

Forging volumetric methods

Article

Published Version

Creative Commons: Attribution 4.0 (CC-BY)

Open Access

Jackman, Anna ORCID logoORCID: <https://orcid.org/0000-0003-4832-4955> and Squire, Rachael (2021) Forging volumetric methods. *Area*, 53 (3). pp. 492-500. ISSN 0004-0894 doi: <https://doi.org/10.1111/area.12712> Available at <https://centaur.reading.ac.uk/100179/>

It is advisable to refer to the publisher's version if you intend to cite from the work. See [Guidance on citing](#).

To link to this article DOI: <http://dx.doi.org/10.1111/area.12712>

Publisher: Wiley

All outputs in CentAUR are protected by Intellectual Property Rights law, including copyright law. Copyright and IPR is retained by the creators or other copyright holders. Terms and conditions for use of this material are defined in the [End User Agreement](#).

www.reading.ac.uk/centaur

CentAUR

Central Archive at the University of Reading

Reading's research outputs online

Forging volumetric methods

Anna Jackman  | Rachael Squire

Department of Geography, Royal
Holloway University of London, Egham,
UK

Correspondence

Anna Jackman

Email: Anna.Jackman@rhul.ac.uk

The last two decades have seen a “volumetric turn” within Anglophone social sciences and humanities scholarship. This turn is premised on the idea that space may be better understood in three-dimensional terms – with complex heights and depths – rather than as a series of two-dimensional areas or surfaces. While there is an increasingly diverse and rich set of scholarship accounting for voluminous complexities in the air, oceans, ice, mountains, and undergrounds, all too often this work foregrounds state and military-led approaches to volume. This has resulted in a limited methodological toolkit through which to explore voluminous complexities as they emerge and extend beyond military and state contexts. Often reliant on elite interviews, archives, and cartographies, there has been little critical discussion of both methodological practice and the “flatness” of research outputs articulating three-dimensional worlds. In this paper we address this by foregrounding the role of immersive and multisensory methodologies (sounding volumes, seeing-sensing drone volumes, and object volumes). To conclude, we offer avenues for further inquiry, including attending to shifting everyday voluminous experiences in the Anthropocene, and the need to diversify the communication of “volume” research.

KEYWORDS

drone, everyday, object, sound, volume, volumetric methods

1 | SITUATING VOLUME: MAKING SPACE FOR METHODOLOGY

Over the last two decades, Anglophone social science and humanities scholarship has undergone a “volumetric turn” (Billé, 2019). Such scholarship foregrounds the idea that space is better understood in three-, rather than two-, dimensional terms – with complex heights and depths (Billé, 2017, 2019; Elden, 2013; Squire & Dodds, 2020; Weizman, 2002). Indeed, there is an increasingly rich set of scholarship accounting for voluminous contexts and their complexities, with work on air (Adey, 2013, 2015; Jensen, 2020; Klauser & Pedrozo, 2015; Shaw, 2016; Weizman, 2007; Williams, 2011), shifting ice (Bruun, 2020; Dodds, 2019), watery ocean volumes and depths (Childs, 2020; Peters & Steinberg, 2019; Squire, 2017; Steinberg & Peters, 2015), mountainous heights (Baghel & Nüsser, 2015; Gordillo, 2018) and underground subterranea (Childs, 2020; Garrett, 2016; Hawkins, 2020; Slesinger, 2020; Squire & Dodds, 2020). Human Geography is, as Adey highlights, “afloat with volumes” (2015, p. 55).

Such interventions, while incredibly rich, have largely retained a focus on state-led accounts of volume (Jackman et al., 2020). Practices of the state and military strategy are foregrounded, with interventions guided by questions of calculation, exploitation, “control, enclosure and exclusion” (Squire & Dodds, 2020, p. 4; see also Elden, 2013; Hawkins, 2020; Squire, 2016; Slesinger, 2020). These interventions have been pivotal in shaping articulations of “volume” and the formation of a

This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

The information, practices and views in this article are those of the author(s) and do not necessarily reflect the opinion of the Royal Geographical Society (with IBG).

© 2021 The Authors. *Area* published by John Wiley & Sons Ltd on behalf of Royal Geographical Society (with the Institute of British Geographers).

“rhetoric of volumetry” attentive to issues of territorialisation, access, control, and conflict (Benwell, 2020, p. 93). This rhetoric, however, privileges “certain kinds of space, actions, relations,” and visions (Campbell, 2019, pp. 11, 14).

In order to unsettle this western and state-centric framework, we argue that methodological interventions are needed. While Adey suggests that this state/technocratic “gaze” is “difficult to escape” (2013, p. 53), more recent scholarship has begun to respond to this challenge. Perez and Zurita’s (2020, p. 1) exploration of experiences of cavers navigating cavernous undergrounds in Venezuela, Cuba, and Mexico acts as a case in point. In articulating the need to attend to multiple “imaginaries” of the volumetric, they foreground the karst’s “fissures and flows” (Dodds, 2017; Perez & Zurita, 2020, p. 8), attending to both volumetric “geophysicalities and materialities” (Campbell, 2019, p. 16) and their “fluidity” and “dynamism” (Childs, 2020, p. 191). Further, Perez and Zurita foreground the bodily “knowledges” and embodied practices that act on and mediate experiences of “karsts’ qualities” (2020, pp. 8, 2). Such work shares parallels with feminist approaches that, driven by a desire to “destabilize dominant and often disembodied geopolitical discourse” (Hyndman, 2007, p. 36), centre diverse bodies as they “negotiate and transform the geopolitics they both animate and inhabit” (Dixon & Marston, 2011, p. 445). It re-focuses the scales and contexts commonly at the centre of geopolitical accounts and frames away from the “global” and “grand” and toward the “everyday” (Koopman, 2011; Hyndman, 2007, p. 37; Williams & Massaro, 2013). Alongside feminist approaches, indigenous scholarship is formative here. While not explicitly articulated in “volumetric” terms (Elden, 2013), scholars have long-noted the inherently “voluminous” ways in which a range of actors live through everyday voluminous encounters. In articulating the significance of the sea to Pacific Islanders, for example, Hau’ofa (1998) foregrounds the sea’s shoals, depths, and mobilities – and the profound ways they shape Pacific community life-worlds and inhabitation in volume. More recent work exploring Inuit knowledges of sea ice in the Arctic also speaks to similar sensibilities whereby the earth and its voluminous complexities are navigated in everyday contexts (see Aporta, 2002). Here, the sea emerges as “an active agent in the making of beings and knowledge” (Barker & Pickerill, 2020, p. 640).

