### Submission 73 - Dr Murray May

### Dr Murray May, Canberra, ACT – comments on Infrastructure planning guidelines for drone delivery services - Public consultation draft 1 December 2022

I have only recently become aware of this consultation, and therefore have had to put together comments quickly. I have been involved with the issue of delivery drones for some time, and will draw on a previous submission I made to the 2019 ACT Legislative Assembly inquiry on delivery drones (**attached** here as 074May). I have also had a long-term involvement with aircraft noise at a community level, and one published paper of mine in the *Journal of Transport Geography* (linked to research from my PhD in 2004) continues to be well cited in the international literature (**attached** here as JTG-May and Hill).

I will make some relevant observations and refer you to other parts of my earlier submission for more detail, including references, if desired. The consultation website states that: "Drone delivery services offer a sustainable and cost-effective solution to transport goods to customers in the community. Drone delivery trials have been operating in Australia since 2019 with new operations expected as the sector grows".

This is akin to the industry generated spin pushed by companies such as Wing. My experience with the drone issue suggests that extensive drone delivery services would in fact create a community dystopia of the worst order. The outcome of the Wing delivery drone trial in Bonython ACT suggests it was a massive failure. The community was driven to distraction by the invasive high pitched noise of delivery drones, with noise well above the usual community noise standards enforced by legislation e.g. a noisy air conditioner next door. Some people had to leave the suburb entirely on weekends for respite. The mental health consequences of continuing this reckless trial would have been considerable.

I've seen communities particularly bothered by aircraft noise, but the reaction by the community to delivery drones in Bonython was even more acute. Community members formed the group Bonython against Drones with its own website and Facebook page and gathered over a thousand signatures on a petition to then initiate an ACT Legislative Assembly inquiry on the issue. People reacted angrily to the invasive attack on their quality of life and the valued peaceful lifestyle previous to (and after) the Wing trial. Over 80% of submissions to the inquiry were against delivery drones being introduced, and people who gave evidence at the inquiry included those from organisations representing dogs and horses. These animals are even more bothered by drone noise with their more acute hearing. Much wildlife, include birdlife, disappeared from Bonython during the trial. How can these outcomes possibly represent a sustainable transport solution?

There are a host of open questions regarding the commercial use of drones covering technical, legislative, societal aspects, safety and environmental risks. The trial in Bonython demonstrates that it was approved and implemented in the absence of sufficient foresight being given to these issues.

Just because we can do something it doesn't necessarily mean we should. As an editorial in the Canberra Times put it: "what if the residents of Gungahlin decide ... they'd rather not

deal with the noise and lack of privacy that Bonython residents have complained of? What if it's decided that Canberra, as an already liveable and progressive city, has no real need for drones to deliver things at all?" (Canberra Times. Drones need to get public on board. 2018, November 15, p. 16).

**Included as an attachment** is a 2018 report *Delivery drones from a technology assessment perspective* by the Institute for Technology Assessment (ITA) of the Austrian Academy of Sciences (Institute for Technology Assessment of the Austrian Academy for Sciences, 2018). Of particular value is the report's consideration (p.37) of two scenarios for drone deployment:

The **basic scenario no. 1 (the so-called "pizza scenario")** is the widespread delivery of all kinds of small goods (parcels) by drones, instead of (or in combination with) delivery vans and trucks. The AlphaBeta consultancy for Project Wing estimated that by 2030 there would be 5.6 million drone deliveries a year or 11,000 drone deliveries a day.

The **alternative scenario no. 2 (the so-called "emergency scenario")** is less extensive: the delivery service by drones would only be a niche market, in which special goods, e.g. in the medical field, would be routinely transported between hospitals, pharmacies, and practitioners, or for other emergency purposes. Another potential niche market could be the regular supply of goods to remote areas, where no roads lead or there is no other connection.

Most of the impacts are much aggravated in the case of scenario no. 1 as it is associated with ubiquitous and massive drone flights, whereas in scenario no. 2 flights take place less frequently, perhaps only occasionally. Those with significant concerns about scenario 1 usually support the wide range of other less invasive uses for drones in scenario 2 such as for mapping and surveying, emergencies, insurance industry use after floods, environmental protection, inspection of power lines in Canberra by Evoenergy and so on.

More often than not, proponents of expanded drone delivery such as the ACT government and Project Wing mix up the two scenarios rather than recognising the many pitfalls from a community point of view of scenario 1. In scenario 1, considerable numbers of drones filling the lower airspace bring the noise pollution normally associated with heavily trafficked roads or worse, or with living near airports, with likely negative impacts on real estate values in those areas. The aesthetic appearance of drones swarming the lower airspace can also be expected to be met with resistance from the population.

The optimistic projections of the Infrastructure consultation assume that a drone-filled future is desirable and inevitable. Even the technologically focused ITA document above acknowledges ethical issues, and suggests that the so-called pizza scenario is highly controversial and likely to arouse opposition.

Noise pollution is already recognised by health authorities as of considerable public health significance, with a World Health Organization publication *Burden of disease from environmental noise: quantification of health life years lost in Europe* drawing together much relevant information (World Health Organization, 2011). While Project Wing uses

consultancy firms such as AlphaBeta to argue for large economic benefits for ACT businesses, the economic framework used is very narrow and commercially focused, and ignores the considerable adverse health effects and costs outlined in the WHO report for example.

**Attached** is a 2017 policy overview on environmental noise from the Public Health Association of Australia (Public Health Association of Australia, 2017). Particularly salient points include:

- Environmental noise is a public health issue that requires serious attention.
- Common noise sources vary in sound level, and sound can also be characterised by frequency (pitch).
- The repetitive nature of a particular noise and/or the inability of an individual to control it can cause annoyance and stress.
- Environmental noise pollution relates to ambient sound beyond comfort levels. When background levels are low as in a suburb such as Bonython, the experienced noise pollution is more prominent.
- Vulnerable groups such as children, older persons, people with mental health issues, people who are unwell may be affected in more marked ways.
- Long-term environmental noise exposure can affect stress levels, and increase the risk of hypertension and elevate risks of heart attacks.
- Categorising noise with respect to sound level, pitch, how often etc, is important in assessing impact.
- Action to ensure a safe and healthy environment is a critical public health priority.
- Authorities need to make use of "strategic noise maps" and undertake strategic noise impact assessment.
- Governments need to develop policies and strategies to promote public health and reduce adverse environmental consequences from environmental noise pollution.

My own background work and experience on aircraft noise issues suggests that experts in the field of psychoacoustics should be drawn on to a much greater extent in order to better understand the impacts of noise on health.

The Bonython against Drones community group on its website

(https://bonythonagainstdrones.com/about-us/) states that "the peaceful amenity of our homes is the foundation of our lives, and paramount to our health and wellbeing". As reflected in many letters and comments to the *Canberra Times* and other local publications, and the many representations to local politicians, this peaceful amenity was seriously disturbed by the Project Wing drone trial in Bonython. The public health literature on the impacts of environmental noise underlines the significance of the negative impacts observed in Bonython.

The Infrastructure consultation unfortunately suffers from technological determinism with many of the claimed benefits of delivery drones unproven. It also suffers from a very narrow frame of reference and is apparently unaware of a much wider public health and ecological literature relevant to whether delivery drones should be introduced on a wide scale at all.

On environmental sustainability, consider the example related to a common drone delivery item, coffee. The only way drone delivery could be "environmentally sustainable" would be if one counted drone delivery of a cup of coffee as less polluting that driving to the coffee shop to collect a coffee. The environmentally sustainable options would be to walk to the coffee shop, make your own coffee at home, or drink water (personal communication, Keith Thomas).

Almost all the official environmentally sustainable options seem to be about marginally less polluting ways of continuing a fundamentally and massively unsustainable lifestyle. Often with microelectronics embedded at many points along the way e.g. drone deliveries facilitated by 5G.

The Bonython delivery drone trial was completely at odds with the normally accepted standards for community noise, and even with what is normally accepted outside those standards such as the use of lawn mowers, which don't continue week after week every day. The Bonython trial was truly a "trial", riding roughshod over community rights to the quiet enjoyment of one's home, and I am surprised it was ever approved.

The approach largely taken by the ACT Government and the ACT Chief Minister to date shows little understanding, if any, of the important public health implications of environmental noise (as outlined above) or of fields such as soundscape ecology. This is the study of sound in landscapes in order to understand how sound from various sources can be used to understand coupled natural-human dynamics. Soundscapes provide ecosystem services to humans in the form of many life-fulfilling functions. Many soundscapes also have cultural, historical, recreational, aesthetic, and therapeutic values. In light of the multitude of threats, unique and natural soundscapes have been referred to as an endangered resource. This has been shown in no small way by the strong reaction from many residents of Bonython.

Many, including a good few people in Bonython, are open to the selective use of drones for environmental and monitoring purposes as outlined in scenario 2 above, the so-called "emergency scenario". Evoenergy's use of small drones for yearly monitoring of power lines is a good example.

The widespread delivery scenario 1, the so-called "pizza scenario" is another matter altogether, and should be avoided because of its broad environmental impacts on humans and wildlife. People in Canberra appreciate the city's quality of life and don't want it further degraded. Australia Post's model of quiet delivery e-trikes and electric bicycles ticks the right boxes. The birds will be around, the greenhouse emission argument holds, and the peaceful amenity of people's homes and suburbs is preserved.

My expectation is that the widespread adoption of delivery drones assumed in the Infrastructure consultation would build considerable community resistance. We know that aircraft noise was a defining local issue at the last federal election for many who live under flight paths that emerged when Brisbane airport opened its second runway in mid-2020, playing a role in the election of Greens MPs in three inner city seats. This is an incredible outcome for some of Brisbane's most desirable and expensive suburbs such as Hamilton.



LEGISLATIVE ASSEMBLY FOR THE AUSTRALIAN CAPITAL TERRITORY

STANDING COMMITTEE ON ECONOMIC DEVELOPMENT AND TOURISM Mr Jeremy Hanson MLA (Chair), Ms Suzanne Orr MLA (Deputy Chair), Mr Michael Pettersson MLA

# **Submission Cover Sheet**

### Inquiry into drone delivery systems in the ACT

Submission Number: 074 Date Authorised for Publication: 27 February 2019

# Dr Murray May – submission to the ACT Legislative Assembly Standing Committee on Economic Development and Tourism: Inquiry into drone delivery systems in the ACT

20 February 2019

**Dear Committee Members** 

I have structured my submission using the following main headings as these intentionally cut across the terms of reference in order to provide another perspective for the committee to consider.

- 1. The standing committee's frame of reference
- 2. Two scenarios
- 3. Invasive noise
- 4. Quality of life, well-being, and public health
- 5. Project Wing's marketing and unpacking the drone debate
- 6. Conclusion

There is also a reference list at the end.

I have also forwarded two separate attachment documents with my submission for the committee's consideration, namely:

1. Institute for Technology Assessment of the Austrian Academy for Sciences (2018). Delivery drones from a technology assessment perspective. While not necessarily agreeing with all of it, nevertheless this document provides a useful overview of the many still to be answered questions on drones and their place in societies.

2. Public Health Association of Australia (2017). Policy-at-a-glance - environmental noise policy. I have included this as a short useful summary, as some ACT politicians appear to be unfamiliar with the public health aspects of environmental noise.

### 1. The standing committee's frame of reference

I note from the ACT Legislative Assembly website that the Standing Committee's role is defined as follows:

A Standing Committee on Economic Development and Tourism to examine matters relating to economic and business development, small business, tourism, [market and regulatory reform, public sector management, taxation and revenue], procurement, regional development, international trade, skills development and employment creation, and technology, arts and culture.

On 26 October 2017 the Legislative Assembly resolved to amend:

*Omit the words "market and regulatory reform, public sector management, taxation and revenue", substitute "Access Canberra".* 

The committee's frame of reference by definition is biased towards economic issues and could well mean that a limited lens is used to examine this issue, rather than a holistic approach. Implicit in the term of reference (b) "the economic impact of drone delivery being tested in the ACT" is that introduction of drone delivery systems in the ACT will inevitably be desirable. This bias is also apparent in the assumption of the inquiry term of reference (e) "ways to improve the use of drone delivery technology within the ACT". One hopes "improve" here includes limiting the scope of drone delivery technology in the ACT, rather than just assuming that drone delivery systems are a foregone conclusion. For example, a recent email from Mick Gentleman states that [Project Wing] "have been trialling their new business model in the ACT over the last two years, and the ACT government welcomes this business investment in Canberra". It's true that term of reference (d) addresses "the extent of any environmental impact", though if the committee were a standing one on "quality of life and community health", its overriding concerns and priorities would be quite different..

### 2. Two scenarios

**Attached** for the committee's consideration is a 2018 report **"Delivery drones from a technology assessment perspective"** by the Institute for Technology Assessment (ITA) of the Austrian Academy of Sciences" (Institute for Technology Assessment of the Austrian Academy for Sciences, 2018). Of particular value is the report's consideration (p.37) of two scenarios for drone deployment:

The **basic scenario no. 1 (the so-called "pizza scenario")** is the widespread delivery of all kinds of small goods (parcels) by drones, instead of (or in combination with) delivery vans and trucks. The AlphaBeta consultancy for Project Wing estimated that by 2030 there would be 5.6 million drone deliveries a year or 11,000 drone deliveries a day (Evans, 2018).

The **alternative scenario no. 2 (the so-called "emergency scenario")** is less extensive: the delivery service by drones would only be a niche market, in which special goods, e.g. in the medical field, would be routinely transported between hospitals, pharmacies, and practitioners, or for other emergency purposes. Another potential niche market could be the regular supply of goods to remote areas, where no roads lead or there is no other connection.

Most of the impacts are much aggravated in the case of scenario no. 1 as it is associated with ubiquitous and massive drone flights, whereas in scenario no. 2 flights take place less frequently, perhaps only occasionally. Those with significant concerns about scenario 1 usually support the wide range of other less invasive uses for drones in scenario 2 such as for mapping and surveying, emergencies, insurance industry use after floods, environmental protection, inspection of power lines in Canberra by Evoenergy and so on. For example, Canberra MP Gai Brodtmann readily recognises the benefits of drones in rural and remote

Australia, in contrast with the widespread concern by residents in her electorate about the delivery trial in Bonython (Jervis-Bardy, 2018e).

More often than not, proponents of expanded drone delivery such as the ACT government and Project Wing mix up the two scenarios rather than recognising the many pitfalls from a community point of view of scenario 1. In scenario 1, considerable numbers of drones filling the lower airspace bring the noise pollution normally associated with heavily trafficked roads or worse, or with living near airports, with likely negative impacts on real estate values in those areas. The aesthetic appearance of drones swarming the lower airspace can also be expected to be met with resistance from the population.

Flowing from the above is the conclusion that just because we can do something it doesn't necessarily mean we should. As an editorial in the Canberra Times put it: "what if the residents of Gungahlin decide ... they'd rather not deal with the noise and lack of privacy that Bonython residents have complained of? What if it's decided that Canberra, as an already liveable and progressive city, has no real need for drones to deliver things at all?" (Editorial, 2018b)

There are a **host of open questions** regarding the commercial use of drones covering technical, legislative, societal aspects, safety and environmental risks. The trial in Bonython demonstrates that it was approved and implemented in the absence of sufficient foresight being given to these issues. For example, there is no agency responsible for the very significant noise issue arising from commercial drone use. The Civil Aviation Safety Authority (CASA) states that both noise and privacy are not its remit, as it is only the safety regulator. Airservices Australia has a role in managing aircraft noise in Australia, but states there are no federal noise regulations applying to drones. The ACT Environment Protection Authority (EPA) has a role in managing community noise e.g. air conditioner noise from a neighbour, but has no role in relation to noise from drones. This is completely unsatisfactory. The ACT government claims that "Wing would need to meet all the necessary legal and regulatory requirements of the territory and/or Commonwealth" (Jervis-Bardy, 2018b) but forgets to mention that governance arrangements for drones are deficient or absent altogether.

### 3. Invasive noise

Invasive noise is top of the list of concerns for residents of Bonython which has been subject to the delivery drone "trial" in recent months. The noise level has been recorded at the 80 dB level, which is well above the community noise standards applicable in Canberra. In residential areas, the standards are 45 dB(A) during the day and 35 dB(A) overnight. This applies for example to air conditioner noise from a neighbouring property. In the ACT government flyer on these standards, the daytime levels in a quiet residential suburb are listed as being typically 35-45 dB(A) whereas a lawn mower 15 at metres is listed as 70 dB(A) (ACT Government, 2015).

Some activities such as garden maintenance and regarded as acceptable to the community make noise above the permitted standards in prescribed timeframes. However, the tenor of the document is on noise reduction wherever possible. With excessive noise, people are

encouraged to discuss the issue with the person causing the noise or alternatively initiating mediation via the Conflict Resolution Service. When purchasing and installing reverse cycle air conditioners, heat pumps, pool pumps etc. people are advised to consider the location in relation to neighbours. Such advice makes sense, given that almost 80 per cent of all complaints made to the ACT Environment Protection Authority in 2017-18 are about excessive noise (Brown, 2018).

Although a comparison of drone noise with lawn mowers has been made by Chief Minister Andrew Barr, such an analogy is flawed and shows a lack of understanding of the ACT government's own advice on noise in residential areas. The trial in Bonython was approved by CASA for the following timeframes:

- Monday to Saturday from 7 am to 8 pm
- Sunday from 8 am to 8 pm.

Is Andrew Barr suggesting it is acceptable to have 20 to 40 overflights of drones each and every day of the week, at sound levels equivalent to or greater than a lawn mower? It should be remembered that the decibel scale is a logarithmic one, meaning that every 10 dB increase is a doubling of perceived loudness. Further, loudness is only part of the problem, with the high pitched frequency of drone noise producing annoyance responses greater than those associated with regular road vehicles. A NASA study on this issue concluded that this result "casts doubt on the idea that [drone] operators can expect their operations to be greeted with minimal noise-based opposition as long as the sound of their systems are 'no louder than' conventional package delivery solutions" (Christian & Cabell, 2017). With scenario 1 discussed above, is Andrew Barr then suggesting it is acceptable to have the equivalent of multiple high pitched lawn mowers overflying suburbs each day of the week, affecting many people and not just a few neighbours as is the case with a mower, the latter perhaps once a fortnight? The additive effects of multiple drones only increase noise levels still further.

The threats posed to wildlife and birds in particular are discussed in the ITA document attached (Institute for Technology Assessment of the Austrian Academy for Sciences, 2018, p. p. 38). Noise and the frequent presence of drones can be a stress for them, and this has been borne out in Bonython by the "on the ground" observations of missing birdlife and dogs barking constantly, the latter acting as a further noise irritant in the suburb. Residents from other suburbs have expressed concerns about the disturbance of birds and impacts on patterns of feeding, nesting and breeding and argue that they should not be disturbed or driven away by unnecessary technological intrusion for narrow commercial advantage (Blount, 2018). Urgent action has been called for on the loss of 3,000 trees a year in Canberra, with the Canberra Ornithologists Group informing another ACT assembly inquiry on nature in the city that the loss of large numbers of trees is leading to a decline in endangered and common bird species (Burgess, 2019b). The massive drone invasion scenario 1 would certainly exacerbate the threat to birdlife in Canberra generally.

Given the above, it is little surprise that 80 per cent of hundreds of Bonython residents canvassed about Project Wing's trial in the suburb were not in favour of commercial drone use in residential areas (McIntyre, 2018). As is often the case with developers such as

Project Wing, they have attempted to portray objections to their commercial plans as coming from just a small group of residents. In contrast, the reality is that Bonython residents in late 2018 delivered a petition with more than 1,000 signatures to the ACT Legislative Assembly, calling for a block on future household drone delivery services in the capital, including Wing's planned operation in Canberra's northern suburbs (Jervis-Bardy, 2018a). As at 18 February 2019, the Bonython against Drones Facebook group has 228 members.

Other sources of community feedback summarised by Gai Brodtmann MP, Member for Canberra (Brodtmann, 2019) include:

- In December 2018, the Canberra Times published a poll canvassing a broader range of people than Bonython residents. The result was 68 per cent against drones, 17 per cent for and 15 percent unsure.
- The RiotAct's online poll on the delivery drone services showed 66 per cent of respondents saying "Keep them out of my backyard".
- ABC Radio's poll on 13 February 2019 with 793 participants found 65 per cent were against the drone delivery trial, or the service in general.

### 4. Quality of life, well-being, and public health

There is a very large literature on quality of life and well-being which challenges that notion that all that matters in life is economic growth and material well-being, including popular books such as Clive Hamilton's *Growth Fetish* (Hamilton, 2003) This has even been expressed of late in the ACT government's intention to introduce a well-being index – this seeks to go beyond economic and population data to measure progress via such an index (Burgess, 2019a). It also expressed through the idea of "liveability" of a city.

ANU human ecologist Emeritus Professor Stephen Boyden AM has long considered such issues and encourages planning for biosensitive cities that address human health needs and also the health needs of ecosystems (Boyden, 2010, p. 45). Quality of life or lack of it is strongly associated with mental health issues and stress related challenges, with mental health compromised in response to unsatisfactory physical and psychosocial conditions. Boyden addresses a range of physical and psychosocial factors that are important for human health. The physical ones include, for example, clean air, clean water, healthy (natural) diet, protection from extremes of weather, and *noise levels within the natural range*. The psychosocial factors include, for example, emotional support networks, recreational activities, sense of purpose and belonging, sense of security etc.

With respect to noise and legal requirements, the residential tenancy legislation of every state and territory enshrines the right of tenants to quiet enjoyment. In most jurisdictions, the legislation expands the right to quiet enjoyment so it also includes the right to reasonable peace, comfort and privacy (Victorian Law Reform Commission). These rights are akin to the basic health needs considered above in human ecology terms.

Contrast the above with an opinion piece on the invasion of all manner of noisy technology into public spaces. The author states that the more time she spends outdoors, the more it feels like she is being besieged by noise intrusion in ways that were previously unimaginable. She continues: "Since when was it socially acceptable to blast out nightclub anthems at the beach? Or fly a noisy drone with its incessant, high-pitched buzzing through the tranquil canopy of a national park? Just because you got state-of-the-art Bluetooth speakers for Christmas doesn't mean you have a free pass to play music at full bore" (Stark, 2019).

Noise pollution is already recognised by health authorities as of considerable public health significance, with a World Health Organization publication *Burden of disease from environmental noise: quantification of health life years lost in Europe* drawing together much relevant information (World Health Organization, 2011). While Project Wing uses consultancy firms such as AlphaBeta to argue for large economic benefits for ACT businesses (Jervis-Bardy, 2018c), the economic framework used is very narrow and commercially focused, and ignores the considerable adverse health effects and costs outlined in the WHO report for example.

As a short summary of the above issues, I **attach** to my submission a 2017 policy overview on environmental noise from the Public Health Association of Australia (Public Health Association of Australia, 2017). Particularly salient points include:

- Environmental noise is public health issue that requires serious attention.
- Common noise sources vary in sound level, and sound can also be characterised by frequency (pitch).
- The repetitive nature of a particular noise and/or the inability of an individual to control it can cause annoyance and stress.
- Environmental noise pollution relates to ambient sound beyond comfort levels. When background levels are low as in a suburb such as Bonython, the experienced noise pollution is more prominent.
- Vulnerable groups such as children, older persons, people with mental health issues, people who are unwell may be affected in more marked ways.
- Long-term environmental noise exposure can affect stress levels, and increase the risk of hypertension and elevate risks of heart attacks.
- Categorising noise with respect to sound level, pitch, how often etc, is important in assessing impact.
- Action to ensure a safe and healthy environment is a critical public health priority.
- Authorities need to make use of "strategic noise maps" and undertake strategic noise impact assessment.
- Governments need to develop policies and strategies to promote public health and reduce adverse environmental consequences from environmental noise pollution.

My own background work and experience on aircraft noise issues suggests that experts in the field of psychoacoustics should be drawn on to a much greater extent in order to better understand the impacts of noise on health.

The Bonython against Drones community group on its website (https://bonythonagainstdrones.com/about-us/) states that "the peaceful amenity of our homes is the foundation of our lives, and paramount to our health and wellbeing". As reflected in many letters and comments to the Canberra Times, RiotACT etc. and the many representations to local politicians such as Gai Brodtmann MP Member for Canberra, this peaceful amenity has been seriously disturbed by the Project Wing drone trial in Bonython. The public health literature on the impacts of environmental noise underlines the significance of the negative impacts observed in Bonython.

### 5. Project Wing's marketing and unpacking the drone debate

Project Wing's marketing has repeatedly promoted particular themes suggesting that the adoption of commercial drone delivery is "forward thinking" and "progressive". Thus Wing chief executive James Ryan Burgess states that "We decided to invest in Canberra because it's a growing innovative city and Canberrans have a reputation as early adopters of new technology" (Editorial, 2018b). The economic benefits are described in "gold rush" terms, with the AlphaBeta consultancy report claiming that "projections rely on the premise that deliveries by air are more time and cost effective than deliveries by road, making customers more likely to indulge in 'additional or higher-value purchases' " (Jervis-Bardy, 2018c). Naturally drone technology is promoted as being "environmentally friendly" by reducing greenhouse gas emissions. A more critical review suggests that much of this is marketing hype to support the company's commercial objectives.

