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Big data from the sky: popular perceptions of private drones in Switzerland

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Abstract. Camera-fitted drones are now easily affordable for the public. The resulting extension of the vertical gaze raises a series of critical questions, ranging from the changing regimes of visibility and control that characterise today's world of "big data from the sky" to the novel opportunities, risks, and power dynamics hence implied. The paper addresses these issues empirically, focussing on the popular perception of commercial and hobby drones in Switzerland. This provides a deeper understanding of the driving forces and obstacles that shape current drone developments and highlights that the societal diffusion of private drones today transforms the very ways in which the aerial realm is lived and perceived, as a highly contested space of risks, opportunities, and power. This discussion is rooted in a research approach that places questions of power and (air-)space at the centre when approaching the drone problematic.

1 Introduction

In recent years, camera-fitted drones – here understood as remotely piloted unmanned aerial vehicles with imaging capabilities – have become smaller and much more affordable. In Switzerland as elsewhere, ready-to-fly drones can now be purchased for less than 100 CHF. Drones have also become much more technologically advanced. They can be customised easily, augmented with additional sensors and software that automates data collection, transfer, and analysis (Wall and Monahan, 2011), and incorporated within wider network-centric forms of military intervention and policing (Graham, 2010:166), farming (Krishna, 2016) or self-management and tracking (Wolf, 2016:67). Consider the example of social media site Twitter, whose 2015 patent on drones aims to allow users in future years to share and livestream "dronies" and self-made videos on their accounts (Shead, 2015).

In Switzerland, according to official estimates, more than 22 000 drones are currently in use, of which 20 000 are thought to be in private hands, serving both commercial and recreational purposes (Sacco, 2014; Office Fédérale de l'Aviation Civile, 2016a). Other estimates speak of 16 million private drones that will be sold globally between 2016 and 2020 (Aruco, 2016); 7 million of these are expected to be flying in the US alone, the most dronophile country in the world (AFP, 2016; Bonnet, 2014). The global market potential of drones is estimated at 89 000 billion dollars for the period of 2013 to 2021 (Homeland Security News Wire, 2011).

Many additional speculative numbers could be provided with regard to the current and future scope and scale of drone usage, mirroring the ongoing media hype and exploding expectations in the field. However, none of these numbers could ever be truly verified, as there is as yet no obligation to register private drones. In Switzerland, for example, private drones below 30 kg only require registration and special authorisation if flying over crowds or beyond the pilot's line of sight (Office Fédérale de l'Aviation Civile, 2016a:16). Still, it is safe to say that drones have become mass-marketed visualisation devices (Haggerty, 2006:255) that are being sold and used in ever more diverse and wide-ranging ways, not merely for military surveillance and policing but also, in particular, for entertainment and for commercial purposes. Drones have become the aerial expression of big data. They literally add a new horizon to contemporary data gathering, transfer, and analysis.

2 Aims of the case study

Given the rapid technological, functional and numerical evolution of drones, a growing number of business representatives (Meilleur Drone, 2014), commentators (Bonnet, 2014), and academic scholars (Dorrian, 2011; Dunn, 2013; Flückiger, 2013) are today talking of a veritable democratisation of unmanned aircraft, the aerial gaze, and indeed the air itself (Clarke, 2014a; Tremayne and Clark, 2014; Schmidt, 2015; Sedlar, 2015). The key idea behind this stance is that drones are now available at an affordable price to the whole population. Drawing upon a quantitative opinion survey conducted in the Swiss Canton of Neuchâtel in 2015, our investigation provides deepened insight into how far the actual use of private drones truly reaches, thus differentiating and indeed challenging the idea that the drone gaze is becoming a truly democratised mass phenomenon. Thus rather than merely focussing on the generalised availability of drones, we here study to what extent drones are truly being democratised from a practical viewpoint. Furthermore, the survey also indicates how the usage and societal diffusion of the technology is perceived and lived by the population at large. We argue that such a perspective is needed in order to understand the driving forces and obstacles that shape current and future drone developments, to explore the wider societal implications of the technology, and to problematise the multiple issues raised, ranging from privacy concerns to perceived security threats (Geiger, 2011; Goodman, 2013; Bracken-Roche et al., 2014; Valavanis and Vachtsevanos, 2015; Gettinger et al., 2014).

In this, the paper connects with, and further develops, a small body of work that has in recent years started to explore the perception of drones by the general public. Relevant studies are of variable quality and revolve almost exclusively around public attitudes towards armed drones deployed in military conflict (LaFranchi, 2013; Cohen, 2014; Kreps, 2014) and towards other state-driven drone practices (Ackerman, 2012). Such accounts reduce the drone problematic to but one user category and to but one "family" of drone gazes. Although there are some notable exceptions to this (Miethe, 2014; Thompson and Bracken-Roche, 2015), an exclusive anglophone, if not North American, focus remains across existing literatures. Furthermore, relevant studies are predominantly descriptive rather than conceptually driven and thus limited in analytical prowess.