Cognisant of this wider work and attentive to the relative absence of methodological discussion within Western volume scholarship (Squire, 2017), our paper centres on the question of how everyday experiences of volume might be captured to further expand and diversify the agenda of volume research. This paper emerges from a need to unsettle the dominance of the (state-sanctioned) visual that accompanies accounts of volume, moving beyond two-dimensional maps, photos, and text to instead apprehend and present everyday experiences of volume in ways that both recognise multiple experiential and material registers, and lift them off the two-dimensional page. The paper outlines three potential approaches to take this forward: sounding volumes, sensing volumes, everyday instrumentations. It concludes by reflecting on the question of communicating everyday volumes, and understanding everyday experiences of volume in the wake of stark environmental change.

2 | CAPTURING EVERYDAY VOLUMES

While increasingly diverse, existing accounts of “volume” remain approached through a limited methodological toolkit, often tied to elite interviews, archives, and cartographies while providing little discussion of methodological practice. In thinking with feminist literatures, alongside decolonial agendas, an entry point is provided to further diversify accounts of volume, opening them to the “plural” and “contingent” nature of knowledge and the multitude of ways volume can be known and inhabited (Noxolo, 2017, p. 317). Collaboration with non-state, everyday actors and communities is key here in challenging the ways “geographic knowledge is produced” (Askins, 2018; Basile et al., 2018; de Leeuw & Hunt, 2018, p. 6). Here the mobilisation of community-based participatory action research, participatory and participant storytelling, and counter-mapping methods to foreground different “ways of knowing and being” (de Leeuw & Hunt, 2018) invite methodological diversification.

In so doing, we can think both with and beyond traditions of embodied research. As scholars writing of diving in underwater depths have demonstrated, watery volumes confront their occupants with “feelings of weightlessness,” nervousness, and the therapeutic (Merchant, 2012, p. 215; Squire, 2017). Approaching the submersed diver’s body through the framework of volume, Squire (2017, p. 4) calls for us to reflect on the ways we might develop immersive methodologies enabling accounts of volume fostered from our embodied inhabitation of it. Such corporeal encounters in/with volume recognise the centrality of the body within feminist scholarship. We also see purchase in engaging work seeking to differently approach the “micropolitical” while acknowledging that corporeality and embodiment are not the “be all and end all” (Dixon, 2014, p. 147, 2015). Here, the full range of human and non-human actors that both “compose, enable and give texture to volume” (Jackman et al., 2020, p. 7; Squire, 2020) can be further foregrounded.

In the following paragraphs, we think both with and beyond the body in pursuit of more diverse accounts of volume. We draw inspiration from literatures both attentive to the “messy-ness” of multiple and “entangled worlds” (Dowling et al.,

2017, p. 825), and those calling for more “multisensory ways of knowing” and immersive data collection (Hawkins, 2020, p. 235; Squire, 2017). As scholars working at intersections between airspaces and subsurface depths, we outline three potential volumetric methods – sound, drone, and object – each designed to provoke questions around voluminous data collection and the forms of knowledge that may emerge as a result.

2.1 | Sounding volumes

Sound plays an essential role in how we make sense of the world around us, both helping us to “orient” in and to “give meaning to” space (Saldanha, 2009, p. 236), and actively “constructing and mediating” our experiences (Gallagher & Prior, 2014, p. 267; Kanngieser, 2012; Revill, 2016). Cutting across such work are concerns around the “importance of hearing, listening and perceiving sound in everyday life” (Gallagher & Prior, 2014, p. 267) and the “making of sonic sensibilities” (Revill, 2016, p. 240). Responding to claims that geographical research on sound has remained somewhat “methodologically conventional” (Gallagher & Prior, 2014, p. 268), scholars have forged “amplified sonic sensibilities” (Gallagher et al., 2017, p. 618) through the development of a range of phonographic methods and “sound walks” (Butler, 2006). Such methods facilitate greater attentiveness to both “marginal aspects of place” and its inhabitation (Gallagher & Prior, 2014, p. 268) and the multisensorial nature of embodied experience. Writing of the construction of “accessible” sound walks, for example, Butler (2006, p. 879) describes deploying a float drifting down the River Thames in London, plotting its “landing” points to inform the route. Comprised of 12 “sound points,” Butler’s resulting sound walk layered “binaural recordings of the river bank” and its accompanying sounds – ebbs, flows, footsteps, “background” chatter (2006, p. 903).

While not articulated in “volumetric” terms, as Saldanha (2009, pp. 240, 237) notes sound at once “envelops” and is “registered throughout the body,” and further, when the audible “volume” of sound is adjusted, it represents “not only a linear measure of amplitude, but a three-dimensional quality of sound.” There is thus clearly opportunity here for sound-orientated volume methodologies seeking to capture the three-dimensional world in ways thus far unaccounted for. For example, in deploying “binaural” recordings of the river bank, Butler utilises a “stereo two-part microphone placed in each ear of the recorder” to “pick up sound in the same way as the human head” (2006, p. 903). While certainly offering an immersive form of recording, the growing popularity of “ambisonics” and their alternative “sonic spatialities” (Revill, 2016, p. 241) warrant further attention.