The introduction of new technology often has many unforeseen consequences. For example, while smartphones are now ubiquitous, distraction from smartphone use while driving is now common and a significant factor in road traffic crashes, resulting in deaths and serious injuries.

With respect to consumer behaviour, drone delivery has the potential via its quick delivery aspect to create an induced consumer need with a new environment based on the promise of fulfilment of wishes and instant gratification in a very short time. This could easily fuel binge buying and increase levels of consumer indebtedness. Further increasing the online shopping trend could change the landscape of shopping outlets considerably with many non-virtual shops going out of business (Institute for Technology Assessment of the Austrian Academy for Sciences, 2018, p. 42).

The transport and logistic sector is personnel-intensive, and the labour market for drivers of delivery vehicles would very likely be under threat in an expanded drone delivery scenario. This group of relatively lowly skilled workers could easily be a casualty of commercial drone delivery (Institute for Technology Assessment of the Austrian Academy for Sciences, 2018, p. 39).

In respect to energy consumption and greenhouse gas emissions, drones need electricity and although each individual flight would not consume much, the overall picture of a generalised drone delivery system may be different, in particular if compared with current deliveries with vehicles carrying many parcels at once. Recent research concludes that for parcels up to 0.5 kg the energy balance is in favour of drones. Heavier packages were found to be best suited for efficient, often electric, ground delivery vehicles (Samaras & Stolaroff, 2018). The overall assessment may be different if the whole infrastructure is put in perspective. Overall, a life-cycle assessment is warranted, including among other factors the life cycle of the batteries needed (Institute for Technology Assessment of the Austrian Academy for Sciences, 2018, p. 38). Moreover, the environmental lens in the Samaras & Stolaroff research is constrained, in that the impacts of delivery drones on wildlife including birds are not considered, nor the impacts of environmental noise on people, other than the throwaway line at the end of their piece: "Now we just have to do something about the noise of all those propellers overhead". This is always a disadvantage of studies that are not holistic, with the recommendations arising limited by the narrow evaluation framework used.

Project Wing responds to the community angst about noise in various ways. On the one hand it suggests that "it is a new sound that may at first be unfamiliar to people" (Editorial, 2018a), and on the other it says "the company is developing a quieter, 'more pleasant' aircraft model ahead of its Mitchell launch" (Jervis-Bardy, 2018d). Just because a sound is new is not a reason that people should have to adapt to it. And as with improvements in aircraft noise, there are limits on improvements to drone noise as the airflow around many rotors cannot be avoided.

Comparative work on the greenhouse advantages of ground based electric vehicles needs to be considered. Australia Post estimates the volume of parcels has grown 10 per cent per year for the past three years and is rolling out new electronic delivery vehicles (eDVs) with more sun protection and carrying capacity (Burt & Mackay, 2019). Along with the new etrikes, Australia Post has also ordered a new fleet of 4,000 electric pushbikes. Both electric vehicles will be much quieter than the traditional postie motorbikes. There are health and safety advantages for the posties and also the community being delivered to.

Though I have not addressed the issue of regulation much, there are clearly many unaddressed issues. In a dense population area, collisions of drones with people are possible and injuries are quite likely. Though the Civil Aviation Safety Authority created an exemption to its usual distance requirements to allow drone deliveries in Bonython, there still remain concerns about safety. What happens if a recreational drone collides with a commercial drone for example, bring the commercial drone down on a person? CASA's highest priority is no doubt collision with an aircraft, but misuse of recreational drones has received prominence of late including the grounding of firefighting aircraft.

### 6. Conclusion

The Bonython delivery drone trial was completely at odds with the normally accepted standards for community noise, and even with what is normally accepted as outside those standards such as use of lawn mowers which don't continue week after week every day. Such a trial was truly a "trial", riding roughshod over community rights to the quiet enjoyment of one's home, and I am surprised it was ever approved. Countenancing exposure of further suburbs in Gungahlin to this onslaught is even more surprising given the strength of feedback from the Bonython community, not to mention the negative feedback from the broader Canberra community. The approach largely taken by the ACT Government and Chief Minister to date shows little understanding, if any, of the important public health implications of environmental noise (as outlined above) or of fields such as soundscape ecology (Pijanowski, Farina, Gage, Dumyahn, & Krause, 2011). This is the study of sound in landscapes in order to understand how sound from various sources can be used to understand coupled natural-human dynamics. Soundscapes provide ecosystem services to humans in the form of many life-fulfilling functions. Many soundscapes also have cultural, historical, recreational, aesthetic, and therapeutic values. Unique and natural soundscapes can be subtle or powerful links for humans to their environment. In light of the multitude of threats, unique and natural soundscapes have been referred to as an endangered resource. This has been shown in no small way by the strong reaction from many residents of Bonython.

Many, including a good few people in Bonython, are open to the selective use of drones for environmental and monitoring purposes as outlined in scenario 2 above, the so-called "emergency scenario". Evoenergy's use of small drones for yearly monitoring of power lines is a good example.

The widespread delivery scenario 1, the so-called "pizza scenario" is another matter altogether, and should be avoided in my view because of its broad environmental impacts on humans and wildlife. People in Canberra appreciate the city's quality of life and don't want it further degraded. A permanent installation of a scenario 1 scheme would only depress real estate values in the exposed suburbs. Australia Post's model of quiet delivery e-trikes and electric bicycles ticks the right boxes. The birds will be around, the greenhouse emission argument holds, and the peaceful amenity of people's homes and suburbs is preserved.

### **References:**

ACT Government. (2015). Noise in residential areas.

- Blount, J. (2018, November 13). What about the birds? [Letter to the editor], *The Canberra Times*, p. 16.
- Boyden, S. (2010). *Our place in nature: past, present and future* (2nd ed.). Canberra: Nature and Society Forum.
- Brodtmann, G. (2019, 18 February ). 90 second statement: community feedback on drones. Retrieved 18 February 2019, from https://www.gaibrodtmann.com.au/90\_second\_statement?fbclid=IwAR3A7hSrRy8

W5xsurgo1GwJIZ6ZD6IgnVfY7kS4OfUCuiSSkfVqn-t3RTCs

- Brown, A. (2018, September 16). Noise is EPA's most common complaint, *The Canberra Times*, p. 4.
- Burgess, K. (2019a, January 16). ACT government to introduce wellbeing index, *The Canberra Times*.
- Burgess, K. (2019b, January 29). Unacceptable: city losing 3000 trees a year, *The Canberra Times,* pp. 1, 6.
- Burt, J., & Mackay, J. (2019, February 9). Postie bikes to make way for e-trikes as growth in parcels stamps out letter delivery. Retrieved 20 February, 2019, from https://www.abc.net.au/news/2019-02-09/postie-bikes-make-way-for-e-trikes/10793136

- Christian, A. W., & Cabell, R. (2017). Initial investigation into the psychoacoustic properties of small unmanned aerial system noise 23rd AIAA/CEAS Aeroacoustics Conference: American Institute of Aeronautics and Astronautics.
- Editorial. (2018a, November 10). Balancing ACT on drones, The Canberra Times, p. 8.
- Editorial. (2018b, November 15). Drones need to get public on board, *The Canberra Times*, p. 16.
- Evans, S. (2018, December 10). More than 10k drone flights daily in ACT, *The Canberra Times*, p. 9.
- Hamilton, C. (2003). Growth fetish. Sydney: Allen & Unwin.
- Institute for Technology Assessment of the Austrian Academy for Sciences. (2018). Delivery drones from a technology assessment perspective. Vienna: Austrian Academy of Sciences.
- Jervis-Bardy, D. (2018a, November 27). Documents reveal ACT government's concerns over drone delivery trial. Retrieved 18 February, 2019, from https://www.canberratimes.com.au/national/act/documents-reveal-actgovernment-s-concerns-over-drone-delivery-trial-20181127-p50iis.html
- Jervis-Bardy, D. (2018b, November 9). Drone capital: plan for HQ flies north, *The Canberra Times*, pp. pp. 1, 6.
- Jervis-Bardy, D. (2018c, November 16). Drones could deliver \$40m boost: study, *The Canberra Times*, p. 8.
- Jervis-Bardy, D. (2018d, November 10). Mitchell traders in tech-hub push, *The Canberra Times*, p. 6.
- Jervis-Bardy, D. (2018e, October 27). MP raises issues with Bonython drone trial, *The Canberra Times*, p. 4.
- McIntyre, R. (2018, November 21). Open ears on drone [Letter to the editor], *The Canberra Times*, p. 14.
- Pijanowski, B. C., Farina, A., Gage, S. H., Dumyahn, S. L., & Krause, B. L. (2011). What is soundscape ecology? An introduction and overview of an emerging new science. *Landscape Ecology, 26*, 1213–1232.
- Public Health Association of Australia. (2017). Policy-at-a-glance environmental noise policy. Retrieved 19 February, 2019, from <u>www.phaa.net.au</u>
- Samaras, C., & Stolaroff, J. (2018, February 14). Delivering packages with drones might be good for the environment. Retrieved 20 February, 2019, from https://theconversation.com/delivering-packages-with-drones-might-be-good-forthe-environment-90997
- Stark, J. (2019, January 12). The right to holiday silence, *The Canberra Times*, p. 12.
- Victorian Law Reform Commission. (18 January 2019). Right to quiet enjoyment. Retrieved 18 February 2019, from https://www.lawreform.vic.gov.au/content/4-right-quietenjoyment
- World Health Organization. (2011). Burden of environmental disease from environmental noise: quantification of healthy life years lost in Europe. Copenhagen: WHO.





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# Delivery drones from a technology assessment perspective

Overview report



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Overview report

Institute for Technology Assessment of the Austrian Academy of Sciences

Authors: Michael Nentwich (project leader) Delila M Horváth

Vienna, March 2018

#### MASTHEAD

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### Zusammenfassung

War das Thema Drohnen vor Jahren noch vom Militär dominiert, ist es längst im zivilen Bereich und im Alltag angekommen. Hunderttausende Spielzeugdrohnen sind weltweit im Einsatz und wir haben uns an atemberaubende Filmaufnahmen aus bisher ungeahnten Perspektiven gewöhnt. Immer öfter begegnen uns auch Überwachungsdrohnen, viele haben schon einen Videoclip eines "Drohnen-Balletts" gesehen oder beobachtet, wie sich eine Touristin mit einem "fliegenden Selfie-Stick" filmt. In vielen Bereichen werden Pilotversuche durchgeführt, um den Nutzen von Drohnen zu testen, etwa in der Landwirtschaft, im humanitären und medizinischen Bereich, bei der Überprüfung von Anlagen, im Vermessungswesen und nicht zuletzt in der Forschung, um nur ein paar Beispiele zu nennen. Schließlich lassen die großen Online-Händler, einige Postunternehmen und zahlreiche Startups weltweit vor unserem geistigen Auge eine Welt entstehen, in der Lieferungen des täglichen Bedarfs durch die Lüfte erfolgen werden.

Insbesondere die Vision eines drohnenbasierten Lieferverkehrs ist freilich nicht voraussetzungslos. Viele regulative und technische Hürden werden noch genommen werden müssen, um sie Wirklichkeit werden zu lassen. Aufgrund der großen Eingriffstiefe dieser Technologieentwicklung – immerhin würde sich der uns umgebende Luftraum, der bislang nur von Vögeln und gelegentlichen Hubschraubern benutzt wird, gravierend ändern – stellen sich freilich eine Reihe von typischen Fragen der Technikfolgenabschätzung (TA): Bestehen Sicherheitsbedenken? Gibt es Umweltrisiken? Kann die Technologie für kriminelle oder terroristische Zwecke missbraucht werden? Besteht ein gesellschaftliches Konfliktpotenzial angesichts unterschiedlicher Interessen? Reicht die aktuelle Regulierung aus oder müssen neue Regeln geschaffen werden?

Diese Überblicksstudie stellt das Thema in groben Zügen dar und gibt erste Antworten auf die genannten Fragen. Sie basiert im Wesentlichen auf einer ausführlichen Internet- und Literaturrecherche, einigen ExpertInnen-Interviews sowie auf analytischen Überlegungen.

Die wesentlichen Ergebnisse lassen sich so zusammenfassen:

- Es gibt zahlreiche Anwendungsgebiete für zivile Drohnen: vom Einsatz in Katastrophengebieten, in der Landwirtschaft und in der Forschung über die Filmindustrie, den Tourismussektor und den Journalismus bis zur privaten Überwachung, Unterstützung von Wartungsarbeiten und der Kartographie.
- Ein von bereits vielen Akteuren als vielversprechend erkanntes Gebiet ist die Logistik, konkret der Transport von kleineren Gütern zu den EndkundInnen.

drohnenbasierter Lieferverkehr ist voraussetzungsvoll, es stellt sich eine Reihe von Fragen, die noch nicht beantwortet sind

Überblicksstudie gibt erste Antworten

zahlreiche Anwendungen

Hoffnungsgebiet für die Logistik

- einige technische
   Damit Lieferungen "durch die Luft" ökonomisch machbar sind, müs-Herausforderungen sind noch zu meistern
   Damit Lieferungen "durch die Luft" ökonomisch machbar sind, müssen die Drohnen autonom fliegen können, also ohne Piloten am Boden. Dafür müssen noch eine Reihe technischer Herausforderungen gemeistert werden. Diese reichen von Gewichts-, Reichweiten- und Wetterproblemen bis zur Perfektion der Sensor- und Ausweichtechnologien. Prinzipiell dürfte davon ausgegangen werden können, dass es nur eine Frage der Zeit ist, bis diese Probleme gelöst sind. Darüber hinaus muss auch die nötige Infrastruktur am Boden bereitgestellt werden, etwa Landeplätze.
  - ein Markt entsteht
     Der Markt für Drohnenlieferungen entwickelt sich weltweit. Es gibt bereits viele Pilotanwendungen, insbesondere in Afrika und Asien, aber auch in Europa. Die bislang transportierten Güter reichen von Fast Food bis zu Medikamenten und Blutproben.
    - Österreich
       In Österreich gibt es eine Reihe von Drohnen-Herstellern und einige Forschungseinrichtungen, die sich mit Drohnen aus unterschiedlichen Perspektiven beschäftigen. Amazon testet hierzulande Drohnen und auch die Österreichische Post hat in Graz einen groß angelegten Pilotversuch durchgeführt.
  - fehlende Regulierung
     Die rechtlichen Voraussetzungen f
    ür autonom fliegende Drohnen sind in Europa und Österreich noch nicht geschaffen. Es gibt jedoch weltweit zahlreiche Gesetzesinitiativen.
    - Der Bericht unterscheidet bei der Untersuchung der potenziellen Folgen zwei Szenarien: (1) Lieferungen aller möglichen Güter des täglichen Bedarfs (von der Pizza bis zur Kleidung) und (2) Speziallieferungen zu schwer zugänglichen Orten oder bei besonderer Dringlichkeit, etwa im medizinischen Bereich. Der Bericht kommt zum Schluss dass folgende Aspekte im Detail untersucht werden sollten:
      - Umwelt
         Drohnenlieferungen können Wildtiere stören (Vorbeiflug, Lärm); abstürzende Pakete oder Drohnen können die Umwelt verschmutzen; eine Lebenszyklusanalyse und eine Untersuchung des Energieverbrauchs müssten durchgeführt werden.
      - Gesundheit Abstürzende Drohnen können Verletzungen verursachen; bestimmte Ladungen könnten dabei auch Verseuchungen hervorrufen.
      - Arbeitsmarkt
         Der Markt f
        ür Arbeitskr
        äfte, der im Zuge des Online-Shoppings massiv gewachsen ist, k
        önnte wieder schrumpfen, abh
        ängig von den konkreten Liefermodi und -szenarien. Insbesondere Jobs f
        ür gering ausgebildete Menschen k
        önnten wegfallen.
        - Resilienz
           Eine massive Umstellung des Systems auf Drohnenlieferungen "auf der letzten Meile" müsste berücksichtigen, dass Drohnen nicht immer fliegen können, also ein redundantes Liefersystem benötigt würde.
          - Ethik
             Bekannt aus der Diskussion zu autonomen Kfz stellen sich auch bei autonomen Drohnen ähnliche ethische Fragen, da vorab programmierte Algorithmen im Fall von Unfallsituationen ethische Entscheidungen treffen müssen. Weiters stellt sich etwa die Frage, ob dieser

Service für alle offen sein muss.

•	Online-Shopping hat bereits das Verhalten und die Erwartungen der KonsumentInnen massiv verändert, noch raschere Lieferung durch die Luft wird das weiter verändern.	Verhalten von KonsumentInnen
•	Insbesondere in Szenario 1, in dem es zu praktisch allgegenwärtigen Drohnen in der Luft, auch im urbanen Gebiet, kommen würde, ist Lärmbelästigung zu erwarten, da zwar die einzelne Drohne leise, aber Schwärme laut wären.	Lärm
•	Es steht zu erwarten, dass Teile der Bevölkerung mit der massiven Nutzung des bodennahen Luftraums auch aus ästhetischen Gründen Probleme haben.	Ästhetik
•	Um autonom fliegen zu können, wären Drohnen mit einer Vielzahl von Sensoren und Kameras ausgerüstet, die eine große Menge von potenziell sensiblen Daten erzeugen. Diese können gespeichert und missbraucht werden.	Privatsphäre
•	Drohnen können auf einfache Weise für verschiedene illegale Zwe- cke missbraucht werden, vom Schmuggel bis zu terroristischen Ab- sichten. Missbrauch ist schwierig unter Kontrolle zu bringen.	Missbrauch
•	Der Bericht gibt vor dem Hintergrund der o.g. möglichen Folgen eines Einsatzes von Drohnen im Lieferservice einen Überblick über poten- zielle Regulierungserfordernisse. Insbesondere müsste das Luftver- kehrsrecht "drohnen-fit" gemacht werden; der Bereich KonsumentIn- nen- und Privatsphärenschutz untersucht werden; eventuell das Steuer- bzw. Abgabenrecht angepasst werden; sowie wirksame Me- chanismen zur Rechtsdurchsetzung gefunden werden.	mannigfache Regulierungs- erfordernisse
Im Fra reic wer	Abschlusskapitel wird argumentiert, dass aufgrund der vielen offenen gen und der Konfliktträchtigkeit dringend eine umfassende, auf Öster- ch fokussierende TA-Studie mit partizipativen Elementen durchgeführt rden sollte.	vertiefende TA-Studie mit BürgerInnen- Beteiligung für Österreich dringend

notwendig

### 1 Introduction

While 'drones' have been predominantly used by the military until quite recently, they arrived meanwhile in the civilian domain and in everyday life. Hundreds of thousands of toy drones or quadrocopters are around worldwide and we all got used to breath-taking shoots from so far unimagined perspectives. Increasingly we encounter surveillance drones, many of us have already watched a video clip of a "drones' ballet dance" or observed how a tourist films herself with a "flying selfie stick". In many other areas pilot tests are carried out to test the usefulness of drones, for instance in agriculture, in the humanitarian and medial sector, for inspection of facilities, in the field of mapping and surveying, and last but not least in research, just to mention a few examples. Furthermore the large online retailers, a few post enterprises and numerous start-ups worldwide lead us finally to imagine a world, in which everyday commodities will be delivered by drones through the air.

In particular the vision of drone-based delivery is not without presuppositions. To realise it, many technical and regulatory obstacles have to be overcome. Given the considerable depth of engagement – considering that the airspace around us, which was so far used by birds and occasional helicopters only, would change profoundly – a number of typical technology assessment (TA) questions are on the table: Are there safety concerns? Are there environmental risks? Could criminals or terrorists misuse the technology? Are we in the face of a societal conflict given the divergent interests involved? Does the current regulatory framework suffice, or do we need new rules?

This overview study presents this topic along general lines and gives first answers to the above questions. It is mainly based on an extensive internet and literature search, a few expert interviews and on analysis. Given the many open questions and the potential of conflict, we propose that an encompassing TA study with participatory elements focussing on Austria should be carried out urgently. drones recently became ubiquitous, many fields of application are being tested

drones-based delivery is not without presuppositions

an encompassing TA study is urgently needed

### 1.1 Definitions and common abbreviations in the field

a 'drone' is an unmanned aircraft vehicle or system<sup>1</sup>. This definition has two main parts: we talk about a flying object which has no pilot on board. Drones can be based on different technologies, some resemble more airplanes and have wings, others are more like helicopters with a rotor system. The latter, unlike helicopters, however, have more rotors, at least three, usually four and more. For instance a 'quadrocopter' or 'quadrocopter' has four rotors and a 'hexacopter' has six rotors. Whatever the number of rotors, they are alternatively called 'multicopter' or just 'copter'.

- civilian drones Within this report, we focus on 'civilian drones', that is, unmanned aerial vehicles for civilian purposes only. We distinguish them clearly from drones that are used by the military or for military purposes. In particular, armed drones are not dealt with here. Use of drones by the police, e.g. for surveillance, strictly speaking is no civilian use either.
- consumer vs. enterprise Among the civilian drones, some distinguish between consumer drones, drones also known as personal drones, and enterprise drones<sup>2</sup>, also known as commercial drones. While the first category refers to drones that are sold for hobby purposes and recreational use, the latter are used by enterprises to offer services by drones.<sup>3</sup>
  - autonomous drones As mentioned earlier, drones have no human pilot on board. They could either be piloted remotely by an operator on the ground or they may be more or less flying autonomously. Although a remotely controlled flying object may give the impression of being autonomous, we define an object as 'autonomous' only if it is flying automatically on the basis of its program, meaning that it can operate and reach its target without human supervision, control, or intervention.
  - levels of autonomy The concept of autonomous driving is well developed in the context of cars (and even ships: Krieger-Lamina/Nentwich 2016). We may apply and adapt the so-called 'levels of autonomy' used by the car industry to flying vehicles. In Table 1 below shows on the left side the five levels of autonomy with regards to autonomous vehicles. Based on this logic, on the right side we show how these levels of autonomy translate to drones and other autonomous aerial vehicles.

<sup>&</sup>lt;sup>1</sup> This definition of the European Aviation Safety Agency, easa.europa.eu/easa-andyou/civil-drones-rpas. is also shared by the Federal Aviation Administration of the United States, faa.gov/uas/. All URLs in this report have been last checked on 5.3.2018.

<sup>&</sup>lt;sup>2</sup> Business Insider, 08.09.2017, businessinsider.de/commercial-uav-marketanalysis-2017-8?r=US&IR=T.

<sup>&</sup>lt;sup>3</sup> gartner.com/newsroom/id/3602317.

Table 1: Levels of autonomy or smartness

SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/	Monitoring of Driving Environment	Fallback Performance of Dynamic	System Capability (Driving	Drone Smartness-Level	
Huma	<i>n driver</i> monito	ors the driving environment	Deceleration		Driving lask	Modes)		
0	No Automation	the full-time performance by the <i>human driver</i> of all aspects of the <i>dynamic driving task</i> , even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a	A. Remote-controlled flight from ground with the pilot controlling with direct visibility	
1	Driver Assistance	the driving mode-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task	Human driver and system	Human driver	Human driver	Some driving modes	B. Remote-controlled, cameras on drone	
2	Partial Automation	the driving mode-specific execution by one or more driver assistance systems of both steering and acceleration/ deceleration using information about the driving environment and with the expectation that the <i>human</i> driver perform all remaining aspects of the <i>dynamic driving</i> task	System	Human driver	Human driver	Some driving modes	c. Remote-control by autopilot with GPS	
Automated driving system ("system") monitors the driving environment						stabilization		
3	Conditional Automation	the driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task with the expectation that the human driver will respond appropriately to a request to intervene	System	System	Human driver	Some driving modes	D. Automatic: programmed route with self- reliant landing	
4	High Automation	the driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task, even if a human driver does not respond appropriately to a	System	System	System	Some driving modes	······································	
5	Full Automation	request to intervene the full-time performance by an automated driving system of all aspects of the dynamic driving fask under all roadway and environmental conditions that can be managed by a human driven.	System	System	System	All driving modes	E. Autonomous: programmed to target, self- reliant route-planning, self-sufficient in averting obstacles	
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Source: SAE International (2014)<sup>4</sup>, adapted by Krieger-Lamina/Nentwich (2016), partly translated by authors

For additional reference, see the following short list of typical abbreviations used in the context of drones:

BVLOS	Beyond Visual Line of Sight
FPV	First Person View
MAV	Micro Aerial Vehicle
OPV	Optionally Piloted Vehicle
RPAS	Remotely-Piloted Aircraft Systems
SAA	Sense and Avoid Technology
UAV	Unmanned Aerial Vehicle
VFR	Visual Flight
VLOS	Visual Line of Sight

 $<sup>{}^{4}\</sup> motor authority.com/image/100593055\_sae-levels-of-autonomy.$ 

### 1.2 Structure of this report

chapter 6 is this study's core, focusing on potential impacts of widespread drone delivery Apart from this introductory chapter 1 this report has seven more chapters. In chapter 2 we give an overview of the areas of application of drones in the civilian domain, focusing on delivery drones in the second part. chapter 3 describes the technical status quo of the technology and the current challenges. In chapter 4 we give a preliminary overview on the emerging market of drone deliveries. chapter 5 gives a short introduction on the current legal rules applicable to (delivery) drones. Chapter 6 is the core chapter of this report. It distinguishes between a more far-reaching and a much more restricted scenario of drone delivery and then systematises the potential main effects, from safety and environmental issues to various kinds of societal impacts and potentials for conflict. On the basis of the results of the previous chapter, chapter 7 summarises the potential need for regulation. Finally, the concluding chapter 8 contains our reasons for advocating an encompassing and participatory technology assessment study, because the timing is perfect for anticipatory governance.