Our investigation adds a non-anglophone viewpoint to the debate, focused on the popular understandings, fears, hopes, and expectations that mediate, and are reinforced by, the usage of private drones, here understood as unmanned aircraft used by private organisations or individuals for commercial and recreational purposes. Furthermore, the paper extends existing studies, reinstating the question of how drones are lived and perceived by the public within a wider set of problematics relating to (1) the multifaceted "volumetric politics of the air" enacted by, and acting on, differing types of private drone users; (2) the popular perception of the complex "geographies of proximity and reach" (Allen, 2003:139) that emerge from the drones' capacity to see from afar; and (3) the dynamics of power, counter-power, and resistance hence implied. These reflections afford more expansive insights into how drones today transform the very ways in which the aerial realm is lived and perceived as a contested space of risks, opportunities, and power.

3 Drones, (air-)space, and power

With the present investigation, we pursue a more longstanding reflection on the power issues and aero-spatial functioning, logics, and implications of drones (Klauser and Pedrozo, 2015; Pedrozo, 2017), bound up with a yet still wider theoretical project of developing a specifically politico-geographical approach to the problematics of big data and surveillance (Klauser, 2013, 2017). Hereby, we understand political geography as the academic field that studies power and space in its co-constitutive and mediated relationship (Cox et al., 2008:7). Furthermore, and in connection with the emerging "aerial turn" in contemporary human geography (Adey, 2010), we approach space not merely as a planar "surface" but as a sociopolitically constructed, regulated, and exploited "volume" that comprises both aerial and earthly realms (Elden, 2013). In this respect, and with a view to providing a broader framework for the analysis that follows, it is useful to outline in more detail some of the aero-spatial and power dimensions of drones.

Drones are intrinsically bound up with space. Fitted with imaging capabilities, they combine various geographical scales and spatially articulated logics of IT-mediated vision and visualisation from above and afar. The resulting spatial logics of vision are conditioned by the drones' flight altitude, reach, and autonomy, by their mobility or fixity in the air, and by the cameras' technical features (type of camera, zoom, angle of vision, etc.). In combining several cameras, or in actively manipulating the cameras' focus, direction, and angle, differing spatial logics and scales of vision can be combined. This invites a broader investigation of the complementarities and tensions between differing spatialities of vision from above, relating to specific points in space as well as to wider spatial lines or planes, to fixity and mobility, to enclosure and openness, and to specific spatial connections and separations (Klauser, 2017).

As remote, spatially articulated "vision machines" (Virilio, 2000), drones thus enable specific relationships with, and ways of acting on, the ground from and through the air. Conceptually speaking, this leads to an understanding of drones as aero-visual "techniques of power" in a Foucauldian sense, i.e. as chains of acting entities that allow and mediate action on other action (Foucault, 1982). With the current proliferation of drones, their action potential is more widely distributed, rearticulated, and inverted, thus breaking off the

longstanding monopoly and privilege of the "powerful" to look on space from above (O Tuathail, 1996), spanning from the ancient emperors' city walls and towers to the modern state's satellites. In this sense, the politics of visibility conveyed by the proliferating drone gaze adds a new chapter to the long history of the vertical gaze, adopted in order to understand, order, control, and act on space (Gregory, 1994; Shapiro, 1997). "Aerial power" and "power through the air" become a social and a political issue in new ways (Williams, 2011a, b; Adey et al., 2013; Bracken-Roche, 2016).

4 Methodology and content

The paper addresses this problematic from the perspective of the population at large, focussing on the popular assessment of differing types of private drone usage. To do so, we take into account selected results from a public opinion survey conducted in October 2015 at the University of Neuchâtel, with the help of a class of Master students in geography. Three thousand residents of four municipalities across the Canton of Neuchâtel were sent a questionnaire (750 addressees in each of Neuchâtel, Le Locle, Val-de-Ruz, and Val-de-Travers). The four municipalities were chosen in order to compare the perception of drones in urban (Neuchâtel and Le Locle) and rural areas (Val-de-Ruz and Val-de-Travers). However, no significant differences can be observed on this level. This variable will thus not be considered in the analysis below.

The applied sampling method consisted in choosing arbitrarily an equal number of male and female residents per municipality, structured into four pre-defined age categories (20–34, 35–49, 50–64, and 65–79 years). Whilst the gender balance across the 604 questionnaires returned (reply rate 20 %) was relatively equal (52 % men, 48 % women), participation varied considerably depending on the age of the addressees (17 % of respondents were aged 20–34, 20 % were 35–49, 27 % were 50–64 years, and 36 % were 65–79). This raises the question of how a higher response rate among younger people, where drones are more popular, would have influenced the overall survey results.

The questionnaire was divided into five parts, the first of which was designed to study the general public's overall assessment of the current scale and future evolution of camera-fitted drones, as well as the main opportunities and risks associated with them. Parts 2–5 of the questionnaire aimed to generate a more detailed understanding of the popular perceptions of (unarmed) military, hobby, commercial, and police drones. To give focus to the discussion that follows, the present article focuses exclusively on the results that relate to drones used for commercial and recreational purposes. A second article will deal with insights from the survey with regard to military and police drones.

The analysis that follows is structured into four main parts, which together explore the popular perceptions of the "politics of the air", "politics of visibility", and "politics of the ground" (Klauser and Pedrozo, 2015) conveyed by private drones. We first study to what extent drones have been diffused across society. Secondly, we investigate the social acceptance of differing types of drones; thirdly, we explore the respondents' assessment of where and for what purposes commercial and hobby drones should, or should not, be used. Fourthly, we highlight a series of risks perceived in connection with current drone usage, leading also to a discussion of the public's demands and expectations regarding future evolutions in the field.

