

# Digital Natures: New Ontologies, New Politics?

Andrés Luque-Ayala\*, Ruth Machen\*\*, Eric Nost\*\*\*

Introduction to the Special Issue  
'Digital Natures: Reconfiguring Ontologies, Epistemologies, and Politics'

*Journal: Digital Geography and Society*

4<sup>th</sup> March 2024

\* Durham University, United Kingdom

\*\* Newcastle University, United Kingdom

\*\*\* University of Guelph, Canada

## Abstract

Digital tools and practices are transforming societal relationships with non-human worlds—whether through smartphone apps that city dwellers use to navigate urban forests, robotic bees that pollinate crops, or webcams that livestream rare birds' nests. Recent academic and popular interest in the coming together of digital and natural worlds has generated both creative and critical reflections on what the digital means for the very concept of nature, troubling the latter's ontological stability. In this Introduction to the special issue *Digital Natures: Reconfiguring Ontologies, Epistemologies, and Politics* we claim that the digital, when considered beyond an epistemological register, is a productive and political force that is unsettling, rather than reinforcing, the boundaries between society and nature. We review the extensive body of work from across geography and the social sciences that is actively engaging with digital–nature intersections, and historicise current debates through reference to the figures of the cyborg, technonatures, biomimicry and digital organisms. Asking whether digitalized practices of sensing, abstraction and algorithmic recombination simply mirror a pre-existing and external Nature, or whether they advance a reconceptualization of nature, we set out to trace the progressive political potential of a digitally-entangled ontological redefinition of nature. We discuss how, within emerging digital natures, agencies are entangled in a reimagining of what both nature and society are about. Here, we argue, lies the transformative potential of digital natures—precisely in challenging and subverting the ontological place of an external Nature. The introduction finishes by simultaneously outlining a research agenda for digital natures and presenting the six papers that comprise the special issue.

## 1. Introduction

Digital tools and practices are transforming societal relationships with non-human worlds—whether through smartphone apps that city dwellers use to navigate urban forests, robotic

bees that pollinate agricultural crops, or webcams that livestream rare birds' nests. On one hand, digital technologies are seen as potentially enhancing people's encounters with nature (Arts, Van der Wal & Adams, 2015; Sandbrook, Adams & Monteferri, 2015; Chang, 2019; Edwards & Larson, 2020). For instance, during COVID-19 lockdowns, the British Library commissioned an online exhibition using their digital collection of sound recordings of nature,<sup>1</sup> provocatively asking whether online connectivity could substitute for access to nature. Over the same period, London's Natural History Museum promoted a 'digital nature journal' as a popular means to record feelings and observations of the surrounding non-human world.<sup>2</sup> Undoubtedly, digital nature technologies are powerful knowledge tools that are increasingly available outside the halls of science, government, and business. But whilst these may indeed expand access to the leaves and birds we could easily call "nature," their transformative potential is limited inasmuch as they operate in an epistemological register, as tools for knowing a stable 'Nature' that is 'out there' for the taking.

However, recent academic and popular interest in the coming together of digital and natural worlds has generated both creative and critical reflections on what the digital means for the very concept of nature, troubling its ontological stability. Do digitalized practices of sensing, abstraction and algorithmic recombination simply mirror a pre-existing and external Nature, or do they reconfigure how people come to conceptualise nature, resignify the ways by which it matters, and alter the definition of the boundary between natural and social worlds? Circulating extensively outside of the ivory tower, the notion of "digital nature" is clearly not just an academic construct (Nelson, Hawkins & Govia, 2022; Turnbull et al., 2023). Cultural, educational and research institutions worldwide are engaging with digital technologies by asking: where does nature start, where does it end, and where do humans sit within these beginnings and ends? In the Netherlands, for example, the Design Museum Den Bosch profiled animations including "alien plants and dream landscapes," as part of an inquiry into whether "we have entered an era where digital nature has become part of biodiversity."<sup>3</sup> In London, the Barbican Centre's immersive exhibitions and new commissioned art on the climate emergency showcase digital works as a means by which humans can rethink their place and identity "within the wider systems of nature".<sup>4</sup> Likewise, at Japan's National Museum of Emerging Science and Innovation, the permanent exhibition 'Digitally Natural – Naturally Digital' suggests that soon "the difference between original nature and computer-created nature will fade away" and a "new nature" will form.<sup>5</sup> Such statements question the ontological demarcation of digital nature as mere representation. They suggest that the digital is a productive force that is unsettling, rather than reinforcing, the boundaries between society and nature. What is at stake is not just the routing of "environmental knowledge, control and conflict... through data technologies" (Nost & Goldstein, 2022: 3) but potentially a radical transformation of what counts as nature.

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<sup>1</sup> Faint Signals, British Library, London (UK) <https://faintsignals.io/> (accessed 20th February 2024).

<sup>2</sup> Natural History Museum, London (UK), <https://www.nhm.ac.uk/take-part/digital-nature-journal.html> (accessed 12th October 2022).

<sup>3</sup> Design Museum Den Bosch (Netherlands), <https://designmuseum.nl/en/tentoonstelling/a-digital-nature/> (accessed 8th February 2024).

<sup>4</sup> Barbican, London (UK), <https://www.barbican.org.uk/our-story/press-room/our-time-on-earth> (accessed 8th February 2024).

<sup>5</sup> Miraikan – The National Museum of Emerging Science and Innovation, Tokyo (Japan), <https://www.miraikan.jst.go.jp/en/exhibitions/future/digitallynatural/> (accessed 8th February 2024).