### 2 Application areas for civilian drones

### 2.1 General overview

While in the media and in everyday experience we encounter mainly toy drones and those employed by the film industry, there are many more areas of application for this novel technology. Its main characteristics – being relatively cheap, lightweight, fast, versatile, relatively quiet and so on – open up many potential fields of action in which drones may solve problems or replace the incumbent socio-technical arrangements, because they are more efficient or would improve the quality of a service. And indeed, there are already many pilot projects and sometimes regular operations in the field. See Table 2 for an overview, followed by a more detailed explanation and sources to each of the areas.

Table 2: Application areas for civilian drones

Disaster and emergency response/civil defence	Private surveillance Science
Environmental protection	Agriculture
Surveying and mapping	Facility management and
Film Industry	maintenance
Journalism	Delivery of goods
Hobby/toy	Law enforcement
Tourism	Illegal applications

In the following we give an overview of the current fields of usage of drones:

Disaster and emergency response as well as civil defence purposes can include in particular situation survey, location survey, civil protection through monitoring, search-operations. Drones can further be used as flying ad-hoc Internet access providers (especially in remote locations), and they can support rescue helicopters in their operations (as a 'second eye', see Bergtora Sandvik/Lohne 2014).<sup>5</sup> In the insurance business drones can be used for quick data collection, e.g. after a flood, for location survey, and for mapping.<sup>6</sup>

In the field of environmental protection drones can be used for data collection, location survey, and mapping.<sup>7</sup> In general, mapping and surveying is a prime field of application, for instance for recording footage, where drones produce special maps (not only high resolution pictures, but also infrared and other wave-lengths, laser images etc.).<sup>8</sup>

The film industry uses drones to achieve spectacular shots from new perspectives; in addition footage is also often used for marketing and other commercial purposes.<sup>9</sup> In journalism current applications include observing sport events and being able to take footage from locations that are difficult to reach (closer to the target location, or approaching locations that are closed for humans)<sup>10</sup>.

Drones are also used for the purposes of arts. This can manifest itself in many forms, such as 'dance' performances (e.g. 'drone ballet'<sup>11</sup>), perfor-

<sup>8</sup> New Atlas, 10.05.2017, newatlas.com/intel-drones-falcon-8-bridgeinspection/49452/; DJI, 11.10.2016, newatlas.com/intel-drones-falcon-8-bridgeinspection/49452/. of drones: emergency response insurance business environmental protection mapping and surveying film industry journalism arts

current fields of usage

<sup>&</sup>lt;sup>5</sup> European Commission, 21.11.2016, ec.europa.eu/echo/field-blogs/stories/howdrones-can-help-humanitarian-crises\_en.

<sup>&</sup>lt;sup>6</sup> Air-World, 20.06.2017, air-worldwide.com/Blog/5-Ways-Drones-Are-Transforming-the-Insurance-Industry/; The Balance, 03.02.2017, thebalance.com/how-drones-change-insurance-industry-4125242.

<sup>&</sup>lt;sup>7</sup> Environmental Law Institute, February 2017, epic.org/news/Drones-and-Environmental-Monitoring-ELLpdf; SenseFly sensefly.com/industry/environmental-protection/; Remote Aerial Surveys remoteaerialsurveys.co.uk/environmental-monitoring.

<sup>&</sup>lt;sup>9</sup> Production Hub, 02.10.2017, productionhub.com/blog/post/drones-and-theirimpact-in-the-film-industry; SkySeeVideo, 16.08.2017, skyseevi- deo.com/ drones-changing-film-industry/; Boston Globe, 23.06.2017, bos- tonglobe.com/ business/2017/06/23/drones-rising-valuable-tool-commercial-filmindustry/mbvWUH4Ydc5rkdHrMqxgjN/story.html.

<sup>&</sup>lt;sup>10</sup>There are a few websites dedicated to this topic: Professional Society of Drone Journalism, dronejournalism.org; and Drone Journalism Lab, dronejournalismlab.org. Furthermore, several articles discuss the topic: Cisco, 03.07.2017, newsroom.cisco.com/feature-content?articleId=1851973; Simulyze, 27.03.2017, simulyze.com/blog/drones-and-journalism-how-drones-have-changed-newsgathering.

<sup>&</sup>lt;sup>11</sup>FuturZone, 19.12.2015, futurezone.at/digital-life/drohnen-verhuellen-nacktetaenzer/170.384.779/slideshow.

mances of drone swarms on the sky.12

- recreational activity, Obviously drones can be used for recreational purposes. This includes model-building, air races, private filming, using drones as a flying selfie-stick, and generally as entertainment for children, as well as adults.<sup>13</sup>
  - tourism Apart from the just mentioned use of drones by the tourists instead of photo cameras, they can be used for marketing purposes, providing footage from new perspectives to advertise a particular place or event.<sup>14</sup>
- private surveillance Drones can be used by private persons as well as commercial enterprises as burglar alarms or supplements to CCTV on private estates; they can as well be tools for private investigators.<sup>15</sup> Although this is not a civilian application in the narrow sense also the police may use drones for surveillance, in particular during events (e.g. protest marches, sports events, cultural open-air events), or, potentially, for the pursuit of suspects, etc.<sup>16</sup>
- illegal applications Drones can also be used for illegal purposes, for instance for smuggling (e.g. of weapons into prison buildings, of drugs across a border, of illegal documents or money)<sup>17</sup>, and for criminal (e.g. shooting) or terrorist attacks (for e.g. transporting of bombs); finally, espionage may be a wide field of application.
  - science Within the domain of science drones can serve in particular as data collection devices, for instance in hard-to-reach areas like caves, the wilderness, or at archaeological sites; surveying and monitoring of wildlife and measuring environmental parameters (quality of air, level of pollution) may be easier and more efficient; finally special cameras (night light, infrared) can be used for observation.<sup>18</sup>

maintenance and The monitoring and inspection of various sites and large infrastructure nets, like pipes systems, rooftops, cables, rail tracks, ski-lift pillars etc. can also be done by special drones.<sup>19</sup>

<sup>&</sup>lt;sup>12</sup>Tech Radar 10.02.2018, techradar.com/news/intels-drones-broke-a-worldrecord-at-the-winter-olympics-opening-ceremony.

<sup>&</sup>lt;sup>13</sup>Dronethusiast, dronethusiast.com/drone-videos-that-blow-your-mind/; TechCrunch, 08.01.2018, techcrunch.com/2018/01/08/watch-intels-drones-playthe-piano- and-dance-in-the-air/.

<sup>&</sup>lt;sup>14</sup>Global Drone Solutions gdronesolutions.com/use-drones-tourism-marketing/; Skytango, 13.04.2016, skytango.com/how-drones-are-changing-tourismmarketing/.

<sup>&</sup>lt;sup>15</sup>Tech Crunch, 22.08.2016, techcrunch.com/2016/08/22/drone-startupaptonomy-has-created-robotic-flying-security-guards/.

<sup>&</sup>lt;sup>16</sup>For a science-fiction account of police drones see (Hillenbrand 2014).

<sup>&</sup>lt;sup>17</sup>FutureZone, 05.02.2015, futurezone.at/digital-life/us-start-up-plant-marihuanalieferung-per-drohne/145.301.373.

<sup>&</sup>lt;sup>18</sup>Columbia University, 16.06.2017, blogs.ei.columbia.edu/2017/06/16/how-dronesare-advancing-scientific-research/; Nature, 12.06.2013, na- ture.com/news/ drones-in-science-fly-and-bring-me-data-1.13161.

<sup>&</sup>lt;sup>19</sup>Control Solutions, 25.04.2017, controlyourbuilding.com/blog/entry/drones-infacilities-management-saving-lives-time-and-money; ORF-Salzburg, salzburg.orf.at/m/news/stories/2737193/.

Farming and agriculture is a field where drones may support the digitisation and precision farming efforts are currently under way. For instance particular parameters of the fields may be surveyed (such as humidity, temperature, pest attacks etc.); the application of fertilizers could be optimised and drones can be used for protecting young animals sleeping in the grass in front of a harvester. Drones can also be used as scarecrows.20

Delivery of goods can entail the transportation of small goods, meals, everyday supply goods, pharmaceutical products, medical samples, spare parts etc. This will be the main focus of this report. Passenger transport entails aspirations to use drone technology to transport people, i.e. in small electrical copters with several rotors for short distance flights.<sup>21</sup>

#### 2.2 Drones for delivery in focus

In this report, the focus is on one specific application of drones, namely the delivery of goods. Either due to popular trends or economic considerations the idea of delivering items (small parcels, food, medicine and others) by drones is an idea that several enterprises from various fields have taken up and continue to engage with (e.g. Bruckner 2017).

Following initiatives of small enterprises<sup>22</sup>, large corporations as diverse as Amazon, Google (Project Wing), DHL or Mercedes-Benz and many others started to invest a lot of resources in testing delivery by drones and lobbying for making this service a reality. Many start-ups are launching delivery services by drones all around the word, testing the market and the legislative frameworks with this novel approach. Furthermore national companies such as national postal service providers have expressed interest in this novel idea, including the Austria Post.<sup>23</sup>

Concerning the entire phenomenon, many questions arise: would delivery services by drones be successful on the market only for special items (e.g. in the medical sector), or would it expand to the delivery of all kinds of goods. Will this be a special service, serving only a small fraction of the population, or will this practice replace all existing delivery practices? Will fast delivery by drones be a premium-service for special occasions, or will society demand acceleration (e.g. delivery within one hour) for all deliver-

agriculture

logistics

a new market is unfolding

many open questions

<sup>&</sup>lt;sup>20</sup>Microaerial Projects, microaerialprojects.com/services/agricultural-environmentalmonitoring/.

<sup>&</sup>lt;sup>21</sup>A successful test was just recently carried out, see TechCrunch, 05.02.2018, techcrunch.com/2018/02/05/watch-ehangs-passenger-drone-take-flight/.

<sup>&</sup>lt;sup>22</sup>Like pizza delivery by drones in New Zealand by the company Dominos, see CNBC, 16.11.2016, cnbc.com/2016/11/16/dominos-has-delivered-the-worldsfirst-ever-pizza-by-drone-to-a-new-zealand-couple.html.

<sup>&</sup>lt;sup>23</sup>Post AG has also engaged itself in a pilot project with drones, mapping up and testing the feasibility and economic dimensions of the idea. For further information on this see chapter 4.2.

ies? Finally, would even long-distance delivery be a field for drones?

These and many other questions will be opened up and discussed through the rest of the report. First, we start by examining the technical aspects of these questions.

### 3 Technical challenges

Civilian drones as multicopters are relatively recent. It is only a few years that they appeared on the market and increased in numbers. No wonder that the technology is still in development and the technicians face a number of challenges with a view to construct viable, secure and wellfunctioning systems. In this chapter we address a few of the main issues to be solved on the path to widespread use of delivery drones.

### 3.1 Autonomous flying

Launching delivery services by drones seems only reasonable when they can be operated in an autonomous mode – except for very special scenarios (e.g. occasional fast delivery to remote areas). Otherwise the main reasons for launching such a service (such as cost reduction, automatization, speed) would be compromised if pilots are needed for each drone. However, to operate a drone autonomously is challenging in technical terms.–

The main challenge regarding the operation of autonomous delivery drones is the development of a robust *sense & avoid technology* (AAE/3AF 2015, p. 40ff). This term refers to a drone's capability to take-off, fly and land at the intended location and in the intended manner with-out colliding on the way. In order to do so the device has to have a continuously functioning and accurate geo-location device; clear vision through cameras (or radar) and well-developed algorithms to execute accurate landing. Beyond these, delivery drones would need to have the technical readiness to overcome challenges that weather, physical obstacles on the way (tall buildings, electric poles, cables, flying birds, other drones, and not least humans) and internal malfunctions could cause.

It is yet unclear which sense & avoid technologies (or which combination) would be the most reliable and cost-efficient. In particular, the development and testing of GPS, radar, infrared and other technologies are still ongoing. Up to today the threat of drones crashing (with another object or with each other) is a challenge, which the technicians have so far not solved satisfactorily.

Furthermore, delivery drones would need to be able to respect the designated no-fly zones (see section 7.1 on geo-fencing), i.e. the need to have up-to-date access to the respective databases or air signals. Finally they need the ability to communicate and coordinate autonomously and constantly with the other air traffic and with air control. drones are technically not yet fully ripe for delivery services

sense & avoid technology to be perfected

reliable geo-location is essential

respecting no-fly zones

communication skills

### 3.2 Further technical challenges

Apart from enabling secure autonomous flights, there is a wide range of further technical challenges for a drone-based delivery system to function properly.

- atmospheric conditions A prime concern is the weather. Most pilot projects to date have been carried out in 'ideal' weather conditions which raise the question: How would drones perform when there are typical, non-ideal conditions? Wind, precipitation (rain, snow), humidity, strong UVA radiation, fog, zones of low air pressure etc. are still difficult external circumstances for delivery drones<sup>24</sup>. Technical readiness of delivery drones need to reach a level so that they are able to cope with all possible micro-climate conditions of the territory they fly through. These questions would become especially relevant when we imagine launching a wide-scale delivery service that offers 'instant' delivery.<sup>25</sup> In addition, low temperatures would decrease battery performance significantly and hence reach (see below).
- securing parcel Beyond weather, an additional technical challenge is how to efficiently seon drones cure parcels on drones. The scenario of losing packages involves a number of additional concerns, in particular questions of responsibility and insurance, as well as the consequences of delivering hazardous materials or if precious or vital parcels are lost (e.g. with a badly needed blood sample).

cargo weight restrictions Regarding further aspects of delivery, the question of 'weight' represents another challenging factor. To date, there has been a number of pilot tests carried out with parcels ranging between 0.5-3.5 kg.<sup>26</sup> If the weight of the good exceeds this range, the wide-scale nature of a possible service would be in question (or different delivery drones would need to be employed that may affect the cost of the service – which is "advertised" to a more economic option compared to regular delivery services).<sup>27</sup>

decisive factor As the typical delivery drone has an electric engine, the battery capacity battery capacity directly contributes to the overall weight of the aircraft and hence to the distance the drone is able to fly in one go. Reach is a decisive factor when we speak about both feasibility and cost-efficiency. While energy efficiency and battery capacity is certainly a field of rapid improvement, the current drone models diverge a lot in their capabilities based on the type of engine and battery and performance in speed and distance. A pilot project for example which was carried out in collaboration with the Austrian Post, tested drones with packages that weighted maximum 3.5 kg and which flew with up to 60 km/h to a 10 km distance.

<sup>&</sup>lt;sup>24</sup>UPS tests show delivery drones still need work', techcrunch.com/2017/02/21/upstests-show-delivery-drones-still-need-work/.

<sup>&</sup>lt;sup>25</sup>futurezone.at/science/tu-graz-testet-drohnen-als-paketzusteller/274.382.090.

<sup>&</sup>lt;sup>26</sup>futurezone.at/science/tu-graz-testet-drohnen-als-paketzusteller/274.382.090.

<sup>&</sup>lt;sup>27</sup>See e.g. RedStage, 01.04.2017, redstagfulfillment.com/drone-delivery-is-aboutto-revolutionize-the-supply-chain-industry/.
Another relevant technical challenge is the act of re-mating with the delivery van. This part of the delivery sequence is reportedly one of the most challenging aspects when gross delivery is carried out with an accompanying van or truck.28

Lastly, there is a group of technical challenges that would result from vandalism and other human-generated actions against delivery drones: Spoofing is an act of manipulating the course or behaviour of drones by sending false GPS signals to them. By this, hijacking or crashes can be achieved. To date, technology to prevent such actions or to evade them is still underdeveloped, anti-jamming technology, shielding against radiation etc. seems to be in its infancy. But when such a service becomes widespread, its importance is going to increase and become outstandingly relevant.

#### 3.3 Necessary infrastructure

In order to have delivery by drones as an everyday reality, several infrastructural elements need to be worked out and established.

If delivery by drones would be permitted in urban settings, the first question to be addressed is where they would land. Initiatives aspiring for drone delivery in urban settings have approached the matter in various ways:

- In sub-urban areas, delivery to the backyard, balcony, terrace or doorway are imagined as viable options; in more urban areas they are not available. therefore
- · WinPort (a German company) is currently developing landing ports that can be attached to windows;29
- Connect Robotics (a Portuguese company)<sup>30</sup> builds designated landing points for delivery drones, at which parcels could be collected;
- Matternet (a Silicon Valley start-up)<sup>31</sup> has approached the matter in a similar manner, diverging only in that aspect that it builds stations on private grounds (such as hospitals).32
- There are pilot tests in the United Arab Emirates<sup>33</sup> and on the grounds

<sup>31</sup>mttr.net.

re-mating with the delivery van

spoofing and hijacking

landing spots

<sup>&</sup>lt;sup>28</sup>Blick, 27.09.2017, blick.ch/news/wirtschaft/neuer-service-von-mercedes-undcoop-heute-weltweit-erster-test-in-zuerich-die-drohne-liefert-das-paeckli-zumauto-id7385534.html.

<sup>&</sup>lt;sup>29</sup>win-port.de.

<sup>&</sup>lt;sup>30</sup>connect-robotics.com.

<sup>&</sup>lt;sup>32</sup>The Verge, 20.09.2017, the verge.com/2017/9/20/16325084/matternetautonomous-drone-network-switzerland.

<sup>&</sup>lt;sup>33</sup>By Costa Coffee, arabianbusiness.com/industries/technology/379426-costacoffee-tests-drone-delivery-service-in-dubai.



of a universities (Virginia Tech, US<sup>34</sup>) aiming to deliver goods right into the hands of recipients.

Figure 1: Delivery drone brings coffee on the beach

Source: Arabian Business 2017<sup>35</sup>

There are different delivery modes: The drone

• lands and deposits the parcel,

delivery modes and

- stays in the air and lowers the parcel with a rope, or
- drops the parcel with a small parachute attached.

There are trials with all three methods, and the manner of choice will be dependent on the actual circumstances of the target location.<sup>36·37·38</sup> Depending on the delivery method, a different infrastructure on the ground may be needed, e.g. a basket in which the dropped parcel would fall or specifically marked and possibly sheltered areas for drone delivery. Here regulatory measures are to be expected (see below chapter 7).

parcel design Additionally, there is another aspect regarding infrastructure that needs to be considered: the specific design of the parcels that the drones would be carrying. Obviously the current cardboard boxes would not be suitable for all weather conditions and some goods would need special protection that

ITAProject Report No.: 2018-01 | Vienna, March 2018

<sup>&</sup>lt;sup>34</sup>time.com/4493291/google-tests-drone-deliveries-virginia-tech/.

<sup>&</sup>lt;sup>35</sup>arabianbusiness.com/industries/technology/379426-costa-coffee-tests-dronedelivery-service-in-dubai.

<sup>36</sup> the verge.com/2017/9/20/16325084/matternet-autonomous-drone-networkswitzerland.

<sup>37</sup> technologyreview.com/s/602356/burrito-delivering-drones-seriously/.

<sup>&</sup>lt;sup>38</sup> the verge.com/2016/4/5/11367274/zipline-drone-delivery-rwanda-medicine-blood.

goes beyond the usual packaging fillings as there is always the danger of dropping them from the air. Furthermore it may be necessary to develop more streamlined parcels as opposed to the usual, rectangular shapes. Another question would be whether in the future there would be a need for standardized parcels (shape and size), similar to the EURO pallets, in order to allow for general delivery services as opposed to companyspecific services.

Our interim conclusion is therefore that several technical aspects and standards of drones still need further development before it would be safe enough to launch commercial delivery services.

# 4 Amarket for drone deliveries in the making

Despite the fact that technological readiness of delivery drones is not yet fully developed, it can be observed that initiatives continuously pop-up aspiring to put delivery services by drones onto the market (Lee et al. 2016; AAE/3AF 2015, p. 30ff).

#### 4.1 Worldwide development

In the landscape of services by delivery drones various approaches can niche markets: be observed. Some business models are built on the idea of transporting special goods special goods, aiming to serve a niche market, some target a wider audience. The former specialise on the delivery of medicine, blood samples, organs and business-specific small parcels. The latter business models local delivery of pizzas usually target local delivery, frequently fast-food (e.g. pizza, burrito), variand drinks ous drinks (coffee, beer) or the delivery of small non-perishable goods (such as books, small electronics, etc.). Other business models would aim to expand, perhaps even revolutionize the whole market of delivery of general parcel delivery small-scale packages that are now delivered by delivery vans. Note that often these services are closely linked to the parallel implementation of other digital tools, in particular online ordering.

Within this landscape of drone manufacturers there are a couple of large enterprises whose activities already stand out in pursuing further applications for drones.<sup>39</sup> The biggest producers are in China and the USA (see Table 3). The figures are impressive: In 2016 about 2.2 million drones have been manufactured and sold for recreational and commercial use.<sup>40</sup> That shows an estimated 60 % growth in production numbers, and 35 % growth in sales compared to 2015.<sup>40</sup> Revenues for toy drones and commercial drones were 1.7 billion USD and 2.8 billion USD in 2016, respectively.<sup>40</sup> Revenues for personal drones and commercial drones are estimated to rise to 11.2 billion USD by 2020.<sup>40</sup>

<sup>39</sup>See also droneii.com/drone-market-environment-map-2018 for a large database of the drone market.

drone manufacturers

<sup>&</sup>lt;sup>40</sup>Gartner, 09.02.2017, gartner.com/newsroom/id/3602317.

Enterprise	Headquarter	Specialisation	Website
DJI	China	producing a wide range of commercial and recreational drones <sup>41</sup>	dji.com
Zero Zero Robotics	China	embedded Artificial Intelligence-powered camera in drones	gethover.com
3D Robotics	USA	autonomous drones with GPS point planning, so-called "smart drones"	3dr.com
Yuneec	China	manufacturing of commercial and recreational drones, software development <sup>42</sup>	us.yuneec.com
Parrot SA	France	recreational and commercial UAVs especially quadrocopters	parrot.com

Table 3: Largest producers of drones worldwid	able 3: Lai	rgest produce	ers of drone.	s worldwide
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the main actors in the field of logistics

*Amazon, Google,* and *DHL* are the largest companies worldwide that are on the frontline of testing the employment of drones for various services. However, not these big companies are the most important players of this developing industry. Rather there are dozens of start-ups at various locations worldwide that aspire to develop this market and which already run delivery services using drones. Indeed, the majority of the most widely known initiatives by drones have been carried out by small start-ups (e.g. *Zipline International, Matternet*). Note that only a few of these companies are located in Sillicon Valley, but the hotspot of delivery services by drones seems to be Africa (and Asia) – however some of those operators have their headquarters in first-world countries (see sub-section 4.1.1 below for specific examples).

<sup>&</sup>lt;sup>41</sup>DJI also covers approximately 70% of the market, see Business Insider, 09.08.2017, businessinsider.de/commercial-uav-market-analysis-2017-8?r=US&IR=T.

<sup>&</sup>lt;sup>42</sup>Yuneec together with DJI have been referred to as the 'Samsung and Apple of the drone industry', see Business Insider, 09.08.2017, businessinsider.de/commercial-uav-market-analysis-2017-8?r=US&IR=T.

Enterprise	Headquarter	Specialization	Website
Zipline International	USA	blood samples and medical supplies	flyzipline.com
Matternet	USA	emergency goods and medical supplies	mttr.net
Amazon	USA	small parcels	amazon.com
Google/ Project Wing	USA	small parcels	x.company/projects/wing/
DHL	Germany	small parcels	dhl.com
Flirtey	New Zealand	pizza	flytrex.com
Flytrex	Israel	fast food	flytrex.com
Mercedes- Benz	Switzerland	coffee and sandwiches	mercedes-benz.com
Win-Port	Germany	small goods	win-port.de
JD.com	China	small goods	jd.com
AEON	Japan	small goods	aeon.info
Connect Robotics	Portugal	small goods	connect-robotics.com
Alibaba	China	small/middle-weight goods	alibaba.com
Asda	USA	small parcels	asda.com
Rakuten	Japan	small goods	rakuten.com
Starship Technologies	Estonia & UK	small goods	starship.xyz

Table 4: Big players and start-ups in the delivery sector

In addition, it is noticeable that several public sector entities also perceive the idea of delivery by drones as a potential opportunity. Numerous national post enterprises entered partnerships with start-ups specialized in delivery services by drones and launched pilot projects, most notably those of Switzerland, France, Finland, the United Kingdom, Ukraine, South Korea, Australia and also Austria.

