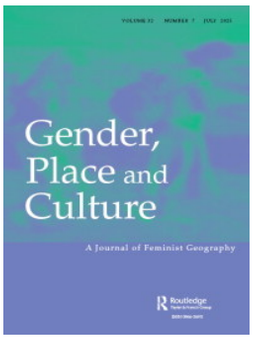
Techno-legal geographies: consumer drone misuse and harms



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Techno-legal geographies: consumer drone misuse and harms

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ABSTRACT

Drones increasingly feature beyond battlefields, deployed across civil, commercial and hobbyist applications and contexts. So too are off-the-shelf consumer drones increasingly being misused. From their outfitting with improvised weapons to the deployment of drones to harass individuals, both incidents involving consumer drones and the (potential) harms accompanying them, have diversified. Interested in emerging techno-legal geographies of consumer drone misuse, this paper deploys a feminist analytic to interrogate drone-enabled harms. It brings drone geographies into dialogue with feminist legal and digital geographies, to interrogate the drone as a technology encountered and interpreted in legal terms and accompanied by gendered impacts. Responding to calls for the expansion of the methodological toolkit underpinning the drone's study while also affording geolegal attention to the drone, the paper draws upon focus groups designed in collaboration by a geographer and barrister and bringing together lawyers across diverse specialisms in an exploration of drone misuse and harm. Through analysis of examples of drone misuse and the legal process accompanying its investigation, we underscore both that drones can introduce novel as well as extend existing technology-enabled harms, and that such harms exceed the confines of aviation law, cutting across multiple areas of law. Collectively, we argue that employing a feminist approach in the drone's critical analysis acts to foreground diversified drone harms and their uneven impacts.

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KEYWORDS
Drones; drone geographies; drone misuse; feminist legal geographies; feminist digital geographies; gendered harms

Introduction

In 2020 the United States Attorney's Office announced that Jason Muzzicato was sentenced to 'five years in prison… for using an unregistered drone to drop explosive devices to terrorize his…former girlfriend' (Department of Justice 2020, n.p). The press release continued that the defendant plead 'guilty to possession of a destructive

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device, possession of firearms by a person subject to a domestic violence protective order, and knowingly operating an unregistered aircraft' (Department of Justice 2020, n.p). It observed that 'with this combination of homemade bombs, guns and a drone, this defendant terrorized an entire community', adding that their office would 'work… to ensure the security of our communities is not threatened by people who hide behind a remote control' (Department of Justice 2020).

Attention to consumer off-the-shelf drones used to 'terrorize former partners' and more widely perpetrate harm has grown (Dellinger 2019, n.p). Media reports around the globe detail diverse incidents, from drone-enabled voyeurism and privacy violations to drone-assisted harassment. Citing the trend of 'drone hunting', news outlets described a drone user 'terrorising people…following them around to post their frightened reactions on social media' (News.com.au 2023, n.p). Drones have also reportedly been deployed in 'invasive behaviour' including flying above women's homes to 'peep into their windows' and 'monitor' them (*BBC News* 2020; Dellinger 2019). Impacted women describe 'living in fear' and feeling like 'prisoners' while their ex-husbands and their devices remain 'free to roam' (Branley and Armitage 2018, n.p). While continuing to gain popularity, drones remain entangled with misuse and harm and thus presents 'a novel set of risks and challenges' and 'emotional and physical harms' requiring 'confrontation' (Jackman and Brickell 2022, 166).

Interested in the emerging techno-legal geographies of consumer drone misuse, this paper deploys a feminist analytic to interrogate drone-enabled harms. It brings drone geographies into dialogue with feminist legal and digital geographies to interrogate the drone as a technology encountered and interpreted in legal terms and accompanied by gendered impacts. Responding to calls for the expansion of the methodological toolkit underpinning the drone's study while also affording geolegal attention to the drone, it draws upon focus groups designed collaboratively by a feminist geographer and a barrister and bringing together lawyers across diverse specialisms, to explore drone misuse and harm. Through both analysis of examples of drone misuse (including those related to gender based harm) and attention to the legal process accompanying their investigation, we underscore that drones can introduce novel as well as extend existing technology-enabled harms, and that such harms exceed the confines of aviation law, cutting across multiple areas of law. We argue that employing a feminist approach in the drone's critical analysis acts to foreground diversified drone harms and their uneven impacts.

The paper first contextualises drone misuse, before situating its investigation within relevant geographical literatures. We bring drone geographies into dialogue with feminist legal and digital geographies, to facilitate an interrogation of drone harms attentive to the drone's techno-capacities, governance, and potential gendered impacts. The paper then introduces the focus group methods underpinning this collaborative project. In the analysis, we first outline how participants understood and categorised drone harms, reflecting on the spatial and legal implications of the drone's remote operation. Second, we turn to examples of drone-enabled harm (trespass and nuisance), highlighting their gendered and embodied implications and the importance of employing a feminist analytic attentive to spaces such as the home therein. Third, we examine drone futures, drawing on participant reflections on emerging technological developments (e.g. automation, intelligent flight) and urge consideration of

gender in the technology's continued development. Finally, we highlight our contributions in widening understandings of drone misuse and harm beyond the confines of aviation law, while also outlining further recommendations.

Contextualising drone misuse

Aerial drones refer to craft without a pilot on board which can be 'controlled remotely' by a ground-based pilot or fly with 'various levels' of automation or autonomy (UK Parliament 2020, 1). Aerial drones vary in size, ranging from 'small hand-held' devices to large aircraft (UK Parliament 2020, 1). While deployed across military, commercial, civil and recreational contexts, this paper focuses on consumer off-the-shelf drones encountered in domestic UK skies. In January 2023, the UK's aviation regulator stated that it had 500,000 drone 'operators and flyers' registered under its Drone and Model Aircraft scheme and processes 7000 operational authorisation applications per year (Westminster Business Forum 2023). Deployed across civil, commercial and recreational applications, small drones are commonly associated with capturing imagery, data gathering, and/or the carrying of items. Praising drones as enabling the carrying out of 'tasks faster, safer, cheaper and with less environmental impact', the UK Government continues work apace to integrate drones into UK skies, as evidenced in its vision 'that by 2030 commercial drones will be commonplace…in a way that safely benefits the economy and wider society' (HM Government 2022, 6, 10).