In this special issue of the journal *Digital Geography and Society*, titled 'Digital Natures: Reconfiguring Ontologies, Epistemologies, and Politics', we claim that when considered beyond an epistemological register the digital is a productive force that is unsettling, rather than reinforcing, the boundaries between society and nature. Acknowledging that the techno-hype of the current moment may obscure how nature has always been both discursively and technologically mediated (e.g. by the magnifying glass, the air pump, or the algorithm [c.f. Shapin & Schaffer, 1985]), we suggest that there is indeed something new. While academics have long questioned nature/society binaries, the digital provides fresh grounds for these challenges to circulate widely beyond academia. Through this special issue we bring together scholars from geography and allied disciplines to consider whether contemporary digital technologies are advancing a transformative moment in socio-natural relations—one where the digital does more than provide novel means to encounter nature but forges new widely-circulated understandings of what nature is.

In this introduction to the special issue we acknowledge the extensive body of work from across geography, science and technology studies (STS), media studies and other fields within the social sciences and humanities that is actively engaging with digital–nature intersections. This research has been advanced by scholars examining, for instance, the roles of digital technologies in environmental and climate governance (e.g. Bakker & Ritts, 2018; Gabrys, 2020; Machen & Nost, 2021), the implications of datafied natures (e.g. Boucquey, Martin et al., 2019; Nost & Colven, 2022; Leonelli, 2016), and the natures that emerge through digital encounters (e.g. Büscher, 2016; Turnbull, Searle et al., 2023). While we focus our review on this last set of conversations, we also historicise them by tracing contemporary debates back to their intellectual roots in the figures of the cyborg, technonatures, and biomimicry and digital organisms.

In the final section of the introduction, we outline a research agenda for digital natures whilst also presenting the papers that comprise this special issue. The six papers stem from two online workshops we hosted in 2021 around the questions, how does the digital shape how we inhabit and conceptualise nature, and to what extent does this open up space for contesting or foreclosing a politics of nature? In each paper, an agency that is generated, enhanced, or co-opted by the digital is at stake in the making of political possibilities. Often this agency is entangled in a reimagining of what both nature and society are about. Here, we claim, lies the transformative potential of digital natures—precisely in challenging and subverting the ontological place of an external Nature.

Ultimately, our concern with how the digital transforms nature-society relations rests in what sorts of subjects and beings, means and practices of knowing, and discourses and agencies it affords for more pluralistic, just, and abundant futures. We invite the possibility that digital tools enable forms of sensing, feeling, and entanglement that make environmental decision-making more relevant, open, political, and accountable, and that make everyday life more joyful and wonderful. Our perception is that digital engagements that are more politically progressive and disruptive of socio-environmental injustices achieve this by tending to ontological claims around new natures in the making.

## 2. Materialising digital natures: mediation, ontogenesis, and the more-than-real

Can digital technologies and practices—as materialities with ‘virtual’, ‘mediated’, and ‘more-than-real’ presences—complicate the traditional ontological separation of nature and society? We start from the position that there is no unmediated Nature ‘out there’ that digital tools are more precisely, accurately, or holistically capturing as data. There is no hard and fast boundary to be found between nature and society, though digital tools may reflect and reinforce the idea of a such a boundary or attempt to show us otherwise.

Ontology-oriented scholarship over the past two decades has challenged conventional Western dichotomies that distinguish between and separate nature and society (Descola, 2013; Latour, 2013; Law, 2015; Tsing, 2015). In its broadest sense, ontology refers to the metaphysical disquisition around the nature of being, reality, and becoming. Core questions within ontology are who or what counts as a being, what entities have agency, and through what macro-categories (such as nature and society) is the world made sense of (Bunge, 1977). In a narrower sense, drawing on the social sciences’ ontological turn (Deleuze & Guattari, 1988; Latour, 2012; DeLanda, 2016; Povinelli, 2016), ontology is related to a distinction between ‘world views’ (understood as a matter of beliefs, or epistemology) and ‘worlds’, whereby a recognition of ontological difference leads to an acknowledgement of plural or multiple worlds (Braidotti, 2006; Haraway, 2016; Whatmore, 2017; Escobar, 2020). Such a position, rather than emphasising a pre-existing objective reality, treats the real(s) as “*effects of contingent and heterogeneous enactments, performances or sets of relations*” (Law, 2015: 127, original emphasis). It also tends to recognize agency within nonhumans—from entities in the natural world to technological objects (Keating, 2023). In Jane Bennett’s (2004: 365) vital materialist ontology, for example, “humans are always in composition with nonhumanity, never outside of a sticky web of connections or an ecology.”

Within media studies, digital computation is characterised by both human–nonhuman entanglements and co-constituted beings and spaces. For example, understandings of digital media as a ‘dynamic adaptive ecosystem’ are explicitly aimed at overcoming binary oppositions between nature and culture. The argument here is that the terms ‘ecology’ and ‘ecosystem’, rather than pointing to an external ‘natural’ world, recognise the entanglement of living and non-living agents at different scales (Taffel, 2019; for a contrasting view, see Krivý in this issue, who unpacks the ‘digital ecosystem’ as a discursive metaphor of digital capitalism).