A form of “spatial audio,” “ambisonics” is an audio format enabling a “listener to experience sound in all directions” (Huether, 2018, n.p.). Employing a recording device comprising four microphones arranged in a “tetrahedral array,” ambisonics captures sound not just on the “horizontal plane” but instead “from every direction surrounding the microphone” (Creative field recording, 2017, n.p.). Following the placement of a microphone, a “full 360 degree representation of sound” around it is made possible (2017, n.p.). In practice, a binaural (or stereo) recording is locked – meaning if you turn your head the recording remains the same. With ambisonics you can instead navigate in sound – the sound is responsive and more “realistic.” As ambisonics is associated with a “3D sphere of sound,” it is increasingly being paired with “surround” media such as Virtual Reality and 360° video, to create more immersive gaming and journalism (Huether, 2018). While not to eschew challenges around calibration and processing (Berklee Online, 2018), ambisonics is growing in accessibility, with consumer-grade equipment being employed in live music and dance projects, which when paired with 360° video sees volume sonically represented and the viewer enabled to immerse themselves in a three-dimensionally navigable scene (see for example ZoomSoundLab, 2018).

The format’s growing popularity generates questions about how geographers engage with the capturing and curation of three-dimensional sound-worlds. Further work at this juncture could act to widen theorisations of volume. Consider, for example, the Malaysian tradition of “fish listening,” in which an individual fishing “clings” to their boat, “submerging” themselves with “eyes and ears open” to “listen for fish sounds” (Malay Mail, 2014, n.p.). While experiments with spatial audio underwater remain nascent given the complexity of sounds that “don’t pierce waterlines” but “bounce back into the depths” (Scales, 2019, n.p.), we can think further with this “multi-sensory” act (Malay Mail, 2014). It remains both an everyday navigation in volume, one attentive to fish as vocal characters (Squire, 2020), and a community practice grappling with climate-shifting volumes.

2.2 | Drone volumes

Drones have emerged as increasingly popular devices for a growing number of state and non-state actors (Bradley & Cerrera, 2019; Jackman, 2017; Jackman & Jablonoski, 2021; Klauser & Pedrozo, 2015; Millner, 2020). Similarly, given their capacities to collect imagery and data, drone methodologies are increasingly prevalent (Birtchnell & Gibson, 2015; Fish

et al., 2017; Garrett & Anderson, 2018; Garrett & McCosker, 2017). Here the drone's ability to "maneuver freely" while affording a "kind of surround sight" (Choi-Fitzpatrick, 2019, n.p.) is increasingly important. While associated with the capture of "visual" aerial imagery, drones too are "multi-sensual and multimodal," meaning they can be outfitted with sensors (Garrett & Anderson, 2018, p. 355; Garrett & McCosker, 2017), thus "reshaping methodological imaginations" (Fish, 2016, n.p.). As interest has grown in the capacity of drones to generate research data, their potential to "reveal new directions informing the volumetric turn" is being explored (Garrett & Anderson, 2018, p. 356; Jensen, 2020).

While representing increasingly diverse agendas, it remains that drone geographies have yet to be adequately "informed by empirical material so as to afford more expansive insights into the volumetric geopolitics of the air" (Klauser & Pedrozo, 2015, p. 288). We thus see two-fold potential for empirically rich volumetric drone methods. First, following extant scholarship, drones could be further mobilised as research tools enabling image and sensor data collection in and of volume. As is evidenced through projects like "Unequal Scenes" (n.d.), increasingly accessible drones have been employed to capture imagery of the "inscribed histories" of urban inequality, in a sense acting to democratise the aerial view (Choi-Fitzpatrick, 2019). Similarly, in "Points of Presence," Fish et al., (2017, n.p.) re-imagine the (military) drone's data capture, conducting a "visual and vertical examination of undersea fibre-optic cables" in the North Atlantic as an exercise in "creatively engaging the atmospheric element," rather than coercively surveilling it.

Second, we see value in turning instead to the diverse communities deploying drones. While, as per volume itself, drones are commonly narrated as tools employed by the state, communities around the globe are increasingly deploying them in developing understandings of their everyday environments (Choi-Fitzpatrick, 2019), particularly as these volumes shift in the context of climate change. While not to eschew the "egis of military need" through which drones emerged (Dodge, 2018, p. 954), examples such as We Robotics' "flying labs," in which drones are deployed with communities in response to local challenges and need (Nepal Flying Labs, n.d.), provide a useful counterpoint. Nepal's Flying Lab (2019), for example, has deployed drones in mapping glaciers and the effects of climate change on water reserves.

Here, the employment of both conventional interviews, drone-assisted participatory mapping, and "drone-alongs" with drone-deploying communities could act as methodological tools through which to re-approach and re-narrate volume in more diverse ways. For example, in a disaster recovery project following a 2015 earthquake, a Flying Lab mobilised drones to capture imagery and point cloud data of village destruction to inform the development of virtual 3D models (Garrett & Anderson, 2018; Meir, 2015). While working in "3D because disaster damage is a 3D phenomenon" (Meir, 2015, n.p.), the team were centrally interested in the expertise and needs of local people in their mapping. Given that some local collaborators did not have "easy access" to computers, participatory mapping using "large rollable banners" featuring "high resolution" drone maps was undertaken, with the community "hacking" and annotating maps with local knowledge to later inform "community discussions on recovery efforts" (Meir, 2015, n.p.). While cognisant of the longstanding power relations bound to the "god's eye view," we are interested in how increasingly accessible drones might act – through their opening of the aerial perspective – to diversify and disrupt volume (Choi-Fitzpatrick, 2019; Kaplan, 2020). Just as Harris writes of a need for multiple vertical "experiences, practices and textures to be opened up" through "3D ethnographies" (2015, p. 608), we imagine purchase in drone methodologies that "open" volumes as differently exploratory and navigable, and volumetric scholarship as more multiply comprised and inhabited.

