density (ND) filters. ND filters reduce the amount of light that enters the lens, "sunglasses for a camera". They are available in a variety of ratings depending on how much light needs to be blocked from entering the camera. Source: The SkyBound Rescuer Project

Visual image is often regarded as the most basic data for a RPAS to collect, there are still numerous variables that will impact performance.

Conclusion: to reach maximum efficiency, all variables need to be understood and purchasing decisions need to be thoroughly backed up with research and evidence; ultimately, the choice of technology purchased will decide how much an RPAS can help with emergency response.

CHAPTER 3: RPAS SELECTION

PAYLOAD SELECTION - THERMAL CAMERA

Picture: www.service-drone.com

Aerial thermal cameras offers vast opportunities to the SAR community.

But only when the correct one is chosen.

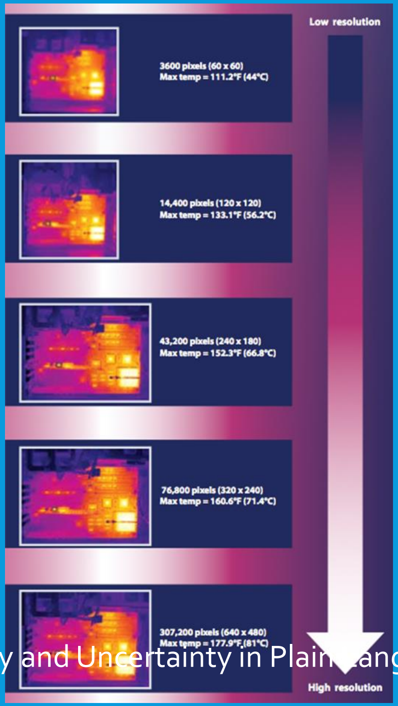
Key performance criteria of a thermal camera needs to be explained in plain language.

Firstly, infrared wavelengths - too long for the human eye to detect; it is the part of the electromagnetic spectrum that is perceived as heat.

Infrared is split into categories based on wavelength:

- near-infrared,
- short-wavelength infrared,
- mid-wavelength infrared,
- long-wavelength infrared,
- far infrared.

The “thermal imaging” region usually concerns the latter two types.



Source: Infrared Camera Accuracy and Uncertainty in Plain Language, FLIR

CHAPTER 3: RPAS SELECTION

PAYLOAD SELECTION - THERMAL CAMERA

Picture: www.service-drone.com

The “thermal imaging” region technology usually concerns:

- long-wavelength infrared, and far infrared.

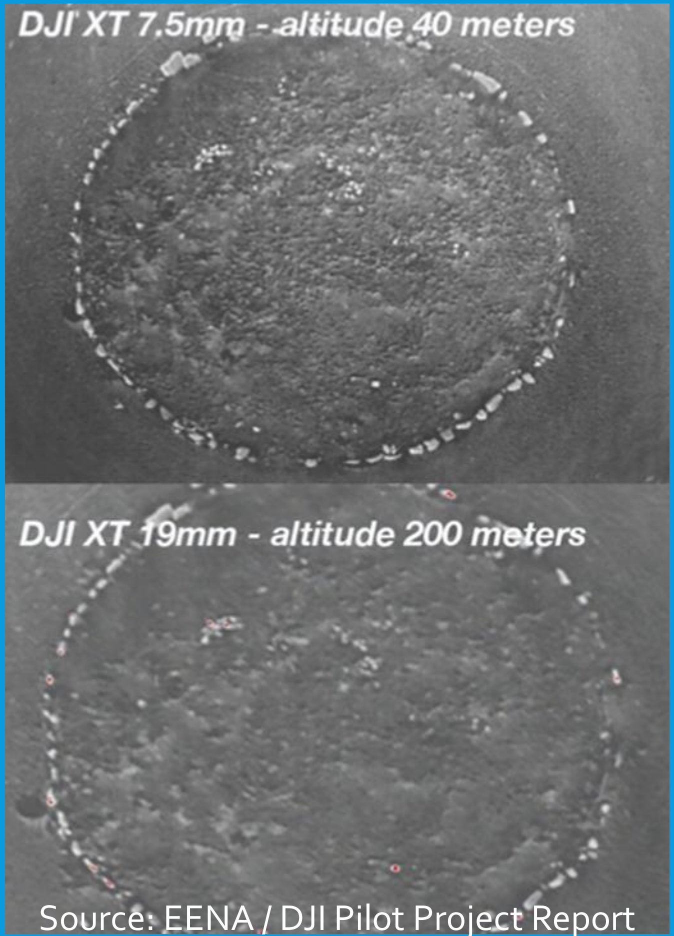
All objects having temperature above zero emit heat:

