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EDITORIAL

Drones – the third generation source of remote sensing data

1. Introduction

The first generation of platforms for instruments generating remotely sensed data from the surface of the Earth comprised pilot-flown aircraft and the second generation consisted of Earth-orbiting satellites. Recent developments in the technology of drones (UAVs (Unmanned Aerial Vehicles), etc.) have opened up important new possibilities in the field of remote sensing so that drones can be regarded as the third generation of platforms generating remotely sensed data of the surface the Earth. In considering the potential sources of remotely sensed data for addressing a particular problem one has to address the requirements of spatial, spectral and temporal resolution. The drone particularly addresses the questions of spatial and temporal resolution in the acquisition of data. Once you have a drone you can acquire data where and when you want it, and reasonably cheaply.

The precursors of the modern drones were, of course, the pigeons of J. Neubronner in 1907, see Figure 1, and the long-established hobby of flying model aircraft. The *International Journal of Remote Sensing* was quick to recognize the importance of drones in remote sensing and published a major special issue in 2017 ('Special Issue: Unmanned aerial vehicles for environmental applications' *International Journal of Remote Sensing*, **38**, nos 8–10, 20 April – 20 May 2017, pages 2029–3202.) That special issue contained 64 papers on many different aspects of environmental remote sensing using drones, see Table 1.

This has been followed by a second special issue on the subject ("Special Issue: Unmanned Aerial Systems (UAS) for Environmental Applications, *International Journal of Remote Sensing*, **39**, nos X-Y, date 1 – August 2018, pages 4845–5595) containing 36 papers. In fact we now see drones as such an important source of remotely sensed data that we are introducing a regular section of the *International Journal of Remote Sensing* devoted to drones in the context of remote sensing. This section has its own editor, Anita Simic Milas of Bowling Green State University in the USA. Papers should be submitted in the usual way through ScholarOne Manuscripts indicating, where appropriate, that the paper is intended to be considered for the Drones section of the journal.

2. Drones as a hazard

Having made our announcement we thought it was important to dwell on something that is dear to our hearts in relation to drones. And that is to urge anyone involved in a remote sensing project involving drones to act responsibly. Recent technological, commercial and marketing developments mean that anyone with a small amount of money can go into a store and buy themselves a drone and start flying it around as a potential danger to other people, see Figure 2.

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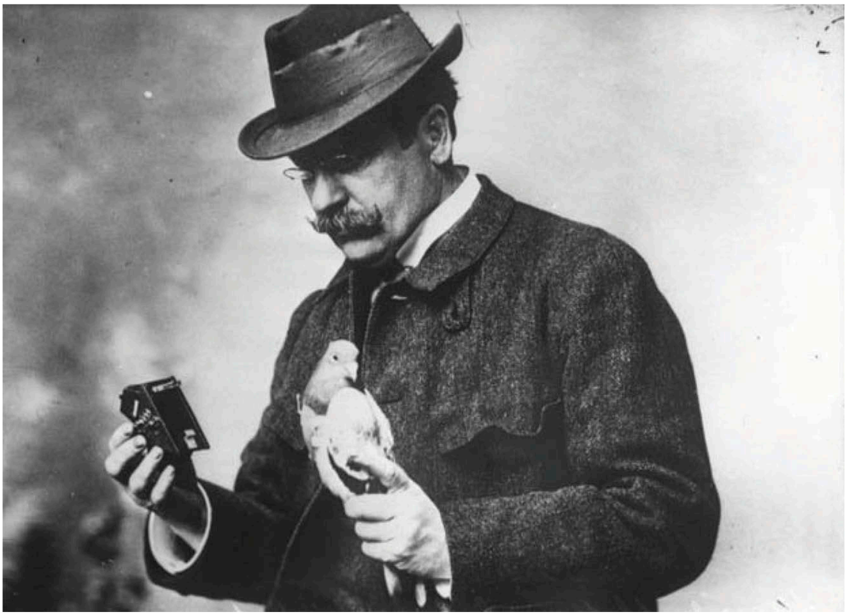

Figure 1. J. Neubronner with one of his pigeons in 1907 (By Julius_Neubronner_with_pigeon_and_camera_1914.jpg: Agence Rol (agence photographique)derivative work: Hans Adler (Julius_Neubronner_with_pigeon_and_camera_1914.jpg) [Public domain], via Wikimedia Commons).