Yet, so too have such drones been met with challenges. Consultation with members of the public exploring future flight technologies (including drones) highlights concerns spanning the 'privacy implications' of drones intruding 'into private and domestic lives' to potential noise and visual disruptions (Camilleri et al. 2022, 6, 5). While wider surveys indicate levels of public support for drone use in emergency response and risky jobs, so too do they highlight concerns around drone misuse (BT 2021).

A parliamentary POSTnote exploring drone misuse asserts that given the availability, cost, and 'flight range' of drones, they can make 'attractive' tools for malicious misuse or 'criminal intent' (UK Parliament 2020, 3). As drone-related reports to UK police – spanning drones flown in proximity to manned aircraft and sensitive infrastructure (e.g. military bases, schools, cash machines) to harassing individuals - increase (Protect UK 2022; Mercer 2019), the Government recognise both 'careless and inconsiderate' as well as the 'more deliberate' misuse of drones 'for criminal acts' as continuing to prompt safety, security and nuisance concerns (HM Government 2019, 1). Recognition of the risks posed by drones is echoed through the passing of the Air Traffic Management and Unmanned Aircraft Act 2021 (introducing powers for police to respond to drone misuse), the development of the 2019 Counter-Unmanned Aircraft Strategy (detailing UK strategy 'for harnessing the benefits' of drones 'by reducing the risk posed by malicious or illegal use') (Home Office 2019), and the addition of a 'malicious drone incident' entry in the Government's National Risk register. In their enabling of 'emergent user groups', drones are thus understood as posing 'unique' criminal 'risks and rewards' (Coliandris 2023, 300). Bringing drone misuse into dialogue with feminist legal and digital geographies, this paper interrogates the drone as a technology encountered and interpreted in legal terms, as well as accompanied by specifically gendered impacts.

Understanding drone-enabled harms: engaging feminist debates

Feminist geographies encompass a 'broad and historically shifting collection of theories, practices and movements' that at once 'research and challenge gender inequalities' and draw attention to alternative spaces, scales and encounters (Freeman and Calkin 2020). In so doing, feminist geographies 'challenge assumptions' about both the where and how of geographical research (Freeman and Calkin 2020). This has included rendering visible the 'absences, silences and exclusions' of women and gendered concerns in geography (Freeman and Calkin 2020; Brickell and Maddrell 2016) and bringing more diverse actors (human and non-human), scales (from the international to the body), and spaces (e.g. home) to the fore of geopolitical accounts (Massaro and Williams 2013). Bringing drone geographies into more sustained dialogue with feminist legal and digital geographies, this section outlines the feminist analytic underpinning the paper's exploration of drone misuse and harms attentive to the drone's techno-capacities, governance and potential gendered impacts.

Drone geographies

An established literature on the 'dronification' of contemporary warfare has emerged. Scholars have interrogated the spatial, ethical and legal dimensions of escalating drone deployment (Akhter 2019; Gregory 2011). Approaching the drone as a 'dispersed and distributed apparatus' comprised of human and non-human actors and agencies (Gregory 2011, 196), research draws attention to the entanglement of human operators and communities below drones with machinic non-humans enabling the drone's functioning. In recognition that 'like all warfare, drone warfare is deeply gendered' (Clark 2022, 75) and yet that drone research largely 'averts feminist perspectives' (Parks and Kaplan 2017, 9), growing attention is paid to gendered discourses of drone warfare (Clark 2018) and 'embodied' dimensions of militarized violences (Parks and Kaplan 2017, 9).

So too are scholars attending to the drone's growing deployment beyond the battlefield in diverse applications 'at home' (Kaplan and Miller 2019, 419). Observing that while drones 'started under the egis of military need…airpower is becoming more unstable and…more available' (Dodge 2018, 954), such work reflects on shared technologies, logics and practices (Cuomo and Dolci 2025). Here, research traces the drone's emergence across contexts from policing (Klauser 2022), commercial applications (Richardson 2018; Jackman and Brickell 2022), to conservation (Millner 2020). Critical accounts have also spotlighted citizen-led drone use (Zuev and Bratchford 2020), calling for a 'specifically domestic drone theory' (Bradley and Cerella 2019, n.p) attentive to the drone's repurposing and subversion (Kaplan 2020). This has included nascent work approaching the drone through a feminist lens. Through the concept of 'everyday droning', namely the 'honing and homing of military technology and drone capitalism', Jackman and Brickell (2022, 157) re-orient attention to diverse non-state actors 'mobilising, experiencing, and subject to the drone'.

Alongside drawing attention to the drone's opening of expanded visual and sensory terrains (Gregory 2011), research also raises legal questions, spanning 'targeted killing' as a challenge to 'traditional' legal understandings of armed conflict (Boyle 2015, 105)

to the relationships between drone war and domestic police violence (Wall 2016). Building upon such work, in developing our approach we turn now to feminist legal geographies.

Feminist legal geographies

As a field, legal geographies examines relationships between law, space and power, unpacking how they are 'co-constitutive' (Brickell and Cuomo 2019, 104). Attention is turned to law as it variously touches down, through 'process, text, and practice' (Pettersen 2022, n.p), is performed through institutions, spaces, and expressions of the legal (Delaney 2015, 97), and is experienced everyday at the 'micro-scale' (Kymäläinen 2024, 1).

Feminist legal geographies specifically draw attention to the spatialities of law and its uneven effects, while 'expanding' attention to wide-ranging 'spaces of law' (Pettersen 2022: n.p). Arguing that feminist analysis of the law attentive to its 'gendered character', everyday materialities and sites nonetheless remains in its 'infancy' (Brickell and Cuomo 2019, 1047), geographers make the case for 'feminist geolegality', a project integrating legal geography and feminist geopolitics (Brickell and Cuomo 2019a). This approach turns attention to power as it unfolds across multiple scales (from the intimate to global) and how law differently impacts diverse bodies (Brickell and Cuomo 2019a). This resonates with drone-related work in the discipline of law, arguing that existing analyses negate careful attention to how drones can 'enhance or undermine women's privacy' (Thomasen 2018, 308). Thomasen (2018, 323) continues that while drones should not be understood as causing gendered harms (e.g. harassment or stalking), nor are they a 'necessary condition' for these, in recognising the 'social context' within which the drone resides, further attend should be afforded to potential gendered impacts of technology and reflected in its regulation. This paper heeds calls for feminist geolegality through attention to diverse drone harms and their uneven effects, while developing distinct methods to examine the scope and limits of legal approaches to drone misuse. In also attending to the drone's techno-capacities, we turn now to feminist digital geographies.