this what thermal cameras detect.

Plus, thermal imagers are usually **radiometric**, meaning they measure and store the temperatures that they’ve detected at every point in an image.

Nine main specifications are critical in the process of selecting a thermal imager:

frame rate - lens choice - detector resolution - thermal sensitivity (NETD) - temperature effective range - pixel pitch – accuracy - and picture-in-picture (PiP) imaging.



Source: EENA / DJI Pilot Project Report

CHAPTER 3: RPAS SELECTION

PAYLOAD SELECTION - THERMAL CAMERA - PICTURE-IN-PICTURE (PIP) IMAGING

Picture: www.service-drone.com

Most specifications in the process of selecting a thermal imager can be readily understood e.g.:

frame rate - lens choice - detector resolution - thermal sensitivity (NETD) - temperature effective range - pixel pitch – accuracy - (PiP) Imaging

NOTE - Picture-in-Picture (PiP) Imaging:

Because thermal imaging camera uses infrared radiation, instead of using visible

light like photography/videography cameras, familiar surroundings can appear very different looking. (EENA, 2016)

PiP combines thermal and visible-light images by placing a “framed” thermal image over its corresponding visible-light photo. This allows the radiometric data of a thermal camera overlaid a digital photographic image, like a digital camera, to give reference to the environment being measured.

Bringing clarity to the feedback you are observing, reducing information overload.

CHAPTER 4: CONCEPT OF OPERATIONS

Picture: 8abc TV

- CREW ORGANISATION:

CREW ROLES - SPANS OF CONTROL - LEGISLATIONS AND REGULATIONS - QUALIFICATIONS AND TRAINING - NUMBER OF QUALIFIED RESPONDERS REQUIRED - LIST OF QUALIFIED RESPONDERS

- PROCEDURES FOR DEPLOYING THE RPAS:

PRE-FLIGHT CHECKS – LOGISTICS – COMMUNICATIONS - SEARCH PATTERNS / STANDARD OPERATING PROCEDURES (SOPS) / LOCAL OPERATING PROCEDURES (LOPS) - NOTES TO AIRMEN (NOTAMS) - COLLISION AVOIDANCE - LANDING AND POST-FLIGHT PROCEDURES - PROCEDURES FOR LANDING - POST FLIGHT CHECKLIST

- EMERGENCY PROCEDURES
- RISK MANAGEMENT
- COMMUNICATIONS
- NOTE: due to time constraints – only look at a few areas, all covered in our paper.

CHAPTER 4: CONCEPT OF OPERATIONS

Once all prior information has been properly assessed, i.e. mission(s) stated & understood and suitable technology selected, then and only then can a framework of best practices be established.

Unfortunately, understanding the optimal procedures for RPAS at present seems patchy.

Emergency Services are scrambling to form RPAS units without fully considering a 'Concept of Operations' (CONOPs) for their use.

Offer suggestions and guidance towards achieving future-proof RPAS CONOPs.

Most of the information listed throughout is from EENA's Operations Manual Template and is combined with research from lessons learnt from real RPAS deployment case studies.