Table 1. IJRS 2017 UAVs special issue papers by topic.

Application	Number of papers
Agriculture, vegetation (excluding trees), land cover	15
Forestry	9
Geology	3
Image Processing	9
Instruments	5
Lakes and rivers	8
Lidar	5
Miscellaneous	6
Photogrammetry	4
Total	64

On 17 April 2016 the pilot of British Airways flight BA727 from Geneva reported to air traffic control a near collision with a drone. The Airbus A320 was approaching Heathrow Airport at the time. None of the 132 passengers or 5 crew were injured. After an inspection by engineers, the aircraft was cleared to take off for its next flight. In late April 2016 the Transport Secretary Patrick McLoughlin told Parliament that experts believed that the incident was not related to drones. There was no damage to the aircraft and it wasn’t clear if it was a plastic bag rather than a drone. An investigation by the Air Accidents Investigation Branch had been closed due to lack of evidence. Police had searched a wide area near the airport and found nothing. Although this event, in the end, appears to have been of no significance one should not disregard it. There have been various similar reports from other airports around the world and, sooner or later, there may be a major accident with many deaths and injuries.

TERROR IN MID-AIR

BA JET HIT BY DRONE AT HEATHROW

DANGER BA passenger jet and drone

BY PAUL HOOPER and CHRIS HUGHES

A BRITISH Airways plane has been struck by an unmanned aircraft.

The collision, believed to be the first of its kind, happened yesterday as the jet carrying 132 passengers landed at Heathrow.

It follows warnings that terrorists could arm a drone with a bomb. Security expert Colonel Richard Kemp said: "It is a very real threat."

FULL STORY: PAGE 6

Safety fears after plane with 132 passengers is struck as it comes in to land

Figure 2. Front page of the *Daily Mirror* newspaper (London) on 18 April 2016.

Figure 3 shows the number of Airprox incidents over the last few years involving drones in UK airspace and it can be seen that their number is increasing rapidly.

An airprox can be defined as 'a situation in which, in the opinion of a pilot or an air traffic controller, the distance between aircraft, as well as their relative positions and speed, was such that the safety of the aircraft involved was, or may have been, compromised' (https:www.airproxboard.org.uk) (viewed 16 February 2017). Many such events involve two aircraft, but they may involve only one aircraft and another object. Lest it should be imagined that we are focusing only on Britain, it should be noted that there are many other examples mentioned in Wikipedia under the heading 'UAV-related events' which incudes a selection of over 50 events. Potential accidents associated with drones (UAVs) are, of course, not restricted to the UK but are worldwide. Wikipedia describes a wide array of incidents involving drones and separates the incidents into two sets of events. One is events involving a drone and a commercial aircraft, see Table 2 which describes 26 events involving 7 countries:

These incidents are all very similar to one another; in most cases an aircraft had just taken off or was just in the final stages of landing and the crew spotted a drone close by, but there was no collision and in most cases the operator of the drone could not be traced. The other category of incidents includes more varied situations where only a drone was involved and no aircraft but there was damage to property, injury to someone (a third party) on the ground or the drone crashed and was damaged or destroyed. In all, Wikipedia lists 33 examples from 9 countries, see Table 3.