Of course, caution must be exercised. While offering exciting potential in the forging of volumetric methods, mobilising drones requires care-ful[l] and critical attentiveness to their data capturing in and of volume, and the range of "disturbances" that "potentially alarming" drones may prompt to both human and non-human life (Duffy et al., 2018, p. 16; Dittmer et al., 2018). Just as Billé writes of the need to reflect on volume's "social, political and cultural reverberations" (2017, n.p.), so too do drones "reverberate," resonating with diverse actors in different ways. While remaining critical, drones may then offer alternative stories of inhabiting and knowing volume, while acting to decentre elite knowledges therein.

2.3 | Everyday instrumentations and objects

Amid a "more-than-human" or "non-human" turn, geographers are increasingly interrogating the role of objects as geopolitical actors. As Meehan et al. (2013, pp. 1-2) assert, objects "constitute and exercise state power," acting not as "mere vessels," but rather agential in "transforming the networks into which they are enrolled" (see also Shaw, 2012). This is echoed in diverse geographical work exploring discarded belongings left by migrants as revealing of the violent geographies of the border (Sundberg, 2008), and examining how attending to "stuff" improves understandings of links between geopolitics, militarisation, and the everyday (Rech, 2019). Such accounts are attentive to diverse "calculations" made, enacted, and mediated by objects.

Geographers have also employed different object methodologies, including “reading” the role of objects in popular culture (Meehan et al., 2013), interviews with elite actors (Slesinger, 2020), and reflections on the role of objects in volumetric spatialities such as military outpost tunnels (Zhang & Crang, 2016). However, generally speaking objects – particularly those relating to the everyday and non-state actors – remain curiously absent in accounts of volume. We argue that there is thus potential in re-approaching volume through everyday encounters with objects, prompting revised reflections of instruments and attending to alternative instrumentalizations.

Interactions with the physical world offer a useful entry point here. As Harraway (2016, p. 3) highlights, the Anthropocene is characterised by a reliance – by states and companies alike – on instruments and “techno-fixes” to try and mitigate against a voluminous earth in revolt. Flooding is a prime example, increasing in “frequency and intensity” by as much as 50% globally in the past decade (Sawas, 2019), and prompting a swathe of techno-fixes such as glacial lake draining. While a “manifestation of a global problem,” flooding remains a “relational phenomenon,” felt and experienced locally (Brace & Geoghegan, 2010, p. 284). Deploying ethnographic and archival work, geographers have thus foregrounded local community flooding experiences and knowledges as those which can contribute to both flood risk dialogue and “flood heritage ‘from below’” (McEwen et al., 2014, p. 328). While interrogating the “concept of lay knowledge” and everyday “stories” in and as “expertise” (McEwen et al., 2017, p. 16), potential nonetheless remains to articulate such inherently voluminous experiences in alternative sensory and material registers.

Following growing concerns around “our watery futures” (DeLoughrey, 2017, p. 34) and the communities at the forefront of climate-shifting volumes (Squire & Dodds, 2020), we argue that a focus on the role of objects in everyday encounters with volumetric challenges marks an opportunity through which to forge volumetric methods. As waters rise, communities around the globe are tangibly confronted with water in new ways – wading, floating, avoiding and catching debris carried, draining and pumping it away, and left dealing with its sludgy aftermaths. Here, everyday objects are enrolled as instruments through which to navigate, mitigate, and disrupt water. State-led efforts and archetypal objects such as the sandbag are accompanied by alternative and “informal, do-it-yourself responses” (Udelsmann Rodrigues, 2019, p. 319). Alongside wading sticks, we see improvised “flood hacks” spanning make-shift floats and “water bottle life jackets” for people and pets (Coconuts Bangkok, 2011). Such creative and *ad hoc* interventions (Zhang & Crang, 2016, p. 426) warrant further exploration. Attentiveness to objects as volume-making projects thus helps diversify the multiple yet often “poorly represented” types of expertise comprising extant accounts of action in climate-shifting volume (Suliman et al., 2019, p. 298).

3 | CONCLUSIONS

This paper has argued for more diverse and democratised accounts of volume, outlining three approaches that work to alternatively foreground everyday volumes. Such approaches are increasingly necessary as the earth’s shifting volumes interact with everyday lives in increasingly profound, unequal, and violent ways. As Billé (2017, n.p.) writes, we are “continually confronted” with the changing “textures” of spatial volumes, whether through ocean warming, changing precipitation, heat waves, sea-level rise, or ice melt. Everyday lives and bodies are immersed within this context, “grating against” Earth’s “textured materiality – choking on its dust,” inhaling pollution particulates, wading through submerging waters, and baking in the sun (Billé, 2017). The Anthropocene thus necessitates further experimentation and development of methods that grapple with Earthly volumes and lived experiences of them (see Harris, 2020).

By way of conclusion, we argue that there also remains both need and opportunity to communicate “volume” research in novel ways, less bound to two-dimensional pages, and more experimentally communicating lived experiences of tumultuous volumes. Volumetric scholarship – while punctuated with images, maps, graphs, and infographics – too remains page-bound and reliant on the written word (Dowling et al., 2017, p. 828). Addressing this, is, as Bille (2019, n.p.) highlights, a challenging endeavour given the difficulties in representing (cartographically or mentally) “geopolitical forays into vertical spaces such as the atmosphere or subterranean.” There have been, however, some powerful examples of the articulation of volume in three dimensions. While not put to work to understand everyday experiences, The Guardian’s (2016) *Underworld* project, narrated by geographer Bradley Garrett, is a prime example. Using Virtual Reality, the project invites participants to explore the “subterranean labyrinth of London’s Victorian sewers that lie active, deep beneath” the city; the underground is cracked open, made immersive and accessible rather than distant and obtuse.