In human geography, the digital is conceptualised as both material and generative of space-times and agentic beings (Keating, 2023). Geographical approaches to digital computation have long problematised an understanding of digitality as productive of mere ‘virtual’ realities; they refuse virtual/real and associated immaterial/material dichotomies (Kinsley, 2014; Ash, Kitchin & Leszczynski, 2018). Rather, digital computation operates *through* an “animated and modulated” materiality (Kinsley, 2014: 366), while also *bearing on* the material conditions of the everyday (Leszczynski, 2015). In Agnieszka Leszczynski’s work, for example, “coming-into-contact with [digital] spatial media is generative of spatiality” (2015: 746). Similarly, for Louise Amoore (2011: 34), what is at stake with the digital is an ontology concerned with “actuality and the actualization of an array of possibilities.” In her work, algorithms used in surveillance do not *observe* the world but in effect *construct* worlds (Amoore & Raley, 2017). These

generative understandings of the digital build on the work of literary critic Katherine Hayles, who sees a new category of beings with different capacities emerging when humans work in tandem with digital technologies: “As bodies enter more into the [digital] circuit, subjects cease to be circumscribed by these dynamics and are constructed through them” (Hayles, 2005: 9). In this context, setting an agenda for digital geographies whilst also pointing us in important directions for our examination of digital natures, Ash, Kitchin and Leszczynski (2018: 36) call for “further attention to be given to the work that non-human infrastructures perform that always exceeds the technical parameters of their design.”

### **Digital natures as new material formations**

A number of works on the coming together of the digital and nature draw on this material and generative understanding of society-technology relations. Jennifer Gabrys, for example, describes the digital sensing of natural environments as a process of ontogenesis. Instead of sensors mediating between two preestablished entities—Society and Nature—they produce “medial relationships that are world-making and world-sustaining” (Gabrys, 2016: 263). Drawing on the work of philosopher Gilbert Simondon and mathematician Alfred North Whitehead, Gabrys sees digital information as ‘in-forming.’ Sensing infrastructures give form to and inform experience, whereby both socio-technical entities and their environments *concrese*—understood as the ways in which entities and occasions are realised as both joined up and distinct creatures.

Several other accounts of digital natures see them as a novel form of real involving newly co-constituted beings. Reflecting on geotagged animals, Adams (2020) discusses the idea of ‘digital animals’. These are co-constituted via animals’ ‘digital presence’, “a second life lived through the continuous unspooling of location data” (Adams, 2020: 17). He distils two relevant forms of animals’ digitization, both of which exemplify co-constitutions that are neither animal nor machinic. First, robotic animals—ranging from robotic pets produced for domestic companionship or military applications to the biohacking of living insects via mini-robots acting as swarms. Second, virtual animals in virtual worlds—created for entertainment, museology, and other purposes. Stinson’s (2017) analysis of new media technologies for wilderness recreation/re-creation also claims the emergence of a new type of entity. Transcending the question of whether digital technologies connect or disconnect people and nature, he argues that digital engagement with wild animals involves a new ontology. This Wilderness 2.0 becomes “an augmented reality that blurs the lines between the ‘actual’ and the ‘virtual’” (Stinson, 2017: 174), whilst outdoor recreation is transformed into a virtual form of labour.

The concern with how digital technologies generate new entities in and through nature extends to data, as a flow enabled by the digital. Tretter and Burns (this issue) examine fossil fuel extraction as a process enabled and sustained by abstracting environmental relations into data models. Their account (via Sadowski, 2019) explicitly transcends representation in referring to these practices not as simply mirroring but as ‘ordering’ and ‘constructing’ nature as a set of resources. Likewise, for Nost and Goldstein (2022), data is *imbricated in* (e.g. through data centre footprints) and has performative material and spatial *effects on* the environment (e.g. through data-driven decision-making). A contrasting account is provided by Luque-Ayala and Marvin (2020), who, in their analysis of computational urbanisms, see a more direct

materialization of data emerging through its coupling with urban ecological flows such as water, waste, and energy. In their argument, the coming together of digital and ecological flows in the city generates a particular material form that transcends both resource flow and disembodied information. Data-as-infrastructure not only becomes a new type of urban utility (generating a common language across urban processes), but data itself emerges as an urban ecological flow. In turn, the data-based recombination of different urban ecological flows generates new flows, processes and bodies that embody urban data (Luque-Ayala & Marvin 2020; see also Luque-Ayala & Rutherford, 2023). In this way, urban data gains power through its materialization in the form of a new generation of ‘smart’ or computational urban infrastructures.

### **Digital encounters as more-than-real natures**

Many of these emerging accounts of digital natures as generative of new kind of entities draw on digital geographer Jessica McLean (2020)'s idea of the ‘more-than-real’. Her more-than-real concept is aimed at “invert[ing] the diminishing that accompanies use of the terms ‘virtual’ and ‘immaterial’ as applied to digital spaces, moving away from tendencies to place these realms as inferior and subordinate to the ‘real’” (McLean, 2020: 3). Like Amoore (2011), McLean builds on Deleuze and Guattari’s idea that (digital) simulation and (digital) models don’t exist in opposition to the real (see Massumi, 1987). Combining this with Sarah Whatmore’s more-than-human thinking (2006) and Sara Ahmed’s emotional geographies (2004), digital interventions as more-than-real are both material and affective, generative of messy, contradictory, and paradoxical spaces and relations that at times “amplify and collapse geographies, reworking spatial connections and disconnections” (McLean, 2020: 34).