These are quite varied and, by contrast with the first group, in many cases the operator of the drone was identified and in some cases punished. We merely quote

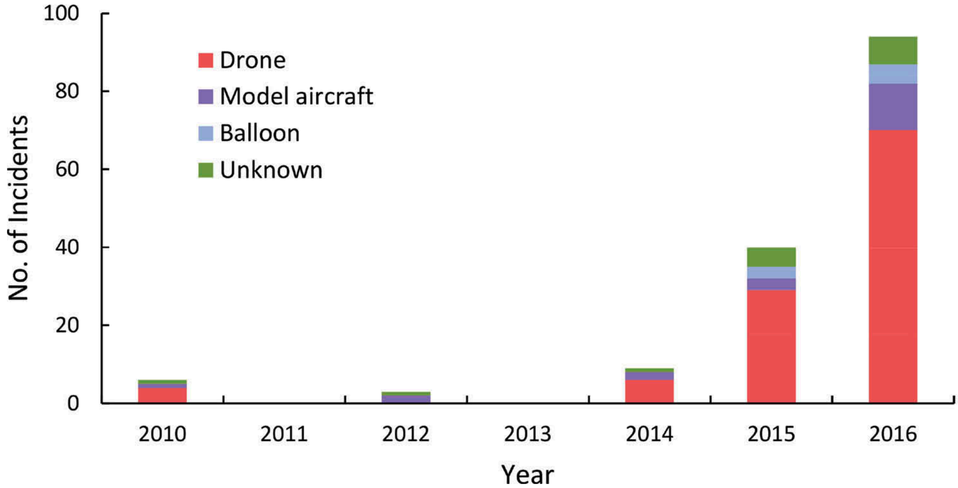

Figure 3. Airprox incidences involving drones in UK airspace up to December 2016 (source of data UK Airprox Board).

Table 2. Events involving drones and civilian aircraft.

Country	No. of incidents	Country	No. of incidents
Austria	1	Poland	1
Canada	3	UK	15
China	1	USA	4
France	1		
		Total	26

Source: Wikipedia <https://en.wikipedia.org/wiki/UAV-related_events (consulted 1 July 2018)>

some examples and would refer the reader to the Wikipedia article (Wikipedia 2018) for more examples.

In October 2013 in Australia a drone collided with Sydney Harbour Bridge and the Australian Civil Aviation Safety Authority (CASA) started an investigation. The police returned the drone to its owner! In April 2014, again in Australia, a triathlete was injured in an incident involving a drone which was filming a race. She claimed that the drone collided with her and said '*the ambulance crew took a piece of propeller from my head*'. Taking into account the young age and antecedents of the drone operator the Director of Public Prosecutions chose not to proceed with a charge against the operator and handed the matter back to CASA which subsequently fined the operator AU$1,700 for flying the drone within 30 m of people. In February 2016 a recreational drone pilot

Table 3. Events involving drones and no aircraft.

Country	No. of incidents	Country	No. of incidents
Australia	3	Italy	1
Canada	1	South Africa	2
France	3	UK	6
India	1	USA	15
Ireland	1		
		Total	33

Source: Wikipedia <https://en.wikipedia.org/wiki/UAV-related_events (consulted 1 July 2018)>

crashed a drone during a ceremony at the Australian War Memorial in Canberra. No one was injured. The drone reportedly landed near the Memorial's Director, and former defence minister, Brendan Nelson, who picked it up and subsequently handed it to security staff. Following a CASA investigation the drone pilot was fined AU$900, which according to a CASA spokesman, closed the matter (Wikipedia 2018).

In France in October 2013 a tourist was arrested in Paris and fined €400 for 'operating an aircraft non-compliant with safety laws'. In India in May 2014 Francescos' Pizza of Mumbai made a test delivery from a branch in Lower Parel to the roof of a building in Worli. Police in Mumbai began an investigation on the grounds that security clearances had not been sought. In South Africa in June 2013 police officers apprehended a man who flew a multicopter outside the hospital that Nelson Mandela was in. The equipment and footage were confiscated by the police (Wikipedia 2018).