Media coverage of delivery drones is especially high. Many articles follow and report on the development of this technology, giving account of initiatives, estimations, calculations and perceptions regarding the future, costefficiency, technical-readiness and social aspects of delivery drones.<sup>43</sup> Occasionally one gets the impression of a hype or technology push agenda. The social-media presence of delivery drones is outstanding. It is obvious that the theme is a hot topic from the point of view of various spheres and sectors from investment firms to public institutions. public-sector companies

delivery drones are a hot topic

<sup>&</sup>lt;sup>43</sup>Television, radio, news portals, magazines and websites of investment firms, business magazines, tech magazines, social media (Twitter and Facebook), and other field-specialized websites (Drone World Expo; AUVSI International; Drone Life).

associations, conferences, expos

Furthermore, there are several events and organizations that specialize on unmanned aerial vehicles and commercial services by drones: for instance the Drone World Expo, AUVSI Unmanned and AUVSI Exponential by the Association for Unmanned Vehicle Systems International.<sup>44</sup>

# 4.1.1 Selected pilot tests with delivery drones internationally

The sphere in which delivery drones have first proven their usefulness and efficiency was the sphere of healthcare in developing countries. The companies that launched pioneering services were Matternet and Zipline International.

- emergency good delivery in developing countries *Matternet* has been the first to carry out pilot projects in Haiti, Lesotho and the Dominican Republic in 2014, transferring emergency goods and medical supplies to areas that are difficult to access. In 2015 they carried out further pilot projects in Papua New Guinea and Bhutan.<sup>45</sup> *Zipline* International is known to be the organization that started the first and still operational commercial delivery service in Rwanda in 2016, delivering blood samples and medical supplies. Further on, just recently in August, 2017 they acquired a contract with the Tanzanian government to launch permanent services in Tanzania as well.
  - food delivery The value of services by delivery drones have been first recognized in such locations where sufficient infrastructure was lacking, or streets were in a bad condition, but there are other pilot projects that saw business potential from a different angle. A number of pilot projects were carried out for testing drones for food delivery. One noteworthy example was the pilot delivery of pizza in New Zealand in November 2016 by a drone start-up named Flirtey together with Domino's Pizza Enterprise Limited.46 Another interesting example is *Flytrex* (an Israeli company), which tested delivery of fast food in Rejkjavík, Iceland. Since August 2017 the service went beyond the experimental phase - so it is the first permanent food delivery service by drones. Others are following, such as Mercedes-Benz, which launched in September 2017 a pilot project in collaboration with Matternet and the Swiss company Siroop to deliver coffee in Zürich. By now this pilot has been completed and the latest articles say that this service will be launched in Zürich on a continuous basis, making it the world's first delivery service by drones in an urban setting.47

<sup>&</sup>lt;sup>44</sup>auvsi.org.

<sup>&</sup>lt;sup>45</sup> fortune.com/2015/05/01/matternet-drone-delivery/.

<sup>&</sup>lt;sup>46</sup>dominos.com.au/inside-dominos/media/november-2016-pizza-by-drone-a-realitywith-world-first-customer-deliveries-in-new-zealand.

<sup>47</sup> cleantechnica.com/2017/09/25/matternet-launching-first-permanentautonomous-drone-delivery-network-switzerland/.

Other than the mentioned examples there are several more reports about food delivery services in various locations all around the word (India, Korea, Japan, etc.), but so far, due to various regulations and regulatory processes (see section 5.2) the launch of these services is in limbo.

#### 4.2 The status quo in Austria

In Austria there are a number of companies and start-ups that engage themselves with drones. Some of them are manufacturers, others offer various commercial services by drones, and a few do both.

Austria has a number of manufacturers of drones, although only some for commercial activities. *Schiebel* produces drones and other unmanned vehicles for both commercial and military purposes. *Stromkind* is a company that develops aerial, 'land', and 'aquatic' drones to fulfil environmental protection, disaster response, and risk mitigation functions. It might be worthy to note that just recently, this company won the Pioneer's Challenge Award for 2017.<sup>48</sup> *Austrodrones* and *Diamond Aircraft* are also special purpose drone manufacturers. *Dynamic Perspective* is a manufacturer of various unmanned aerial vehicles (UAVs), high precision cameras and sensor stabilization systems, which are specifically developed for the film industry. *Airborne Robotic* is not a manufacturer, but provides services for video and photography. *Riegl* is a company that has over 40 years of experience in developing and applying laser measurements systems, and which also employs drones and various other unmanned vehicles while doing so.

Other entities that engage themselves with drones are various universities and research institutes such as the Technical University Graz, Technical University Wien, AEC Linz, and the Alpen-Adria-University of Klagenfurt.

The Technical University of Graz has a division that engages itself with drones within its Institute of Computer Graphics and Vision. The division is called "Dronespace" which is a Micro Aerial Vehicle (MAV) Flying Environment, where testing of drones is carried out with a motion tracking system called Optitrack<sup>49</sup>. With this technology, researchers are aiming to better understand and control the movement of drones and improve its sense & avoid technology.

The Technical University of Vienna is engaged with the technology of combining autonomous flights with Smartphones. Within the project SmartCopter<sup>50</sup>, researchers within the laboratory of Virtual and Augmented Reality<sup>51</sup> are testing an on-board core processing unit on the basis of

quite a few Austrian drone manufacturers

<sup>&</sup>lt;sup>48</sup>pioneers.io/blog/post/stromkind-wins-pioneers-challenge-pioneers17.
<sup>49</sup>optitrack.com.

<sup>&</sup>lt;sup>50</sup>ims.tuwien.ac.at/projects/smartcopter.

<sup>&</sup>lt;sup>51</sup> ims.tuwien.ac.at/research/virtual-and-augmented-reality.

smartphones to allow for autonomous localization, mapping, exploration and navigation in an unknown environment, without requiring additional ground hardware for UAVs.<sup>52</sup> This could allow to reach an additional level within the development of delivery services by drones if on a mass scale.

Enterprise	Headquarter	Specialisation	Website
Schiebel	Vienna	development of larger UAVs and mine detection systems - also for the military	schiebel.net
Stromkind	Vienna	development of UAVs for environmental protection, disaster response, risk mitigation	stromkind.at
Austrodrones	Alberschwende	drone manufacturing and flight services	austrodrones.com
Dynamic Perspective	Vienna	development of UAVs and high precision cameras, sensor stabilization systems	dynamicperspective.com
Airborne Robotics	Klagenfurt	drone manufacturer especially for the film industry	airborne- robotics.com
Riegl	Horn	development of laser measurement systems that are employed by using drones	riegl.co.at
Drone Rescue	Graz	development of parachutes for drones	dronerescue.at
Team BlackSheep	St. Anton a. A	manufacturing quadcopters	team- blacksheep.com

The Ars Electronica Center (AEC) in Linz engaged itself in a project that aimed at making a spectacle with 100 autonomous drones to demonstrate what can be achieved by the power of technology and programming. This performance was created in 2016 in collaboration with Intel and made a world record at this time.<sup>53</sup>

In the Alpen-Adria-University Klagenfurt, within the scope of project SO-SIE<sup>54</sup>, researchers have specialized in advancing system intelligence connected to drone technology, where they are working to develop a method for dimensioning a drone-based delivery service that would be used by start-ups and companies that plan on deploying a drone delivery service. <sup>55</sup> The research group is funded by the Carinthian Economic Development

<sup>&</sup>lt;sup>52</sup>ims.tuwien.ac.at/projects/smartcopter.

<sup>&</sup>lt;sup>53</sup>Since then, Intel surpassed previous world record at the opening of the 2018 Winter Olympics in South Korea, techradar.com/news/intels-drones-broke-aworld-record-at-the-winter-olympics-opening-ceremony.

<sup>&</sup>lt;sup>54</sup> aau.at/en/blog/packages-delivered-by-air-drones-as-delivery-service/.

<sup>55&</sup>lt;sub>nes.aau.at/?p=7093.</sub>

Fund and works closely in collaboration with Lakeside Labs GmbH<sup>56</sup>.

To date, there is only one known company in Austria that carried out a delivery pilot project by drones, and that is the Austrian Post (Post AG)<sup>57</sup>. Please see next section for details.

See also a recent bachelor thesis, to be defended at the Vienna University of Economics and Business Administration (Lustig 2018), which approaches the subject from a transport logistics perspective.

#### 4.2.1 Pilot projects in Austria with delivery drones

Austria seems to be an interesting territory concerning the development and testing of delivery drones, perhaps because of the varied landscape. For instance, it is one of the few sites worldwide where Amazon's delivery drones are being developed and tested<sup>58</sup>, and there are a number of Austrian start-ups which engage themselves with the development of delivery drones for emergency response (e.g. *Stromkind*); finally, just recently the Austrian Post conducted a pilot project, testing alternative delivery methods by drones.

In collaboration with Technical University Graz, Austria gives home to the development of Amazon drones' sense & avoid technology. The research centre is situated in the outskirts of Graz where the work is led by leading experts from various technical universities and research institutes.

Amazon testing area

<sup>&</sup>lt;sup>56</sup>Lakeside Labs is an entity that claims to be a 'hub for science and innovation in self-organizing networked systems' in Klagenfurt, lakeside-labs.com.

<sup>&</sup>lt;sup>57</sup>tugraz.at/tu-graz/services/news-stories/tu-graz-news/einzelansicht/article/postag-und-tu-graz-erproben-autonome-transportlogistik-auf-der-letzten-meile/.

<sup>58</sup> theverge.com/2016/5/10/11642686/amazon-prime-air-lab-drone-deliverymicrosoft-experts-austria; techcrunch.com/2016/05/10/amazon-prime-air-opensaustrian-outpost-with-focus-on-sense-and-avoid-tech/.

#### pilot project of the Austrian Post

In another notable pilot project with drones the Austrian Post was recently experimenting with alternative delivery methods. In September 2017 a pilot project called 'HEIDI' was completed. The test comprised 1000 test flights with drones that were carrying up to 3.5 kg packages to a distance of 10 km and flying with up to 60 km/h to a rural setting in the Alps in Styria. Besides the drones, a special utility vehicle called 'ELI' was also tested. In this setting, the drones were completing the deliveries, flying off of a special delivery van and repeatedly returning to it while the van is in motion. The pilot project was reported to be successful, functioning well from a technical point of view in 99% of the cases.<sup>59</sup> The team announced its plans to test delivery by drones very soon within an urban setting as well (in the centre of Graz).<sup>60</sup>



Figure 2: Customer receiving a parcel by a drone from the Austrian Post Source: futurezone.at <sup>61</sup>

# provisioning an alpine hut

In summer 2017 another experiment with a delivery drone took place: Initiated by the Naturfreunde Österreichs, a hiking NGO owning a number of shelters in the mountains, a (remote-controlled) drone delivered food to a hut in the alps in the Salzburg region. The drone could carry 100 kg, fly with 120 km/h and up to 1000 meters. The trial was successful; the main problem was the capacity of the batteries (only 20 min). The initiator argued that this may be the future for provisioning remote huts as an alternative to expensive and environmentally unfriendly helicopter flights.<sup>62</sup>

<sup>&</sup>lt;sup>59</sup>futurezone.at/science/tu-graz-testet-drohnen-als-paketzusteller/274.382.090.

<sup>&</sup>lt;sup>60</sup>Apart from drones the Austrian Post also experimented with unmanned vehicles as an alternative delivery method. Within this pilot, TU Graz, Post-AG und i-Tec Styria conducted a pilot project in downtown of Graz, testing a land unmanned vehicle, kurier.at/wirtschaft/steirischer-roboter-stellte-post-in-graz-zu/293.798.027.

<sup>&</sup>lt;sup>61</sup> futurezone.at/science/tu-graz-testet-drohnen-als-paketzusteller/274.382.090.

<sup>&</sup>lt;sup>62</sup>ORF Salzburg, 21.8.2017, salzburg.orf.at/news/stories/2861539/.

The local helicopter company seems not alerted, arguing that such drones would have to fly ten times more often than the helicopter; in addition a spokesperson raised safety concerns.<sup>63</sup>



Figure 3: A drone delivers food to an alpine hut Source: ORF Salzburg<sup>64</sup>

These examples suggest that there is either a sense of need or business opportunity from a practical point of view (to experiment with delivery by drones), or a demand felt in the logistics industry, not only in Austria, but also by several other postal services elsewhere.<sup>65</sup>

<sup>&</sup>lt;sup>63</sup>ORF Salzburg 22.8.2017, salzburg.orf.at/news/stories/2861765/.

<sup>&</sup>lt;sup>64</sup>salzburg.orf.at/news/stories/2861539.

<sup>65</sup> techworld.com/picture-gallery/apps-wearables/best-uses-of-drones-in-business-3605145/.

# 5 Legal aspects of employing drones

#### 5.1 Civilian drones in general

The legislative system surrounding drones is a remarkably complex matter on which various countries have various uptakes, approaches, and as a result different laws. While there are certain common elements, there is a large degree of variation, especially when we look at the situation worldwide, but even within the European Union.

Generally speaking, the regulation distinguishes between non-commercial (recreational) and commercial use.<sup>66</sup> Several criteria and conditions apply to each use and operation. The drones themselves have to be licensed by the European Aviation Safety Agency (EASA) if they weigh more than 150 kg, below that it is the national aviation agency, for instance Austro Control. If still lighter they may be regulated differently; in Austria, for instance, all drones lighter than 25 kg are licenced by Aeroclub (ÖAeC)<sup>67</sup>, if the drones are not commercially used. The toy drones with less than 0.25 kg that fly no higher than 30 meters are usually not covered by the more strict rules. Beyond that the main distinction by the law is about whether or not the pilot is in eye contact with his/her drone. Without eye contact - which includes piloting with the help of a camera transmitting pictures taken from the drone ('first person view') - flights need to be individually allowed (for more details see Knyrim/Kern 2014). The current regulation, at least in Europe, does not cover autonomous unmanned aerial vehicles. In most legislative frameworks neither flying a drone with a camera<sup>68</sup> nor above a crowd of people is permitted unless with a special licence.

Interestingly there are several legal concepts that are either not exactly defined or not defined at all, for instance airspace: above what height do we consider the space 'airspace', or up to what height is it a person's property? There are certain countries where it is not clearly defined whether the air over one's property is *their* property, therefore in many cases it is unclear whether one is entitled to claim rights for or against objects flying over their property or not.

This and various other parameters are not clear or exact, but would come afore in the case of the launch of wide-scale delivery services by drones. autonomous aerial vehicles are not covered by legislation in Europe and need therefore individual licences for each flight

<sup>&</sup>lt;sup>66</sup>dronerules.eu/de/; for a short overview see also (ITA 2014).

<sup>67&</sup>lt;sub>aeroclub.at</sub>.

<sup>&</sup>lt;sup>68</sup> futurezone.at/digital-life/drohnen-fotografie-alle-fluege-muessen-genehmigtwerden/163.784.355.

### 5.2 Delivery drones in particular

current laws do not allow delivery drones	Obviously delivery drones do not belong to the category of lightweight fly- ing objects (which their toy equivalents are) because they need to carry a load in addition to the equipment needed for autonomous flying (such as cameras and other sensors etc.). So delivery drones could only be em- ployed under special conditions (e.g. license). For on-board cameras etc. one would need a special extra license given by the aeronautical authori- ty. However, so far, autonomous drones do not exist in the law and are therefore currently not permitted for use in Austria. In addition, delivery drones would have to fly over people and urban areas, something which – under the current regime – can only be allowed by the authorities on a case-by-case basis, which is obviously not suitable for a business model for regular deliveries.
need for new rules	The legal framework would have to be adapted for delivery drones, for in- stance with an additional drone category with special rules. This means that there would be a need for regulation in order to enable mass deploy- ment, especially when the delivery service by drones would be authorized in urban areas.
the cross-border and international dimension	Furthermore, more questions would arise when it comes to cross-border flights, similar to the big airplanes, for instance: Would one need also a license in the other country or does the home license suffice? Are there different rules in the other air territory? The European Union is currently developing a legal framework aiming at harmonizing the different national approaches. <sup>69</sup>
examples of legislative initiatives	Since the inception of the idea of delivery with drones, the United States was in the forefront of starting initiatives for the legislation of commercial drone activities for delivery services. At the same time, even recent as well as past initiatives were so far unsuccessful in reaching substantial progress. It would be interesting to know why a country which is usually at the forefront of enabling new technological ideas is in a legislative limbo. The question of speed and the question of success in making drone delivery services possible seem to depend on numerous factors that are deeply embedded in the particular country's socio-cultural and economic context and their legislative traditions. In a number of cases in Africa (Lesotho, Rwanda, Tanzania) and Central America (Haiti, Dominican Republic), it can be inferred that the legislation of delivery activities by drones were made possible in a faster way. It seems that for these countries it may have been the condition to receive aid and support by those organizations offering help in various humanitarian and emergency response

<sup>&</sup>lt;sup>69</sup>See IDG News Service 20.06.2017, via cio.com/article/3202386/verticalindustries/eu-wants-to-ease-commercial-drone-use-with-future-flight-rules.html; in 2015 the EASA European Aviation Safety Agency, easa.europa.eu made proposals for drones 'with restricted risk', see easa.europa.eu/download/ANPAtranslations/205933\_EASA\_Summary%20of%20the%20ANPA\_DE.pdf.

#### situations.70

The vision of potential growth seems to drive legislative initiatives. In China, reasons of practicality enabled legislation in regions where it would otherwise be very difficult to manage logistics.<sup>71</sup> This was also the case in Iceland where, additionally, population density and their socio-cultural background favoured drone delivery as an ideal solution.<sup>72</sup> Various benefits and the potential of economic growth was probably also the reason driving legislative initiatives in Europe as well. In the summer of 2017 it has been reported that the European Commission aims to ease regulations on light-weight drones to enable logistics, inspection services and agricultural businesses.<sup>73</sup> various legislative initiatives world-wide...

...including at the EU level

<sup>&</sup>lt;sup>70</sup>See the following examples: Tanzania, flyzi-

pline.com/uploads/Tanzania%20Announcement%20Press%20Release%20vFinal.pd f; money.cnn.com/2017/08/24/technology/east-africa-drones/index.html; **Rwanda**, qz.com/1003810/the-worlds-first-commercial-drone-delivery-operates-froma-hill-in-rwanda/.

<sup>&</sup>lt;sup>71</sup>Economic Times 07.11.2017, economictimes.indiatimes.com/news/international/business/alibabas-drones-deliverpackages-to-islands/articleshow/61545583.cms.

<sup>&</sup>lt;sup>72</sup>Bloomberg 23.08.2017, bloomberg.com/news/articles/2017-08-23/iceland-setto-become-island-of-drone-deliveries.

<sup>&</sup>lt;sup>73</sup>IDG News Service 20.06.2017, via cio.com/article/3202386/verticalindustries/eu-wants-to-ease-commercial-drone-use-with-future-flight-rules.html.

# 6 Overview on potential impacts of employing drones for deliveries

In this chapter, we give an overview about the possible impacts of the introduction of commercial delivery drones (AAE/3AF 2015; Rao et al. 2016; from a TA perspective see Čas 2015; ITA 2014; Nentwich 2015; Krieger-Lamina/Nentwich 2016; Nentwich 2017; Moe 2013; POST 2014). In this overview study, only a preliminary analysis can be made, which should be explored in a follow-up study. The topics addressed here are: environmental risks (6.1), health risks (6.2), societal impacts and potential areas of conflict (6.3) and protection against misuse (6.4). Section 6.3 in particular is addressing the following aspects: the job-market, resilience of delivery systems, ethics, consumer behaviour, noise pollution, aesthetic derogation of airspace, protection of private sphere, and commercial use of the public good ground-level airspace.

Throughout this chapter we use two scenarios<sup>74</sup> in which we preliminarily test and assess the potential consequences of drone deliveries:

The basic scenario no. 1 (the so-called 'pizza scenario') on which we focus our examination on is the widespread delivery of all kinds of small goods (parcels) by drones, instead of (or in combination with) delivery vans and trucks. Within this scenario, drones would be fulfilling the function of the so-called "last mile delivery": this means that various logistics providers would use the urban (and rural) airspace on a regular basis to deliver goods by drones to the consumer.

The alternative scenario no. 2 (the so-called 'emergency scenario') is less far-reaching: the delivery service by drones would only be a niche market, in which special goods, e.g. in the medical field, would be routinely transported between hospitals, pharmacies, and practitioners, or for other emergency purposes. Another potential niche market could be the regular supply of goods to remote areas, where no roads lead or there is no other connection in specific seasons.

Obviously most of the impacts discussed below are much aggravated in the case of scenario no. 1 as it is about ubiquitous and massive drone flights, whereas in scenario no. 2 flights will take place less frequently, perhaps only occasionally. We flag out those risks that are negligible if only scenario no. 2 would be implemented.

chapter overview

scenario 1: wides pread delivery of all kinds of small goods

scenario 2: delivery of special goods only (niches)

<sup>&</sup>lt;sup>74</sup>Note that these ,scenarios' are not scenarios in a strict technical sense, i.e. not created using the scenario technique, but rather ad-hoc 'narratives' describing in general terms possible futures.

#### 6.1 Environmental aspects

- threat to wildlife As drones would move in the environment (both natural and man-made) they pose potential risks for it. The first concern is the drones' effect on wildlife, and birds especially. When drones intrude into the habitat of animals, there would be a double risk: either the animals may be harmed, or they could be a threat to the effective operation of drones. Concerning the latter, such scenario has already been documented in Austria when eagles mistook drones for food.<sup>75</sup> Regarding the former, there are concerns that due to the possibility of collision, the safety of birds could be at higher risk (see the related discussion with regard to windmills). Note that it is not only wildlife that could be affected. Depending on the territory the drones would be allowed to fly through, they could have an impact on various range of domesticated animals (pets and farm animals) as well.
  - noise Even without collisions, the noise and frequent presence of these devices in the habitats of animals may be a stress for them, similar to nearby roads. To date, the effect of noise produced by drones onto wildlife has not been studied yet, but there are serious concerns that should be taken into consideration. Several factors play a role: the height drones would be required to fly, the territories they would be allowed to fly over, and the places where they would be allowed to land.
  - debris A further possible environmental risk is debris. Either as a result of collision or in the case of forgotten or abandoned goods, the question of waste poses another series of challenges. The matter or responsibility and actual response comes afore: who would be responsible for cleaning up debris, and who would bear the cost of damage or compensation? This issue reminds us of wild dumps, for which it is difficult to assign responsibilities.
- energy consumption A further environmental aspect to be considered from a technology assessment perspective is energy consumption. Drones need electricity and although each individual flight would not consume much, the overall picture of a generalised drone delivery system may be different, in particular if compared with current deliveries with cars carrying many parcels at once. In a recent research article the authors conclude that for parcels up to 0.5 kg the energy balance is in favour of the drones (Stolaroff et al. 2018). However, the overall assessment may be different if the whole infrastructure is put in perspective (Redaktion 2018). Overall, a serious ecobalance (life-cycle assessment) is warranted, including among other factors the life cycle of the batteries needed.

<sup>&</sup>lt;sup>75</sup>The Independent, 13.11.2015, independent.co.uk/video/News/two-eaglesmistake-a-drone-for-food-in-austria-a6733351.html.

#### 6.2 Health and safety

There are two kinds of health risks resulting from accidents. First, malfunctions of the navigation system, in particular in bad atmospheric conditions, may lead to accidents. In particular in urban areas with a dense population collisions of drones with humans are possible and injuries are quite likely, as the rotors are sharp and a loaded drone weighs a few kilograms. As long as delivery drone systems are not in place and also depending on the scenario implemented, it is difficult to estimate the likelihood of accidents for now.

Another potential health risk stems from the load. In the event of a crash of a drone carrying a dangerous good various unpleasant scenarios are imaginable. The definition what counts as dangerous would have to be refined; for instance one may ask whether blood samples of ill people, medical probes, or vaccines would be included, as they could potentially contaminate the environment or threaten people directly. Possibly the transport of dangerous goods could be banned altogether.

#### 6.3 Societal aspects and potential areas of conflict

With regard to societal aspects and conflict potential, the first wave of critique has already appeared in various forms on different platforms, and the first signs of resistance have already been articulated. For instance, in the US you can buy anti-drone guns to shoot them down if they trespass your private territory.<sup>76</sup> In the following, we give an overview of the most relevant areas in which concerns have been raised.

#### 6.3.1 Labour market

A first area of concern is potential effects of this technology on the jobmarket (OECD 2015). The transport and logistics sector is personnelintensive, as drivers who deliver the parcels in person are needed on the last mile. With the advent of 24/7 online shops, the market segment of delivery to the homes of the customers increased considerably<sup>77</sup>, and so did the labour market for packet assemblers and for drivers of delivery vans. In the event of widespread employment of drones for the last mile, the latter part of the labour market would eventually shrink again. injuries because of collisions

contamination with dangerous loads

the labour market for delivery services increased considerable with the diffusion of online shopping ...

...and may shrink again

<sup>&</sup>lt;sup>76</sup>Wired, 27.07.2017, wired.com/story/watch-anti-drone-weapons-test/; The Drive, 21.06.2017, thedrive.com/aerial/11505/the-7-most-significant-anti-drone-weapons.