McLean's notion of the ‘more-than-real’ has been taken up by the interdisciplinary Digital Ecologies research group, whose focus is the examination of how digital technologies mediate relations between humans and nonhumans.<sup>6</sup> Combining McLean’s material presence of computation with the idea of digital mediation (via Leszczynski, 2015), alongside a strong emphasis on the need to advance just forms of environmental governance, they argue that “digital mediation must be understood ontologically as a material process...[whereby] *materialities* places digitisation in an assemblage of material entities and relations, and foreground the socioecological injustices that underpin it” (Turnbull, Searle et al., 2023: 5, original emphasis). In examining the technonatural history of peregrine falcons observed by humans through webcams, Searle, Turnbull et al. (2023a) apply such more-than-real notions to argue for the emergence of the ‘digital peregrine’. This entity, distinct from the wild peregrine falcon that inhabits church towers and other urban sites, is co-produced through data streaming, nestcams, and other digital practices: “The digital peregrine occupies a liminal space, in perpetual translation between physical and cybernetic forms... [resulting] in alternative visions of peregrine falcons” (2023a: 196 and 204). Never simply a diminished form of the ‘real’ peregrine, this natural digital entity is rather a more-than-real formation—“moored to the actual corporeal peregrine” (Searle, Turnbull et al., 2023a: 207), but with its own distinctive set of affects and viewing publics. As a nature co-produced by humans and a multiplicity of nonhuman animals and technologies—and continuously converted from

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<sup>6</sup> See <http://www.digicologies.com/> (accessed 8th February 2024).

analogue to digital via different mediums, publics and sites—the digital peregrine is multiple, emergent, transient, subjective and partial.

Similar accounts to the one put forward by Searle, Turnbull et al. can be found in other research aimed at exploring how a range of publics use digital technologies to observe animals in the wild. Recognising that nature has historically been mediated through analogue technologies (from printed material and photography to taxidermy, amongst others), von Essen, Turnbull et al. (2023) discuss the authenticity of wild animals' image online. Their point is not that digital engagements with wildlife lack authenticity, but that authenticity is *constructed* differently in each case—be it through high resolution observation, extended temporal interaction in 24-hour virtual livecasts, or the dual observation of radio-tagged animals in person and on digital maps. What results is multiple overlapping digital and actual presences that “co-exist and map onto each other” (von Essen, Turnbull et al., 2023: 692).

### 3. In search of new politics? Re-defining subjects and agencies

The works discussed above substantiate how the digital is creating both new entities and new relations between nature, society, and technology. But do these emerging readings of digital natures give rise to new politics? For political ecologists, weighing-in on the epistemological, the digital may represent nothing new inasmuch as it accelerates the devolving of collective natures to the market and generates a “biopolitics in action” (Luke, 2009: 208). As we encounter ontological claims in the making of digital natures, are we only looking at the making of new forms of commodification, virtual exchange values (Luke, 1999), and nature-based forms of digital capitalism (Schiller, 1999; Zuboff, 2019)? Or could less structuralist interpretations of digital natures offer novel and perhaps more progressively creative political avenues?

On one hand, works informed by political ecology have pointed to digital natures as means to advance both dominant and marginalized perspectives. For instance, Büscher coined the term Nature 2.0 to describe how digital media allows users to engage, act on, and prosume nature via sharing, co-creating and rating online content. In the face of concerns over whether digital engagements alienate people from tangible nature experiences, Nature 2.0 is seen as potentially promoting greater levels of commitment to environmental action (Sullivan, 2016; Fletcher, 2017). However, as Büscher (2016) describes in his analysis, the co-created nature that results from these digital interventions is a nature—as global environmental non-profit The Nature Conservancy puts it—“tailored to your interests” (Büscher, 2016: 735); characterised by individual over collective concerns. In this way, Nature 2.0 is both anthropocentric and individualistic, taking shape in the context of a capitalist commodification of biodiversity. Whether through Twitter (Hawking & Silver, this issue) or TripAdvisor (Astaburuaga et. al., this issue), what emerges is an entity commodified for the purpose of capital accumulation. To this end, Büscher proposes caution in an ontological decentering of human agency, suggesting that the coming together of platform capitalism and nonhuman nature has led to a “system of domination that structurally diminishes both humans and nonhumans and appears to pressurise life-as-a-whole” (Büscher, 2022: 69).

Whilst Büscher (2021) describes the alignment of social media and hegemonic approaches to conservation, Matulis and Moyer (2018) suggest that digital tools and media enable broader participation in contesting hegemonic discourses. Hawkins and Silver (2017) show that social media is not simply an echo chamber for dominant discourses about society-environment relations but a site where they are resisted, with, for instance, Indigenous peoples pushing back on Western moralizing around seal hunts. Young (2021) finds something similar in arguing that “Inuit are engaging in digital forms of politics ... to intervene in the colonial relationships that produce environmental vulnerability in the first place.” Cifuentes (this issue) also points to the complex and contentious politics that are imbricated with the digital, beyond social media. Examining Indigenous involvement in forest monitoring programs in the Amazon Basin, Cifuentes shows how digital tools such as drones co-produce territorial politics. At once, these tools both advance Indigenous autonomy and threaten it via open data sharing demands that narrow the ways in which territory come to be defined, mapped and acted upon.

Our own view is that regardless of whether we see digital technologies as affording the commodification of nature or the amplification of more progressive voices and practices within environmental action, these alone do not add up to new politics. Digital tools may provide new ways of fighting the same battles, but the contours of politics themselves haven’t shifted. Still, we believe the kinds of ontological approaches we reviewed in section 2 take us somewhere political ecology’s epistemological emphasis on knowing nature hasn’t.