Feminist digital geographies

As the digital is increasingly 'enmeshed' in everyday lives and spaces (Osborne and Jones 2023), geographers are approaching it as both 'subject and object' of geographical study (Elwood and Leszczynski 2018, 629). Therein, the digital is understood as: the devices and systems that capture, store and process data; underpinned by distinct 'logics' and 'practices', and enabled by particular knowledges (Ash, Kitchin, and Leszczynski 2018, 26; Elwood and Leszczynski 2018). In exploring different elements of the digital, Ash, Kitchin, and Leszczynski (2018, 32) offer a tripartite typology exploring how geography is *produced by the digital* (i.e. how the digital mediates and informs the production of socio-spatial relations), *geographies through the digital* (i.e. the ways geography as a discipline employs and is produced by technological instruments), and *geographies of the digital* (i.e. investigating the 'digital as a geographical domain with its own logics and structures').

Wider geographical investigations of the digital have underscored that to engage critically with the digital is to consider both its 'constraints and possibilities' (McLean, Maalsen, and Prebble 2019, 740); that is, recognising that the digital empowers and excludes. Here, digital geographies have engaged feminist thinking to explore both the ways and spaces in/through which the digital (re)produces power (Elwood and Leszczynski 2018). Through the lens of Technology-Enabled Coercive Control (TECC), geographers have highlighted how abusers employ digital technology (including drones) in the coercive control of 'survivors anywhere and at any time' Cuomo and Dolci (2025, 244). Such work demonstrates both the centrality of (digital) technologies in 'regulating, disciplining and governing at the scale of the body' and that they enable a 'continuation' of domestic violence and harms (Cuomo and Dolci 2025, 247), while underscoring the 'inadequacy' of the law to keep apace with such forms of abuse (Cuomo and Dolci 2023, 907).

Approaching the drone as at once hardware (machine), software (enabling remote flight, data visualisation and processing), and regulated practice ('droning'), we are invited to consider its materialities, governance, and (uneven) effects. In developing our reading of consumer drone misuse in conversation with feminist digital and legal geographies, so too can we pause with Cuomo and Dolci (2025, 244) recent intervention approaching TECC 'through the lens of remote warfare'. As drone scholars highlight, remote warfare can be understood as the countering of threats from a distance, enacted through diverse technologies (including drones) which collectively mark a 'shift' in the 'spatialities' of violence beyond the 'conventional battlefield' (Cuomo and Dolci 2025, 247). Such work underscores that while military drones are operated remotely, at a distance, they nonetheless represent a (re)configuration of space as at once remote and proximate. This is demonstrated through pilots and sensor operators reporting embodied responses to violent scenes unfolding on their screens (Bryant 2017; Jackman 2023; Williams 2011). Notably, following the commitment of feminist geopolitics to trace expressions of power and violence across scales (Dowler and Sharp 2001; Pain 2015), in their investigation of TECC, Cuomo and Dolci (2025, 244) trace the 'common tools and tactics' used by military, police and domestic abusers alike in the perpetration of violence. While clear that TECC and remote warfare are not 'equivalent', they underscore how such violences are undergirded by shared 'logics' and work at and across 'all scales' (Cuomo and Dolci 2025, 247, 244). Notably, the authors highlight drones as an example of remote control technology entangled in TECC yet largely not 'to feature in empirical research studies on domestic violence' (Cuomo and Dolci 2025, 251). In this article we thus develop an interrogation of consumer drone harms attentive to both the drone's techno-capacities and governance, and considering drone harms as they span multiple spatialities, scales and unevenly impact diverse bodies.

Methods

This paper forms part of Dr Anna Jackman's 'Diversifying Drone Stories' (ES/W001977/1) project, exploring the use, perception, and impact of drones in changing UK airspace and engaging with diverse stakeholders to understand different uses, experiences and perspectives on how drones may be (re)shaping UK airspace and everyday life. This paper reflects on activities developed with project partner Barrister Louise Hooper.

Inspired by conversations regarding the focus of existing drone regulation and law upon particular aviation-based understandings of safety and risk, we were interested in re-approaching drone misuse and harms from the perspective of wider legal specialisms. In the UK, drone regulation is the responsibility of the Civil Aviation Authority, drones fall under two legislative frameworks (the 'basic regulation' and the Air Navigation Order), and the police lead on 'action against the misuse of drones' (Jackman and Hooper 2023, 13, 11). While such approaches centre on 'how to fly drones safely and reduce risk to aviation' and provide 'enforcement powers' in relation to 'aviation safety', highlighting diverse drone incidents nonetheless underscores that drone misuse can raise wide-ranging risks that exceed aviation frameworks (Jackman and Hooper 2023, 11, 14). We thus co-designed and delivered focus groups bringing together lawyers from diverse specialisms, resulting in the publication of a report entitled 'Drone incidents and misuse: Legal considerations' (Jackman and Hooper 2023). This section outlines the methods employed in, and contribution of, this paper.

Contextualising methods

This paper was underpinned by focus groups bringing together lawyers across diverse specialisms. Exploring the theme of drone misuse and harms, the focus groups sought insight into the range 'of views individuals hold' while also enabling group 'interaction' and 'negotiation' (Conradson 2005, 129). Held between September 2022 and March 2023, we co-delivered: two focus groups with lawyers in the UK (one in London; one in Manchester), and one online with international participants from 7 countries. We recruited participants across diverse legal specialisms, sending targeted invitations as well as circulating an open call *via* relevant networks. Twenty participants participated in the three focus groups, and participant specialisms were wide-ranging in both legal practice and research, from data protection to domestic violence, aviation and national security to protest, to name a few. Participants were not required to have pre-existing knowledge on drones, though some had experience of drone-related cases. In analysing participant's responses regarding drone misuse and harms, we then applied a feminist lens in interrogating the drone's potential implications. Focus groups were audio-recorded and anonymised transcripts emailed to participants, providing the opportunity for amendments. The transcripts were coded by the researcher, who undertook 'data reduction' by identifying 'key themes', including identifying 'surface' descriptive codes (e.g. category labels regarding 'who, what, where, when and how'), and building upon these to develop analytic codes (Cope 2021, 357–369) which were used to structure our analysis below.