<sup>&</sup>lt;sup>77</sup>Global online retail sales are growing and are estimated to reach 8.8% of total retail spending in 2018 as compared to 7.4% in 2016. In 2016 this meant 1.88 billion USD, which rose to 2.19 billion USD in 2017. By the end of 2018 this number is projected to be 2.48 billion USD. See invespcro.com/blog/globalonline-retail-spending-statistics-and-trends/.

effects depending on delivery modes and scenarios These effects very much depend on the concrete scenario and the delivery modes put in place. Obviously the labour market for drivers in the pharmaceutical sector is much smaller than the field of consumer goods. In case the drones would start from automated intermediate storage facilities, van drivers would be out of business in the longer run (except for the large and/or heavy parcels). In case the drones would start from the delivery vans, there is still a need for drivers – unless those vans eventually become autonomous themselves – but much less than hitherto, because using the drones for the last mile is supposedly much more time efficient: not only are drones faster than a human walking up the stairs, there could also be more drones starting from one van in parallel, which would lead to faster turnovers of the delivery vans with still only one driver.

We couldn't find any specific study about the last-mile delivery, but there are several studies that examined the process of digitalization and automatization in various job markets in different countries (EPTA 2016; Frey/Osborne 2013; Čas et al. 2017). The economists are split about the exact figures, but for some sectors they predict huge job losses, and the transport sector in general (taxi drivers, lorry drivers etc.) is a case in point. Further research is needed.

the societal importance of jobs for unskilled labour

economic estimations

market in the transport sector is certainly under

are split, but labour

threat

It is important to acknowledge that mundane tasks, which can be carried out by unskilled workers, serve as a social safety-net for those individuals who lack formation and specific training, but who need a job they can fulfil without further qualifications, at least for an interim period.<sup>78</sup> As the process of automatization would result in less need for human workers, the group of unskilled workers could suffer most.<sup>79</sup>

The threat of delivery by drones to the job market is also a recurrent topic in the media. The majority of the articles and debates are centred on economic aspects of automatizing delivery. In particular the threat to unskilled labour is being discussed frequently, as are distributional issues.<sup>80</sup>

#### 6.3.2 Resilience/redundancy of the delivery system

When the launch of any infrastructural service is under consideration, it is advisable not only to look at the potential economic advantages (like to opening up of new markets), but also to examine how resilient the overall system would be.

<sup>&</sup>lt;sup>78</sup> Especially in the case of immigrants or in case of job losses and a need for fast employment to secure income.

<sup>&</sup>lt;sup>79</sup> Forbes, 17.4.2017, forbes.com/sites/quora/2017/04/17/should-package-deliverybe-automated-with-drones-a-look-at-the-pros-and-cons/#3ccf82681bc9.

<sup>&</sup>lt;sup>80</sup> Forbes, 17.4.2017, forbes.com/sites/quora/2017/04/17/should-packagedelivery-be-automated-with-drones-a-look-at-the-pros-andcons/# 3ccf82681bc9; Goldman Sachs, 2016, goldmansachs.com/our-thinking/ technology-driving-innovation/drones/; Reuters, 21.03.2017, reu-ters.com/article/ us-usa-drones/u-s-commercial-drone-use-to-expand-tenfoldby-2021-government-agency-idUSKBN16S2NM.

There are certain circumstances when drones cannot fly safely, for instance in case of strong wind or icy rain or thick fog (just like the big airplanes). This means that in a scenario in which the existing van-based infrastructure is replaced to a large extent with delivery drones, the dronebased system would not be able to deliver. We may assume that the delivery firms would not keep the van pool "just in case". The question then is, whether this is acceptable or would we need alternatives?

For our general scenario no. 1, a temporary delivery stop may be acceptable (but needs further analysis), but what about scenario no. 2 in which the medical sector counts on daily delivery service by drones? This vulnerability of an important part of our life-saving infrastructure has to be avoided. In this case, alternative delivery services need to be on call at all times.

#### 6.3.3 Ethics

For the scenario of an impending and non-avoidable accident, what behaviour will be pre-programmed in the software of drones? Similar to algorithms that are discussed with regard to other autonomous vehicles, e.g. passenger cars, there are a number of decisions to be made, prior to events, which become operative in the time of split-seconds. For autonomous cars, these tricky issues have already seen extensive discussions among ethicists and technologists (Maurer et al. 2015), a respective discussion for drones is still missing (see, however, Luppicini/So 2016).

In one often quoted scenario in which damage seems unavoidable, there would be at least three options what the car/the drone could do: i. hit two adults with a great possibility of heavily injuring them; ii. hit a child with a great possibility of heavy injuries; or iii. somehow manage to avoid crashing into the two formerly mentioned, but instead crashing down and destroying itself and its parcel which could have saved someone else's life (e.g. the parcel containing a human organ for transplant). It is an open and difficult ethical question what decision to take. All this has to be decided and programmed beforehand. Is it the programmer who decides in advance, is it the drone manufacturer, the delivery service enterprise, the sender or the recipient of the parcel, or rather the society at large and hence the legislator? How would we - whatever decision is taken - oversee the implementation of these decisions? We may easily assume that answering all these questions is not easy (Krieger-Lamina/Nentwich 2016). Note that for the drone to be able to take whatever decision, permanent surveillance and analysis of the environment is a precondition.

By the way, this ethical dilemma is also present in the case of a delivery service restricted to emergency parcels only (our scenario no. 2). If the fact that it is an emergency would be taken into consideration for that difficult appreciation, we still face the question, what counts as an emergency situation and what doesn't? We may assume that the delivery of living organs may safely be considered an emergency, what about other cases,

dependency on drones that cannot fly at all times may be a source of risk

pre-programmed algorithms take ethical decisions

the ethical dilemma of autonomous cars revisited

what counts as an emergency?

like the transfer of medical probes and blood samples?

In our scenario no. 2 we may even go one step further: Would delivery services by drones in urban settings be an exclusive right of medical entities? If so, what counts as a medical entity? Would we strictly regulate who is allowed to fly and who is not, and how would we react if these privileges would be misused? If there is strict control, time restrictions, flight corridors etc., then this kind of service would be a scarce commodity. Usually this would lead to higher prices. For instance, a certain patient's blood could be given priority because she or he paid extra fees just to have their results faster. This is a typical technology assessment reasoning that we could term 'drones' divide': in one scenario only the rich may afford it (but still use the common good airspace) and it may lead to an additional difference in the quality of healthcare that patients receive. The same set of questions may also be asked for other services.

#### 6.3.4 Consumer behaviour

What consumers buy, how and when they buy, how they pay, what their expectations are, all this varies geographically and is changing constantly, not least because industry and commerce try to influence their behaviour, even creating previously unknown needs. Recently the advent of online shopping with 24/7 availability instead of fixed opening hours and with no need to leave home, neither for the search & order activity nor for the delivery, has the potential to enduringly change consumer behaviour (Lee et al. 2016). And so have drones.

Previously, mail-order firms, now web-shops delivered within a couple of days, and even expensive fast-track delivery usually takes a day to arrive. The promise of drone delivery is to reduce this to an hour or less. We may rightfully ask whether this would satisfy an already existing need or rather a new one is about to be created. Whatever the answer, it seems safe to predict that this development would speed up the whole consumer market and be an additional strain on location-based shops. Actually, even today we can observe a fierce competition between the latter and the online shops with their usually much broader portfolio, driving many non-virtual shops out of business (Bruckner 2017). This competition will certainly increase and may change the landscape of shopping outlets considerably. At the end, the consumer may be left with less local choices, but a vast online offer, perhaps with much less competitors on the market.

This new world of commerce – online and very prompt delivery (by drones) – could be assessed from both psychological and egal perspectives: this new environment would lead to almost instant gratification, and the promise of the 'fulfilment of all wishes' in a very short time. While on the one hand this is certainly welcomed by many, it may on the other hand fuel problems with binge buying, increasing levels of consumer debt, the danger of excessive indebtedness, and finally insolvency. From the point of view of consumer protection, legislating this is certainly an issue.

'drones divide': a service not available for everyone?

> drones have the potential to change consumer behaviour

instant delivery as an induced consumer need

novel consumer protection issues Note that the right to step back from an online purchase is psychologically speaking even more reduced (usually two weeks from the time of order) in case the delivery time is negligible; hence the opportunity to 'think twice' is diminished.

#### 6.3.5 Noise pollution

It is not only the wildlife (see above 6.1) that is affected by noise pollution, so are also humans. Just like those who live nearby high-traffic roads or airports, those who would live directly under the delivery air-corridors where drones fly regularly could suffer the disadvantages of noise pollution as well. Note that at in our scenario no. 1 massive drone traffic would develop over time. While a single drone with eight electrical mini-engines is not very noisy (unless it is very near), many of them at the same time certainly would. Even if we assume that later generations of drones would be more silent, there is certainly a limit to further improvements because the airflow around the many rotors cannot be avoided – similarly to the noise produced by car tires which is, together with the airflow around the autobody, above a certain speed louder than that of the engine and, hence, even the most silent electrical engines cannot produce silent e-cars.

Apart from highly used corridors, the expected delivery manoeuvers close to the customers, in particular in a densely populated urban area, are not negligible, at least not by those more noise-sensitive. Only the noise produced by the air traffic expected in scenario no. 2 would not be a of substantial concern.

So in scenario no. 1 we may assume that noise could be a problem which if unsolved may lead to resistance in the population. The question then is how the society would decide where drones would be allowed to fly to reduce the noise problem. No-fly zones may be part of the solution, as would be corridors high above street level and away from buildings, but can there be any solution for the last mile, i.e. the surroundings of the prospective landing spots close to the customers? These are open questions that cannot be answered without an informed public debate; we shall come back to this in the concluding chapter.

#### 6.3.6 Aesthetic derogation of airspace

Similarly to powerlines, windmills and skyscrapers in the past, the aesthetic appearance of drones swarming the lower airspace can be expected to be questioned by parts of the population. noise in densely populated areas may be a problem



Figure 4: A sky full of delivery drones

Credit: RikoBest/Shutterstock.com

At first this sounds like a luxury problem and indeed our societies have accepted a lot of similar compromises in the past: there are less and less untouched natural landscapes, and in urban areas the utilization of the ground level for traffic and all sorts of public furniture and appliances is standard. Furthermore opinions about the aesthetic value of all kinds of buildings and infrastructure will always remain split. However, one may argue – and we assume it would be put on the table if discussed widely – that using massively the so far empty airspace could be considered a new and qualitatively different step in exploiting a common good.

commercial use of the common good 'groundlevel airspace' Note that at least in our scenario no. 1 drones would fly mainly for commercial purposes in the private interest, whereas the use of the ground level is a shared space for commercial, public and private activities. This raises the additional question whether, if allowed at all, would the commercial enterprises be required to pay for the use of the space? There are many examples from the past, not least from the traffic sector, such as road charges, motor vehicle taxes, and the famous Austrian 'Luftsteuer' (air tax)<sup>81</sup>, which is due if one uses public ground for private purposes, e.g. with billboards extending into the air above sidewalks (see section 7.3).

#### 6.3.7 Protection of the private sphere

drones potentially threaten privacy In case packet delivery by drones would become a (legally) accepted service, this technology has the potential to affect and possibly conflict with the private sphere. Today even without large numbers of drones in the air, the issue is already tabled. In particular many toy drones are equipped with cameras (which is actually not allowed under most regimes unless you have a specific license), and so neighbours are alerted when drones fly over one's ground or approach one's balcony. There are numerous ar-

<sup>&</sup>lt;sup>81</sup> Gebrauchsabgabengesetz

ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=LrW&Gesetzesnummer=20000131.

ticles in the popular media addressing the issue<sup>82</sup> and several firms offer anti-drone devices for self-helped 'law enforcement' purposes.<sup>83</sup>

Even though taking pictures, filming or audio surveillance is not among the main functions of delivery drones, these are however needed to sense where they are going (and constantly survey their environment) and therefore are necessarily equipped with technology that can 'see' to orient them (see section 3.1).84 The data generated by these sensors during the flight could be immediately deleted. However, it may be the case that they would be legally required to keep a record of a flight, in case they need to prove that they were not the cause of damage or have obeyed all flying rules. Such a scenario seems likely as it parallels similar developments in other areas, in particular the black boxes of airplanes, in the near future also of cars, as well as the trip-recorders of trucks. This means that video material coupled with location data and time stamps would be generated and stored. All this data can be quite sensitive if people are on the videos or can be indirectly related to it. Also birds' eyes views from private properties may be sensitive, as are public buildings (e.g. the parliament building) or military facilities.

We assume that the privacy issue should not be underestimated. In section 7.2 we shall therefore come back to this topic.

#### 6.4 Protection against misuse

With all new technologies comes the potential of misuse. The dissemination of delivery by drones is expected to be no different (AAE/3AF 2015, p. 49f). Acts of misuse could be theft of the drones' loads, vandalism and so-called 'spoofing', i.e. electronic hijacking by overtaking control of the drone remotely or sending false GPS signals. Furthermore drones could be used by criminals to transport illegal goods, e.g. drugs, or to deliver something (e.g. weapons) to prison inmates.<sup>85</sup> Finally terrorists may load bombs onto drones or simply use drones to spy out potential targets (e.g. challenge: autonomous drones technically need a variety of sensors ...

...and the resulting data may be required to be stored

drones can be a target of criminals or used for a variety of illegal purposes

<sup>&</sup>lt;sup>82</sup>Consumer Reports, 10.02.2016, consumerreports.org/electronics/drone-privacyis-anyone-in-charge/; The Next Web, 24.08.2017, thenextweb.com/tech/2017/08/24/amazon-patent-details-the-scary-future-of-dronedelivery/; Recode, 15.03.2017, recode.net/2017/3/15/14934050/federal-privacylaws-spying-drones-senate-hearing.

<sup>&</sup>lt;sup>83</sup>E.g. special rifles, 20min.ch/digital/news/story/Drohnen-Gewehr-holt-Gadgetsvom-Himmel-25911389?redirect=mobi&nocache=0.6997041974682361 and http://www.spiegel.de/netzwelt/gadgets/battelle-dronedefender-das-antidrohnen-gewehr-a-1058093.html and spiegel.de/video/dronedefender-gewehrbeschiesst-drohnen-mit-radiowellen-video-1617446.html. Another option seems to be to train birds (falcons or eagles) to hunt drones, futurezone.at/digitallife/niederlaendische-polizei-trainiert-adler-fuer-drohnenjagd/178.424.561.

<sup>&</sup>lt;sup>84</sup>This is also true for remote controlled drones, not only for autonomous ones, as the pilot needs the camera to be able to fly at distance.

<sup>85</sup> tagesspiegel.de/berlin/gefaengnis-in-berlin-moabit-drogen-per-drohne-in-denknast/19931882.html.

nuclear plants<sup>86</sup>). These criminal purposes become easier to execute the denser the air traffic is, because the prospective high numbers of drones may be good to hide and go undiscovered. Also the drone itself could be the weapon if flown into a crowd of people or highway traffic.

knowledge about the<br/>rules for drones is<br/>generally lowEven non-criminals, just ordinary citizens often employ drones not correct-<br/>ly, e.g. when flying over crowds of people or with a camera attached; ob-<br/>viously, the general knowledge of the applicable legal rules is very low or<br/>it is imply indifference or neglect (Pfluger 2017).<sup>87</sup> To counteract, the Aus-<br/>trian authorities recently launched websites targeting the ordinary user<br/>with information about the applicable rules.<sup>88</sup>

how could authorities So we need to ask the question how authorities could prevent acts of misuse and criminal activities. To date, the legislation does not give the police the means to effectively counteract and penalize misuse. We shall come back in section 7.4 what options the legislator would have to improve the situation (e.g. electronic license plates).

<sup>86</sup> spiegel.de/wissenschaft/technik/drohnen-ueber-akw-frankreich-raetselt-ueberterror-gefahr-a-1005559.html.

<sup>&</sup>lt;sup>87</sup>See also welt.de/regionales/bayern/article147407964/Viele-Hobbypiloten-kennendie-Vorschriften-nicht.html.

<sup>&</sup>lt;sup>88</sup>See austrocontrol.at and bmvit.gv.at/verkehr/luftfahrt/drohnen/.

# 7 Potential need for regulation

Based on our preliminary analysis of possible societal impacts, we are now in a position to assess whether or not it would be necessary to regulate this emerging market for delivery of goods by drones.

A general problem with new technologies and in particular with rapid developments such as in this case, regulation either lags behind and would need to constantly adapt to new technological options or it is a formal barrier to innovation, as is the case at the moment (remember that under the present legal framework autonomous drones cannot be licensed at all). Furthermore this particular field of activity, like all transport-related activities, has an international dimension as flying objects may easily transgress international borders and fly into territories with another legal regime.

In this chapter we give a first overview of legal fields touched upon by delivery drones, in particular we look at open issues in air traffic laws (7.1), consumer and privacy protection (7.2), tax law (7.3), and measures for law enforcement (7.4).

#### 7.1 Air traffic laws

As mentioned earlier (5.2), to date, autonomous drones are not permitted by the law in Austria and many other countries (see AAE/3AF 2015, p. 52ff, on the regulatory discussion). So if society and the legislator wish to allow for delivery drones operations – which remains an open question, see our conclusions in chapter 8 – the option of not only remotely controlled, but also autonomously flying drones need to be legislated in the first place. Together with this new option, both technical requirements for licensing delivery drones, the service enterprises, and specific air traffic rules would need to be worked out:

To begin with, the drones themselves would need to be licensed and undergo special test processes to check safety and performance, weight, accuracy of geo-positioning and sense & avoid systems, type of engine (electrical only or also combustion engines), etc. Special rules may apply to drones with special purposes, like transporting dangerous goods. A further aspect is, what data a black-box, if it will be mandatory, should include, how long this data would be stored etc.

In addition, it is most likely that enterprises offering delivery services would be required to fulfil certain conditions and would have to acquire specific licenses. This may also encompass a data protection and privacy assessment. The licensing could be handled according to the current system, i.e. by the respective flight control authority and/or transport ministry.

legislation is lagging behind technology development and commercial aspirations

international dimension

technical licensing of the drones

licensing service providers

	In particular in scenario no. 1 the air space would become densely popu-
	lated with massive and regular drone traffic. Similar to the traffic on the
no-fly zones,	streets traffic rules are needed to avoid chaos. Air traffic rules would have
corridors,	to include speed limits, flight heights, minimum distance to other objects
geo-fencing	and in particular humans and animals, drone identification, emergency
	procedures, etc. In addition, it seems advisable to think about air corridors
	where drones would be allowed to fly and 'no-fly zones' where they are
	not. These no-fly zones would be flagged out in a dynamic database ac-
	cessed by the drones during flight (or shortly before taking off) and would
	tie to the more and more frequently mentioned practice of geo-fencing.
	Special cases are temporary or locally established no-fly zones around
	helicopters or in an emergency area, but geo-fencing could be aimed to
	serve both security and privacy purposes. These rules would take into ac-
	count the differences in the urban and rural environments.

- ground-level air space surveillance body It is an open question whether we would need, at least in scenario no. 1, a specific ground-level air space surveillance body (like air traffic control that exists for airplanes) or whether an automated or even decentralised system of mutual traffic control is conceivable. The latter would mean that a protocol needs to be established for drones coordinating among themselves in order avoid collisions. This may also include a functional hierarchy to allow for priority flights (e.g. a pizza delivering drone would give way to a drone that carries medical samples).
  - dangerous goods Further regulatory decisions would need to be made regarding the delivery of dangerous goods, and for security reasons. Apart from specific technical safety requirements of the drone itself, it may or may not be allowed to fly dangerous goods at all or only under specific circumstances.

#### 7.2 Consumer and privacy protection

withdrawal from contract	Although this is primarily an issue connected to online shopping in gen- eral, we observed earlier (6.3.4) that ubiquitous delivery by drones would speed up the fulfilment of consumer contracts. In this context the legisla- tor may reconsider the right of withdrawal, that is, under what conditions and in what timeframe could a consumer cancel an order without further obligations.
insurance issues	Furthermore the rules of liability would possibly need amendment when it comes to the loss or damage of a good, either during the flight (for instance in case the customer ordered despite heavy rain) or during the de- livery process (who is responsible for the correct functioning of the landing platform or window-attached basket?). Would insurance be obligatory, for the drone or for the delivered good, and who would have to pay the fees? (AAE/3AF 2015, p. 49)
privacy protection	Last but not least, as already discussed above in section 6.3.7, existing data and privacy protection would need to be adapted to the new tech-

nical possibilities (AAE/3AF 2015, p. 48), including black-box recordings.

#### 7.3 Tax law

It is conceivable that states would consider drone flights a new object of taxation. The reasoning behind would probably be that drone operators use the common good near-ground airspace for non-public purposes – similar to car owners using the streets and people putting out an overhead billboard.

7.4 Law enforcement

Law enforcement with regard to the current air traffic is complex but relatively easy with a great, but still limited number of licensed airplanes and helicopters, with a limited number of operators, and with any particular airborne airplane on one or more radar screens, and even stand-by interceptor planes to enforce national no-fly zones. In addition, almost everything that boards an aircraft has undergone a safety check. In our scenario no. 1, by contrast, this would be different in many respects: drones are very small; many, many more flying objects would be airborne at any given moment; radar would partly not detect drones flying near-ground and between buildings and in valleys; and there would be many more operators. In some respect overseeing drone traffic would be similar to car traffic on the ground with essentially no possibility of full surveillance.

As we have seen, however, the potential for drone misuse is nonnegligible (see 6.4). So a future regime for delivery drones needs to take these challenges into account. Whatever the institutional solution would be (the traffic police or a special authority entrusted to supervise), these authorities would need to be given the respective resources to fulfil this demanding task.

One possible option would be to establish a remote identification system. This would include compulsory registration of every drone and its permanent identification by a radio signal and would further allow the authorities – and perhaps also the private citizen<sup>89</sup> – to identify every drone in sight remotely. The authority may then have access to a database with the current details of each flight (provider, route, load), like with truck, cargo planes and container ships. Special devices could be developed (similar to radar guns in use to control car speeds) that would receive the identification data.

A further option, which would have an equally deterrent effect for potential misusers (not criminals or terrorists though), would be a mandatory black box on board of each drone (similar to those on airplanes), i.e. a specially protected and tamper-proof storage device that stores flight data for immediate (i.e. even during the flight with the help of the above mentioned

compensation for using a common good?

preventing misuse is particularly challenging when it comes to drones

remote identification system?

mandatory black box?

<sup>&</sup>lt;sup>89</sup>The wish of private persons may be considered legitimate to know who is flying over one's garden or passes-by one's window for the third time in ten minutes.

special radar gun) or at least control after a specific flight.

permanent near-ground air traffic control? Technically it may further on be possible to let drones be connected to the general or a specific mobile communications network during flight even permanently and let them send the data constantly for automated tracing and supervision of all rules. However, the problem of non-compliant drones would persist.

# 8 Conclusion: Debate now!

As we have seen, there are a lot of open questions regarding the commercial use of drones. Questions concern the technical, legislative as well as societal aspects, safety, and environmental risks.

The answers to these salient questions will differ when we distinguish between possible implementation scenarios as outlined in the introduction to chapter 6. In the case of the "pizza scenario" (1) with ubiquitous delivery drones being part of our everyday reality the impacts on our societies are obviously more severe than in the restrictive "emergency scenario" (2) with deliveries only in special cases.

While realising scenario 2 still needs quite some preparation, both technically and in legal terms, establishing such niche markets would be probably without wider opposition. By contrast, scenario 1 not only requires much more sophisticated infrastructure and rules, but also raises some potentially controversial questions.

From a technology assessment perspective these questions cannot be answered without in-depth interdisciplinary examination. The present overview study only provides a preliminary stock-taking of the issues involved; it is to be expected that some of the points raised in this short report are less controversial or turn out to be negligible, but there may even be more salient issues to find out.

Furthermore many of the issues detected are value-laden and the technology touches upon the private lives of a large number of individuals. To give a few examples: the relationship between economic interests and the protection of wildlife is not an obvious one; the question of the aesthetic consequences of mass-droning is difficult to answer in a top-down manner; noise is another issue where society constantly searches for compromises.

As the technologies are almost mature and many commercial entities wait in the wings, it would be high time to open up a debate now, and examine the possible chances and risks of such a service. Our recommendation is to conduct a participatory technology assessment study, that is, a combination of expert-, stakeholder- and citizen-oriented research. The study would try to give an answer to this question: "Which of the above scenarios (or any other that may come up) do we want as a society, and under what conditions?" Such a study would have four elements:

- A detailed examination of the technical, regulatory and economic framework as well as the risk issues (this would be an enriched, extended and updated version of the present report);
- An informed debate with stakeholders (drone manufacturers, delivery service providers, airspace authorities, police, NGOs from the fields of consumer protection and environmental protection, etc.);
- 3. An informed debate with citizens; lay participation would be particularly

numerous open questions

'pizza scenario' (no. 2) is highly controversial

in-depth and interdisciplinary TA research needed

a technology close to everyone's private life

participatory TA is recommended

work packages of the TA process proposed

rewarding in order to bring in everyday knowledge and values from non-experts;

4. A concluding, policy-oriented analytical part aiming at proposing policy options.

the issue is timely for anticipatory governance and public debate On a final note, the authors of this report are convinced that the issue is timely for carrying out such an encompassing study now and for inducing a public debate about it. Today the technology is not yet fixed and the commercial actors have not yet invested heavily in their business models; in other words: today, anticipatory governance aiming at shaping the technological and economic path is still an efficient and effective option.