In the UK in April 2014 a man pleaded guilty to flying a small drone within 50 m of a submarine testing facility. He was fined £800 and ordered to pay legal costs of £3,500. The Civil Aviation Authority (CAA) claimed that the case raised safety issues related to flying unmanned aircraft. In September 2015 a man from Bingham, Nottinghamshire, admitted nine breaches of the Air Navigation Order the previous year. He was fined £1,800 and banned from buying or using a drone for two years. In March 2016 a drone collided with a train hauled by the Flying Scotsman steam locomotive. British Transport Police opened an investigation, having identified the operator of the drone, and warned drone operators not to fly within 50 m of a train saying that it was illegal to do so. In July 2016 a man from Lewisham, London, pleaded guilty to using a drone to send a psychoactive substance and tobacco into Swaleside Prison. He had also flown over several other prisons (Wikipedia 2018).

In the United States in August 2013 a drone filming events at the Virginia Bull Run in Dinwiddie County, Virginia, crashed into the crowd, causing minor injuries. In July 2015 firefighting aircraft were grounded for 26 minutes in Southern California because of fears of collisions with five drones which had been seen in the area. It was the fourth time in as many weeks that drones had hampered firefighters in Southern California. In October 2015 a drone collided with power lines in West Hollywood, causing a power cut to 700 Southern California Edison customers (Wikipedia 2018).

And so it goes on and on; these are just a few examples of problems that have occurred and they are recounted to show that there is a wide range of incidents and that in many cases the pilot was identified and in some cases punished. This brings us to the question of what is the legal situation with regard to owning and operating a drone. An initial attempt to clarify this situation was undertaken in the article by Cracknell (2017).

3. Drones, the third generation of sources of remotely sensed data

For a long time the problems preventing the use of remote sensing for some applications have centred around restrictions of spatial, spectral and temporal resolution or the cost or delay in getting access to the data. These limitations, particularly of spatial and temporal resolution, are no longer a serious problem with a drone. One can easily acquire a drone reasonably cheaply and determine where and when to fly it.

Let's go back briefly to the pigeons, see Figure 4.

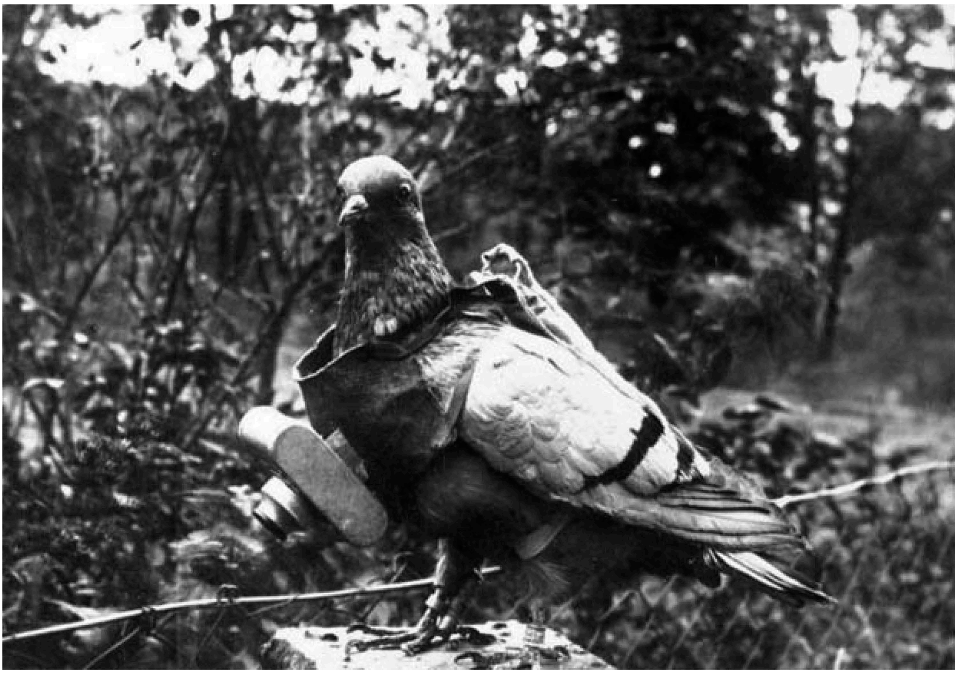

Figure 4. One of Neubronner's pigeons (By Bundesarchiv_Bild_183-R01996,_Brieftaube_mit_Fotokamera.jpg: o.Ang.derivative work: Hans Adler [CC BY-SA 3.0 de (https://creativecommons.org/licenses/by-sa/3.0/de/deed.en)], via Wikimedia Commons).