Situating methods

While growing attention is afforded to the drone, there remains a need to 'expand the methodological toolkit employed' in its study (Jackman 2022, 2). While recognising challenges around access and 'empirically grounding' the military drone (Klauser and Pedrozo 2015, 289), accounts nonetheless approach the military drone through: operator testimony, 'official' documentation, military events and tradeshows, and commercial and military representations (Clark 2018; Jackman 2022a, 2022b; Boyle 2015).

Approaching drones beyond the battlefield, scholars have also explored how drones are perceived and represented by commercial and civil users and communities (Klauser and Pauschinger 2021; Millner 2020) as well as in commercial and anticipatory visualisations (Jackman 2022). Understanding lawyers as under-examined 'domain of expertise' underpinning the drone's 'functioning' (Klauser and Pedrozo 2015, 290), while more fully accounting for the 'complex ways in which civilian life is lived with, through and against the drone' (Bradley and Cerella 2019, n.p), this paper addresses the comparative lack of attention to legal questions, issues and voices.

In relation to the 'doing' of feminist legal geographies, Brickell and Cuomo (2019, 1044–1045) assert that opportunity remains to 'propose new methodologies'. To this end, legal geographers have reflected on the methods through which to 'investigate the co-constitution of the legal, spatial and social' (Bennett and Layard 2015, 409), calling for further attention to the 'location' of legal knowledge creation (Ojeda and Blomley 2024, 2). To this end, we were interested in developing focus groups centring on law(yers) 'in action' (Faria et al. 2020, 1108) and bringing diverse specialisms into dialogue to collaboratively develop novel insights around drone misuse and harms. Such an approach recognises the importance of reconsidering 'existing laws' in light of technological advancements around more-than-analogue 'forms of abuse' (Cuomo and Dolci 2023, 907), while also reflecting on how we approach drone legalities more widely. For example, when we think about drones in legal terms, they are typically narrated in relation to aviation-based understandings of safety. Reapproaching the drone through wider legal lenses, we highlight that by recognising the ways that different yet 'overlapping legal orders…operate simultaneously' (Brickell and Cuomo 2019a, 106) we can usefully extend our vocabularies of drone misuse. Here, bringing drone geographies into dialogue with feminist digital geographies was also useful. Following calls for further attention to the methodologies and the diverse empirical sites and practices of digital geography (Ash, Kitchin, and Leszczynski 2018; Elwood and Leszczynski 2018), we took particular inspiration from work calling for the development of 'innovative methodologies' in relation to the 'embodied' dimensions of digitality and its 'uneven geographies' (McLean, Maalsen, and McNamara 2020, 473, 467).

Focus groups

The focus groups were structured as follows:

1. Familiarising participants with reports of drone incidents and misuse, and tasking participants with grouping and categorising examples provided;
2. Small group discussion of specific case studies of drone misuse in which participants reflected on questions around the actors involved, how they might proceed, and any challenges they anticipated encountering;
3. Discussion of specific drone capability developments in relation to their potential legal implications and harms;
4. Speculative discussion of potential drone futures and their legal dimensions.

Techno-legal analysis of drone misuse and harms

Turning to our analysis of drone misuse and harms, the first section explores how participants understood drone misuse and harms, drawing particular attention to the spatial and legal implications of the drone's remote operation and geographies. Second, we turn to two examples of drone misuse and -enabled harm (nuisance and trespass), highlighting both the gendered and embodied implications, and the importance of employing a feminist analytic attentive to diverse spaces, such as the home, therein. Third, we turn to drone futures, exploring participant speculations around emerging technological developments (e.g. intelligent flight) and futures (e.g. automation, autonomy and artificial intelligence) and their gendered dimensions.

Understanding drone misuse and harms: remote geographies

The focus groups opened with an activity designed to familiarise participants with reports of drone incidents and misuse (Figure 1), while encouraging small group discussion about how these incidents might be grouped.

While participant discussions were wide-ranging, their groupings informed the identification of overarching categories, outlined in Figure 2. It is important to note that participants often understood these as overlapping, rather than separate, categories.

Across discussions of understanding and grouping drone misuse, participants highlighted several themes, including intention and the nature of drone criminality. Regarding intention, participants distinguished between 'intentional' and 'non-intentional' drone incidents, noting that for a criminal offence to exist, there needs to be an 'act' (actus reus) and an 'intention' (mens rea). In discussing what they understood as 'legitimate' and 'non-legitimate' drone uses, participants distinguished between 'intentional versus non-intentional' acts and incidents (i.e. 'some are intentional acts, and some are potentially unintentional but reckless'), while also noting that challenges remain around determining intention (e.g. flying a drone into an airport Flight Restriction Zone could be intentional to disrupt airspace, or could be unintentional, demonstrating a lack of awareness of relevant rules).

In discussion of understanding drone misuse, participants also focussed attention to the nature of criminality associated with/enabled by drones. Participants

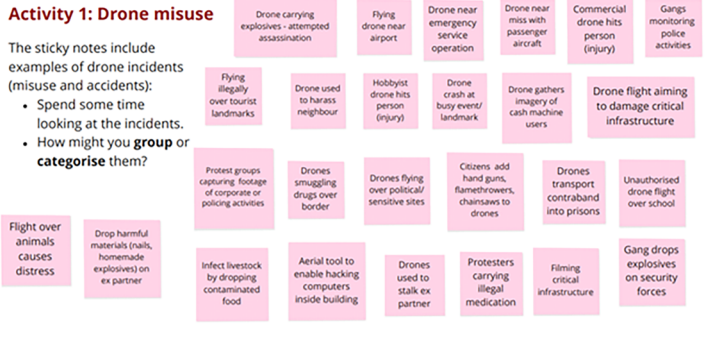

Figure 1. Focus group activity 1.