# Bibliography

AAE/3AF, 2015, Present and Future of Civilian Drones, No. AAE Dossier #40/3AF Cahier #16, Paris: Air and Space Academy/French Aerospace Society

<http://espas.eu/orbis/sites/default/files/generated/document/en/D40 \_Ebook\_UK.pdf>.

- Bergtora Sandvik, K. and Lohne, K., 2014, The Rise of the Humanitarian Drone: Giving Content to an Emerging Concept, *Millennium – Journal of International Studies 43(1)*, 145-164 <a href="http://droneprivacyplease.wikispaces.com/file/view/Rise+of+Humanitarian+Drones.pd">http://droneprivaf>.</a>
- Bruckner, R., 2017, Ihr Packerln, so kommet doch all, *Der Standard*, 19.12., 18.
- Čas, J., 2015, Drohnen TA-Perspektiven, UAV SIFO Workshop (Sicherheitsakademie des BM.I), 6.10., Wien.
- Čas, J., Rose, G. and Schüttler, L. (Institut für Technikfolgen-Abschätzung), 2017, Robotik in Österreich: Kurzbericht – Entwicklungsperspektiven und politische Herausforderungen; Endbericht, commissioned by: BMVIT, No. ITA 2017-03, Wien: ITA <a href="http://epub.oeaw.ac.at/ita/ita-projektberichte/2017-03.pdf">http://epub.oeaw.ac.at/ita/itaprojektberichte/2017-03.pdf</a>>.
- EPTA (European Parliamentary Technology Assessment), 2016, *The Future* of Labour in the Digital Era. Ubiquitous Computing, Virtual Platforms, and Real-time Production; Report, October, Wien: EPTA <http://epub.oeaw.ac.at/ita/ita-projektberichte/EPTA-2016-Digital-Labour.pdf>.
- Frey, C. B. and Osborne, M. A., 2013, *The future of employment: How* susceptible are jobs to computerisation?, January: Oxford Martin Programme on the Impacts of Future Technology.
- Hillenbrand, T., 2014, Drohnenland: Kriminalroman, Köln: Kiepenheuer & Witsch.
- ITA, 2014, Drohnen fliegende Alleskönner? ITA-Dossier Nr. 6 (Jänner 2014; Autorin: Julia Haslinger) (2014-01-30), Wien: Institut für Technikfolgen-Abschättzung <a href="http://epub.oeaw.ac.at/ita/ita-dossiers/ita-dossier006.pdf">http://epub.oeaw.ac.at/ita/itadossiers/ita-dossier006.pdf</a>>.
- Knyrim, R. and Kern, C., 2014, Drohnen Fliegen im rechtsfreien Raum?, in: Jahnel, D. (Ed.): Jahrbuch Datenschutzrecht, Graz: NWV, 207-215.
- Krieger-Lamina, J. and Nentwich, M., 2016, Zivile Autonome Fahrzeuge zu Land, in der Luft und zu Wasser, *Smart New World – Was ist smart an smarten Technologien? (TA16)*, 30.5., Wien.
- Lee, H. L., Chen, Y., Gillai, B. and Rammohan, S., 2016, *Technological disruption and innovation in last-mile delivery*; White Paper, June, Palo Alto: Standford Business.
- Luppicini, R. and So, A., 2016, A technoethical review of commercial drone use in the context of goverance, ethics, and privacy, *Technology in Society 45*, 109-119.
- Lustig, J., 2018, *Lieferungen per Drohnen (Arbeitstitel)*, Bachelorarbeit (unveröffentlicht), Dept. für Transportwirtschaft, Wirtschaftsuniversität Wien.
- Maurer, M., Christian J., G., Lenz, B. and Winner, H., 2015, *Autonomes Fahren – Technische, rechtliche und gesellschaftliche Aspekte*, Wiesbaden: Springer Vieweg.

- Moe, Å. R. (Norwegian Board of Technology), 2013, *Take-off for civilian drones*; Blog; Last update: 19.06.2013 [Accessed on: 02.03. 2018] <a href="http://teknologiradet.no/english/take-off-for-civilan-drones">http://teknologiradet.no/english/take-off-for-civilan-drones</a>>.
- Nentwich, M., 2015, Zivile Drohnen aus TA-Perspektive, Statement am Podium, *Science-Talk "Invasion der Drohnen"*, 19.10., Wien.
- Nentwich, M., 2017, Zivile (Liefer-)Drohnen aus Sicht der Technikfolgenabschätzung, Österreichische Computer Gesellschaft: OCG Horizonte, 28.11., Wien <a href="http://epub.oeaw.ac.at/ita/ita-papers/Nentwich-OCG-28112017.pdf">http://epub.oeaw.ac.at/ita/ita-papers/Nentwich-OCG-28112017.pdf</a>>.
- OECD (Organization of Economic Co-operation and Development), 2015, *Employment Outlook*, Paris <a href="http://dx.doi.org/10.1787/empl\_outlook-2015-en">http://dx.doi.org/10.1787/empl\_outlook-2015-en</a>>.
- Pfluger, B., 2017, Hälfte der Drohnenbesitzer missachtet Gesetz, *Geldstandard*, Oktober 5, 17.
- POST, 2014, *Civilian Drones*. POST Notes, No. 479 (October), London: Parliamentary Office of Science and Technology <http://researchbriefings.files.parliament.uk/documents/POST-PN-479/POST-PN-479.pdf>.
- Rao, B., Goutham Gopi, A. and Maione, R., 2016, The societal impact of comercial drones, *Technology in Society* 45, 83-90.
- Redaktion, 2018, Drohnen könnten Pakete energiesparender liefern, *Der Standard*, 14 Februar.
- Stolaroff, J. K., Samaras, C., O'Neill, E. R., Lubers, A., Mitchell, A. S. and Ceperley, D., 2018, Energy use and life cycle greenhouse gas emissions of drones for commercial package delivery, *Nature Communications 9(1)*, 409 <a href="https://doi.org/10.1038/s41467-017-02411-5">https://doi.org/10.1038/s41467-017-02411-5</a>.


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# Questioning airport expansion—A case study of Canberra International Airport

Murray May <sup>a,¤</sup>, Stuart B. Hill <sup>b</sup>

<sup>a</sup> School of Social Ecology and Lifelong Learning, University of Western Sydney, Australia <sup>b</sup> Foundation Chair of Social Ecology, University of Western Sydney, Locked Bag 1797, Penrith South DC, NSW 1797, Australia

#### Abstract

World air traYc is expected to grow substantially in the next decade and beyond. Associated with this are accelerated programs to build new airports and expand existing ones. However, aviation futures are increasingly contested globally on ecological and resource grounds, and in relation to the quality of life of aVected local communities, and to growing fears associated with terrorism, wars and civil unrest. This case study addresses the issues arising from the privatisation and expansion of Canberra International Airport in Australia. Aircraft noise is a major concern for community groups, and land use planning also emerged as a key issue in a highly publicised conXict between a land developer and Canberra airport management. An important outcome is the recognition of the need for independent policy institutes—working in conjunction with community groups—to challenge the prevailing hegemony of the business-political nexus.

Keywords: Airport expansion; Air transport; Aircraft noise; Community

#### 1. Introduction

This article presents a case study (Stake, 1995) of the privatisation and expansion of Canberra International Airport. It documents how and why airport expansion is being questioned at a local level, in parallel with concerns about the growth of aviation globally. Given that the critique at a local level comes largely from the community sector, individual interviews conducted with community group representatives were an important source of information. Other signiWant sources of information included airport policy documents and newsletters, email and letter communications with airport management, observations of public meetings convened by Canberra International Airport, newspaper articles and letters to the editor, and press releases from government ministers.

The dominant thinking in relation to the growth of the aviation industry worldwide is that it is indisputable and

<sup>\*</sup> Corresponding autnor. Present address: 75 wydalena Grove, Cook, ACT 2614, Australia. Tel.: +61 2 6161 9116.

E-mail address: murraym@webone.com.au (M. May).

good. This is reXected in "business as usual" assumptions underlying economic growth and global consumer capitalism, as for example with the globalisation of tourism (Knowles et al., 2001). Planning by the aviation industry is based on the assumption that air travel will continue to grow substantially in the decades ahead (Boeing, 2000; Boeing Commercial Airplanes, 2002).

The aviation and tourism industries have consistently ignored and downplayed ecological, resource, security, and health concerns (May and Hill, 2004), despite the more widespread recognition of aviation's increasing environmental, energy, pollution, and noise impacts (International Civil Aviation Organization, 2001a; Penner et al., 1999; Vedantham and Oppenheimer, 1998). The Royal Commission on Environmental Pollution (2002, p. 37) in the UK has consistently expressed deep concern about the global impacts, particularly with respect to climate change, of the rapid growth in air travel.

Because of these and other related concerns, there is an increasing recognition that present and projected trends in mobility cannot be sustained. In a study of air transport liberalisation in the European Union,

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Graham and Guyer (1999, p. 165) conclude that the current *laissez-faire* attitudes of airlines and their regulators are unlikely to prevail, and that environmentally driven capacity constraints at airports will eVectively limit air transport's development. Similarly, the Centre for Sustainable Transportation (CST) (2000) in Canada considers that the two factors likely to curtail the aviation growth envisaged by the industry are the need to curb greenhouse gas emissions and the lack of availability of low-cost aviation fuel, a consequence of the end of cheap oil. For these reasons, CST considers that the current rate of investment in airport infrastructure would appear to be both unjustiWed and unwise.

Aviation futures are also being increasingly contested at the local level, the focus of the case study assessed here. The key issues are typically aircraft noise and the declining quality of life of aVected residents, with airport expansion becoming an ongoing, highly controversial process (Van Eeten, 2001). Many of the world's major airports face capacity constraints based on noise (Thomas and Raper, 2000).

This case study covers the period 2000–2004, and illustrates a range of issues in community and environmental politics (Dryzek and Schlosberg, 1998). Over the course of the study the perception of the key issues both broadened and deepened. Land use planning became a major issue, in addition to the original concerns by community groups about aircraft noise. This became most evident in a highly publicised conXict that emerged in 2002 between a land developer (The Village Building Company) and Canberra International Airport. This involved full-page advertisements in *The Canberra Times* and coverage on local radio and television. The issue was constructed as airports and cities invading each other's space, or as one author put it: "Airports and cities: can they coexist?" (Ayres, 2001).

#### 2. Background to case study

World air traYc is expected to grow substantially in the next ten years, with the number of passengers rising annually by 4.5–6%, and passenger-km Xown rising by around 5.5% per annum (International Civil Aviation Organization, 2001b). Accompanying this projected growth in air traYc and travel is the building of new airports and expansion of existing ones. Dempsey's (2000) *Airport Planning and Development Handbook* includes a global survey of new airports and airport expansion projects. Although not exhaustive, he catalogued US\$200 billion of projects worldwide, including US\$98 billion for the fast growing Asia-PaciW region and the Middle East. China, in particular, is experiencing rapid growth in civil aviation, with Hong Kong likely to retain the lead as the busiest airport on the Asian mainland for many years to come (Francillon, 2000).

Governments across the world are devoting substantial economic resources to building new airports and to expanding existing ones. This "accelerated attempt to keep pace with rapidly growing passenger and cargo demand for air transportation" (Dempsey, 2000, p. 2) is a striking illustration of the widely questioned "predict and provide" philosophy that has dominated road building and transport planning in general (Whitelegg, 1997). It stands in marked contrast to more socially and ecologically oriented approaches.

#### 2.1. Australia and Canberra airport

In Australia, because the population is mainly distributed along the south-east coast, much of the airline traYc is associated with the centres of Sydney, Melbourne, Brisbane, and Adelaide (Fig. 1). For example, the city-pair markets between these cities represent about 50% of domestic Australian airline activity. Canberra as the national capital is the sixth busiest airport in Australia for passenger movements. Canberra–Sydney, Canberra–Melbourne, and Brisbane–Canberra are in the top 20 Australian airline city-pair markets (Bureau of Transport and Regional Economics, 2003).

Passenger and air traYc movements and forecasts for Sydney Airport are indicative of the expected growth under "business as usual" assumptions. Sydney Airport's most recent master plan predicts a near trebling of passenger numbers (to 68.3 million per year) between 2003 and 2023 and a doubling of aircraft movements over the same period (Robins and Davies, 2003). There also appears to be a trend towards greater dispersal of air travel patterns, implying a pressure to develop additional airport capacity away from very large cities to those in the next rank and below (O'Connor, 2003, p. 89).

Canberra airport has operated on its present site since 1927. It was privatised in May 1998, via a long-term lease to the Capital Airport Group, led by local businessman, Mr. Terry Snow, for the sum of \$66.5 million. The Commonwealth government signed a 50 year lease with the new operator, with an option of a further 49 years (Fahey and Vaile, 1998a,b). Whereas Canberra International Airport (CIA) and the Australian Capital Territory (ACT) Government have been promoting its economic beneWs, a number of community groups within the region have been raising concerns, particularly in relation to aircraft noise.

Passenger movements through Canberra airport have more than tripled over the past 21 years, from 708,000 in 1982-1983 to 2.3 million in 2003-2004-at an average annual growth of 6.1%. These are forecast to reach 5.2 million by 2024–2025 (Canberra International Airport, 2005). The airport has direct services to We of Australia's mainland capital cities, but in spite of the "International" in the airport's name, has only minor international traYc at present. The airport's managers are seeking to build an increasing international contribution over time, with links to New Zealand, the South PaciWe, and Asia. An earlier report made projections for the airport to the year 2050 (Canberra International Airport, 2002a), indicating huge growth ahead. 13.9 million passenger movements were estimated by 2050, assuming a long-term average growth rate of 3.98% per annum.



Fig. 1. Australian state and territory capital cities, and Australia's national capital, Canberra.

When Canberra International Airport began to expand its operations in 1999, the North Canberra Community Council Inc. (NCCC) (http://www.nthcanberracc.org.au/) an umbrella community group that actively lobbies government for the residential interests of people living in North Canberra—formed a working group to investigate the airport issue. It sought to examine the environmental, and especially noise, ramiWations of the proposed expansion, and to suggest what might be done about it.

#### 2.2. Methodology

The case study drew on a three main sources of information. One depended on 11 semistructured interviews (labelled where used in subsequent discussion as A-K) with members of We community groups and residents' associations in the ACT region.<sup>1</sup> The interviews were selective (rather than randomly representative), given the particular knowledge and expertise that the participants had developed on airport and aviation issues. This was reinforced by the fact that most of the interviewees were also community representatives on Canberra airport's noise consultative committee. The data are geographically representative, however, as the people interviewed came from across Canberra, Queanbeyan, and the sub-region.

A second source of information drew on direct observations, including of We public meetings between 2000 and 2002, either convened by Canberra International Airport or residents' associations. A variety of stakeholders, including the airport's managers, gave presentations at these meetings.

A third signiWeant source of information included a range of documents, which became increasingly voluminous as the study progressed. These included airport policy documents and newsletters; email and documentary communications between community groups (especially NCCC) and others, including airport management, bureaucrats, and politicians; newspaper articles, "letters to the editor", and "opinion pieces"; reports from government agencies; and press releases from government ministers. In addition, the academic literature relevant to airport expansion and aviation and sustainability was accessed.

Although the author who conducted the interviews had a partial role as an insider (as a member of the North Canberra Community Council), he endeavoured to achieve "objective/critical subjectivity" (Heron and Reason, 2001, p. 184) in order to detect and record diVerences of opinion and approach by the various community group members. "Triangulation" was also used as a veriWation procedure. Triangulation is "generally considered a process of using

<sup>&</sup>lt;sup>1</sup> The groups included the North Canberra Community Council, the Gungahlin Community Council, the Jerrabomberra Residents' Association, the Pialligo Residents' Association and the Carwoola Aircraft Noise Abatement Group.

multiple perceptions to clarify meaning" (Stake, 2000, p. 443), drawing on the range of data sources and literature available to provide corroborating evidence (Stake, 1995). For example, to explore the ramiWations of the projected growth in aviation at Canberra airport, a variety of sources were used, including: Canberra airport management's published reports of these projections, along with their interpretations of these; interviewee comments from a community perspective; and published advertisements, articles and "letters to the editor" in *The Canberra Times*, representing a range of stakeholder interests, e.g., airport management, tourism business interests, government aviation agencies, and community groups.

#### 3. Aircraft noise

The 2001 State of the Environment Report for Australia (Newton, 2001) noted that noise from transport, industry, and the community is perceived to be increasing in cities. Transport noise from road and air traYc was singled out as a particular concern. A few years earlier, the Senate Select Committee on Aircraft Noise in Sydney (1995, para. 1.30, p. 7) noted that the "eVect of airports and aircraft operations on surrounding communities is a contentious and enduring issue, and aircraft noise is perhaps the most contentious and enduring aspect of that issue". The World Health Organization (2001) has highlighted a range of adverse health eVects associated with noise and expressed concern about the deteriorating noise environment in many countries. Aircraft noise at night is of particular concern, because of sleep disturbance and associated eVects on people's health (Department of the Environment, Transport and the Regions, 2000).

Further technological improvements capable of addressing any of these concerns are undoubtedly going to be increasingly diY cult to achieve, and are being outstripped by the sheer increase in the volume of aircraft movements. ReXecting this realisation, the National Research Council Committee on Aeronautics Research and Technology for Environmental Capability (2002, p. 5) in the USA concluded that noise constraints are likely to be part of a "paralyzing collision between the growth of aviation and increasing concerns about the quality of the environment". The lead times for technology development and adoption are long, and the funding for such research and development has been insuY cient to meet the ambitious goals that have been set.

In some areas, noise abatement measures such as quieter aircraft, land use policies, and landing charges have kept the size of the noise footprints in check over the past 30 years, despite the continuing growth in air traYc. However, achieving noise reductions as traYc continues to grow is increasingly diYcult, with ongoing growth reversing the trend in the noise contours. An analysis undertaken for the International Civil Aviation Organization's Committee on Aviation Environmental Protection is instructive (Skogo, 2001). A computer model for assessing global exposure to the noise of transport aircraft (MAGENTA) revealed that, because of the growth in air traYc, noise contours will continue to expand outwards from major airports, progressively a Vecting more people. Other studies showed that this reversal also applied to smaller, regional airports.

Because of growing awareness of the noise issue, communities near airports are placing greater emphasis on low noise environments as part of their quality of life, and uncertainty surrounds the noise levels that will be acceptable to the general public in future. Community reaction to noise is determined not only by the intensity of noise events, but also by their incidence (Department of Transport and Regional Services, 2000). Technological developments may therefore also be constrained by the fact that, for many people, the issue is not just the number of aircraft movements, but whether they are able to seek "respite" from such intrusive noise.

Canberra International Airport (http://www.canberraairport.com.au/) lists on its website 10 noise minimisation measures that are in place at Canberra. These include, for example, noise abatement areas over much of Canberra and the adjacent town of Queanbeyan in response to community pressure over the noise caused by aircraft overXying residential areas. Canberra airport's management contends that these have been successful in protecting 99.5% of the region's population from low-level aircraft overXight. On the other hand, community groups assert that residential areas outside of, or on the borders of, the noise abatement areas are still subject to aircraft noise, which is likely to increase signiWantly if CIA's aircraft growth plans eventuate. They also point to weaknesses such as the fact that light aircraft, no matter how noisy, can overXy the noise abatement areas.

Another noise minimisation measure listed is the signing of agreements with the two principal night freight operators at Canberra International Airport to ensure that residents of Canberra and Queanbeyan experience reduced overXight at night. Such an agreement is in stark contrast with the airport's intentions to establish a 24-h freight hub at the airport, and to further explore Canberra's potential role as a second airport for Sydney. These plans have drawn strong opposition from Queanbeyan and ACT regional residents (Seale, 2004b), with the mayor of Queanbeyan City Council consistently lobbying for a curfew between 11 pm and 6 am to provide some respite for residents (Seale, 2004a).

# 4. Canberra International Airport—Economic development vis-a-vis the community

Canberra International Airport's (1998, p. 2) position is predictably one that regards the expansion of aviation infrastructure as a necessity in a competitive global economy, with a particular focus on being a "major capital city and regional hub", and a "gateway" link to economic development. Although not yet receiving many international Xights, the airport has nevertheless linked its marketing and planning to economic globalisation. In an issue of *The Hub*, its newsletter, the airport "recognises that privatised airports are emerging as signiWant gateways to cities and economic growth" (Canberra International Airport, 2001a, p. 1). The line of argument used puts airports in a similar role to seaports of past centuries, as "engines that drive new economies" (Byron, 2001, p. 2). The negative eVects of such growth are considered to be unavoidable, with a consequent need to be managed, but economic and business objectives are given the strongest priority.

In contrast, community groups tend to focus on what is the best way to meet the region's transport and communication needs, and question the need for airport expansion, particularly when it is heavily subsidised by public funds. The environmental and aircraft noise impacts on quality of life of sustained airport expansion are regarded as too high, whereas the socio-economic beneWs are considered as low and not sustainable over a longer time frame. At the very least, the position taken considers inner city airports as being generally incompatible with high volume operations. The lessons from Sydney (Nero and Black, 2000), the old Essendon airport in Melbourne, and overseas airports such as Washington National are cited as salutary reminders in this respect. Nevertheless, air transport in Australia is being used and promoted to provide links between the state capitals, which in other countries would be forged by highspeed rail.

In Australia, there has been impoverished investment in rail infrastructure because of a lack of political will, and the current rail links with Canberra are no exception. The case for high-speed rail links linking Sydney, Canberra, and Melbourne has been argued strongly, particularly using fast tilt trains (Laird et al., 2001, pp. 30–33). In keeping with this recommendation, the Royal Commission on Environmental Pollution (2002) comments on the disproportionately high environmental impact of short-haul air journeys (800 km or less) for the distance travelled (in this case within the UK and to nearer parts of Europe). In contrast, for rail travel, carbon dioxide emissions and fuel use per passenger-kilometre are typically at least an order of magnitude lower than for air travel.

As the study progressed it became clear that aircraft noise was a symptom of deeper underlying value diVerences. The question for some became one of learning "to look diVerently at products and services which are proXigate in their resource consumption and to reprioritise how we think about impacts and cumulative impacts" (Fawcett, 2000, p. 36). Thus, the highly technical discussions around aircraft noise data militate against a framework seeking "to rethink air travel and how its unquestioned position of growth sits within a sustainability framework".

#### 5. A variety of stakeholders

As with most infrastructure developments of this kind there is a wide range of interested stakeholders. The main stakeholders involved in Canberra International Airport developments include six main groups:

- Politicians, and associated government agencies at national and state levels, encompassing in this case the Commonwealth, New South Wales, and Australian Capital Territory governments, as well as Queanbeyan City Council and others at a local level.
- Airlines such as Qantas and Virgin Blue, and their regulator, Airservices Australia—the organisation responsible for managing airspace and air traYc; the latter includes the use of a noise and Xight path monitoring system at Canberra and other airports.
- Business organisations, including the airport operator— Canberra International Airport management. In addition, others such as Canberra Business Council, and land developers such as The Village Building Company are also involved.
- A variety of non-government community groups and residents' associations, which are represented on the airport's noise consultative committee.
- The media, including local newspapers such as *The Canberra Times*, and local television and radio. *The Canberra Times*, for example, has run a number of front page stories and editorials on the airport's plans, and been an avenue for public participation through "letters to the editor" and "opinion pieces".
- Travellers to and from Canberra and the ACT region.

#### 6. Land use planning

The question of land use planning is exempliWed by the highly visible public relations battle that took place in 2002 between The Village Building Company, the developer wishing to build a major housing estate at Tralee, and Canberra International Airport, which wants the land kept free from residential development as part of its proposed "high noise corridor".

This proposed high noise corridor, where the jet Xight path tracks are most heavily concentrated, runs in a northsouth direction between designated noise abatement areas (Fig. 2). The land developers argue that the location of the proposed development is well within the Australian Standard (AS2021) for land use planning, even for the airport's projections for air traYc in the year 2050. That is, the proposed development does not lie within the so-called 20 ANEF noise contour, a measure designed for land use planning to stop airports being "built out" by noise sensitive land uses (Department of Transport and Regional Services, 2000, p. 1; The Village Building Co., 2003). However, experience in recent years demonstrates that the aircraft noise problem is not conWhed to areas inside the noise contours. In fact most complaints about aircraft noise at Australian airports come from people who live outside the published 20 ANEF contours (Department of Transport and Regional Services, 2000, p. 2). For this reason, Canberra airport management argues that the ANEF system is

# homes don't belong under planes

AIRPORT

PLARS

ALEE

**JERRABOMBERRA** 

GOOGONG

HUM

Tralee lies directly under our SOUTHERN JET DEPARTURE FLIGHT PATH. It's rural land. Yet, incredibly, Queanbeyan City Council is thinking about rezoning it residential to accommodate up to 2,000 new homes.