5 Analysis

5.1 Societal diffusion of drones

While drones can today be purchased by anybody for very little money, our study shows that few people actually do so. Only 12 survey participants own a drone (less than 2 % of respondents), and only 28 participants (5 %) can imagine buying one in future years. This result is all the more significant if we consider that the vast majority of the population expects it to be easy to buy and fly a drone, a statement with which only 3 % of the survey participants disagree. Thus on this first level, it appears that, regarding their actual use, drones have not become democratised across society as a whole despite their generalised availability.

This picture changes slightly if we consider how many people have already piloted a drone (48 affirmative responses, 8 % of the survey participants). Here, both age and gender are important factors. Whilst 17 % of the respondents between 20 and 34 years have previous experience of flying a drone, this decreases to 11, 6.5, and 3.5 % for the older age categories. In addition, while 16 % of the male respondents have previous experience of piloting unmanned aircraft, this is true of only 1.8 % of the female participants. This finding shows that drone usage does not concern all members of society equally, thus causing us again to question over the supposed democratisation of the aerial gaze. Drones are "toys for the boys", as Salter puts it (Salter, 2014).

Thus as has been the case across its long history, the aerial gaze is still a predominantly masculine affair (Rose, 1993), and the airspace within which drones operate remains a highly gendered space (Spain, 1992; Millward, 1998). What has changed is that the view from above is no longer the exclusive privilege of a few elderly rulers or experts (cartographers, geographers, etc.) but of a wider range of ordinary, technophilic young men. It is on this level that the power of vision and visualisation from above can be considered to have become more widely diffused, albeit not fully democratised.

In addition, it should be mentioned that 120 survey participants (20 % of respondents) state that they have already been filmed from the air; here, gender differences are much less important, with 28 % of the male and 16 % of the female

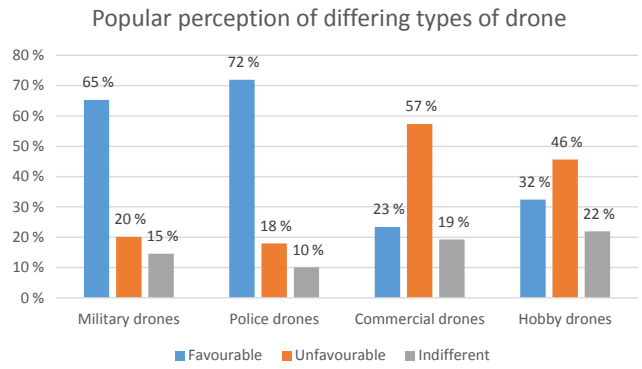

Figure 1. Popular perception of differing types of drone.

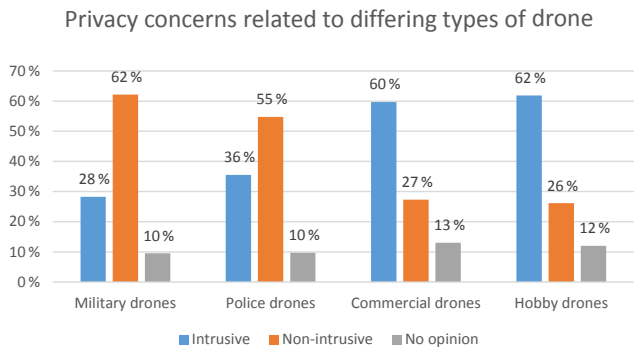

Figure 2. Privacy concerns related to differing types of drone.

participants responding in the affirmative. Thus, whilst the drone gaze has been appropriated mostly by men, it permeates society more broadly in its focus, popular experiences, and perceptions. This raises major questions in terms of gendered power relations that should be explored in more detail in future research.

5.2 Social acceptance of public and private drones

One of the most striking results of the Neuchâtel survey lies in the highly unequal social acceptance of publicly and privately used drones – a finding that is also supported by other surveys on the subject (Thompson and Bracken-Roche, 2015). Whilst the majority of respondents are supportive of the use of unarmed military and police drones (65 and 72 % respectively), relative numbers of approval decrease to 23 and 32 % when it comes to commercial and hobby drones (Fig. 1). Public opinion is that "seeing like a state", to use James Scott's expression (Scott, 1998), should remain the state's exclusive privilege.

A similar picture emerges regarding the issue of privacy in connection with different types of drones (Fig. 2). Whilst only 28 and 36 % of the respondents associate privacy issues with military and police drones, 60 and 62 % are worried about privacy in connection with commercial and hobby drones. From this perspective it appears that the aero-visual monopoly of the state remains intact, being still considered legitimate, whilst private views from the sky are perceived more critically.

In looking at the two preceding graphs together, it is interesting to note that, although police drones are viewed most favourably by the general public (Fig. 1), they evoke greater concern over privacy than military drones (Fig. 2). Equally, while hobby drones are perceived more positively than commercial ones, they are more strongly associated with privacy issues. It thus appears that privacy only partially explains the social acceptance of differing types of drones. This conclusion will be further refined below, by exploring in more detail the popular assessment of where, by whom, and for what purposes drones should, or should not, be used.