The pigeons were successful to the extent that they obtained photographs of the ground, see Figure 5,

but there were several obvious problems. These included:

- No control over the flight path
- No control over the choice of the site photographed
- No record of the location of pigeon/camera when the photograph was taken.
- No GPS to locate the pigeon/camera when the photograph was taken.
- No record of the orientation of the camera.

The other precursor of drones for remote sensing was model aircraft. The hobby of flying model aircraft is long established, but for several decades it was of no relevance to the solution of environmental or scientific problems related to the surface of the Earth. However, recently a number of developments came together to change this. The developments in batteries as power sources to fly the models, the advent of GPS and the development of lightweight cameras all contributed to the viability of model aircraft, alias drones and established them as an important potential source of remote sensing data. People have now started to hold conferences on the use of drones in remote sensing and to publish papers on their work in serious scientific journals. – hence our initiation of our new drones section.

Figure 5. One of Neubronner's pigeon's photos (By Julius Neubronner (1852–1932) [Public domain], via Wikimedia Commons).

It could be said that drones have developed from the long-established hobby of flying model aircraft. But their popularity has suddenly taken off. Many people have bought drones and are flying them around with no licence and with no training. And as we have already noted, sooner or later there are going to be some serious accidents. We face a serious issue. In recent years the massive increase in the availability of drones to the general public has led to a worrying situation where ignorant or careless people, let alone people with malevolent intent, could cause serious damage and even loss of life through irresponsible or malicious flying of drones. We draw the analogy with the invention of the motor car (automobile) over a century ago, where originally there was no registrations of vehicles, no training of drivers and no road traffic regulations. These all came later.

4. The legal situation – international law and national law

This journal is concerned with rather small drones which are being used for scientific research or environmental monitoring and the legislation relating to the operation of such drones and the question of enforcement of that legislation. Legislation without a means of enforcement is largely pointless. This article is not concerned with military drones which tend to be rather heavy, such as the V1 and V2 which were used by Germany in World War 2 and which have been developed extensively since then as vehicles for the delivery of warheads (bombs) to a foreign country without endangering the pilots of the attacking country by having to fly over enemy territory.

All unmanned civilian aircraft, whether remotely piloted, fully autonomous or combinations thereof, are subject to the provisions of Article 8 of the Convention on International Civil Aviation (Doc 7300), signed in Chicago on 7 December 1944 and amended by the International Civil Aviation Organisation (ICAO) Assembly. The ICAO is an agency of the United Nations. It is primarily concerned with aircraft of one country which travel to or overfly the territory of another country and therefore its provisions are largely irrelevant to the operators of small drones for scientific or environmental work over small areas. Within individual countries civilian airspace is regulated by National Aviation Authorities (NAAs) and a directory of NAAs can be found at http://www.airlineupdate.com/content_subscrip tion/authorities/country_index.htm (viewed 16 February 2017) (Cunliffe et al. 2017). Each NAA has it own regulations for all users of civilian airspace, including operators of UAVs. Various countries have been attempting to formalise the development of regulations and this process is ongoing. The regulations developed by various different countries have many elements in common.

5. The responsibility of the operator of a drone

Individual countries are at different stages of controlling drones and their use but we are seeing the introduction of

(a) registration of drones by their owners
(b) licensing of 'pilots' of drones

and this licensing is going to involve training and testing, much as currently there is a need for training and testing if someone wants to drive a car or other motor vehicle on the road. So, the advice is if you are going to use a drone for remote sensing work make sure that you are doing so in accordance with the law of your own country.