Thinking with such work while drawing on the paper’s snapshots, we argue there is also scope for more object-orientated interventions in communicating volume research. While not explicitly articulated in terms of “volume,” the “Disobedient Objects” exhibition at the V&A in London provides a compelling example of the potentials of a stronger engagement with the material in volume. The exhibition featured a range of everyday objects created for use in protest, activism, and

the undermining of dominant power structures. In foregrounding objects such as a makeshift tear-gas mask crafted from household items, the exhibition saw the “privileging of the authorless ad hoc over a more conservative aesthetic” typically associated with formal exhibition space (Soar & Tremlett, 2017, p. 427), while demonstrating DIY responses to inhabiting volumes made hostile. While raising questions about how volumes are propped up, realised, and resisted through objects, it also hints at how objects might feature more prominently in the practice and communication of volumetric research. Here, there is potential in the exhibiting of everyday “volume” objects. This is demonstrated in the “Sarajevo Survival Tools” (n.d.) project, wherein a virtual exhibition enables the user to explore objects created and used by the citizens of Sarajevo during the 3.5-year period that the city was under siege. Each object is accompanied by information about its origin and use, photos, sounds, and an interactive 3D virtual model. This enables users to explore the creativity of citizens while experientially and materially immersing them in a space under stress (Sarajevo Survival Tools, n.d.). Together, both projects highlight the potential of “making” as a practice through which to engage with both experiences of inhabiting volume, and volume in crisis (Carr and Gibson, 2016), and as a lens through which to consider the potential of generating big thoughts through small things (Hawkins & Straughan, 2014).

The ideas within this paper only scratch the surface of a wider debate. After all, to engage with volume is methodologically challenging, and to communicate “volume” off-the-page even more so. We aim in this paper, then, to both generate debate and conversation about how this could take place, and to prompt further exploration of the many dimensions, sites, scales, and senses that as-yet remain under- and unaccounted for in volume.

ACKNOWLEDGEMENTS

The authors would like to sincerely thank Harriet Hawkins for her insights and support in the initial stages of the project. Our thanks also to Klaus Dodds for his comments on the final draft. Further, we are extremely grateful for the thoughtful and constructive comments from the paper’s anonymous reviewers: your reflections improved both the piece and process. All mistakes are our own.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this paper as no new data were created or analysed in this study.

ORCID

Anna Jackman  <https://orcid.org/0000-0003-4832-4955>

REFERENCES

- Adey, P. (2013). Securing the volume/volumen: Comments on Stuart Elden’s Plenary paper ‘Secure the volume’. *Political Geography*, 34, 52–54. <https://doi.org/10.1016/j.polgeo.2013.01.003>
- Adey, P. (2015). Air’s affinities: Geopolitics, chemical affect and the force of the elemental. *Dialogues in Human Geography*, 5, 54–75. <https://doi.org/10.1177/2043820614565871>
- Aporta, C. (2002). Life on the ice: Understanding the codes of a changing environment. *Polar Record*, 38, 341–354. <https://doi.org/10.1017/S0032247400018039>
- Askins, K. (2018). Feminist geographies and participatory action research: Co-producing narratives with people and place. *Gender, Place & Culture*, 25, 1277–1294. <https://doi.org/10.1080/0966369X.2018.1503159>
- Baghel, R., & Nüsser, M. (2015). Securing the heights: The vertical dimension of the Siachen conflict between India and Pakistan in the Eastern Karakoram. *Political Geography*, 48, 24–36. <https://doi.org/10.1016/j.polgeo.2015.05.001>
- Barker, A. J., & Pickerill, J. (2020). Doings with the land and sea: Decolonising geographies, Indigeneity, and enacting place-agency. *Progress in Human Geography*, 44, 640–662. <https://doi.org/10.1177/0309132519839863>
- Basile, S., Asselin, H., & Martin, T. (2018). Co-construction of a data collection tool: A case study with Atikamekw women. *ACME: An International Journal for Critical Geographies*, 17, 840–860. <https://www.acme-journal.org/index.php/acme/article/view/1414>
- Benwell, M. C. (2020). Going underground: Banal nationalism and subterranean elements in Argentina’s Falklands/Malvinas claim. *Geopolitics*, 25, 88–108. <https://doi.org/10.1080/14650045.2017.1387776>
- Berklee Online. (2018, August 26). What are ambisonics? *Youtube*. Retrieved from <https://www.youtube.com/watch?v=-d1uT4QE9k>
- Billé, F. (2017). Introduction: Speaking volumes. *Cultural Anthropology*. Retrieved from <https://culanth.org/fieldsights/introduction-speaking-volumes>