Category	Description
Intention	Participants distinguished between intentional or non-intentional actions and incidents; participants discussed the challenges of determining intent
Actor	Participants reflected on the alleged victim and perpetrator (e.g. 'public versus public', 'public versus commercial', 'public versus state') as well as upon different configurations of actors
Nature of criminality	Participants discussed the use of drones to commit an existing criminal act versus their use for novel criminal activity
Legal context	Participants distinguished between criminal and civil law, while also identifying instances where this distinction may not be clear (e.g. privacy-related incidents)
Nature of threat / consequence	Participants distinguished between a drone posing the threat (e.g. drone crashing) and as a carrier of threat (e.g. carrying explosives or contraband); as well as discussing categorising based upon the potential levels of risk associated
Regulatory context	Participants discussed regulatory context, in relation to both distinctions between recreational and commercial flyers (e.g. liabilities), and different airspace categories (e.g. responsibilities)

Figure 2. Understanding drone misuse: overarching categories.

distinguished between 'using drones' to commit 'an existing criminal act' versus a drone being used for a 'novel criminal activity' that has arisen as a result of 'people having access to drones'. They turned to examples on the incident list (Figure 1), identifying drones used in relation existing criminal acts (e.g. transporting contraband into prisons) wherein the drone was 'a mechanism' or one of a number of ways to do something, as opposed to where a 'criminal issue has arisen' as a result of growing drone use and would 'without a drone not have been likely to occur' (e.g. unauthorised flights over schools', gathering 'footage over private land', and 'flights near emergency service operations'). In such cases, they understood the drone as 'intrinsic to the act' rather than as an incidental 'facilitator'. This distinction is also echoed in research noting that aerial drones 'possibly alter the conduct of crime by augmenting conventional modes or by creating entirely novel ones' (Coliandris 2023, 300). Participants continued that in either instance, the drone's 'remoteness' was significant, asserting that the use of remotely operated drones might be understood as a way to 'evade laws'.

More broadly, in discussion of both categorising drone misuse and of six specific reported drone incidents (Figure 3), participants repeatedly returned to remote operation and the legal dimensions of the drone's remote geographies. As noted in the literature review, geographers have drawn attention to technology-enabled coercive control (TECC). Approaching TECC through the lens of remote warfare, Cuomo and Dolci (2025, 244, 247) highlight 'remoteness' as both a crucial 'spatial dimension' of remote war, and a potential advantage to abusers able to engage 'from any location'. Following calls for further geographical attention to gendered violence (Brickell and Maddrell 2016), legal scholarship has also highlighted that remote operation from a 'distance' is a 'fundamental feature' of drones, affords 'unexpected vantage points' and introduces issues around both (gendered) harm and 'accountability' (Thomasen 2018, 318, 319). Across our focus groups, remoteness was underscored as a central theme. Here, participant reflections widened conceptions of remoteness, both beyond the

Case study	Report	Summary
1. Drones used to monitor ex-partner	ABC News (2018) Perpetrators using drones to stalk victims in new age of technology fuelled harassment https://www.abc.net.au/news/2018-10-01/drones-used-to-stalk-women-in-new-age-of-harassment/10297906	Mother of three has BBQ in her garden on New year's Eve and sees a drone above her head. She is concerned it belongs to her ex-husband, who has been stalking he for 2 years, and has breached a Domestic Violence Order.
2. Drones used by gangs to disrupt policing	BBC News (2018) Drones used to disrupt FBI hostage situation https://www.bbc.co.uk/news/technology-44003860	Criminals use drones to disrupt FBI monitoring of hostage situation. Small drones flown to block the team's view, and caused the FBI to lose sight of the attacker.
3. Drones used to drop harmful materials on ex-partner	MIC (2019) Drones are now being weaponized by abusive exes https://www.mic.com/impact/how-drones-are-being-weaponized-used-to-stalk-harass-people-18784714	Man uses drone to drop explosives onto ex-girlfriend's property. Drone is not registered. Search of his home and business uncovers handmade explosives and guns. A domestic violence protective order was in place.
4. Drones used to drop items to infect livestock	Reuters (2019) Commercial pig farm in China jams drone signal to combat swine fever crooks https://www.reuters.com/article/china-swinefever-idUSL4N28U0QB/	Pig farm used 'transmitter' in attempt to disrupt drones dropping contaminated meat on their farms, to infect livestock. Equipment said to breach radio regulations.
5. Drones used in attempt to disrupt electrical grid	Wired (2021) A Drone Tried to Disrupt the Power Grid. It Won't Be the Last https://www.wired.com/story/drone-attack-power-substation-threat/	Drone modified to carry copper wires and stripped of markings flown towards power substation, crashing on roof of adjacent building. Operator not found.
6. Drones used at environmental protest at airport	Sky News (2019) Heathrow protest fails to take off as drones 'blocked by signal jammers' https://news.sky.com/story/heathrow-drone-protesters-blocked-by-signal-jamming-as-two-arrested-11808171	Climate change activists attempted to fly drones in airport exclusion zone. Several members arrested. Protesters describe experiencing 'signal jamming', making it difficult to launch drones.

Figure 3. Case studies assigned to focus groups.

battlefield and in discussion of implications for legal processes. This was particularly notable during the focus group's second activity, wherein we turned to media reports of specific drone incidents (Figure 3). We selected incident examples that relate to key drone capabilities and issues, including: surveillance (image and data gathering), carrying (carrying and transporting items), and infrastructure (impact on sites and property).

Working in small groups, participants were allocated two case studies and asked questions including: What is reported to have taken place? Who was involved?; If you were handed this case, how would you proceed?; Would you anticipate any challenges or opportunities?; and are there any areas of law that you might cite, or that might need reviewing to ensure drone harms are adequately covered?

While participant discussions were wide-ranging, remoteness was repeatedly evoked, with participants discussing the potential 'evidentiary challenges' surrounding drone flight, narrating these as 'remote actor problems'. Such challenges included: identifying a drone and attribution of a drone to an operator, gathering evidence from the drone (including drone forensics), and determining operator intention. In relation to case study 5 (drones used in attempt to disrupt electrical grid), participants commented that even if someone 'specifically sees the drone' and 'where it goes', the operator may not be operating the drone within their 'visual line of sight' (i.e. may not be

located in proximity to the drone) and it thus remains 'almost impossible' to catch the operator. The challenges surrounding remoteness were also echoed in discussions of case study 6 (drones used in environmental protest at airport), where participants underscored that even if you took 'a picture of that drone in the sky' you wouldn't be able to determine information on it 'because of the distance'. Participants similarly raised issues around attribution, including registration, linking a drone to an individual, and ascertaining responsibility. In the UK, drone rules are 'based on the risk of the flight – where you fly, the proximity to other people, and the size and weight of your drone', specifying three airspace categories (open, specific, certified) (Civil Aviation Authority n.d). Those flying in the open category require a 'Flyer ID' (theory test) and 'Operator ID' (labelled on the drone), depending on the weight of a drone and whether it has a camera (Civil Aviation Authority n.d). Participants raised registration as a source of information about ownership/user, though added that this depends on whether the drone was required to be, or was, registered.