This is bad planning because future residents will be significantly affected by aircraft noise. We know from past experience that they will complain about aircraft noise. They will want to push it back over Jerrabomberra. We have worked closely with the Jerrabomberra community to reduce the impact of aircraft noise. We don't want this good work to be undone. Better land is available elsewhere, at Googong.

It's bad planning to build homes under planes. Don't let it happen.



Fig. 2. Advertisement placed in *The Canberra Times* by Canberra International Airport (2002b).

Xawed, with the aircraft noise impacts not warranting the building of the housing estate at Tralee (Canberra International Airport, 2002c).

The campaign included full- and half-page advertisements in *The Canberra Times* and other newspapers, with captions such as "The development of Tralee will provide major beneWs to Jerrabomberra and Queanbeyan" (The Village Building Co., 2002a), and "Why put our living standards at risk?" (Canberra International Airport, 2002d). The Village Building Co. (2002c) distributed a glossy newsletter (*The Tralee Newsletter*) to the community to support its case for building a new housing estate. In support of the case made by the land developers, Queanbeyan City Council has argued that it is "running out of land" for residential development (Downie, 2002). A series of radio interviews and newspaper articles addressed the various stakeholders' positions.

Examples of these advertisements illustrate the strong polarisation surrounding the controversy (Figs. 2 and 3). Whereas the airport declared, for example, that "Homes don't belong under planes" (Canberra International Airport, 2002b), the land developers asserted the reverse position: "The real noise is coming from the airport owners" (The Village Building Co., 2002b).

In addition, Airservices Australia, the national agency responsible for aircraft traYc management, supported Canberra International Airport's case that the development should not proceed, and that the land be zoned as part of a residential free noise corridor (Moloney, 2002). The ACT Government also raised concerns in relation to the proposed development, stating that it will insist that no development creates the possibility of "noise sharing" (Canberra International Airport, 2003a). Such an outcome could occur if disgruntled future residents of a new development lobbied to distribute aircraft Xight paths over Canberra and Queanbeyan suburbs.

#### 7. Government, the market, and the community

One model of particular relevance for considering the various stakeholder positions highlights three overlapping areas of importance, namely the market, government, and civil society (Newman and Kenworthy, 1999, p. 286). These authors suggest that markets provide the resources needed to make developments happen, whether these are helpful to sustainability or not. The government regulates and sets policy in order to ensure that the "common good" is achieved. Ideally, long-term issues such as sustainability are addressed. Civil society is regarded as the guardian of culture and ethics. Here players such as the media, community organisations, and individuals in the community inXuence the long-term direction of society through their attention to values and visions.

A federal government corporation previously owned most of the major airports in Australia. However, in 1997, three of the largest airports—Melbourne, Brisbane, and Perth—were sold to various consortia, followed later on by

#### ADVERTISEMENT

# THE REAL NOISE IS COMING FROM THE AIRPORT OWNERS

On Wed July 24, airport manager Mr Byron said that 2000 homes at Tralee would be "in the noise zone". Wrong!!!

The blue line represents the boundary of acceptable residential development based on the airport's wildly excessive flight traffic projections. It is the point at which ordinary background suburban noises are more significant than aircraft noise. **Tralee is not in the noise zone even on these projections**.

Noise boundaries are drawn according to the Australian Noise Exposure Forecast – a standard independently set, but based on the airport's own traffic projections. Development of housing outside the 20 ANEF blue line is accepted by all Federal, State, Territory and Local Government agencies responsible for residential development. The map produced from the airport's own website shows the noise zone. Tralee is clearly outside it.

The blue line on this map also represents the maximum ultimate capacity for the airport. As this projection equals the same volume of flights that Sydney currently has, it is wildly excessive. These noise levels will never eventuate.

So the blue line in reality, will always be closer to the airport and substantially further away from Tralee and other areas. There is no need to sterilise the development of Queanbeyan.

Queanbeyan and Southern Canberra will soon have no land for new housing.

from Canberra International Arport's website" Australian Standard AS 2021-200 states: Loss than 20 ANEF – Housing acceptable

QUEANSEYAN



A rapacious land grab by the airport should not be the basis of planning these cities.

the sale of a number of smaller airports, including Adelaide and Canberra (Forsyth, 2002). Of signiWance for privatisation, notes Gerber (2002, p. 36), is the need for a suitable government regulatory framework, given that "with privatisation, airports change roles from being infrastructure providers to commercial entities, which have to maximise shareholder value".

The third component of the government-market-civil society model is civil society, and it is responding to sustainability being a major global and local issue. It recognises that "sustainability requires new approaches, most of which must be worked out by communities" (Newman and Kenworthy, 1999, p. 23).

Although the interviewees were representatives of various community groups working on aircraft noise, the issues mirror those of civil society on a wider range of issues. For example, interviewee "C" focused on the business precinct associated with the airport:

Today the airport is owned and operated privately by a development company that is committed to not just having an airport there, but to having a centre of commercial infrastructuref As developers they're not there for the public good, they're there for proW. They are a private company with shareholders and they're there to ensure their shareholders get value for money. My experience has been that they pay lip service to the noise issues, but if it's a question of proW over public concern, proW wins, every time, without question! So the privatisation has changed the nature of the debate.

"D" raised broader environmental and futures issues considered to be neglected in market-based approaches:

The rhetoric of globalisation is pretty predictable, and pretty disturbing, because a lot of people subscribe to it and believe it. A lot of the Liberal Party, the Labor Party, and most politicians—a lot of the ones we have seen believe it. They seem to believe that strong airports and a thriving aviation industry are good for the economy, for jobs and productivity. But to me it is pretty Xawed, because it's not a sustainable industry, it's very shortterm. There might be jobs associated with it, but for how long?

In the longer term we are going to run out of energy, we are going to wreck the planet, we are destroying people's environment. While they might provide some short-term economic gain, we have to look beyond that to other more sustainable forms of employment, other gateways. We have to manage air travel so that broader interests are included.

"F" questioned whether transport and mobility decisions should be based on market-based criteria:

There is the issue of the privatisation of public goods. I think transport is a public responsibility. I feel it is the responsibility of society rather than private enterprisef So basically, selling an airport is a short-term decision by governments who want to have quick money. It's not a long-term solution for ensuring that people have the facilities to travel and for goods to come in and out. I think it's just limited.

Another interviewee "B" had a professional interest in the symbolism of big projects. In his view, the most relevant questions relate to the contrasting values of the dominant social paradigm and alternative paradigms (Milbrath, 1989, p. 118). Thus, whereas the dominant social paradigm is associated with economic growth, "no limits to growth" and an emphasis on market control, the new environmental paradigms are environmentally aware, appreciate "limits to growth", and are participation and foresight oriented. "B" asserted that the story underlying the dominant social paradigm is closely allied to Canberra airport's expansion:

It's an ideological commitment they have to itf rather than going through all the complexities of the economic arguments and the infrastructure costs as opposed to the environmental costs. It's easier to think, yes of course all big cities have international airports, so an international airport can easily become a symbolf I think this mirrors the local business community [and] the dominant political attitude of the major parties, and that is—airport, international airport, good for economic growth, good for jobs, support it, don't get into the details.

#### 8. Institutional paralysis

Another group of issues of pivotal importance to the government-market-community model includes an apparent lack of institutional concern, the role of government, and the question of who is responsible for addressing the consequences of airport expansion, in particular aircraft noise. A book exploring the politics of Sydney Airport's history summarised it this way in its foreword (Fitzgerald, 1998, pp. i–ii):

If the history of Kingsford Smith Airport in Sydney shows anything, it shows the tendency of the centralised twoparty system to act in the private, rather than the public, interest f The 50-year history also shows that no amount of rational argument about planning, cost/beneW, the environment, the welfare of residents or even the eY ciency of Australia's airports carries any real weight in decisionmaking f It has demonstrated the defects of many of our institutions—representative government, the centralised two-party system, the self-serving nature of our bureaucracies and our inability to cope with the forces of deregulation, privatisation, and globalisation.

This theme of institutional paralysis was also Xagged in the title of the report of the Senate Select Committee on Aircraft Noise in Sydney (1995), *Falling on Deaf Ears?* The report states that "it is curious that developing solutions to the problems of aircraft noise in Sydney seems to have been left to local residents rather than to those responsible for the problems" (para. 9.130, p. 244) and "it is diYcult to escape the conclusion that the aviation authorities are more interested in denying problems than in pursuing solutions" (para. 9.131, p. 244).

A number of interviewees for this case study conWmed this institutional lack of responsibility spanning political, commercial and public service agencies, including interactions across agencies. Interviewee "J" stated:

With this particular issue, I have never seen such an incredible example of "pass the buck". Nobody has taken responsibility.

Likewise, interviewee "F" commented:

In relation to the procedures at local and federal levelf the most frustrating thing was to see a lack of willingness by institutions, both political and commercial, and by agencies like Airservices Australia to Whd best practice procedures to have citizens' concerns heard.

It was clear at the time the airport M aster Plan was publicised that all instruments in place to receive citizens' concerns were in place to buVer institutions like Airservices Australia and commercial institutions like the airport from citizen concernsf it stonewalls anything that could question their procedures, or make them be responsible.

Part of the problem lies in a conXict of interest that exists in the core roles of the agency. As the name Airservices Australia suggests, an alliance exists between the agency and the aviation industry. A US senator commented on a similar situation some years ago (Anthrop, 1973, p. 123):

I understand why the Federal Aviation Administration's response has been inadequate. The FAA's responsibility is not to reduce the environmental impact caused by aircraft noise. Its primary responsibility is to promote air commerce and to protect safety. Regulation of noise from aircraft is not consistent with that primary mission.

#### 9. Determining power and inXuence on policy

The competing ways in which policy and planning issues are constructed and communicated emerged as signiWcant themes in this study.

#### 9.1. Transport policy discourses

A useful model for examining the hegemony of the business-political nexus draws on Vigar's (2002, pp. 15–19) analysis of the politics of mobility. This approach is concerned with determining power and inXuence, and uses three organising concepts, namely: policy discourses, policy networks (discourse coalitions), and policy arenas.

Consider the following comments from "H":

Terry Snow, who is the owner of the airport, is a developer. He wants to develop the airport site and sell it oV at a huge proWf It's totally unrelated to a service industry for Canberra for the population we have *f* it's a business scheme.

[The ACT Government] seem to be going along with the development plans of a developer. It needs to tie in with the transport needs of the city. Aviation is just one other form of transport. It's not the city that then operates around this form of transport.

These comments are consistent with a "new realist" discourse discussed by Vigar (2002, p. 191). This discourse considers that "travel demand can be inXuenced by public policy" and that "policy issues increasingly extend beyond transport policy itself". In addition, it extends to the "broader economic, social, and environmental evaluation of transport policies and schemes".

In contrast, Vigar's (2002, pp. 16-18) analysis of the policy discourse and discourse coalition associated with a "predict and provide" approach to transport is one that characterises the position taken by Canberra International Airport and most politicians backing the case for further growth. Changes in travel demand are viewed as "an expression of underlying social and market dynamics" (p. 191). In 2003, Canberra International Airport sought to become a solution for Sydney Airport as the latter reaches its capacity constraints over time. This involved a \$50 million plan by Canberra airport to strengthen and extend its main runway south, to allow the airport to accept widebodied aircraft such as the Boeing 767, 777, and 747, and the Airbus A330 and A340, on a commercial basis. Marketing associated with the plan promotes the airport as a domestic and regional hub in southern Australia, as well as taking an increasing number of international Xights, particularly those with South Eastern Asia.

An obvious "policy arena" in this case involved advertisements in major newspapers, including The Canberra Times, The Sydney Morning Herald, and the Financial Review. The ads ask "Is the solution to Sydney's second airport 20 years away?", with the reply "Less than three hours, actually" (Cooke, 2003). In addition, a series of front page articles appeared in The Canberra Times (Brewer, 2003; Cooke, 2003; Hannaford, 2003). This coverage also underlines the nature of the discourse among the involved coalitions. For example, the ACT Government and Canberra Business Council welcomed the proposal because of its business and tourism implications (The Chronicle, 2003), whereas the mayor of Queanbeyan City Council expressed concerns that Canberra airport's curfew-free status might be abused at times when Sydney Airport's curfew is in operation (Hannaford, 2003). Further, the developer associated with the proposed housing development at Tralee reaYrmed a commitment to his objectives, describing the runway extension as a "stunt" (Cassidy, 2003b).

In 2004, the Federal Minister for Transport approved the runway extension at Canberra airport, over a year after the proposal was foreshadowed (Brewer, 2004a). This action once again rekindled the debate about the planned housing development at Tralee, with the airport managers describing the development as an "act of planning madness" (Brewer, 2004b). Whereas the airport once again promoted the business and tourism advantages of the runway extension, Queanbeyan City Council raised serious concerns about the airport's plans for a regional freight hub and becoming a second airport for Sydney. In response, the council called for an 11 pm to 6 am curfew on the airport's operations (Brewer, 2004b).

#### 9.2. Planning issues

The land use conXicts between Canberra airport and residential land developers underline the strategic planning issue that became increasingly apparent over the course of the case study. It raises the issue of the extent to which airports can dominate planning processes to serve their ends. For example, the ACT Government's policy and planning agenda has sought to support aviation-driven assumptions such as the linking of airport expansion with regional economic development.

Relevant here are Upham's (2001, p. 247) observations in the United Kingdom and the European Union (EU), where he notes that airport practice and government policy aim to mitigate the impacts of aviation, but not at the expense of aviation growth. Therefore sustainability "should not be taken to mean a realised commitment to environmental impact reduction", but more "a *consideration* of environmental and social impacts alongside environmental and Wiancial performance". For the major EU airports reviewed in his study, he Wids no evidence of a reduction in environmental impact or a commitment to consumption or waste limits.

In 2003, *The Draft Canberra Spatial Plan* was released by the ACT Government to guide its planning for Canberra over a 30 year period (ACT Planning and Land Authority, 2003; Grech, 2003). The plan identiWes the airport as "critical infrastructure for the Canberra region", with planning to ensure the development of the airport "as a regional hub, bringing new jobs to the region, [being] of fundamental importance" (ACT Planning and Land Authority, 2003, p. 55).

The plan invoked strong criticism from a number of sources including from some Members of the ACT Legislative Assembly, Queanbeyan City Council and environmental groups (Hannaford and Brewer, 2003). Members of the North Canberra Community Council expressed particular concern about statements in the draft plan, which eVectively align the ACT Government and Canberra International Airport positions (Willans, personal communication, 16 November 2003). For example, the plan expressed reservations about pressures to introduce a curfew at the airport thereby "constraining [the airport's] opportunity to function as a major regional hub and a possible second airport for Sydney" (p. 55).

An additional planning issue of concern to some is that of increasing oYce development at the airport, including calls from a local politician to restrict further expansion on

the grounds that the airport and associated business park had become a "de facto town centre" (McLennan, 2002). Predictably, the airport owners countered with the assertion that any moratorium on oYce development and further growth at the airport would in eVect be "a moratorium on jobs" (Clack, 2002). More generally, Graham and Guyer (2000, p. 253) note that the aviation functions of airports are increasingly linked to on-site developments such as business parks. They quote one executive's description of an airport as "a runway with a shopping mall beside it". In the case of Canberra airport, the situation has been criticised further on the grounds that the ACT Government does not have planning authority over the airport. Critics argue that the relevant planning control comes under the National Capital Authority, which is much less stringent than under the local ACT Government requirements, with only limited demands for community consultation (Cassidy, 2003a).

In relation to these concerns, an editorial in *The Canberra Times* suggests that the airport's framing of its arguments in terms of its expansion plans vis-à-vis the planned housing development at Tralee is a distraction from much wider planning considerations that need to be debated (The Canberra Times, 2003). The editorial, "Airport pitch a smart move", asserts that Canberra airport's ambitions for commercial development areas at the airport "take place in a vacuum, and without reference to ACT planning about shopping centres, oYce development and land use". In addition to accentuating the negative environmental externalities of airports, Graham and Guyer (2000, p. 261) agree that airport business parks "can be a zero-sum game if the airport-related jobs are diverted from other locations within the region".

Interestingly, a later development in the debate involved resistance from a powerful group of builders and developers who are unhappy with the planning concessions that enable unfettered oYce developments at the airport. This has disadvantaged the group's interests in other parts of Canberra, thus creating additional enmity towards the airport from competing commercial interests (Cassidy, 2004a,b). An editorial cartoon from *The Canberra Times* captures the situation succinctly, referring to the airport owner in the "Snow dome" caption (Fig. 4).

#### 9.3. Questioning airport expansion

A policy position that has a city airport as a necessary node in the global economy needs to be contrasted with other positions that question the beneWs of further aviation growth, or that perhaps more pragmatically search for sustainable solutions to the demand for mobility (Van Eeten, 2001), or that even question our want of mobility. The need to reduce the need for air transport—in eVect a questioning of the "predict and provide" approach to aviation planning—was generally conWmed by the interviewees in this study. This is in accord with the sustainable transport literature, especially in relation to aviation, which



Fig. 4. Pryor cartoon in The Canberra Times, 24 February 2004, p. 12 (Reprinted with permission from GeoVPryor).

increasingly emphasises that the rapidly growing demand for mobility cannot be met in a sustainable way. As Graham and Guyer (1999, p. 179) have summarised the matter, air transport policy generally fails to address both the integrated nature of transport itself and the broader concerns of society.

Some community groups in the ACT region are also proposing broader frameworks for considering aviation and airports than mere demand driven ones, and support the need for a broad-based evaluative research study of Canberra airport taking into account economic, social, environmental and planning factors (May, 2002). This is in contrast to the narrowly deWied economic impact studies of the airport undertaken by ACIL Consulting (Canberra International Airport, 2001b, p. 10; 2003b). In addition, community groups, both in submissions to politicians and in newspaper articles (Willans, 2001, 2002) have questioned the range of subsidies that Canberra International Airport has received. As interviewee "K" stated:

The aviation industry is a mature industry, it's been going on now since the second world war, it's had considerable strength in the country; and there has to be the question: why does it have to be subsidised? It's not a new and starting industry, if it can't stand on its own two feet now, then we should get out of the business.

Investments in more diversi Wed local economic development of regions may be one way of reducing the growing demands of air traYc. This issue was raised in suggestions by interviewees about the need for alternative conceptions of the economy. Where mobility needs must be met, modal change, especially to high-speed rail, is regarded as a sensible option for short-range traYc, for both economic and environmental reasons (Royal Commission on Environmental Pollution, 2002, p. 33–34).

#### **10. Implications**

SigniWant outcomes emerging from this case study include how to facilitate change towards a better quality of life, and the need to develop institutional arrangements supportive of quality of life and environmental objectives.

Lewin's (1935) "force-Weld analysis" model is useful for identifying those forces helping to move towards a better quality of life and those hindering such change. Lewin argued that change can be facilitated by strengthening and adding to the driving forces and removing and weakening the restraining forces (barriers). An outline of some of the driving forces and restraining forces (barriers) in relation to the expansion of Canberra airport, particularly as raised by the interviewees, is given in Table 1.

Pertinent to the restraining forces column of Table 1, is Dryzek's (1998, p. 596) observation that markets are "not exactly an ecological success story" given "the seeming global hegemony of profoundly anti-environmental liberal democratic and capitalist ideas". Governments operating in the context of a capitalist market system are therefore reluctant to pursue policies that damage business proWability. Such constraints on governments are apparently magniWed by the increasing global mobility of capital.

Challenging the paradigm linked to what Hamilton (2003) describes as a "growth fetish", is more typically associated with community group perspectives aligned with the driving forces column of Table 1. Similarly, Dryzek's hopes lie more with civil society and the public sphere, and with "the possibility of democratisation *apart from* and *against* established authority" (p. 595). A signiWant theme emerging from this case study is the critical importance of community group participation for improving quality of life. Communities have power because of their ethics and vision, with "the real visions for change rarely com[ing]

#### Table 1

Driving forces and	restraining for	ces in relation to	the expansion of	of Canberra a	airport ai	nd the city's a	uality of life.	as identi Wed in c	ase study interviews
							1		

Driving forces (helping quality of life)	Restraining forces (barriers to quality of life)				
Community energy and community group participation	<ul> <li>Private business institutions; privatisation of airport emphasises proW motive</li> </ul>				
• Value shifts favouring quality of life, health,	• Short-term politics and proW				
and environment ("green consciousness")					
Long-term ecological vision	<ul> <li>Lack of long-term planning and commitment to environment and quality of life issues</li> </ul>				
• Quality of life an important reason for	Political climate favouring development				
people being drawn to Canberra					
• Alternative conceptions of the role of an airport as part of a city	<ul> <li>Lack of trust by community in business and government</li> </ul>				
Possible relocation of airport	• DiY culty for politicians in challenging business agenda				
• Broad-based research evaluation study of airport, taking into account economic, social, environmental and personal factors	• Lack of alternative conceptions of economy				
Local politician and community synergies	<ul> <li>Fragmentation of government responsibility, complexity of access to bureaucracies</li> </ul>				
Some media support, including letters	• Lack of transparency				
to the editor, opinion pieces					
	• Consumer attitudes related to the "right to Xy"				

from government or from the marketplace, but from civil society" (Newman and Kenworthy, 1999, p. 329).

There is, therefore, a strong argument for bolstering and supporting community groups in order to promote quality of life outcomes for communities. Here, raising social capital—the cooperative networks and processes of social trust between people—is of critical importance in building "a truly civil society" (Cox, 1995). Cox nevertheless notes that it is hard to Wid policies that encourage the practice of social capital formation in the public sphere. In addition, as one study in the USA shows, a number of factors can severely constrain the amount of time, attention, and eVort people can devote to citizenship roles (Tonn and Petrich, 1998). Such factors include, for example, work and family commitments, and social networks that are not "tight" enough to foster ongoing involvement in community issues.

During the course of this case study, the eVort sustained by community groups varied over time, with some people moving to other locations for a period and others constrained by competing commitments. A factor that assisted ongoing eVort in the case of the North Canberra Community Council was the presence of members with scientiWe and aviation expertise who were thus able to provide detailed insights on airport proposals and documents. One person in particular is an ex-aviator with specialist knowledge of aviation, and a long-term interest in protecting the community's quality of life.

Another "lesson learned" from the case study is the strong need for independent institutions such as policy bodies and "think tanks"—working in conjunction with community groups—to develop and promote policy discourses that challenge the prevailing hegemony of the business-political nexus. The Australia Institute (http://www.tai.org.au) is one such body. It is engaged in research on a range of issues linked to quality of life, and the importance of community; the development of alternative indicators for measuring progress; and questioning the values and practices of consumer society (Hamilton, 2003; Hamilton

and Mail, 2003). Community groups and independent policy institutes can form a broader discourse coalition to challenge the dominant social and economic paradigm.

The range of factors outlined in Table 1 suggests that decisions on technology and infrastructure, such as airports, should no longer be considered as one-dimensional market-based ones. Rather, such decisions should be regarded as challenges to choose pathways that will create better economies, better communities, and better local and global environments (Newman and Kenworthy, 1999). Thus, it is relevant to examine questions such as: What are the myths linked to the inevitability of the "Airport City" as part of a global economy? And what kinds of scenarios face "Airport Cities" in an era of oil depletion?

Restraining forces such as the fragmentation of government responsibilities, and the complexity of access to bureaucracies, also need to be addressed. As argued earlier, Airservices Australia is unable to address negative feedback from the community easily because of its conXicting roles, as it is committed to and constrained by the growth paradigm subscribed to by various spheres of government and the airline industry. These observations suggest that an agency or unit in government, whose primary responsibility is concerned with noise control, is required. For example, this could be an environmental agency whose charter is strongly linked to quality of life issues or possibly a specialised role such as an Aircraft Noise Ombudsman (Federal Aviation Administration, 1999).

The present case study reinforces the negative ramiWations of the aircraft noise issue for communities as shown in the literature. At the very least, the degree to which one's neighbourhood is considered as being vulnerable to further increases in noise (Staples et al., 1999, p. 708) is shown by the consensus amongst community groups for the introduction of a night-time curfew (J. Zeil, personal communication, 1 July 2004). It further demonstrates that other contentious issues, such as land use planning in relation to airports, can forge apparently unlikely stakeholder associations, as occurred to some extent in this case between residential land developers and community groups. In addition, the increased publicity associated with land use issues has further increased public awareness and consideration of quality of life issues linked to the expansion of Canberra airport. On the other hand, various powerful players have sought to manipulate public perception of the issues involved to serve their own ends.

We introduced the case study by referring to the issues of aircraft noise and land use at the local level, and climate change at a global level. However, it is apparent that an underlying theme in each case is the difficulty in challenging the dominant social paradigm based on economic growth. Local community groups in this case study focused on quality of life and alternative conceptions for the economy. At a broader level, the Royal Commission on Environmental Pollution (2003) in the UK expressed disappointment in the UK Government's 2003 White Paper The Future of Air Transport. The commission states that the White Paper "reveals a serious fracture between the government's policies on energy and aviation" and "fails to take account of the serious impacts that the projected increase in air travel will have". In contrast with the White Paper announcement of "a huge expansion in airport capacity", the Royal Commission argues instead for the restriction of airport development. At both the local and broader levels, market based considerations are still dominant, even if under challenge.