CHAPTER 4: CONCEPT OF OPERATIONS - CREW ORGANISATION

- **CREW ORGANISATION:**

Many RPAS require significant manpower to be effectively operated.

RPAS operators must be integrated into the overall search effort at the right level and with the right persons, depending on the type of RPAS to be flown and for what purpose.

Ultimately, RPAS is providing services for SAR mission coordinator (SMC) or Incident Commander (IC).

When operating in an emergency response environment, the RPAS team should be a fully integrated component of the Incident Command Structure to coordinate their operations accordingly.

In any SAR case, the RPAS unit should coordinate their operations with the SMC or IC – depending on the incident type.

In this section we offers a breakdown of crew organisation for better coherence.

CHAPTER 4: CONCEPT OF OPERATIONS - CREW ORGANISATION

- CREW ROLES

Generally accepted to operate safely, a 2-person field team is required.

One person controlling the unit & one person searching the video feed for information to be used for decision-making, but is this a common misconception? For example:

EENA outlined 5 roles for RPAS team(s):

A) Commander of the Unit – person ultimately has accountability for the overall RPAS team

B) Chief Pilot – person designated as the pilot who has ultimate control over the operation and who maintains all procedures and processes.

C) Flight Safety Manager – appointed person responsible for all safety aspects of the RPAS unit and/or operation

D) Pilot – person who flies the aircraft and will receive and carry out 'eyes on' requests, typically from the Incident Commander (IC).

E) Spotter/Pilot's Support team – person(s) who acts as the on-the-ground support for the Pilot and be second pair of eyes to observe the on-screen display. May also carry out additional safety checks before, during and after the mission e.g. take-off and landing, battery levels, altitude indicators, wind speed etc.

CHAPTER 4: CONCEPT OF OPERATIONS - SITUATIONAL AWARENESS

Emergency situations - one of first requirements: gain up-to-date situational awareness information at the highest quality available and as quickly as possible.

RPAS can be a key strategic asset – not only to increase the safety of the first responders but also to support better decision-making by providing videos and images to the IC on the ground.

During severe floods, all that was known about an area prior to a flood becomes secondary data.

It may no longer be true. And until it is confirmed it cannot be reliably acted upon.

Added to the challenge of holding potentially inaccurate situational information about a flooded area are sudden gaps in information:

Where are on-going hazards, such as strainers or weirs? Are there sources of contamination as a result of the flood?

RPAS could supply the IC with this crucial real-time information, before sending teams into unknown hazardous areas.

CHAPTER 4: CONCEPT OF OPERATIONS - SEARCH PATTERNS / STANDARD OPERATING PROCEDURES (SOPS)

Picture: 8abc TV

Search Patterns & Standard Operating Procedures - arguably the most important;

without standard operating procedures RPAS would offer very little value, similar to sending a lifeboat out to search without any method of search. Despite this, it is an area that urgently needs more attention.

Flying heights, flying speeds, and gimbal angles for different terrains and different search objects; all remain largely undefined.

Critical to understand the relationship between range and altitude of line of sight (LOS) systems, and how this can degrade the effectiveness of most optical sensors.

Often desirable to employ RPAS at or near its maximum range from the Ground Control Station, the RPAS may need to climb in order to maintain connectivity. In doing so, the increased altitude degrades the resolution of a given image to the point where it may be ineffective. Even at close range, operating at higher altitudes to increase the area covered still may render RPAS ineffective for a particular SAR operation. (NSARC, 2016)

CHAPTER 4: CONCEPT OF OPERATIONS - SEARCH PATTERNS / STANDARD OPERATING PROCEDURES (SOPS)

Picture: 8abc TV

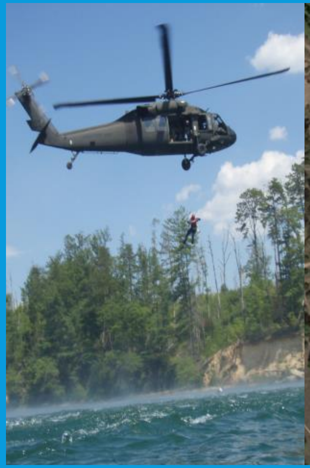
Methods used by SAR helicopters cannot be simply transferred to RPAS, because both aerial vehicles their capabilities differ vastly.