Regarding case study 1 (drones used to monitor ex-partner), participants highlighted that while possible to ascertain information about who a drone was 'registered to', the individual simply may 'not follow' registration rules, adding that the ability to bypass 'aviation laws' remains 'part of the reason why people use [drones] to do illegal activities, because…there is a distance and remoteness to it'. Notably, domestic violence lawyers drew a link between remoteness, evidentiary challenges, and the ways these may come together in the production of gendered harms. While 'freedom from harassment is a basic right and precondition to mental and physical health' (Boyer 2022, 398), participants raised the question of who was flying drones. Following both that domestic violence disproportionately impacts women and that drones are disproportionately owned and used by men (Drones 2017), participants reflected on both whether such drone activity would constitute 'harassment' and whether it would be necessary to demonstrate a 'course of conduct' (pattern of behaviours), expressing concern that even with a potentially 'extensive history' of activity, it may not 'be enough to reach the criminal standard'. They also underscored that the drone's remoteness encompassed the potential to extend the reach of abusers, and that the measures in place to aid with safety and accountability (e.g. registration) could be exploited and bypassed, thus necessitated further questions in relation to different understandings of safety, including potential gendered harms.

Participants also reflected on attribution and the gathering of physical evidence, highlighting that evidence would 'depend on if you've captured the drone' and if so, what information may be determined. In discussion of case study 5, participants asserted that if 'representing the substation', they would 'try and track the drone' to obtain information (including serial number) from the 'memory card', or by undertaking 'forensic analysis'. Drone forensics refers to the forensic examination of drones, and can enable the determination of the flight data (GPS data and altitude) as well as video and image files, which can be used to 'build an evidentiary picture to determine if a drone was used in a criminal offence' (Forensic Access Group 2023, n.p). In addition to data stored on drones, other devices (smartphone apps, drone controllers) may 'contain data of relevance' (Forensic Access Group 2023, n.p). The field does however remain new, with varied access and resource (Jackman and Hooper 2023)

and lacking standardised practice. In this vein, participants cautioned that the lack of common access to such techniques may 'feed into why the CPS [Crown Prosecution Service] don't pursue' drone cases, as they can 'seize [drones], but they ask the police officers and they're not sure if they'll get the conviction'. Participants thus urged further attention to the evidentiary challenges that drones raise, and underscored the utility of bringing to bear multiple forms of expertise in the interrogation of (gendered) technology-enabled harms and legal solutions to these.

Diversifying drone harms: trespass and nuisance

In recognition of the need to further examine diverse forms of drone misuse (Chávez and Swed 2020; Jackman 2024) and the utility of bringing together multiple forms of legal expertise to examine these beyond an aviation focus, our analysis next turns to specific examples of drone misuse – trespass and nuisance. While recognising an existing focus on aviation-based understandings of safety in relation to 'endangering any person or property' (Article 241, Air Navigation Order 2016), we were interested in the legally cross-cutting nature of drone incidents and harms and approaching them through a feminist analytic attentive to gendered harms and more diverse actors, scales and spaces.

Drones and trespass

Prompted by examples of drone incidents, participants turned attention beyond criminal justice responses to instances where private individuals or companies may seek remedies under civil law, including trespass and nuisance claims. In discussion of drones over private property, participants raised the question of whether drones can commit trespass. Trespass refers to 'unjustifiable interference with the possession of land' (Hartmann et al. 2023, 43). In discussion of the rights you have 'by owning a property', participants raised that while 'you have easement', they were unsure about whether you 'actually control the air above you'. Participants mused whether drones could constitute 'trespass in the sky', feeling that this issue would be 'increasingly questioned' as drones emerged as commonplace and made aerial presence 'easier'. They also added that drones introduced distinct challenges for landowners, complicating ground-based forms of 'securing the property' (e.g. fences), which could more easily be circumvented.

Research on the potential legal implications of drones adds another dimension of complexity by asserting that 'unlike other forms of tort, trespass is actionable in the courts whether or not the claimant has suffered any damage' and that 'it would not need to be shown that any damage was attributable to the drone' (Hartmann et al. 2023, 43). While suggesting that 'trespass can be committed by entering another person's airspace', the researchers continue that the law remains 'uncertain in relation to drones' (Hartmann et al. 2023). They provide an example of a case 'held not to be trespass if an aircraft flies high enough above the level of ordinary use of land… more than thirty metres above the property', a decision they suggest was 'influenced by the Civil Aviation Act' (Hartmann et al. 2023). While to benefit from this protection the drone operator must comply with relevant regulation, including in relation to

other actions incidental to the flight (e.g. taking video/photos), questions remain 'about whether the operator of a drone might be responsible for committing the tort of trespass and be liable for damages to the landowner, even if the drone has flown through the landowner's airspace without intention' (Hartmann et al. 2023, 43).

This indicates the ongoing complexity around questions of airspace ownership and rights in the context of aerial harms (Grief 2020), while also highlighting the utility of bringing together diverse legal expertise in their investigation. For example, participants continued that in reconsidering trespass in relation to drones, further attention could be paid to other areas of law. Participants suggested that where a drone uses a camera or takes video, further attention is needed to misuse of private information or data protection law. In addition, in discussion of case study 1 participants stated that drones 'hovering' above the victim's head should be considered beyond aviation law and instead in relation to trespass, privacy and voyeurism. A participant asked 'if you haven't put a foot on the ground' but were a 'peeping Tom' using a drone to get 'some kind of access, remote or otherwise' 'to see someone naked', 'would that be prosecutable?'. Alongside underscoring the remotely-operated drone's potential for (gendered) privacy violations, widened discussions of trespass resonate with the work of feminist geographers unpacking the artificiality of divisions between the 'private' home and 'public' arena (Jackman and Brickell 2022). Considering the drone's entering, traversing and/or disrupting of airspace in proximity to the home, participants across legal specialisms highlighted different notions of people- and property-related 'damage' and harm exceeding aviation law and inviting further questions of drones and their potential 'unmaking' of home (Nowicki 2014). Just as 'upskirting' is recognised as a gendered and spatial issue, with the majority of UK offences committed in 'public places' and the Voyeurism (Offences) Act subsequently coming into force (BBC News 2020a), further attention is needed to the drone's aerial spatialities in/above home and its potential gendered implications.