Our perception is that the digital engagements with nature that are politically more resistive and disruptive, as well as those with the greatest salience beyond any progressive aims, achieve what they do by tending to ontological claims. Figuratively, they say ‘what is being captured is not the nature we know,’ signalling the disruption of realist claims to a Nature out there whose main purpose is to become known to us. In the making of digital natures, those who seek disruptive politics open up political space by foregrounding different ontological claims about nature, not just by homing in on the uses of the digital to know nature differently. In Gabrys’ (2020) recent review of digital technologies in forest management, for instance, the political implications of the digital co-constitution of both subjects and environments are clear: what sensors/sensing generate is both a particular kind of governable entity as well as a technology of planetary governance itself (Gabrys, 2020; Gabrys, Westerlaken et al., 2022). Rather than opening up the question of what practices lead to environmental change, digital infrastructures such as databases and remote observation technologies fix their object of concern, defining what counts as a forest. As they “establish environmental facts, govern land uses, preserve and conserve spaces, and manage and extract resources” (Gabrys, Westerlaken et al., 2022: 61), they also remake natural objects, redefining their reality by changing what they are (i.e. making them into technologies) and how they operate. But Gabrys and colleagues also point to how they can equally be part of a cosmopolitical space (c.f. Stengers, 2005; 2011) whereby multiple entities, human and non-human, act as participants in the constitution of a forest that not only has never been natural, but is political through an enactment of pluralistic worlds that recognise multiple ways of knowing and inhabiting, relationality and self-determination.

We propose that the digital redefinition of natural objects into subjects transcends the governing aim, noting that by definition the experience of becoming a subject involves both subjection and agentic identity (c.f. Foucault, 1982). As such, digital natures provoke an expansion and decentring of (human) agency. Ritts and Bakker (2021) and Bakker (2022)



illustrate how digital technologies in environmental conservation afford listening to non-human voices in new ways. This represents both the deepening of a capitalist organization of nature and the possibility of a new political ontology that contributes to a more radical conservation; yet, citing Haraway, the latter hinges “on the ‘ability to partially translate knowledges among very different—and power-differentiated—communities’ ([Haraway]1988: 580)” (Ritts & Bakker, 2021: 153). In a similar way, the work of Sheikh, Mitchell et al. (this issue) considers the possibility of a more-than-human smart urban governance, one where the voice and agency of natural species are considered within urban planning processes. In their view, “including Indigenous and nonhuman ontologies and epistemologies might allow better collaboration with the multispecies lifeworlds and establish more ethical urban governance in tune with other beings” (Sheikh, Mitchell, et al., this issue: 10)—a feat to be achieved with digital technologies. A similar point is made by Verma, van der Wal et al. (2016: 85) in their examination of digital technologies used for animal tracking in conservation. They consider cases where “animals can occupy ‘active’ and central roles enabled by newer technologies,” leading to some degree of agency through an emerging form of animal, machine and human collaboration.

In practice, however, it is unclear the extent to which this expansion of non-human agency results in an active and/or meaningful exercise of subjectivity. Verma, van der Wal et al. (2016: 85) hedge their argument about animal agency by cautioning that “the animal participants in the process remain generally passive subjects within the new digital monitoring networks.” What is at stake are “situations where humans exerted new forms of calculated dominance over wildlife” rather than any form of conscious subjectivity (Verma, van der Wal et al., 2016: 84). Despite emerging research on the capacities and abilities of animals to resist domination and subjectification (e.g. Evans & Adams, 2018; Hawkins & Paxton, 2019), applications of digital technologies towards animals typically represent both a form of biosurveillance and a new biopolitical instrument for controlling wildlife—a technological gaze that problematises possibilities for realising animal agency (von Essen, Turnbull et al., 2023). This suggests the need to tread carefully when imagining the transformative possibilities of digital natures.

Overall, the extent to which broader and plural ontologies have meaningful purchase in the practical making of digital natures is still unclear. Moss, Voigt and Becker’s (2021) empirical work in Berlin on digital urban natures—looking at a range of apps, platforms and digital mapping initiatives—found that very few projects on the ground actually mobilised a notion of nature that wasn’t based on Cartesian dichotomies between nature and society, illustrating the current limited purchase of plural ontologies of nature within cities. As they put it, many of these digital urban nature projects, “although widely popular and potentially transformative, are essentially anthropocentric in orientation... [they] are opening up new avenues for human enjoyment, but not—as yet—seriously challenging notions of urban environments as objects of human use and control” (Moss, Voigt & Becker, 2021: 273).

#### **4. Historicising digital natures: homing in on the political purchase of technical natures**

In order to situate this state of the art on digital natures, especially the richness of ontological discussions on nature–society–technology, we turn towards the intellectual roots of these discussions. Today’s debates surrounding digital natures implicitly and explicitly build upon

over four decades of theorization on nature–society–technology relationships. Our claim that ontological readings of digital natures may prefigure political possibilities requires a deeper understanding of such historical theorizations—in particular, by foregrounding how concepts that confronted or rearticulated nature–society dualisms opened (and at times closed) spaces for uncovering oppressions, challenging hegemonies, and embracing diversity. We home in on three sets of conceptualizations: the cyborg, technonatures, and biomimicry and digital organisms.