Before moving on to this discussion, however, we should return to the general finding regarding the dichotomous popular perception of public and private drone usage. Interestingly, strong similarities can be found when it comes to the social acceptance of differing types of video surveillance (Klauser, 2004). Here also, cameras focussing on public space are widely considered unproblematic if in public (e.g. police) hands, but those used by private institutions or individuals are viewed more negatively. One of the key factors explaining this is that people relate police cameras to more widely defined, collective, and thus personal benefits, whereas the private view from above is associated with more pragmatically defined, commercial, or even voyeuristic intentions (Klauser, 2006), although this perception must not necessarily be accurate (Norris, 2002).

The Neuchâtel survey suggests that a similar popular reasoning applies to the drone problematic, with 87 % of the survey respondents indeed considering drones to be mobile CCTV cameras. Whilst this stance also reflects terminology deployed by official stakeholders such as the Swiss Federal Office of Civil Aviation, whose website and documentation both refer to "video surveillance by drones" (Office Fédérale de l'Aviation Civile, 2016b), there are in actual fact also important differences between CCTV cameras and drones in terms of how they monitor space from above – with drones being used in more sporadic, punctual, and flexible ways than fixedly installed surveillance cameras (Cogarty and Hagger, 2008:125).

5.3 Popular assessment of differing places and purposes of private drone usage

Moving beyond this initial assessment of the social acceptability of drones, our survey shows that the perception of drones depends on where they are used and for what purposes. It appears that commercial drones, for example, are more easily accepted when used in scientific research and police mandates than for aerial photography or postal deliveries (Fig. 3). The latter is particularly interesting, as there are no cameras involved. This brings us again to the previous

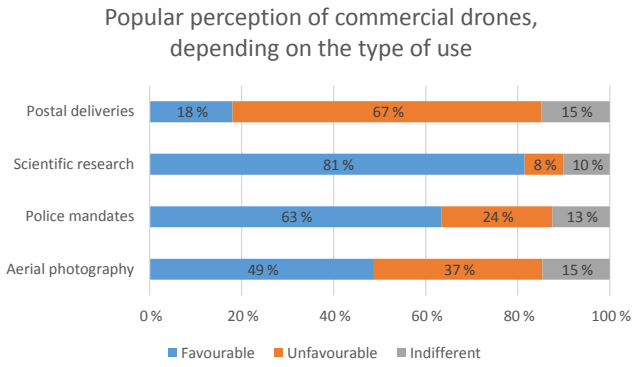

Figure 3. Popular perception of commercial drones, depending on the type of use.

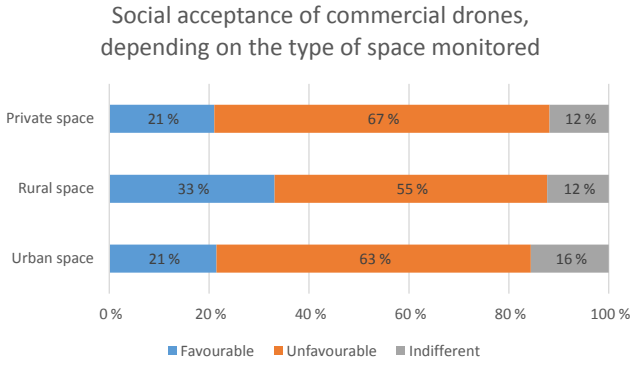

Figure 4. Social acceptance of commercial drones, depending on the type of space monitored.

conclusion that privacy issues but partially explain the social acceptance of drone usage. The public rejects the commercialisation of the air per se. It is not just the commercialisation of the aerial gaze that is seen as problematic.

Regarding the question of space, here understood as "the ground", it appears that both hobby and commercial drones are rejected more strongly in urban settings than in rural contexts (Figs. 3 and 4). There is also a particularly strong resistance to hobby drones being used above private space. With this specific type of drone usage, the "distant intimacy" (Williams, 2015) created by the imaging capabilities of drones is seen as the key problem. An overwhelming majority of the survey participants (95 %) ask for privacy protection to be better respected in this case of drone usage.

In sum, the observation, filming, and geo-graphing of the ground from above is not accepted everywhere or for all purposes. Rather, a more differentiated picture emerges that shows that the public perceives drones in highly unequal ways. These comments also reiterate the relevance of the "spatial curiosity" (Allen, 2003:104) and "power sensitivity" adopted in our research approach. Drones, as aero-visual techniques of power, do not only inhabit and hence co-produce (air-)space whilst implying very specific spatial logics of vision and visualisation from above and afar (in both

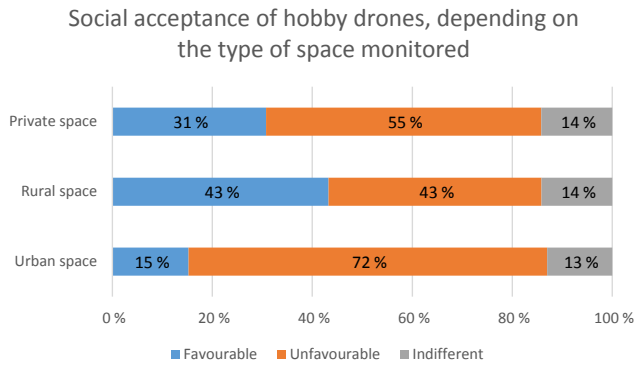

Figure 5. Social acceptance of hobby drones, depending on the type of space monitored.

horizontally and vertically distancing the watchers from the watched, and in their spatially articulated gaze as it "falls" on the ground). Furthermore, we also need to think about space in order to explain the ways in which people live with and perceive drones. For example, the Neuchâtel survey points at the intimacy of private space and at the density of urban space as variables that explain public reservations about private drone usage. However, these initial findings should be further refined through qualitative research methods if we are to gain a fuller understanding of how spatial practices, experiences, imaginaries, and identities explain the ways in which individuals and social groups perceive drones. It should also be noted that the spatial curiosity advocated here is not meant to exclude or trump other ways of approaching the subject. This is exemplified by the fact that popular perceptions of drones also vary in function of their (commercial and recreational) purposes, uses (postal deliveries, scientific research, etc.), and (public/private and individual/institutional) owners.