- Billé, F. (2019). Volumetric sovereignty part 1: Cartography vs. volumes. *Society and Space*. Retrieved from <https://www.societyandspace.org/articles/volumetric-sovereignty-part-1-cartography-vs-volumes>
- Birtchnell, T., & Gibson, C. R. (2015). Less talk more drone: Social research with UAVs. *Journal of Geography in Higher Education*, 39, 182–189. <https://doi.org/10.1080/03098265.2014.1003799>
- Brace, C., & Geoghegan, H. (2010). Human geographies of climate change: Landscape, temporality, and lay knowledges. *Progress in Human Geography*, 35, 284–302. <https://doi.org/10.1177/0309132510376259>
- Bradley, A., & Cerella, A. (2019). Droneland: Towards a domestic drone theory. *Security Dialogue*. Retrieved from <https://blogs.prio.org/SecurityDialogue/2019/07/droneland-towards-a-domestic-dronetheory/>
- Bruun, J. (2020). Invading the whiteness: Science, (sub)terrain, and US militarisation of the Greenland Ice Sheet. *Geopolitics*, 25, 167–188. <https://doi.org/10.1080/14650045.2018.1543269>
- Butler, T. (2006). A walk of art: The potential of the sound walk as practice in cultural geography. *Social & Cultural Geography*, 7, 889–908. <https://doi.org/10.1080/14649360601055821>
- Campbell, E. (2019). Three-dimensional security: Layers, spheres, volumes, milieus. *Political Geography*, 69, 10–21. <https://doi.org/10.1016/j.polgeo.2018.11.010>
- Carr C., & Gibson C. (2016). Geographies of making. *Progress in Human Geography*, 40, 297–315. <https://doi.org/10.1177/0309132515578775>
- Childs, J. (2020). Extraction in four dimensions: Time, space and the emerging geo(-)politics of deep-sea mining. *Geopolitics*, 25, 189–213. <https://doi.org/10.1080/14650045.2018.1465041>
- Choi-Fitzpatrick, A. (2019). *The good drone: How social movements democratize surveillance*. Retrieved from <https://thegooodrone.pubpub.org/>
- Coconuts Bangkok. (2011). *Thai flood hacks celebrates inundated inventions*. Retrieved from <https://coconuts.co/bangkok/news/news-thai-flood-hacks-celebrates-inundated-inventions/>
- Creative field recording. (2017). *An introduction to ambisonics*. Retrieved from <https://www.creativefieldrecording.com/2017/03/01/explorers-of-ambisonics-introduction/01/03/2017>
- DeLoughrey, E. (2017). Submarine futures of the anthropocene. *Comparative Literature*, 69, 32–44. <https://doi.org/10.1215/00104124-3794589>
- de Leeuw S., & Hunt S. (2018). Unsettling decolonizing geographies. *Geography Compass*, 12, e12376. <https://doi.org/10.1111/gec3.12376>
- Ditmer, M. A., Werden, L. K., Tanner, J. C., Vincent, J. B., Callahan, P., Iaizzo, P. A., Laske, T. G., & Garshelis, D. L. (2018). Bears habituate to the repeated exposure of a novel stimulus, unmanned aircraft systems. *Conservation Physiology*, 6, 1–7. <https://doi.org/10.1093/conphys/coy067>
- Dixon, D. P. (2014). The way of the flesh: Life, geopolitics and the weight of the future. *Gender, Place & Culture*, 21, 136–151. <https://doi.org/10.1080/0966369X.2013.879110>
- Dixon, D. P., & Marston, S. A. (2011). Introduction: Feminist engagements with geopolitics. *Gender, Place & Culture*, 18, 445–453. <https://doi.org/10.1080/0966369X.2011.583401>
- Dixon, D. P. (2015). *Feminist geopolitics: Material states*, Abingdon, UK: Ashgate Publishing.
- Dodds, K. (2017). Fissure. Speaking volumes. *Cultural Anthropology*. Retrieved from <https://culanth.org/fieldsights/fissure>
- Dodds, K. (2019). Geopolitics and ice humanities: Elemental, metaphorical and volumetric reverberations. *Geopolitics*, 24, 1–28. <https://doi.org/10.1080/14650045.2019.1697240>
- Dodge, M. (2018). Mapping II: News media mapping, new mediated geovisualities, mapping and verticality. *Progress in Human Geography*, 42, 949–958. <https://doi.org/10.1177/0309132517733086>
- Dowling, R., Lloyd, K., & Suchet-Pearson, S. (2017). Qualitative methods II: 'More-than-human' methodologies and/in praxis. *Progress in Human Geography*, 41, 823–831. <https://doi.org/10.1177/0309132516664439>
- Duffy J. P., Cunliffe A. M., DeBell L., Sandbrook C., Wich S. A., Shutler J. D., Myers-Smith I. H., Varela M. R., & Anderson K. (2018). Location, location, location: Considerations when using lightweight drones in challenging environments. *Remote Sensing in Ecology and Conservation*, 4, 7–19. <https://doi.org/10.1002/rse2.58>
- Elden, S. (2013). Secure the volume: Vertical geopolitics and the depth of power. *Political Geography*, 34, 1–17. <https://doi.org/10.1016/j.polgeo.2012.12.009>
- Fish, A., Garrett, B., & Case, O. (2017). Drones caught in the net. *Imaginations*. Retrieved from <http://imagination.glendon.yorku.ca/?p=9964>
- Fish, A. (2016). Reframing drone methodologies. *Centre for Mobilities Research*. <https://www.lancaster.ac.uk>
- Gallagher, M., Kanngieser, A., & Prior, J. (2017). Listening geographies: Landscape, affect and geotechnologies. *Progress in Human Geography*, 41, 618–637. <https://doi.org/10.1177/0309132516652952>
- Gallagher, M., & Prior, J. (2014). Sonic geographies: Exploring phonographic methods. *Progress in Human Geography*, 38, 267–284. <https://doi.org/10.1177/0309132513481014>
- Garrett, B. L. (2016). Picturing urban subterranea: Embodied aesthetics of London's sewers. *Environment and Planning A: Economy and Space*, 48, 1948–1966. <https://doi.org/10.1177/0308518X16652396>
- Garrett, B., & Anderson, A. (2018). Drone methodologies: Taking flight in human and physical geography. *Transactions of the Institute of British Geographers*, 43, 341–359. <https://doi.org/10.1111/tran.12232>
- Garrett, B. L., & McCosker, A. (2017). Non-human sensing: New methodologies for the drone assemblage. In E. Gómez Cruz, S. Sumartojo, & S. Pink (Eds.), *Refiguring techniques in digital visual research* (pp. 13–23). London, UK: Palgrave Macmillan.
- Gordillo, G. (2018). Terrain as insurgent weapon: An affective geometry of warfare in the mountains of Afghanistan. *Political Geography*, 64, 53–62. <https://doi.org/10.1016/j.polgeo.2018.03.001>
- Haraway, D. (2016). *Staying with the trouble: Making Kin in the Chthulucene*. Durham, NC: Duke University Press.