For example, during the memorial floods in Texas, an RPAS flew a "mowing the lawn" grid pattern.

This obtained images with sufficient overlap in order to create large ortho-mosaic images for mapping purposes. (Kessler et al., 2015)

This task would be too costly for helicopters to achieve.

By simply applying helicopter methods to RPAS technology, Emergency Services will miss out on numerous unique applications that RPAS can achieve and helicopters cannot.



CHAPTER 4: CONCEPT OF OPERATIONS - SEARCH PATTERNS / STANDARD OPERATING PROCEDURES (SOPS)

Simple effective process Wimberley Fire Department followed in 'memorial floods' in order to provide geo-referenced, high-resolution imagers to ground searchers was:

- Collect imagery of either a pre-designated area or requested points of interest;
- Review all imagery in the mobile command vehicle by laptop while looking for abnormalities that might include odd shapes or colours; and
- Contact searchers, and provide details of location and physical description of identified points of interest.

(Kessler et al., 2015)

Breaking up RPAS use into simple tasks – as above – will provide reliable results for RPAS operations.

CHAPTER 4: CONCEPT OF OPERATIONS - SEARCH PATTERNS / STANDARD OPERATING PROCEDURES (SOPS)

Picture: 8abc TV

There may also be a need for local operating procedures (LOPs), for example, Los Angeles, CA; Washington, DC; and New York, NY have special flight rule areas (SFRA) that differ from the rest of the USA. (NSARC, 2016)

Therefore, those cities would require LOPs in order to abide by these special rules.

Similarly, there may be local no-fly zones – e.g. military bases – that may require LOPs.

This will ensure that even new personnel to a RPAS team will be aware of these location specific regulations.

NOTE: RPAS SOPs may differ per service; different first responder incidents and scenarios require a different tactical approach on how an aerial platform is being used. (EENA, 2016)

CHAPTER 5: CONCLUSIONS

Conclusions:

- Potential for RPAS technology in the realm of water and flood SAR is undeniable and truly exciting.
- Many gaps in understanding how this technology should be implemented.
- Use of RPAS by the Emergency Services, SAR and first responder communities is growing rapidly and that the technology on-board the RPAS is also changing rapidly.
- CONOPs for RPAS use should evolve at a similar rate, to avoid detrimental effects.
- Emergency Services are strongly advised to move away from the mindset of simply transferring helicopter techniques and applying them to RPAS.
- In many circumstances RPAS and manned aircraft are not interchangeable alternatives.
- RPAS may provide a unique capability that will augment other search assets.

CHAPTER 5: CONCLUSIONS

This paper has followed a strategic method we suggest that Emergency Services should aim to follow:

- highlighting RPAS use case studies and analysis,
- thoroughly analyse the technology selection,
- then build a CONOPs for best practices.

This emerging technology is still in the proof of concept phase for many response communities,

but continuing RPAS operations without clear understanding of where and how they should be used could see severe consequences.

Safe integration of RPAS involves gaining a better understanding of operational issues, such as training requirements, operational specifications, system equipage, and technology considerations.

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DRONES IN RESCUE OPERATIONS

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THANK YOU AND CONTACTS

Authors' Contact details:

David Lane MIFireE, AssocRINA, FRIN
Director of SAR and Water Rescue Academy, Poole, UK.
E: prorescue@btinternet.com

Gemma Alcock
Director of The SkyBound Rescuer Project
SAR UAS Research, Consultancy and Training Organisation.
E: skyboundrescuer@gmail.com