5.4 Opportunities and problems associated with hobby and commercial drones

In further pursuing our investigation of how private drones are perceived, and how this then translates into specific understandings of the airspace in which they operate, attention should also be paid to the opportunities and problems that people associate with the aircraft. In this respect, consider the difficulties from a lay perceptive of truly grasping the actual extent of the proliferating aerial gaze in the present-day world. While 20 % of respondents state that they have already been filmed by drones, as shown previously, the vast majority indeed underestimate or are completely unaware of the true scope and scale of contemporary drone usage; 73 % believe there to be less than 10 000 drones in the country, with 34 % having "no opinion". This finding again resonates with existing work on video surveillance, which also identifies misconceptions among the public with regard to the extent of visual monitoring (Klauser, 2006). Interestingly, the survey

results also suggest that people are very aware of their lack of knowledge and understanding when it comes to contemporary drone usage, with 87 % of the respondents asking to be better informed about drone flights.

This claim resonates with those literatures that question contemporary techno-mediated forms and formats of management and control from the point of view of the monitored individuals' personal autonomy. As Rössler argues, personal autonomy may be fundamentally threatened if people are structurally mistaken about the possibility that other people may have information about them (Rössler, 2001:233). Regarding our present analysis, people cannot be aware of all of the issues at stake in the world of "big data from above" if they are mistaken about the phenomenon's size and various expressions, although in some cases individuals knowingly either participate in their own monitoring through drones, resist drones, or use drones themselves. This also raises important questions with regard to the possibility of a democratic debate about the opportunities and risks, and thus societal desirability, of the technology.

Moving beyond the questions of privacy and personal autonomy, it is also important to consider public perceptions of the risks associated with drones. Of the respondents, 89 % think that hobby drones should not be allowed to fly above high-risk sites; many fear accidents involving hobby and commercial drones (54 and 57 % respectively). Unsurprisingly, there is a strong correlation between the fear of commercial drone accidents and the fear of hobby drone accidents (correlation coefficient 0.8212; also see Table 1, below).

In this light, it is hardly surprising that most of the survey participants agree with the current Swiss legal obligations for private drone pilots to (1) maintain a permanent visual contact with the aircraft (86 % of respondents) and (2) avoid drone usage within a perimeter of 100 m around major rallies of people (84 %). In passing, note that the latter leads back to our previous comments with regard to how space (i.e. places of heightened density) helps to explain the popular perception of drones.

The perceived risk of terrorism is even greater; 64 % of the respondents fear that hobby drones could be involved in terrorist strikes. Age plays an important part here: whilst 49 % of the respondents between 20 and 34 years are worried about a possible connection between hobby drones and terrorism, these numbers increase to 56, 65, and 85 % for the older age categories. Somewhat in contrast, the Swiss Federal Office of Civil Aviation judges the risk of "criminal usage of drones", including terrorism, as "moderate" (Office Fédérale de l'Aviation Civile, 2016a:25). Thus popular fears, especially amongst older generations, are more heightened than official concern.

However, popular reservations and fears about drones will not necessarily prevent the technology from being more widely diffused across society in future years. Rather, things might evolve in the opposite direction, since popular levels

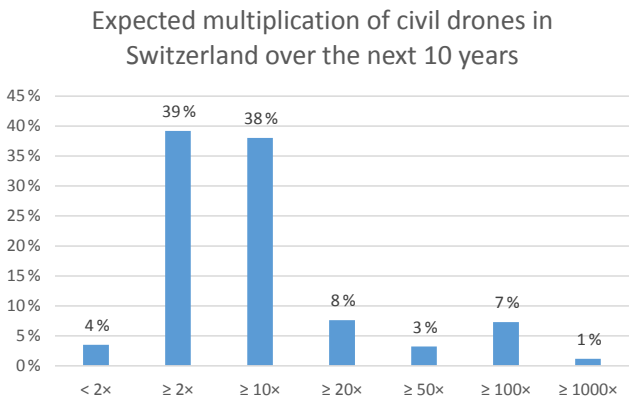

Figure 6. Expected evolution of civil drones in Switzerland over the next 10 years.

of acceptance are likely to increase with the further diffusion of the technology as both policy makers and the population at large get used to it. This "normative power of facts" is well documented in connection with video surveillance (Webster, 2009).

The participants of the Neuchâtel survey hold a broadly shared belief that drones will increase in number over the next 10 years. Whilst their estimations in this respect are not very relevant here in terms of absolute numbers, given the generalised misconception with regard to the current situation, Fig. 6 highlights their expectations in relative terms, comparing the future to the current situation. Of the respondents, 39 % expect the number of drones to multiply 2 to 10 fold over the next 10 years, and 38 % predict that there will be 10 to 20 times more drones in 10 years' time. Whilst less than half of the survey participants actually provided estimates for these questions, reiterating again their difficulty to fully grasp the size of the phenomenon, not one single person thought that the number of drones would decrease in the future.