The development of appropriate national legislation has struggled to keep up with these developments. The state of development of this legislation in a number of countries was considered by Cracknell (2017). An important distinction has to be made between the flying of drones as a hobby and flying them for commercial work. Perhaps the best distinction between a hobby and commercial work is made by CASA (Civil Aviation Safety Authority) of Australia, if only for its neat way of defining what is a radio-controlled model aircraft. According to CASA

> "From our perspective, the difference between RPA [remotely piloted aircraft, i.e. drones] and model aircraft is that RPA [drones] are used for commercial, government or research purposes and model aircraft are flown just for fun – for sport and recreation. In other words, we [the Australians] classify your unmanned aircraft by what you do with it."

This view is widely held among other countries. For present purposes commercial work is defined as commercial/industrial work, scientific research, environmental monitoring, crime detection, etc., in other words where there is any form of payment or benefit as distinct from enjoying a hobby. Rules apply to the flying of a drone for any purpose whatsoever, including flying a model aircraft.

The rules governing the flying of model aircraft in several countries are summarised in sections 3 and 4 of Cracknell (2017). It is becoming increasingly recognized that the pilot of any drone or model aircraft is responsible for any accident, damage or injury caused by that drone. More and more countries are requiring that anyone flying a drone for commercial purposes must have satisfactorily completed a training programme before flying their drone, and must comply with the relevant rules and keep a log of all flights. One problem with the recent sharp increase in airprox incidents is that the owner or operator of the drone often cannot be identified. This is leading countries into requiring that all operators of drones should be registered and that their drones should carry a visible identification number that enables the owner/operator to be traced.

Where individual countries have developed their own laws these national laws are enforceable and, as we have seen, fines have already been imposed in several countries (Australia, France, UK, etc.). However in those countries where laws have not yet been developed no action can be taken against people who operate drones in an anti-social or dangerous manner. While, in theory the operator, or drone pilot, is responsible for the safe operation of the drone, reports of near misses between a drone and a civil aircraft carrying a few hundred passengers and crew almost invariably conclude 'the operator of the drone could not be identified'.

5.1. *The responsibilities of the pilot*

Any unmanned aircraft must be deemed to have a pilot. The aircraft may be being controlled remotely or it may be running autonomously with a program loaded on the aircraft's onboard computer, but the person who loaded the program and initiated the running of the autopilot is still regarded as the pilot.

The moral situation must be that if an individual is piloting a drone which causes damage to property, or injury or death to a person that individual has to be regarded as being responsible for the accident and should be liable to pay compensation; for example, this is stated explicitly in the case of the regulations in PR China. There is a parallel with driving a motor vehicle on a public road. Motorists in many countries are required to hold valid insurance to cover the driver's liabilities in case of accidents. Similarly it is reasonable to suppose that if one operates a drone in (public) airspace one should be in possession of suitable insurance cover.

5.2. *The training of pilots. the UK as an example*

The legislation of many countries emphasises the responsibility of the pilot and the need for pilots to be trained and licensed. The situation in the UK, as an example, is described in some detail by Cunliffe et al. (2017), where the authors describe the process of obtaining permission from the UK's Civil Aviation Authority (CAA) to fly a drone for commercial work, which as we have already indicated above includes academic research or environmental monitoring work.

However, the development of laws is one thing but their enforcement is quite another thing. To pursue the analogy with driving on the roads in the UK. The use of hand-held mobile phones while driving a motor vehicle on a public road has been illegal for some years now and yet one can still see hand-held phones being widely used by drivers. A few people get caught and are punished, but the law is widely ignored.