Drones and embodied nuisance

In considering drone harms more widely, participants turned to the site of home and the scale of the body. Stating that drones flying overhead and 'making noise and disturbing' people and animals at home may also 'come under nuisance', participant discussions resonated with legal commentary asserting that drones 'pose complex questions over the torts (legal wrongs) of trespass and nuisance', adding that a person 'may be able to bring a claim if their right to quiet enjoyment of their property is violated by an intentional or reckless act of a drone user' (Mills and Reeve 2016, n.p). Reflecting upon the rights of landowners in relation to airspace above their property and the challenges of determining drone-related nuisance, participants narrated nuisance in different ways. In discussion of case study 1 (drones used to monitor ex-partner), whereby drones hovered above the heads of individuals who 'lived in fear, in a virtual prison', participants remarked that the drone may be 'causing emotional distress, psychological damage in claims'. Here, participants also raised questions around legal remit, asking 'would the family court have jurisdiction in the sky?'. This reminds us of the importance to take embodied experience 'seriously' (Freeman and Calkin 2020, n.p) and of the psycho-somatic effects of drones

that 'buzz' overhead and overheard, which can prompt 'fear' in and beyond battlefields (Schuppli 2014a, 381).

In addition to raising questions of embodiment and nuisance in case study 1, participants highlighted that drones flying 'low' over a property also raises questions around experience beyond the human, recognising the potential of drones 'flying over animals' as potentially 'causing distress' (see also Millner et al. 2023).

Here the introduction of the Air Traffic Management and Unmanned Aircraft Act 2021, an act introducing drone-related police powers, is significant as it includes mention of: causing 'harm, harassment, alarm or distress' and 'nuisance or annoyance relating to [an individual's] occupation of the premises'. Yet, while it is recognised that drones may be associated with nuisance, it remains that the law has not definitively determined what constitutes a 'reasonable height above ground' or the point at which intrusive viewing becomes nuisance (Jackman and Hooper 2023), and that by approaching drone misuse through diverse legal specialisms, different legal questions (e.g. trespass, nuisance), as well as embodied dimensions, are brought to the fore.

Speculating drone futures

In the paper's final analysis section, we turn to participant speculations around emerging technological developments and potential drone futures. The future-oriented part of the focus groups comprised two activities. We first introduced participants to particular drone capability developments (Figure 4), inviting them to discuss emergent potential harms and legal questions these.

Across discussions, data was pronounced theme. Participants focused particular attention to livestreaming *via* drones, raising concerns around privacy and the implications of drone-livestreamed footage containing identifiable and/or personal data shared to an open social media account 'visible to a public audience'. Participants discussed the 'live' sharing element as precluding the opportunity for 'thoughtful review' of footage, raising potential invasions of privacy 'before you even realise you're doing it', and adding that such a breach and any associated 'claims' may be impacted by sharing *via* social media, given that the 'extent of violation has been broadened'. Such discussions reflect emergent regulatory concerns about privacy following growing drone use across 'public and private spaces' (The Information Commissioner's Office 2024, 30) and invite further attention to the potential gendered dimensions of drone data collection and privacy (Thomasen 2018).

Development	Description
Live streaming drone imagery to social media	Some consumer drones can live broadcast drone footage to social media
Drones paired with other technologies	Drones can be paired with other technologies, such as facial recognition
Intelligent flight	A flight mode on some consumer drones enabling them to lock onto and follow particular points, objects, or people, and/or to rapidly ascend or descend from/towards these
Racing drones	Small drones capable of high speed flight (e.g., over 100 miles per hour), flown as part of the recreational activity or sport of drone racing
Drone swarms	Development of groups of drones that fly collectively, in collaboration and communication with each other

Figure 4. Emerging technological drone capability developments.

Participants also turned attention to activists using drones to capture and livestream protest footage, sharing an example of a police officer hitting an individual with a 'riot shield, breaking his teeth' and, years later, footage from a drone 'enabling the man to recover the costs of his dental work'. As discussions unfolded, they also reflected on activist practice and the potential implications of such drone capabilities, highlighting that activist groups often 'don't use Twitter [X] or Facebook', but instead stream drone footage to 'their own servers' overseas, an approach that can lead to difficulties for UK police seeking to obtain the footage. Here we are reminded of the utility of considering diverse everyday droning practices (Jackman and Brickell 2022) and engaging feminist thinking, including theorisations of the 'glitch' – namely the 'generative' everyday ways in which digital devices can be diversely and creatively deployed and 'interrupted' by citizens (Leszczynski and Elwood 2022, 361).

In the focus group's final activity, we invited participants to speculatively explore potential drone futures and their legal dimensions. We focused attention to particular areas of development (automation, autonomy and artificial intelligence (AI)). By way of context, automation and autonomy are commonly understood on a spectrum, with automated systems as those that have 'been instructed to automatically perform a set of specific tasks within human-set parameters' and autonomous systems as those 'using AI to determine its own course of action by making its own decisions' (UK Parliament 2022, 2, 1). While AI can be 'defined in many ways', it is an 'umbrella term for a range of algorithm-based technologies that solve complex tasks by carrying out functions that previously required human thinking' (The Information Commissioner's Office n.d.).

Initially, participants approached discussions through particular examples, including Intelligent Flight and ChatGPT. As detailed in Figure 4, intelligent flight is a drone capability enabling some consumer drones to lock onto and follow particular points, objects, or people, and/or to rapidly ascend or descend towards these. Regarding ChatGPT, while AI takes diverse forms, particular hype has emerged around AI chatbots, which train on large datasets with the aim of recognising, summarising and generating human language (Nawaz 2023, n.p). While commonly used to 'write essays and answer questions', Microsoft researchers have used 'the chatbot to control robots' (Kan 2023, n.p). While acknowledging that ChatGPT 'still needs help' (e.g. 'text prompts'), researchers have nonetheless 'instructed ChatGPT to control' robots, with ChatGPT requesting 'clarification' where 'instructions were ambiguous' (Kan 2023, n.p). In this vein, participants were asked for their views about 'ChatGPT being attached to drones…deciding on what your drone's going to do'.