- Harris, A. (2015). Vertical urbanisms: Opening up geographies of the three-dimensional city. *Progress in Human Geography*, 39, 601–620. <https://doi.org/10.1177/0309132514554323>
- Harris, D. M. (2020). Telling stories about climate change. *The Professional Geographer*, 72, 309–316. <https://doi.org/10.1080/00330124.2019.1686996>
- Hau'ofa, E. (1998). The ocean in us. *The Contemporary Pacific*, 10, 391–410.
- Hawkins, H. (2020). 'A volcanic incident': Towards a geopolitical aesthetics of the subterranean. *Geopolitics*, 25, 214–239. <https://doi.org/10.1080/14650045.2017.1399877>
- Hawkins, H., & Straughan, E. (2014). Nano-art, dynamic matter and the sight/sound of touch. *Geoforum*, 51, 130–139. <https://doi.org/10.1016/j.geoforum.2013.10.010>
- Huether, A. (2018, November 27). A guide to recording spatial audio for 360-degree video. *NPR Training*. Retrieved from <https://training.npr.org/2018/11/27/360-audio/>
- Hyndman, J. (2007). Feminist geopolitics revisited: Body counts in Iraq. *The Professional Geographer*, 59, 35–46. <https://doi.org/10.1111/j.1467-9272.2007.00589.x>
- Jackman, A. (2017). Sensing, speaking volumes. *Cultural Anthropology*. Retrieved from <https://culanth.org/fieldsights/sensing>
- Jackman, A., Squire, R., Bruun, J., & Thornton, P. (2020). Unearthing feminist territories and terrains. *Political Geography*, 80, 102180. <https://doi.org/10.1016/j.polgeo.2020.102180>
- Jackman A., & Jablonowski, M. (2021). Investments in the imaginary: Commercial drone speculations and relations. *Global Discourse*, 11, 39–62. <https://doi.org/10.1332/204378920x16067521422126>
- Jensen, O. (2020). Thinking with the drone – Visual lessons in aerial and volumetric thinking. *Visual Studies*, 32, 417–428. <https://doi.org/10.1080/1472586X.2020.1840085>
- Kanngieser, A. (2012). A sonic geography of voice: Towards an affective politics. *Progress in Human Geography*, 36, 336–353. <https://doi.org/10.1177/0309132511423969>
- Kaplan, C. (2020). Atmospheric politics: Protest drones and the ambiguity of airspace. *Digital War*, 1, 50–57. <https://doi.org/10.1057/s42984-020-00005-y>
- Klauser, F., & Pedrozo, S. (2015). Power and space in the drone age: A literature review and politico-geographical research agenda. *Geographica Helvetica*, 70, 293. <https://doi.org/10.5194/gh-70-285-2015>
- Koopman, S. (2011). Alter-geopolitics: Other securities are happening. *Geoforum*, 42, 274–283. <https://doi.org/10.1016/j.geoforum.2011.01.007>
- Malay Mail. (2014, August 19). *Harun Muhammed – One of Malaysia's last 'fish listeners'*. Retrieved from <https://www.malaymail.com/news/malaysia/2014/08/19/harun-muhammad-one-of-malaysias-last-fish-listeners/729413>
- McEwen, L., Garde-Hansen, J., Holmes, A., Jones, O., & Krause, F. (2017). Sustainable flood memories, lay knowledges and the development of community resilience to future flood risk. *Transactions of the Institute of British Geographers*, 42, 14–28. <https://doi.org/10.1111/tran.12149>
- McEwen, L., Jones, O., & Robertson, I. (2014). 'A glorious time?' Some reflections on flooding in the Somerset Levels. *Geographical Journal*, 180, 326–337. <https://doi.org/10.1111/geoj.12125>
- Meehan, K., Shaw, I. G. R., & Marston, S. A. (2013). Political geographies of the object. *Political Geography*, 33, 1–10. <https://doi.org/10.1016/j.polgeo.2012.11.002>
- Meir, P. (2015). Video: Crisis mapping Nepal with aerial robotics. *iRevolutions*. Retrieved from <https://irevolutions.org/2015/11/04/crisis-mapping-nepal-aerial-robotics/>
- Merchant, S. (2012). Negotiating underwater space: The sensorium, the body and the practice of scuba-diving. *Tourist Studies*, 11, 215–234. <https://doi.org/10.1177/1468797611432040>
- Millner, N. (2020). As the drone flies: Configuring a vertical politics of contestation within forest conservation. *Political Geography*, 80, 1–13. <https://doi.org/10.1016/j.polgeo.2020.102163>
- Nepal Flying Labs. (n.d.). *About*. Retrieved from <https://flyinglabs.org/nepal/>
- Nepal Flying Labs. (2019). *Nepal Flying Labs launches drones to study Himalayan glaciers*. Retrieved from <https://blog.werobotics.org/2019/12/04/nepal-flying-labs-launches-drones-to-study-himalayan-glaciers/>
- Noxolo P. (2017). Introduction: Decolonising geographical knowledge in a colonised and re-colonising postcolonial world. *Area*, 49, 317–319. <https://doi.org/10.1111/area.12370>
- Perez, M. A., & Zurita, M. L. M. (2020). Underground exploration beyond state reach: Alternative volumetric territorial projects in Venezuela, Cuba, and Mexico. *Political Geography*, 79, 1–10. <https://doi.org/10.1016/j.polgeo.2019.102144>
- Peters, K., & Steinberg, P. (2019). The ocean in excess: Towards a more-than-wet ontology. *Dialogues in Human Geography*, 9, 293–307. <https://doi.org/10.1177/2043820619872886>
- Rech, M. F. (2019). Ephemera(l) geopolitics: The material cultures of British military recruitment. *Geopolitics*, 25, 1075–1098. <https://doi.org/10.1080/14650045.2019.1570920>
- Revill, G. (2016). How is space made in sound? Spatial mediation, critical phenomenology and the political agency of sound. *Progress in Human Geography*, 40, 240–256. <https://doi.org/10.1177/0309132515572271>
- Saldanha, A. (2009). Soundscapes. In R. Kitchin, & N. Thrift (Eds.), *International encyclopedia of human geography* (pp. 236–240). London, UK: Elsevier.
- Sarajevo Survival Tools. (n.d.). Retrieved from <http://h.etf.unsa.ba/srp/project.htm>