UK legislation, specifically the 2016 Air Navigation Order (Articles, 2, 94, 95, 214 and Schedule 1), states that:

- The operation of the aircraft, i.e. the drone, must not endanger anyone or anything.
- The aircraft must be kept within the visual line of sight (normally taken to be within 500 m horizontally and 122 m vertically) of its remote pilot (i.e. the 'person in charge' of it). Operations beyond these distances must be approved by the CAA (the basic premise being for the operator to prove that he/she can do this safely).

- Small unmanned aircraft (irrespective of their mass) that are being used for acquiring imagery are subject to tighter restrictions with regard to the minimum distances that one can fly near people or properties that are not under your control. If you wish to fly within these minima, permission is required from the CAA before operations are commenced.
- CAA permission is also required for all flights that are being conducted for aerial work (i.e. commercial work, in very simple terms, where one is being paid for doing it).
- The 'remote pilot' has the responsibility for satisfying himself/herself that the flight can be conducted safely.
- The aircraft must not be flown (a) over or within 150 m of any congested area, (b) over or within 150 m of an organised open-air assembly of more than 1,000 persons, (c) within 50 m of any vessel, vehicle or structure which is not under the control of the person in charge of the aircraft, or (d) within 50 m of any person except during take-off or landing, when the aircraft must not be flown within 30 m of any person except for the person in charge of the aircraft, or a person under the control of the person in charge of the aircraft.
- Details of UK restricted airspace can be found at www.noflydrones.co.uk .
- Careful note should be taken that the collection of images of identifiable individuals, even inadvertently, when using surveillance cameras mounted on a small unmanned surveillance aircraft, will be subject to the Data Protection Act. This Act contains requirements concerning the collection, storage and use of such images. Small unmanned aircraft operators should ensure that they are complying with any such applicable requirements or exemptions. Further information about the Data Protection Act and the circumstances in which it applies can be obtained from the Information Commissioner's Office and website www.ico.org.uk (viewed 16 February 2017).

As already mentioned, Cunliffe et al. (2017) describe in great detail their experience in getting CAA approval for operating a drone and their Operations Manual (OM) has been deposited in the Supplementary Information attached to their paper. That paper is intended to provide guidance to other workers in the UK who are interested in seeking CAA accreditation. Although it is not directly relevant to other countries it may nevertheless provide some general guidance for people working elsewhere.

5.3. *Line of sight*

A key component of the legislation in many countries is to require that a drone always remains in the line of sight of the person on the ground who is controlling it. The vertical and horizontal distances involved in defining the line of sight vary somewhat from one country to another, but the principle is common. There are, however exceptions for areas which are remote and almost uninhabited and where there is little danger of collision with passenger-carrying aircraft, or injury to persons, or damage to property. An example of this in wildlife monitoring is provided by Su et al. (2018) who used a UAV for studying wild yaks over a large area in the Kumkury Desert on the Qinghai-Tibetan Plateau in China. Their UAV had a maximum radius of operation of 60 km and could fly at an altitude up to 5,000 m and was clearly operated out of the line of sight of the operator. This was possible, despite the fact that China has very strict and detailed laws on the operation of UAVs, because of the remoteness of the study area. There are very many areas throughout the world where researchers would like to use UAVs to gather scientific remote sensing data where such remoteness does not exist and where the line of slight rule applies. Thus there is pressure from scientists as well as from commercial users of UAVs for a relaxation of the line of sight limit of operation. It is worth mentioning an item in the *Times* newspaper (London) from 12 June 2018 described as a 'Breakthrough flight paves way for drone deliveries'. We quote:

> "The commercial use of drones took a leap forwards yesterday when a device was flown for more than seven miles over East Sussex. For the first time a company was granted special permission from the Department for Transport and the Civil Aviation Authority to fly a drone beyond the operator's line of sight as part of an official trial programme. Sensat, a digital mapping company, operated the flight yesterday. The drone, a Delair DTI8 aircraft-shaped device, flew at a height of 400ft [122 m] and a speed of 38mph [60 kph]. It followed a route from Ditchling towards Uckfield in East Sussex. It was about 16 miles [26 km] south of Gatwick Airport but well below the height of any commercial aircraft. The CAA said that no aircraft were in the vicinity, which was one of the conditions of the flight. Normally users are banned from flying drones beyond the line of sight, up to a maximum distance of 1,600ft [488 m]. Sensat said that it was the longest flight of its kind anywhere in the world in complex airspace traditionally shared with other aircraft. The test was part of a government-backed trial to explore the commercial potential of drones.
>
> Figures suggest that the devices could be worth an estimated £42 billion [$56 billion] to the UK economy by 2030. This includes innovations such as home deliveries. Amazon is testing its own delivery drones. Sensat said that its drones were used to map and inspect transport infrastructure such as roads and railways. It says that flying them long distances could dramatically cut costs and save time. James Dean, the firm's chief executive, said that the concept of beyond the line of sight was often cited as the turning point for the industry, adding 'It is the moment from which we can begin to see drones truly making a positive impact on our daily lives'."

A related issue to the line of sight rule is the suggestion of having distributed UAVs connected through a mobile network or a satellite-relay network to synchronize observation tasks over large areas. This concept is discussed in some detail by Liao et al. (2018).

6. Rule zero for remote sensing using drones

The general principle that we have noted is that the operator (or the 'pilot') of any drone, including a model aircraft, must operate it in a responsible and considerate manner and is responsible for any accident caused by that drone. Sometimes in the academic world the distinction between paid employment and one's hobby becomes blurred. For some academics their hobby is their work. Thus initially some academic researchers have conducted their work using UAVs under the regulations applying to hobbyists. But this is changing; for further discussion see Section 3 of Cunliffe et al. (2017). The managers of universities and research institutes are becoming aware of the danger that their staff who fly drones for research or environmental monitoring could cause serious accidents involving damage to persons or property and they are now increasingly insisting that there is adequate insurance cover in place for these activities, and that, where necessary, the pilots are licensed. In order to obtain insurance cover, the insurers are almost

Request from the Editors

Please fly your drone

responsibly, safely and legally

Figure 6. Rule zero.

certain to demand that the work is properly classified as commercial (in the sense of the definition that we are using) and that the operators have the proper approval from their NAA for such activities.

So we come to Rule Zero for anyone embarking on a scientific or environmental management remote sensing project using a drone. In first generation (piloted aircraft) remote sensing or second generation (satellite) remote sensing, one does not usually get involved in the original data collection. The data is obtained from someone else who flew the aircraft or built and operated the satellite. The case of a project involving a drone is quite different. Apart from the usual tasks of deciding what data one needs, or would like, to have and planning how to process and interpret the data one has – before that – to choose what drone to use and what instruments it should carry. So we enunciate Rule Zero: 'When planning to use a drone to gather data for a remote sensing project, ensure that you follow the legal requirements of the country in which you will be operating, obtain any necessary licences, permissions, etc. and ensure that the operator (pilot) of the drone is qualified to fly the drone legally and safely. Ensure that you have adequate third party insurance.' See Figure 6. As promoters of a new special section of the IJRS on remote sensing using drones we hope that all our authors will have observed this rule.

7. Conclusion

The recent technological developments of drones have revolutionised methods of data acquisition, and have thus permitted new avenues of scientific research and environmental monitoring. Whilst drone technology has been advancing rapidly however, the law has had difficulty keeping up. Different countries are at different stages in the development of their legislation regarding drones and their use. There are many things in common among the legislations of different countries, although there are some differences. The legislative situation is evolving constantly, and to date has been difficult to enforce in practice. It is clear, however, that drone pilots have a critical responsibility to ensure they are flying in a safe and legal manner, see Figure 6. Furthermore, those pilots using drones for commercial applications (including scientific research) should be aware that typically, different regulations are in place for hobbyists. Approved training, permissions to fly and appropriate drone registration should always be sought where applicable in the location of flight.

Disclosure statement

No potential conflict of interest was reported by the authors.

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