In addition, 57 % of the survey participants expect the commercial drone market to evolve significantly in future years. This provides yet another indication of the technology's future potential. Still, it remains to be seen whether these evolutions will truly occur and whether they will fundamentally change the picture emerging from our analysis with regard to the necessary differentiation and relativisation of the thesis of a democratisation of the aerial gaze.

6 Conclusions

Connecting with wider considerations about the changing regimes of visibility that characterise the present-day world of big data (Koskela, 2004; Haggerty and Ericson, 2006; Gilliom and Monahan, 2013), our study paints a highly differentiated picture of the popular perception of private drones as novel and increasingly diffused, yet not fully democratised, aero-visual techniques of power. This reiterates the ur-

Table 1. Fears of drone accidents connected to commercial and recreational usages.

		I am worried about accidents with commercial drones			
		Agree	Do not agree	No opinion	Total
I am worried about accidents with hobby drones	Agree	253	20	29	302
	Disagree	24	61	17	102
	No opinion	41	14	99	154
	Total	318	95	145	558

gent need to think more carefully about the aerial realm as a geopolitical space that is lived, experienced, and sociopolitically produced in highly unequal ways. The insights provided in this respect can be structured into three main points.

6.1 The aerial realm as a contested space

As shown by the Neuchâtel survey, drones are not used by everybody, and there is no generalised popular motivation to buy drones in the future. Rather, although the aerial gaze is perceived as permeating society ever more widely, drone technology itself has so far been appropriated primarily by young men, raising major questions in terms of the gendered and intergenerational power relations that today underpin the sociopolitical production of airspace as a lived, perceived, and conceived space in a Lefebvrian sense (Lefebre, 1991).

Furthermore, it appears that the resulting unequal occupation and co-production of the aerial realm as a novel terrain for commercial activities and entertainment is also perceived in highly unequal ways, with the elder generations being more critical and fearful than the younger. Thus whilst it may be said that drones have redefined the aerial sovereignty and supremacy of the state, this does not go without inner-societal tensions and contestations. Put differently, drones make airspace more explicit and more available for social reflection and action, but it is also this very novel potential of societal co-production that makes airspace today an increasingly contested space in which, and through which, power is exercised in unequal ways.

6.2 The aerial realm as a space of risks and opportunities

If the aerial realm is today socially co-produced in unequal ways, this is above all because it is perceived to present different risks and opportunities for different social groups. The vast majority of the population is aware of the commercial and entertainment potential arising from the opening-up of airspace for and through drones but does not appreciate this being actualised by specific private institutions or individuals. Of major importance here are privacy concerns and perceived security threats. It appears that the population at large perceives private drones as harmful or intrusive rather than beneficial. This results in a series of popular demands that may slow down the future societal diffusion and potential application of the aircraft. At the same time, most people expect the number of drones to increase in future years, which may further accentuate the key issues and problematics associated with the technology.

In contrast, the appropriation of the aerial realm for public benefits – here referring in particular to military surveillance and policing purposes – is widely and somewhat uncritically accepted. As argued, the drone-related opening up of airspace is here seen to be of wider collective interest and thus perceived as more beneficial. The state, in this sense, maintains its monopoly of the air and of the aerial gaze.

6.3 The aerial realm as a space of power

In light of the above, it appears that there is a general public awareness that airspace can be instrumentalised for action on other action. In a Foucauldian sense, airspace thus appears not only as a (socially contested) stake of power in itself but also as a realm that mediates the exercise of power on the ground. However, as shown, the possibility to act on and through the air is not seen as legitimate in all contexts, for all people, or for all purposes.

This then also tells us something about the popular perception of the power dynamics unfolding from the visual, aerial, and spatial logics of the drone gaze, whose further reduced acceptance above private space is indicative of the ways in which it is perceived to intrude on and thus appropriate the ground. One specific line of future interrogation arising from this issue then revolves around the necessary security and regulatory responses to be found and especially to follow through, as the majority of the population seems content with the contemporary legal conditions imposed, which limit the power from the air for some and optimise it for others.

Data availability. The quantitative data underlying this paper are not publicly available. For further information please contact the authors.

Competing interests. The authors declare that they have no conflict of interest.

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References

Ackerman, E.: Poll shows concern about drones and domestic surveillance, IEEE Spectrum, http://spectrum.ieee.org/automaton/robotics/military-robots/poll-shows-concern-about-drones-and-domestic-surveillance (last access: 12 August 2016), 25 June 2012.

Adey, P.: Vertical security in the megacity legibility, mobility and aerial politics, Theor. Cult. Soc., 27, 51–67, 2010.

Adey, P., Whitehead, M., and Williams A. J.: From Above: War, Violence, and Verticality, Hurst Publishers, London, 2013.

AFP: Le nombre de drones civils va quasiment tripler d'ici 2020, L'Orient Le Jour, http://www.lorientlejour.com/article/977477/usa-le-nombre-de-drones-civils-va-quasiment-tripler-dici-2020.html (last access: 12 August 2016), 24 March 2016.

Allen, J.: Lost Geographies of Power, Blackwell, Oxford, 2003.