### **The cyborg**

When Donna Haraway wrote *A Cyborg Manifesto* (1985), the world was awash with the kinds of visions of machine and biological hybrids that we see today in discourse around artificial intelligence. The figure of the cyborg—as a hybrid of machine and organism—forced an abandonment of illusions of a natural, essentialist, and originary whole. It offered powerful possibilities for a politics that escaped the exclusionary politics of essentialising and totalising narratives around gender, class, and race. Cyborgs offered a more realistic imagery of the human condition and “a way out of the maze of dualisms in which we have explained our bodies and our tools to ourselves” (Haraway, 1985: 101). Merging nature and culture, the cyborg embodied the possibility of transcending patriarchal and fixed notions of gender based on biological difference. For Haraway, there was an urgency to examining the social relations of science and technology, not simply because of the threat that digital technologies themselves posed, but because of what she terms an “informatics of domination” that intensified hardship, insecurity and cultural impoverishment (Haraway, 1985: 79). It was precisely a particular way of thinking about nature and the natural that underpinned multiple oppressions. This is what the notion of the cyborg, in pointing out the extent to which ‘we have never been natural’, shook up. When it is “not clear who makes and who is made in the relation between human and machine” (Haraway, 1985: 97), the possibility for cyborg futures becomes one of rewriting, recoding, and re-defining agentic imaginaries in progressive political alliances.

Haraway’s concern with problematic boundary making practices separating ‘the organic’ and ‘the machine’, nature and culture, and man and woman, found wider expression in Katherine Hayles’s (1999) work on the posthuman condition. For Hayles, there is a mystery to the separation of mind from body both in early cybernetics as well as in how information itself also seems to lose its material relations in the era of virtual transmission. Instead, foregrounding the coming together of the human (nature) and the machinic (culture), she argues that “what we make and what (we think) we are co-evolve together” (Hayles, 2006: 164). This requires new ways of approaching digital informational flows and what it means to be human. This posthuman subject “is an amalgam, a collection of heterogeneous components, a material–informational entity whose boundaries undergo continuous construction and reconstruction” (Hayles, 1999: 3). It is through this subjectivity that the political implications of the entanglement of nature, culture and technology emerge: Hayles is optimistic about “the exhilarating prospect of getting out of some of the old boxes and opening up new ways of thinking about what being human means” (Hayles, 1999: 285). Like Haraway, she argues that if the story of what it means to be human (or, for that matter, nature) has been told through mastery—of will, of nature, and of certain people over others—then the posthuman helps us construct an account in which the illusion of control is shattered and we are confronted with more emergent and distributed forms of decision-making and consciousness. Realising that we

are posthuman becomes both an acknowledgement of human's co-evolution, not just with tools and machines but also other biological species, as well as an acknowledgement of the cognisphere (Hayles, 2006)—a term she uses to describe the interconnectedness of cognition systems that include both human and digital nodes.

### **Technonatures**

Explicitly derived from Haraway's work and resonating with actor–network theory's thinking on hybridity (Latour, 1993; Latour, 2005), the term technonature moved beyond the figure of the cyborg to capture a wider sense of technonatural entanglements that, at the turn of the century, were emerging in everything from biotechnology to art installations. In theology, Anne Kull (2000) used the concept to acknowledge the one-world-ness of nature and culture. Combining the work of Donna Haraway and Paul Tillich and echoing the work of geographer David Demerit (1998), Kull (2003) argues that nature is co-constituted; nature is "artefactual, at every level; that is made—but not just by us." In sociology and geography, White and Wilbert (2006: 95-96) mobilised the idea of technonatures to open up novel political positions within environmental debates, challenging claims that environmental advocacy in the early 2000s seemed to have run out of steam.

White and Wilbert's (2006: 95) reading of technonatures offered a "fruitful metaphor/myth" for navigating a perceived crisis of environmentalism—captured by environmental strategy consultants Shellenberger and Nordhaus (2009) in their 2004 thesis 'The Death of Environmentalism'. At stake, White and Wilbert argued, were the contours of the politics of environmentalism in the 21<sup>st</sup> century, where a technologically informed capitalism seemingly was intensifying processes of ecological destruction across the world. Green movement imagery that contrasted the organic and the synthetic had become "not just much harder to maintain ... but also less politically desirable to maintain" (White & Wilbert, 2006: 99). In contrast, technonatures captured a moment of realisation that both technological mediation and entanglement were inevitable. When the dichotomy between technophobia and technophilia was becoming stale and unproductive, technonatures offered instead a "new mood or sensibility, a shift in the imaginative horizons of the environmental debate" (White & Wilbert 2006: 99-100). Technonatures enabled a shift in attention, away from 'matters of fact' and aspirations to get back to a pure Nature, and towards an analysis of power relations that instead centred on 'matters of concern' through questions around environmental justice and responsibility.

A number of political ecology scholars have also used notions of technonatures to examine how ecologies, technologies, and relations of power are co-produced. Swyngedouw (2004), Kaika (2005), and Sultana (2013) each describe how water is always already enrolled with "technologies, ecologies, discourses, and subjects in the technonatural processes of development" (Sultana, 2013: 337). This perspective emphasizes how technologies (re)produce natures whilst also "express[ing] and creat[ing] political economic relations of power, domination, and exclusion" (Swyngedouw, 2004: 70). In then proposing a 'cyborg urbanism', urban political ecologists' home in on questions of environmental justice precisely through foregrounding the political nature of technological hybridity (Gandy, 2005; Swyngedouw, 2006). However, in these accounts the focus is not on the ontological politics that technonatures had seemed to open up. Whilst hydro-social assemblages ask us to rethink how nature