- Sawas, A. (2019, November 25). Why are countries around the world experiencing more floods? *Action Aid*. Retrieved from <https://www.actionaid.org.uk/blog/news/2019/11/25/why-are-countries-around-the-world-experiencing-more-floods>
- Scales, H. (2019, March 20). Scientists learn to hear what fish are saying. *Discover Magazine*. Retrieved from <https://www.discovermagazine.com/planet-earth/scientists-learn-to-hear-what-fish-are-saying>
- Shaw, I. G. R. (2012). Towards an evental geography. *Progress in Human Geography*, 36, 613–627. <https://doi.org/10.1177/0309132511435002>
- Shaw, I. G. R. (2016). *Predator empire: Drone warfare and full spectrum dominance*. Minneapolis, MN: University of Minnesota Press.
- Slesinger, I. (2020). A cartography of the unknowable: Technology, territory and subterranean agencies in Israel's management of the Gaza tunnels. *Geopolitics*, 25, 17–42. <https://doi.org/10.1080/14650045.2017.1399878>
- Soar, K., & Tremlett, P. F. (2017). Protest objects: Bricolage, performance and counter-archaeology. *World Archaeology*, 49, 423–434. <https://doi.org/10.1080/00438243.2017.1350600>
- Squire, R. (2016). Immersive terrain: The US Navy, Sealab and Cold War undersea geopolitics. *Area*, 48, 332–338. <https://doi.org/10.1111/area.12265>
- Squire, R. (2017). “Do you dive?”: Methodological considerations for engaging with “volume”. *Geography Compass*, 11, 1–11. <https://doi.org/10.1111/gec3.12319>
- Squire, R. (2020). Companions, zappers, and invaders: The animal geopolitics of Sealab I, II, and III (1964–1969). *Political Geography*, 82, 1964–1969. <https://doi.org/10.1016/j.polgeo.2020.102224>
- Squire, R., & Dodds, K. (2020). Introduction to the special issue: Subterranean geopolitics. *Geopolitics*, 25, 4–16. <https://doi.org/10.1080/14650045.2019.1609453>
- Steinberg, P., & Peters, K. (2015). Wet ontologies, fluid spaces: Giving depth to volume through oceanic thinking. *Environment and Planning D: Society and Space*, 33, 247–264. <https://doi.org/10.1068/d14148p>
- Suliman, S., Farbotko, C., Ransan-Cooper, H., McNamara, K. E., Thornton, F., McMichael, C., & Kitara, T. (2019). Indigenous (im)mobilities in the Anthropocene. *Mobilities*, 14, 298–318. <https://doi.org/10.1080/17450101.2019.1601828>
- Sundberg, J. (2008). ‘Trash-talk’ and the production of quotidian geopolitical boundaries in the USA–Mexico borderlands. *Social & Cultural Geography*, 9, 871–890. <https://doi.org/10.1080/14649360802441424>
- The Guardian. (2016, November 10). *Guardian launches new virtual reality experience – Underworld*. Retrieved from <https://www.theguardian.com/gnm-press-office/2016/nov/10/guardian-launches-new-virtual-reality-experience-underworld>
- Udelsmann Rodrigues, C. (2019). Climate change and DIY urbanism in Luanda and Maputo: New urban strategies? *International Journal of Urban Sustainable Development*, 11, 319–331. <https://doi.org/10.1080/19463138.2019.1585859>
- Unequal scenes. (n.d.). *About*. Retrieved from <https://unequalscenes.com/projects>
- Weizman, E. (2002, April 23). 1. Introduction to the politics of verticality. *Open Democracy*. Retrieved from https://www.opendemocracy.net/en/article_801jsp/
- Weizman, E. (2007). *Hollow land*. London, UK: Verso.
- Williams, A. J. (2011). Reconceptualising spaces of the air: Performing the multiple spatialities of UK military airspaces. *Transactions of the Institute of British Geographers*, 36, 253–267.
- Williams, J., & Massaro, V. (2013). Feminist geopolitics: Unpacking (in)security, animating social change. *Geopolitics*, 18, 751–758. <https://doi.org/10.1080/14650045.2013.816842>
- Zhang, J., & Crang, M. (2016). Making material memories: Kinmen's bridging objects and fractured places between China and Taiwan. *Cultural Geographies*, 23, 421–439. <https://doi.org/10.1177/1474474015591488>
- ZoomSoundLab. (2018, September 13). The Zoom H3-VR. *Youtube*. Retrieved from <https://www.youtube.com/watch?v=CLP-qyvNRSw>

How to cite this article: Jackman A, Squire R. Forging volumetric methods. *Area*. 2021;53:492–500. <https://doi.org/10.1111/area.12712>