Aruco: 2016, l'Année du drone, https://aruco.com/2015/12/annee-drone-2016/ (last access: 2 June 2017), 2016.

Bonnet, J.: Infographie: 12 preuves de la démocratisation des drones, Usine Digitale, http://www.usine-digitale.fr/editorial/infographie-12-preuves-de-la-democratisation-des-drones.N293478 (last access: 12 August 2016), 27 October 2014.

Bracken-Roche, C.: Domestic drones: the politics of verticality and the surveillance industrial complex, Geogr. Helv., 71, 167–172, https://doi.org/10.5194/gh-71-167-2016, 2016.

Bracken-Roche, C., Lyon, M., Mansour, M. J., Molnar, A., Saulnier, A., and Thompson, S.: Surveillance Drones: Privacy Implications of the Spread of Unmanned Aerial Vehicles (UAVs) in Canada, Report, Queen's University Surveillance Studies Centre, Kingston, 2014.

Clarke, R.: The regulation of civilian drones' impacts on behavioural privacy, Computer Law & Security Review, 30, 286–305, 2014a.

Cogarty, B. and Hagger, M.: The laws of man over vehicles unmanned: The legal response to robotic revolution on sea, land and air, Journal of Law, Information & Science, 19, http://www.austlii.edu.au/au/journals/JlLawInfoSci/2008/5.html (last access: 10 August 2016), 2008.

Cohen, G. M.: Public Opinion and Drones. The Formation of American Public Opinion regarding the Use of Drones as a U.S. Foreign Policy Tool, Report, University of Miami: Department of International Studies, Miami, http://paperroom.ipsa.org/papers/paper_31894.pdf (last access: 12 August 2016), 2014.

Cox, K. R., Low, M., and Robinson, J.: Political geography: Traditions and turns, in: The Sage Handbook of Political Geography, edited by: Cox, K. R., Murray, L., and Robinson, J., Sage, London, 1–14, 2008.

Dorrian, M.: On Google Earth, New Geographies, 4, 164–170, 2011.

Dunn, D. H.: Drones: Disembodied aerial warfare and the unarticulated threat, Int. Aff., 89, 1237–1246, 2013.

Elden, S.: Secure the volume: Vertical geopolitics and the depth of power, Polit. Geogr., 34, 35–51, 2013.

Flückiger, A.: L'autodétermination en matière de données personnelles: Un droit (plus si) fondamental à l'ère digitale ou un nouveau droit de propriété?, Pratique Juridique Actuelle, 22, 837–864, 2013.

Foucault, M.: The subject and power, Crit. Inquiry, 8, 777–795, 1982.

Geiger, H.: The Drones are Coming, Center for Democracy and Technology, Washington, 2011.

Gettinger, D., Michel, A. H., Pasternack, A., Koebler, J., Musgrave, S., and Rankin, J.: The Drone Primer, A Compendium of the Key Issues, Bard College Drone Center, New York, 2014.

Gilliom, J. and Monahan, T.: SuperVision: An Introduction to the Surveillance Society, University of Chicago Press, Chicago, 2013.

Goodman, M.: A view from the unfriendly skies: How criminals are using drones, http://ideas.ted.com/attack-of-the-drones-a-view-from-the-unfriendly-skies/ (last access: 12 August 2016), 2013.

Graham, S.: Cities under Siege: New Military Urbanism, Verso, London, 2010.

Gregory, D.: Geographical Imaginations, Blackwell, Oxford, 1994.

Haggerty, K.: Visible war: Surveillance, speed, and information war, in: The New Politics of Surveillance and Visibility, edited by: Ericson, R. and Haggerty, K., University of Toronto Press, Toronto, 250–268, 2006.

Haggerty, K. and Ericson, R. (Eds.): The New Politics of Surveillance and Visibility, University of Toronto Press, Toronto, 2006.

Homeland Security News Wire, Teal Group: Global UAV market to total $94 billion in the next ten years, Homeland Security News Wire, http://www.homelandsecuritynewswire.com/teal-group-global-uav-market-total-94-billion-next-ten-years (last access: 12 August 2016), 29 September 2011.

Klauser, F.: A comparison of the impact of protective and preservative video surveillance on urban territoriality: The case of Switzerland, Surveillance & Society, 2, 145–160, 2004.

Klauser, F.: Die Videoüberwachung öffentlicher Räume: Zur Ambivalenz eines Instruments sozialer Kontrolle, Campus, Frankfurt, 2006.

Klauser, F.: Political geographies of surveillance, Geoforum, 49, 275–278, 2013.

Klauser, F.: Surveillance and Space, Sage, London, 2017.

Klauser, F. and Pedrozo, S.: Power and space in the drone age: a literature review and politico-geographical research agenda, Geogr. Helv., 70, 285–293, https://doi.org/10.5194/gh-70-285-2015, 2015.

Koskela, H.: Webcams, TV shows and mobile phones: Empowering exhibitionism, Surveillance & Society, 2, 199–215, 2004.

Kreps, S.: Flying under the radar: A study of public attitudes towards unmanned aerial vehicles, Research and Politics, http://

rap.sagepub.com/content/1/1/2053168014536533.full.pdf+html (last access: 12 August 2016), April–June 2014.

Krishna, K. R.: Push Button Agriculture: Robotics, Drones, Satellite-Guided Soil and Crop management, CRC Press, Boca Raton, 2016.