is bound up with technologies (such as tube wells, pump stations, and, more recently, smart meters), water itself—although “com[ing] to signify very different things” (Sultana, 2013: 348)—does not emerge as ontologically challenged. Political ecology accounts frequently employ a language of ‘fusion’ and ‘coming together’. Nature and society are “brought together”, “welded together”, and “become united in the production of a socio-spatial fabric” (Swyngedouw, 2004: 115). This is a process that “*turns nature* into a deeply social process in which nature, society, and the city can no longer be separated” (Swyngedouw, 2004: 175, emphasis added). As Luke (2009) remarks, this language belies slippage into positing an originary, prior Nature and an ecocentric politics that contrasts with what Castree (2001; see also Braun, 2005; Gandy, 2022) describes as ‘social nature’, which posits that nature is intrinsically social, never asocial. The technonatural hybrids of political ecology that conjoin nature and culture therefore differ substantively from those of STS and new materialism that start in the messy ‘middle ground’ (Latour, 1993) where Haraway and Hayles began. For Haraway and Hayles, nature and technology do not exist as separate and distinct categories that are brought together (see also Latour, 2005). It is this reading of the nature–society relationship that led Latour (2004: 9) to argue that “Political ecology, at least in its theories, has to let go of nature.”

Technonatures scholarship, therefore, has long wrestled with differences in the political productivity that this term affords. Whilst for political ecologists, embracing the entanglements of technonatures are necessary for rethinking destructive urban-industrial ecologies—“otherwise environmentalism will stay snared in the hidden and shifting agendas of neoclassical economics” (Luke, 2009: 199)—for others, the value of ‘technonature’ lies in its critique of ‘pure nature’, although it ultimately offers little with which to theorise what lies beyond. This tension was not lost on White and Wilbert (2009: 12), who asked whether “‘Technonatural’ inquiries have to choose between political-economic and ontologically orientated approaches.” Indeed, contemporary digital ecologies scholarship have called for moving beyond digital mediation (a reference to how nature is made) to ‘remediation’ as a progressive and politically charged remaking of nature (Searle, Turnbull et al., 2023). This work entails a return to the radically contingent re-writing, re-coding, and redefining side of Haraway’s work, in ways that grasp both its ontological and its political edge. We suggest that each ontological stance lends itself to foregrounding different political possibilities.

### **Biomimicry and digital organisms**

Biomimicry is a third conceptual figure that captures the technology–nature interface, yet quite differently from cyborgs and technonatures. Defined as taking inspiration from nature towards advancing solutions to human problems, biomimicry is particularly popular within the fields of product design, architecture, urban design, engineering and materials science (Passino, 2005; Bhushan, 2009; Reed, Klumb et al., 2009; Zari, 2018; Pawlyn, 2019; Taylor Buck & While, 2021). Whilst emulating nature in human designs is perhaps as old as humans themselves, the contemporary iterations of the concept were developed and popularised by biophysicist Otto Schmitt (1963, on the idea of biomimetics) and biologist Janine Benyus (1997). In one sense, traditional understandings of biomimicry yield little in the way of ontological insights, since they hold technology and nature separate as distinct objects. However, recent developments within computer science and digital culture studies, informed by debates around the meaning of ‘the artificial’, complicate this reading. For example, naturoids, described as “artificial devices

inspired by natural exemplars” (Negrotti, 2010: 760), are seen as not necessarily less complex than natural beings but rather as generative of new forms of complexity through new interactions of material and context. With naturoids, complexity is therefore not replicated, but both lost and emergent in new sets of relations. For Negrotti (2010: 765), this “transfiguration”—sometimes seen as exciting and sometimes seen as threatening—is unavoidable.

Within the field of computer science, the figure of the ‘digital organism’ also troubles the boundaries of nature, society, and technology. Digital organisms refer to “self-replicating computer programs that mutate and evolve” (Wilke & Adami, 2002: 528). Specifically, digital organisms “live in a controlled environment. ...[they] must explicitly create a copy of their own genome ... to reproduce”—genome here meaning an executable software programme. A variation of digital organisms is referred to as artificial life (AL), a computer science field that emerged in the late 1980s aimed at the generation of life-like phenomena through wetware, hardware and code and to evolve intelligence within a machine. Conceptually, the possibility of AL rests on a radical separation between materiality (body) and information, privileging form (as a set of procedural steps) over matter as the defining characteristic of life; thus, life as disembodied information (Hayles, 1996; Helmreich, 1998). In evolutionary biology, it is claimed that digital organisms and artificial life provide an opportunity to study evolution in “a form of life that shares no ancestry with carbon-based life forms, and hence to distinguish general principles of evolution from historical accidents that are particular to biochemical life” (Wilke & Adami, 2002: 528). Interest lies in how the evolution of these ‘life-forms’ interacts with, and is relational with, computational resources. In both digital organisms and naturoids, we see a move away from a simple ‘fusing together’ of the technological and the natural, and instead an optimism and curiosity towards how agentic digital beings take on a life of their own.

In contrast to debates on the cyborg and technonatures, a critical look at biomimicry and digital organisms reveals the risks and challenges to realizing political possibilities through rethinking nature–technology relationships. Biomimicry is often seen as an inherently sustainable and environmentally friendly practice (Mathews, 2011; Kennedy, Fechey-Lippens et al., 2015; Hayes, Desha et al., 2020)—a claim that requires further unpacking. Both naturoids and digital organisms are subject to the same critique that political economy scholars have leveraged towards the ‘emergent possibilities’ of biotechnology: its entanglement with neoliberalism and the co-optation of the natural within digital capitalism (Cooper, 2008). Critical geography scholars have illustrated how biomimicry produces ‘nature’ through the mechanisms of enclosure and privatization, harnessing a potentially ‘limitless’ capacity of nature to become capital (Goldstein & Johnson, 2015; Johnson, 2016). As Krivý and Gandy (2023: 1069) explain in their argument around “the potentially mystifying role of new materialist inspired vibrant epistemes,” mimesis is only an illusory fix for the contemporary ecological crisis.