#### References

- ACT Planning and Land Authority, 2003. The Draft Canberra Spatial Plan. ACTPLA, Canberra.
- Anthrop, D.F., 1973. Noise Pollution. Lexington Books, Lexington, MA.
- Ayres, E., 2001. Airports and cities: can they coexist? World Watch 14 (July/August), 22–33.
- Boeing, 2000. News release: Boeing projects China will surpass all other aviation markets except the United States: Hong Kong, 8 November. Retrieved 25 September 2002. Available from: <a href="http://www.boeing.com/news/releases/2000/">http://www.boeing.com/news/releases/2000/</a>.
- Boeing Commercial Airplanes, 2002. Current market outlook 2002. Retrieved 6 June 2003. Available from: <a href="http://www.boeing.com/">http://www.boeing.com/</a>>.
- Brewer, P., 2003. \$50m for airport upgrade. The Canberra Times (24 September), 1–2.
- Brewer, P., 2004a. Airport spreads its wings. The Canberra Times (20 November), 1.
- Brewer, P., 2004b. Runway approval restarts debate. The Canberra Times (23 November), 1.
- Bureau of Transport and Regional Economics, 2003. Air Transport Statistics: Australian Domestic Airline Activity: Annual Summary 2002–03 (No. 74). Department of Transport and Regional Services, Canberra.
- Byron, S., 2001. Gateway to the nation's capital: Canberra International Airport. The Hub(March), 2.
- Canberra International Airport, 1998. Canberra International Airport Year 2020 Draft Master Plan. Canberra International Airport, Canberra.
- Canberra International Airport, 2001a. Airport business park takes shape. The Hub(March), 1.
- Canberra International Airport, 2001b. Minimising the Impact of Aircraft Noise: a Proposal by Canberra International Airport to Quarantine Excessive Aircraft Noise from Canberra and Queanbeyan Residential Areas. Canberra International Airport, Canberra.

- Canberra International Airport, 2002a. Draft Minor Variation: Canberra International Airport Year 2020 Master Plan. Canberra International Airport, Canberra.
- Canberra International Airport, 2002b. Homes don't belong under planes [Advertisement]. The Canberra Times (24 July), 5.
- Canberra International Airport, 2002c. Information brieWig for the Jerrabomberra Residents Association (9 October, 2002). Canberra International Airport, Canberra.
- Canberra International Airport, 2002d. Why put our living standards at risk? [Advertisement]. The Canberra Times (18 September), 18.
- Canberra International Airport, 2003a. ACT Government rules out noise sharing. The Hub (August), 1.
- Canberra International Airport, 2003b. Airport business outpaces local economy. The Hub (August), 4.
- Canberra International Airport, 2005. Master Plan 2005. Retrieved 30 June 2005. Available from: <a href="http://www.canberraairport.com.au/pl\_mp.htm">http://www.canberraairport.com.au/pl\_mp.htm</a>>.
- Cassidy, F., 2003a. Airport expansion plans experience some turbulence. The Canberra Times (6 September), B6.
- Cassidy, F., 2003b. Developer says plan to extend runway a 'stunt'. The Canberra Times (25 September), 5.
- Cassidy, F., 2004a. Airport juggernaut makes lots of foes. The Canberra Times (28 February), B9.
- Cassidy, F., 2004b. Growing airport to 'gut' city. The Canberra Times (23 February), 1–2.
- Centre for Sustainable Transportation, 2000. Sustainable Transportation Monitor No. 3: The Future of Aviation. Retrieved 2 May 2001. Available from: <a href="http://www.cstctd.org/CSThomepage.htm">http://www.cstctd.org/CSThomepage.htm</a>.
- Clack, P., 2002. Hargreaves' moratorium on growth is moratorium on jobs, says manager. The Canberra Times (27 September), 3.
- Cooke, G., 2003. ACT push for Sydney air traYc. The Canberra Times (1 September), 1–2.
- Cox, E., 1995. A Truly Civil Society: 1995 Boyer Lectures. ABC Books, Sydney.
- Dempsey, P.S., 2000. Airport Planning and Development Handbook: A Global Survey. McGraw-Hill, New York.
- Department of the Environment, Transport and the Regions, 2000. The Future of Aviation: The Government's Consultation Document on Air Transport Policy. DETR, London.
- Department of Transport and Regional Services, 2000. Discussion Paper: Expanding Ways to Describe and Assess Aircraft Noise. DOTARS, Canberra.
- Downie, G., 2002. Tralee will proceed, land developer says. The Canberra Times (23 November), 11.
- Dryzek, J.S., 1998. Political and ecological communication. In: Dryzek, J.S., Schlosberg, D. (Eds.), Debating the Earth: The Environmental Politics Reader. Oxford University Press, Oxford, UK, pp. 584–597.
- Dryzek, J.S., Schlosberg, D. (Eds.), 1998. Debating the Earth: The Environmental Politics Reader. Oxford University Press, Oxford, UK.
- Fahey, J., Minister for Finance and Administration, Vaile, M., Minister for Transport and Regional Development, 1998a. Joint media release 17/98: New operator for Canberra airport (20 March). Retrieved 30 June 2005. Available from: <a href="http://www.Wnance.gov.au/scripts/Media">http://www.Wnance.gov.au/scripts/Media</a>. asp?Table D MFA&Id D 136>.
- Fahey, J., Minister for Finance and Administration, Vaile, M., Minister for Transport and Regional Development, 1998b. Joint media release 48/ 98: Adelaide, Canberra, Coolangatta, Launceston and ParaWeld Airports-New lessees to commence operations (28 May). Retrieved 30 June 2005. Available from http://www.Wnance.gov.au/scripts/Media. asp?Table D MFA&Id D 131.
- Fawcett, A., 2000. The sustainability of airports and aviation: Repicturing air travel, impacts & opportunities for sustainable change. Transport Engineering in Australia 6 (1/2), 33–39.
- Federal Aviation Administration, 1999. FAA Aviation Noise Ombudsman: Annual Report. Retrieved 4 December 2002. Available from: <a href="http://www.aee.faa.gov/ombud/>">http://www.aee.faa.gov/ombud/></a>.
- Fitzgerald, P., 1998. The Sydney Airport Fiasco: The Politics of an Environmental Nightmare. Hale & Iremonger, Alexandria, New South Wales.

- Forsyth, P., 2002. Privatisation and regulation of Australian and New Zealand airports. Journal of Air Transport Management 8, 19–28.
- Francillon, R J., 2000. Facing more growth. Air International 59 (September), 146–151.
- Gerber, P., 2002. Success factors for the privatisation of airports—an airline perspective. Journal of Air Transport Management 8, 29–36.
- Graham, B., Guyer, C., 1999. Environmental sustainability, airport capacity and European air transport liberalization: Irreconcilable goals? Journal of Transport Geography 7, 165–180.
- Graham, B., Guyer, C., 2000. The role of regional airports and air services in the United Kingdom. Journal of Transport Geography 8, 249–262.
- Grech, J., 2003. City's 30 year plan. The Chronicle (4 November), 1-3.
- Hamilton, C., 2003. Growth Fetish. Allen & Unwin, Sydney.
- Hamilton, C., Mail, E., 2003. Downshifting in Australia: A Sea-Change in the Pursuit of Happiness (Discussion Paper No. 50). The Australia Institute, Canberra.
- Hannaford, S., 2003. \$50m to upgrade airport. The Canberra Times (2 September), 1–2.
- Hannaford, S., Brewer, P., 2003. Stromlo will go within three years (4 November). Retrieved 5 November 2003. Available from: <a href="http://canberra.yourguide.com.au/home.asp">http://canberra.yourguide.com.au/home.asp</a>>.
- Heron, J., Reason, P., 2001. The practice of co-operative inquiry: Research 'with' rather than 'on' people. In: Reason, P., Bradbury, H. (Eds.), Handbook of Action Research: Participative Inquiry and Practice. Sage, London, pp. 179–188.
- International Civil Aviation Organization, 2001a. Colloquium on Environmental Aspects of Aviation (Montreal, 9–11 April 2001): Background Information Paper Assembly Resolution A32-8: Consolidated Statement of Continuing ICAO Policies and Practices Related to Environmental Practices. Retrieved 17 July 2001. Available from: <a href="http://www.icao.int/icao/en/env/>.">http://www.icao.int/icao/en/env/>.</a>
- International Civil Aviation Organization, 2001b. Growth in air traYc projected to continue: ICAO releases long-term forecasts (News release and attached table) (13 June). Retrieved 18 June 2003. Available from: <a href="http://www.icao.int/>.">http://www.icao.int/>.</a>
- Knowles, T., Dimitrios, D., El-Mourhabi, J.B., 2001. The Globalisation ofTourism and Hospitality: A Strategic Perspective. Continuum, London.
- Laird, P.G., Newman, P.W.G., Bachels, M.A., Kenworthy, J.R., 2001. Back on Track: Rethinking Transport Policy in Australia and New Zealand. UNSW Press, Sydney.
- Lewin, K., 1935. A Dynamic Theory of Personality: Selected Papers by Kurt Lewin. McGraw-Hill, New York.
- May, M., 2002. Growing danger in aviation expansion. The Canberra Times (31 October), 11.
- May, M., Hill, S.B., 2004. Unpacking aviation futures. In: Inayatullah, S. (Ed.), The Causal Layered Analysis (CLA) Reader: Theory and Case Studies of an Integrative and Transformative Methodology. Tamkang University Press, Taipei, Taiwan, pp. 371–390.
- McLennan, D., 2002. Call for halt to airport's growth. The Canberra Times (26 September), 1.
- Milbrath, L.W., 1989. Envisioning a Sustainable Society: Learning Our Way Out. State University of New York Press, Albany, NY.
- Moloney, J.-P., 2002. Noise agency backs airport over Tralee. The Canberra Times (17 August), 3.
- National Research Council Committee on Aeronautics Research and Technology for Environmental Capability, 2002.For Greener Skies: Reducing Environmental Impacts of Aviation National Academy Press, Washington, DC.
- Nero, G., Black, J.A., 2000. A critical examination of an airport noise mitigation scheme and an airport noise charge: the case of capacity expansion and externalities at Sydney (Kingsford Smith) airport. Transportation Research Part D 5, 433–461.
- Newman, P., Kenworthy, J., 1999. Sustainability and Cities: Overcoming Automobile Dependence. Island Press, Washington, DC.
- Newton, P.W., 2001. Australia State of The Environment Report 2001: Human Settlements Theme Report. Retrieved 28 May 2002. Available from: <a href="http://www.ea.gov.au/soe/2001/settlements/">http://www.ea.gov.au/soe/2001/settlements/</a>>.

- O'Connor, K., 2003. Global air travel: toward concentration or dispersal? Journal of Transport Geography 11, 83–92.
- Penner, J.E., Lister, D.H., Griggs, D.J., Dokken, D.J., McFarland, M. (Eds.), 1999. Aviation and The Global Atmosphere: A Special Report of IPCC Working Groups I and III (For the Intergovernmental Panel on Climate Change). Cambridge University Press, Cambridge, UK.
- Robins, B., Davies, A., 2003. Airport traYc forecast stirs up noise anger. The Sydney Morning Herald (2–3 August), 7.
- Royal Commission on Environmental Pollution, 2002. The Environmental EVects of Civil Aircraft in Flight: Special Report. RCEP, London.
- Royal Commission on Environmental Pollution, 2003. Royal Commission responds to aviation White Paper (News release) (16 December). Retrieved 2 May 2005. Available from: <a href="http://www.rcep.org.uk/news/03-12.htm">http://www.rcep.org.uk/news/03-12.htm</a>>.
- Seale, D., 2004a. Mixed reaction to draft airport plan. The Canberra Times (21 August), 9.
- Seale, D., 2004b. Residents put their case for a good night's sleep. The Canberra Times (4 August), 4.
- Senate Select Committee on Aircraft Noise in Sydney, 1995. Falling on Deaf Ears? Report of the Senate Select Committee on Aircraft Noise in Sydney. Department of the Senate, Parliament House, Canberra.
- Skogo, I., 2001. Public opposition to air transport development underscores importance of tackling noise issue. ICAO Journal 56 (4), 22–23.
- Stake, R.E., 1995. The Art of Case Study Research. Sage, Thousand Oaks, CA.
- Stake, R.E., 2000. Case studies. In: Denzin, N.K., Lincoln, Y.S. (Eds.), Handbook of Qualitative Research, second ed. Sage, Thousand Oaks, CA, pp. 435–454.
- Staples, S.L., Cornelius, R.R., Gibbs, M.S., 1999. Noise disturbance from a developing airport: Perceived risk or general annoyance? Environment and Behavior 31, 692–710.
- The Canberra Times, 2003. Airport pitch a smart move. 25 September, p. 16.
- The Chronicle, 2003. Concrete plans for jumbo suitors. 9 September, p. 12.
- The Village Building Co., 2002a. The development of Tralee will provide major beneWs to Jerrabomberra and Queanbeyan [Advertisement]. The Canberra Times (9 August), 9.
- The Village Building Co., 2002b. The real noise is coming from the airport owners [Advertisement]. The Canberra Times (2 August), 7.
- The Village Building Co., 2002c. Tralee Newsletter No. 1. The Village Building Co., Canberra.
- The Village Building Co., 2003. Tralee and Canberra Airport: A Case Study in Compatible Land Uses. The Village Building Co., Canberra.
- Thomas, C., Raper, D., 2000. The role of aero engineering in the sustainable development of the aviation industry. The Aeronautical Journal 104, 331–333.
- Tonn, B.E., Petrich, C., 1998. Everyday life's constraints on citizenship in the United States. Futures 30, 783–813.
- Upham, P., 2001. A comparison of sustainability theory with UK and European airports policy and practice. Journal of Environmental Management 63, 237–248.
- Van Eeten, M.J.G., 2001. Recasting intractable policy issues: the wider implications of the Netherlands civil aviation controversy. Journal of Policy Analysis and Management 20, 391–414.
- Vedantham, A., Oppenheimer, M., 1998. Long-term scenarios for aviation: demand and emissions of CO<sub>2</sub> and NO<sub>x</sub>. Energy Policy 26, 625– 641.
- Vigar, G., 2002. The Politics of Mobility: Transport, the Environment and Public Policy. Spon Press, London.
- Whitelegg, J., 1997. Critical Mass: Transport, Environment and Society in the Twenty-First Century. Pluto Press, London.
- Willans, G., 2001. Runway upgrade Xies in the face of facts. The Canberra Times (22 May), 9.
- Willans, G., 2002. A bit rich for airport owner to cry poor [Letter to the editor]. The Canberra Times (3 October), 12.
- World Health Organization, 2001. Occupational and community noise: Fact sheet No. 258. Retrieved 30 September 2001. Available from: <http://www.who.int/inf-fs/en/fact258.html>.



# Public Health Association of Australia: Policy-at-a-glance – Environmental Noise Policy

Key message: PHAA will -

1.	Advocate for environmental noise to be regarded as a public
	health issue

- 2. Advocate for clear standards for prevention and management of noise
- 3. Advocate for development and implementation by government of policies and strategies to both promote health and reduce adverse environmental consequences from noise pollution.
- 4. Ensure that advocacy includes measures designed to raise community awareness of and commitment to implementing the necessary policy, structural and systemic, political and behavioural changes for addressing adverse environmental noise.
- **Summary:** Environmental noise is a public health issue that requires serious attention to limit its adverse effects as urbanisation increases. This policy describes environmental noise pollution and proposes action for PHAA to take.
- Audience: Federal, State and Territory Governments.
- **Responsibility:** PHAA's Ecology and Environment Special Interest Group (SIG).

**Date policy adopted:** September 2014

Contacts: Peter Tait, Convenor, Ecology and Environment SIG – aspetert@bigpond.com



# **Environmental Noise Policy**

This policy is to be read with existing PHAA Health Effects of Wind Turbines Policy

### The Public Health Association of Australia notes that:

- 1. Environmental noise is increasingly being recognised as a public health issue (1-3).
- 2. Sounds are created when a vibrating source causes waves of acoustic energy to travel through the air. The sound pressure waves move out from the vibrating source, becoming weaker as they travel further. The waves may be reflected or scattered by objects so that the sound reaching the ear may be different from the sound originally generated. The sound pressure level is measured in decibels (dB) (4).
- 3. Common noise sources vary in sound level, for instance, normal conversation (60 dB), lawnmower (90dB), chain-saw (100dB), rock drilling (120dB) and jet engine at 30m (140dB) (5).
- 4. Sounds can also be characterised by their frequency (pitch)and loudness. Frequency is measured in hertz (Hz), which gives the number of cycles that occur per second (4).
- 5. Noise is a sound that is loud, disturbing or unpleasant in effect, unwanted sound.

People have varying levels of tolerance to noise. In some situations noise may not be particularly loud, but may be distracting. Moreover, the repetitive nature of a particular noise and/or the inability of an individual to control it can cause annoyance. Examples include dogs barking and bass amplification of recreational music (4).

- 6. Vulnerable groups, such as children, older persons, people with mental health issues, may be affected by noise in different ways compared to other members of the population (2).
- 7. Environmental noise pollution relates to ambient sound beyond the comfort levels, as caused by numerous sources including traffic, construction, aviation, industrial, as well as some recreational activities (6).
- 8. Traffic-related noise and industrial noise are significant sources of disturbing environmental noise (7).
- 9. Deleterious effects of noise can include hearing loss (8), sensory effects such as pain, annoyance (7) and sleep disturbance (9,10).
- **10.** Environmental sleep disorder is a sleep disturbance due to an environmental factor that causes either insomnia or daytime fatigue and somnolence. Other effects can include effects on concentration, attention and cognitive performance, depressed mood and irritability (11).

- 11. The relationship between sleep and health is generally well-accepted. Insufficient sleep and sleep loss can affect endocrine and metabolic function (12) as well as inflammatory markers such as C-reactive protein (CRP), which may contribute to cardiovascular events. CRP levels have been found to linearly increase with sleep loss (13).
- 12. Long-term environmental noise exposure can affect stress levels, as measured by levels of endogenous stress hormones (14), and may increase the risk of adverse cardiovascular effects, for instance elevated risk of hypertension due to aircraft and road traffic noise and elevated risks of myocardial infarction due to road traffic noise (15,16).
- 13. Categorising noise with respect to sound level, pitch and intensity, and correct exposure assessment is important in assessing impact.
- 14. The World Health Organization (WHO) published the Night Noise Guidelines for Europe. The Guidelines present evidence of the health effects of night time noise exposure and recommend threshold values that, if breached at night, could threaten health. An annual average night exposure not exceeding **40 decibel (dB)** outdoor has been recommended in the Guidelines (17).

## The Public Health Association of Australia affirms the following principles:

- 1. Action to ensure a safe and healthy environment is a critical public health priority.
- 2. When society-wide change is necessary for the common good, government's role is to lead, inform, regulate, monitor and enforce, and to motivate behaviour change by individuals and corporations.
- **3.** As a general principle, producers of pollution, including noise pollution, should pay the costs of remediation.

## The Public Health Association of Australia believes that the following steps should be undertaken:

- 1. Competent authorities should work together to clearly define parameters for noise level, exposure assessment, and measures for assessing the health effects of noise.
- 2. Competent authorities should draw up "strategic noise maps" for existing major transport routes and other developments, using harmonised noise indicators  $L_{den}$  (day-evening-night equivalent level) and  $L_{night}$  (night equivalent level) as recommended in the EU policy (18).
- 3. Proposed developments such as roads, rail lines, airports, mining, and industry should be required to undertake a strategic noise impact assessment before commencement of the development, and ensure noise minimisation design and engineering is included in development proposals.
- 4. Local noise issues should be identified through consultation with the public and local organisations. A policy to maintain acceptable amenity in terms of environmental noise should be developed and implemented at a local Council level. Strategies to reduce unacceptable noise should also be developed in consultation with residents and implemented at a local level.
- 5. A burden of disease relevant to environmental noise pollution should be established within constraints of current scientific knowledge.

- 6. A public health strategy should be investigated to reduce the number of people currently adversely impacted by environmental noise.
- 7. Innovative strategies for noise reduction in existing buildings and in development of new building materials should be explored.

## The Public Health Association of Australia resolves to undertake the following actions:

- 1. Advocate for development and implementation by government of policies and strategies to both promote health and reduce adverse environmental consequences from noise pollution.
- 2. Ensure that advocacy includes measures designed to raise community awareness of and commitment to implementing the necessary policy, structural and systemic, political and behavioural changes for addressing adverse environmental noise.
- 3. Work with other organisations/agencies at the national, jurisdictional and local level to support these actions.

## ADOPTED 2014,

First adopted at the 2014 Annual General Meeting of the Public Health Association of Australia.

## **References:**

1. Burden of disease from environmental noise. World Health Organisation. 2011. Available at: http://www.euro.who.int/\_\_data/assets/pdf\_file/0008/136466/e94888.pdf

Accessed 4 April 2014.

2. van Kamp I, Davies H. Noise and health in vulnerable groups: A review. Noise Health [serial online] 2013; 15:153-9. Available at: <u>http://www.noiseandhealth.org/text.asp?2013/15/64/153/112361</u> Accessed 4 April 2014.

3. Kim M, Chang SI, Seong JC, Holt JB, Park TH, Ko JH, Croft JB. Road traffic noise: annoyance, sleep disturbance, and public health implications. *Amer J Prev Med* 2012; 43(4):353-60.

4. What is Noise? NOVA, Science in the news. Australian Academy of Science. Available at: http://www.sciencearchive.org.au/nova/072/072box02.html Accessed 11 April 2014.

5. Managing Noise and Preventing Hearing Loss at Work. Safe Work Australia. 2011. Available at: <a href="http://www.safework.sa.gov.au/uploaded\_files/Managing\_Noise\_and\_Preventing\_Hearing\_Loss\_-at\_Work.pdf">http://www.safework.sa.gov.au/uploaded\_files/Managing\_Noise\_and\_Preventing\_Hearing\_Loss\_-at\_Work.pdf</a> Accessed 11 April 2014.

6. The EU Policy on Environmental Noise. EU Commission. 2014. Available at: http://ec.europa.eu/environment/noise/home.htm Accessed 5 April 2014.

7. Olaosun AO, Ogundiran O and Tobih JE. 2009. Health Hazards of Noise: A Review Article. *Research Journal of Medical Sciences* 2009; 3:115-122. Available at: http://medwelljournals.com/abstract/?doi=rjmsci.2009.115.122 Accessed 11 April 2014.

**8.** Van Eyken E, Van Camp G, Van Laer L. The Complexity of Age-Related Hearing Impairment: Contributing Environmental and Genetic Factors. *Audiol Neurotol* 2007; 12:345–358.

9. Rovekamp AJM. Physiological effects of environmental noise on normal and more sound-sensitive human beings. In: Rossi G (Ed) Noise as a public health problem. Milano, Italy: *Centro Richerche e Studi Amplifon* 1983; 1:605-614.

10. Hume KI, Brink M, Basner M. Effects of environmental noise on sleep. Noise Health [serial online] 2012 [cited 2014 Apr 14];14:297-302. Available from: http://www.poiseendhealth.org/text.acp22012/14/61/207/104807

from: http://www.noiseandhealth.org/text.asp?2012/14/61/297/104897

11. The relation between sleep and health. Chapter 2 in Night Noise Guidelines for Europe. World Health Organization Europe. 2009. Available at: <u>http://www.euro.who.int/\_\_data/assets/pdf\_file/0017/43316/E92845.pdf</u> Accessed 23 April 2014.

12. Spiegel K, Leproult R, van Cauter E (1999). Impact of sleep debt on metabolic and endocrine function. *Lancet* 1999; 354:1435–1439.

13. Meier-Ewert HK, Ridker PM, Rifai N, Regan MM, Price NJ, Dinges DF, Mullington JM. Effect of sleep loss on C-reactive protein, an inflammatory marker of cardiovascular risk. *J Amer Coll Cardiol* 2004; 43:678-683.

14. Ising H, Kruppa B. Health effects caused by noise: evidence in the literature from the past 25 years. *Noise & Health* 2004; 6(22):5-13.

15. Jarup L, Babisch W, Houthuijs D, Pershagen G, Katsouyanni K, Cadum E, *et al.* Hypertension and exposure to noise near airports: the HYENA study. *Environ Health Perspect* 2008; 116:329-33.

16. Babisch W. Cardiovascular effects of noise. Noise Health 2011; 13:201-4.

17. Night Noise Guidelines for Europe. World Health Organization Europe. 2009. Available at: <u>http://www.euro.who.int/\_\_data/assets/pdf\_file/0017/43316/E92845.pdf</u> Accessed 23 April 2014.

18. The Environmental Noise Directive (2002/49/EC). European Commission. Available at: http://ec.europa.eu/environment/noise/directive.htm Accessed 11 April 2014.