LaFranchi, H.: American public has few qualms with drone strikes, poll finds, Christian Science Monitor, http://www.csmonitor.com/USA/Military/2013/0603/American-public-has-few-qualms-with-drone-strikes-poll-finds (last access: 12 August 2016), 3 June 2013.

Lefebvre, H.: The Production of Space, Blackwell, Oxford, 1991.

Meilleur Drone: La démocratisation des drones en France, http://meilleurdrone.com/democratisation-drone/ (last access: 12 August 2016), 2014.

Miethe, T. D., Lieberman, J. D., Sakiyama, M., and Troshynski, E. I.: Public Attitudes about Aerial Drone Activities: Results of a National Survey, Report, University of Nevada, Center for Crime and Justice Policy, Los Angeles, http://www.unlv.edu/sites/default/files/page_files/27/CCJP-PublicAttitudesAboutAerialDrones-2014.pdf (last access: 12 August 2016), 2014.

Millward, L.: The "aerial eye": Gender and the colonization of airspace, Michigan Feminist Studies, 13, 1–18, 1998.

Norris, C.: From personal to digital: CCTV, the panopticon and the technological mediation of suspicion and social control, in: Surveillance and Social Sorting: Privacy Risk and Automated Discrimination, edited by: Lyon, D., Routledge, London, 249–281, 2002.

Office Fédérale de l'Aviation Civile: Les drones en Suisse: Un nouveau défi, Report, OFAC, Bern, https://www.bazl.admin.ch/bazl/fr/home/bonasavoir/drones-et-modeles-reduits.html, last access: 12 August 2016a.

Office Fédérale de l'Aviation Civile: Vidéosurveillance par des drones dans le domaine privé, OFAC, https://www.edoeb.admin.ch/datenschutz/00625/00729/01171/index.html?lang=fr, last access: 12 August 2016b.

O Tuathail, G.: Critical Geopolitics, Routledge, London, 1996.

Pedrozo, S.: Swiss military drones and the border space: a critical study of the surveillance exercised by border guards, Geogr. Helv., 72, 97–107, https://doi.org/10.5194/gh-72-97-2017, 2017.

Rose, G.: Feminism and Geography: The Limits of Geographical Knowledge, University of Minnesota Press, Minneapolis, 1993.

Rössler, B.: Der Wert des Privaten, Suhrkamp, Frankfurt, 2001.

Sacco, F.: Premier coup de frein aux drones civils, Le Temps, https://www.letemps.ch/suisse/2014/07/11/premier-coup-frein-aux-drones-civils (last access: 12 August 2016), 11 July 2014.

Salter, M.: Toys for the boys? Drones, pleasure and popular culture in the militarisation of policing, Critical Criminology, 22, 163–177, 2014.

Schmidt, H.: From a bird's eye perspective: Aerial drone photography and political protest. A case study of the Bulgarian #resign Movement 2013, Digital Icons: Studies in Russian, Eurasian and Central European New Media, 13, 1–27, 2015.

Scott, J. C.: Seeing like a State, Yale University Press, New Haven, 1998.

Sedlar, F.: Democratizing The Sky: Toward Civilian Drone Use, Public Lecture, https://www.timeout.com/toronto/things-to-do/democratizing-the-sky-toward-civilian-drone-use-a-public-lecture-by-frank-sedlar (last access: 12 August 2016), 2015.

Shapiro, M. J.: Violent Cartographies: Mapping Cultures of War, University of Minnesota Press, Minneapolis, 1997.

Shead, S.: Twitter has been granted a patent for a social media drone, Business Insider UK, http://uk.businessinsider.com/twitter-has-been-granted-a-patent-for-a-social-media-drone-2015-12 (last access: 12 August 2016), 22 December 2015.

Spain, D.: Gendered Spaces, University of North Carolina Press, Chapel, Hill, 1992.

Thompson, S. and Bracken-Roche, C.: Understanding public opinion of UAVs in Canada: A 2014 analysis of survey data and its policy implications, Journal of Unmanned Vehicle Systems, 3, 156–175, 2015.

Tremayne, M. and Clark, A.: New perspectives from the sky. Unmanned aerial vehicles and journalism, Digital Journalism, 2, 232–246, 2014.

Valavanis, K. P. and Vachtsevanos, G. J.: Handbook of Unmanned Aerial Vehicles, Springer, New York, 2015.

Virilio, P.: The Information Bomb, Verso, London, 2000.

Wall, T. and Monahan, T.: Surveillance and violence from afar: The politics of drones and liminal security-scapes, Theor. Criminol., 15, 239–254, 2011.

Webster, C. W. R.: CCTV policy in the UK: reconsidering the evidence base, Surveillance and Society, 6, 10–22, 2009.

Williams, A. J.: Enabling persistent presence? Performing the embodied geopolitics of the unmanned aerial vehicle assemblage, Polit. Geogr., 30, 381–390, 2011a.

Williams, A. J.: Reconceptualising spaces of the air: Performing the multiple spatialities of UK military airspaces, T. I. Brit. Geogr., 36, 253–267, 2011b.

Williams, J.: Distant intimacy: Space, drones, and just war, Ethics and International Affairs, 29, 93–110, 2015.

Wolf, G.: Quantified self: Reverse engeneering, in: Quantified: Biosensing Technologies in Everyday Life, edited by: Nafus, D., MIT Press, Massachusetts, 67–72, 2016.