Across participant discussions of intelligent flight and ChatGPT, participants foregrounded questions around responsibility and liability, while also evoking a feminist analytic through attention to human and non-human actors and the ways they variously 'animate, inhabit, negotiate and transform' geopolitical worlds (Dixon and Marston 2011, 445). Regarding responsibility, participants remarked that in the context of such innovations 'there's no operator really', while raising questions of 'meaningful control' and who 'would be culpable?'. They continued that such developments challenge 'how to attribute the action of the drone to somebody' (a human), stating that such developments may be associated with or 'lead to a situation where you divorce the culpability'. Alongside resonating with geographical debates around AI which

assert that technologies 'often change faster than our frameworks for understanding them can adjust' (Walker and Winders 2021, 164), such observations foreground questions of the human and notions of the operator.

Therein, in relation to intelligent flight, participants also reflected on the 'who' of human operator/action, asking who is flying drones equipped with such features? Recalling both the profile of the 'typical' UK drone user (male), and the drone's techno-capability, that 'transforms the nature of surveillance' through simultaneously changing potential 'access' to locations (e.g. 'private properties') and impacting interaction (e.g. through 'observing in detail' and 'tracking individuals or groups') (Marzocchi 2015, 21, 22), urges further attention to the gendered dimensions and potential impacts of drone misuse and harm. As Myers West et al. (2019, 5) remind us, AI systems encompass and embed multiple forms of intersectional discrimination, from diversity issues in relation to how and what 'gets built, who [such systems] are designed to serve, and who benefits' and may be marginalised from their development.

Participants also understood increasing automation and autonomy in drones as involving diverse human and non-human actors and representing a dispersal of agency therein. Participants highlighted 'complexity' accompanying the growing range of human and non-human actors 'in the chain' and raised the question of 'who' or 'what' 'is responsible or liable for any issues?'. In highlighting the need to consider diverse actors from the 'manufacturer of the aircraft', those 'supplying…particular enabling technology', as well as the 'operator, the pilot, the entity offering the C2 links' and technical systems used to manage airspace, participants underscored the assemblage of actors underpinning drone flight, described a growing distance between human pilot and control, and raised legal questions related to this. Here, participant testimony resonates with legal scholarship asserting that while humans remain the 'primary subject and object of norms that are created, interpreted and enforced by other humans', the development of increasingly 'intelligent and autonomous' machines marks an important challenge to lawyers and courts regarding regulating the 'conduct' of such machines (Hartmann et al. 2023, 37). So too is this echoed in research highlighting that the 'human being…who might ultimately be found responsible when things go wrong…is no longer tenable' as 'complex systems are rarely, if ever, the product of single authorship' (Schuppli 2014, n.p). Thus, alongside the 'agency of things' (Schuppli 2014, n.p), further attention is needed to the multiple, multi-sited authorship and ownership of such systems, and to the 'maleness' and whiteness of techno-development therein (Chengeta 2022; Myers West et al. 2019).

Conclusions

In recognition that digital technologies 'represent central – rather than ancillary – tools of abuse in the twenty first century' (Cuomo and Dolci 2021, 225), this paper brings drone geographies into dialogue with feminist legal and digital geographies to explore emerging techno-legal geographies of consumer drone misuse and harms. By developing this dialogue, the paper extends feminist thinking within drone geographies to readily accessible consumer drones. It mobilises a geolegal lens to interrogate drone misuse and harms across intersecting scales, while attentive to the 'varied effects of the law and digital technologies…on gendered bodies' (Cuomo and Dolci

2023, 903). Through attention to the drone's techno-capacities and remote capabilities, it highlights both the drone's 'engagement in everyday life' (McLean, Maalsen, and McNamara 2020, 469) and the need to interrogate both the (distant-proximate) spatialities the drone enacts, and the diverse practices it enables. It has drawn attention to emerging and increasingly diverse incidents of drone misuse. Deploying a novel focus group methodology bringing together lawyers from diverse specialisms, it demonstrates both that drone misuse encompasses gendered harms, and can be valuably interrogated through a feminist lens attentive to multiple sites and scales. Collectively, it underscores both that drones can act to extend existing crimes and techno-harms while also introducing novel ones, and, through reference to specific drone incidents (e.g. trespass and nuisance), that drone misuse necessitates attention to drone spatialities (e.g. remote aerial access and the implications of this on understandings and experiences of 'private' spaces of home) and their potential gendered impacts (e.g. embodied impacts of drone misuse and the ways these disproportionately impact women).

In undertaking this analysis, it has demonstrated that while drone regulation remains aviation-led and informed, opening consultation on drone misuse and harms to multiple legal specialisms highlights that drone misuse cuts across multiple areas of law, and that such input challenges legal interpretations of/around such incidents. Alongside the paper's outlining of a distinct methodology, the wider project drew on focus group participant testimony in the development of legal recommendations in this area as well as calls for further resource. Guidance on key considerations for lawyers working on drone-related cases was inclusive of: understanding drone regulation and enforcement, considering the role of the drone, context of use and intention of operator; as well as evidentiary challenges around remoteness, accessing evidence, enforcement powers, and the importance of further considering the potential for drone-enabled discrimination (Jackman and Hooper 2023).

Further, while drawing attention to incidents of drone misuse reported in the news, such as headlines about a convicted sex offender attempting to film women and children in the bath(room) and charged with 'video-voyeurism' (*CTV News.com.au* 2023, n.p), the paper both urges further attention to current drone misuse and its potential legal ramifications, while also engaging the drone as an evolving technology, inviting participants to reflect on the potential gendered and legal implications of emerging techno-capabilities and drone futures. Here, we also developed recommendations moving forward, including: information provision (e.g. for drone users regarding their legal obligations and responsibilities; by regulators around weaponisation; and collaboration between relevant regulators), a review of existing offences (e.g. exploring whether criminal law adequately covers (new) offences committed using drones), the development of further guidance for lawyers (e.g. addressing a lack of drone-related information in standard criminal and civil practitioner textbooks or CPS guidance), and further horizon-scanning work on emerging capabilities and potential drone futures (Jackman and Hooper 2023). While recognising the challenges of balancing the benefits of drone use with its potential for misuse, we urge further attention to both the diversity of drone misuse and the potential harms that can accompany this, as well as to the methodological and practical approaches adopted in response to the very same.

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Ethical approval

This research has received ethics approval from the School of Archaeology, Geography and Environmental Sciences (SAGES) Ethics Committee at the university of Reading. This included review of associated participant information sheets and consent forms (reference: SREC-2021/20).

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Data availability statement

Data associated with the Diversifying Drone Stories project can be found at: https://reshare.ukdataservice.ac.uk/856753/

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