The political economy critique of biological mimesis does valuable work in foregrounding how technonatural ontologies may be amenable to the logics of capital. Yet this critique operates under a view where nature is still conceptualised as a resource, without entanglements or agency. In avoiding the ontological aspects of biological mimesis, political economy critiques miss the political subjectivities embedded in different conceptualizations of technonatures (Braun, 2008; Bakker, 2010). As Karen Bakker (2010: 728) suggested whilst searching for a more

expansive approach to neoliberal natures, “an expanded understanding of what ‘counts’ as nature... enabl[es] greater conceptual precision regarding effects and viable alternatives.”

Expanding what counts does not *necessarily* enact new politics. Returning to Haraway’s machinic and organic hybrids, it is possible to say that biomimicry’s uneasy alliance with, or co-optation by, logics of capital means that the political promises of nature–technology hybridity have not materialized—and indeed, been twisted inside out. Whilst recognition of a post-human condition reveals the illusory character of one of the main narratives of enlightenment heroism—that we can be in full command of Nature—the last thirty years have seen little of the progressive politics around the cyborg that Haraway hoped for. In a sense, in Haraway’s own words, “as an oppositional figure the cyborg has a rather short half-life” (Haraway, Lykke et al., 2004: 326). Arguably, however, where progressive politics *did* surface, it was largely underpinned through an ontological reconfiguration of the nature–society–technology boundary. For this reason, we emphasize the possibilities that digital natures offer for rethinking nature and hence reworking society, through “a distinct preference for processual, dynamic, relational materialisms that can hold the ‘real’ and ‘the symbolic’ in tension and that acknowledge the ‘recalcitrance’ of ecologies as well as the obduracy of objects” (White & Wilbert, 2010: 11).

## 5. Conclusions: towards a research agenda for digital natures

In this introduction to the special issue of *Digital Geography and Society* on digital natures, we have addressed some of the most fundamental and recurring questions about any emerging technology: what about it is new? And does it offer us better or worse futures? The perennial question of ‘is it new/what’s new?’ has merit, but we also caution that it must be taken critically. Here, we hedge our bets by acknowledging that the very question of new or old is itself limiting. If we move beyond a preoccupation with what’s new, then looking at patterns and trends across a longer history might help us to understand how messy orderings of nature and technology both reinforce and rework longstanding dynamics in human’s relationships with both the environment and other human beings. After all, technological society is not marked by progress, for the promises of technology remain remarkably similar even though their forms vary (Barry, 2001). Yet, assuming that the digital simply reinforces status quos, and writing off digital tools and practices as mere expressions of unchanging state and capital powers, can miss the way that tools and practices that are produced and harnessed by these powers can be used in progressive and/or unpredictable ways, and can err—and in doing so, open up new problematizations.

At the same time, assuming newness or transformation from digital tools and practices risks playing into the hype—whether positive or negative—that is purposefully constructed by powerful actors. Both approaches miss the mundanity of technology as it mediates our knowledge of and encounters with nature (Nelson, Hawkins et al. 2023). The doomsday scenario in which AI extracts the world’s resources to turn everything into paperclips is as much hype—deployed for specific reasons—as the scenario in which AI optimizes resource use towards post-scarcity for all. Both seem to reflect a sense of nature over there and society over here, and technology as either run amok or heroically commanded. Between utopia and

dystopia there is room to witness the effects of ‘actually existing’ (c.f. Brenner and Theodore 2002, Shelton, Zook et al. 2015) digital natures in complex relation to humans and environments, and to experiment with alternative conceptualizations of the world as emerging from breaking long-embedded dualisms.

Going beyond an epistemological reading of the digital–natural entanglements, we have claimed that some of the ontologies and politics that arise from digital natures are novel and valuable. Taking a historical perspective has allowed oversight of the different ways in which opportunities for progressive and radical politics might lie in ontological claims to what nature is. This sits alongside emphasising the entanglements of nature and technology and the ways in which these co-construct social and political economic relations. Although in practice such ontological possibilities have-to-date been rather underwhelming, the trace of their political promise lives on in emerging work within public practice and digital natures scholarship.

### **Digital natures: Reconfiguring ontologies, epistemologies, and politics**

The papers in this special issue, along with the debates discussed in this introduction, take a closer look at the dynamics that fold politics into ontological and epistemological claims for nature in complex and sometimes contradictory ways. In doing so, they put in action a research agenda for digital natures. Such an agenda starts with foundational questions such as how, and with what implications, do digital practices and technologies inform how we come to know and engage with nature? But quickly moves forward towards a more politically informed examination of the epistemological and ontological implications of reconceptualising nature through the digital. How do digital interventions transform nature–society relationships and the agencies and subjectivities involved? How do they lead to novel understandings of life and its hybrids, alongside new ways of securing it? Do digitalized practices of sensing, abstraction and algorithmic recombination simply mirror a pre-existing and external Nature, or do they reconfigure how people come to conceptualise nature, resignify the ways by which it matters, and alter the definition of the boundary between natural and social worlds? And finally, up to what extent the encounter between ‘the digital’ and ‘the natural’ can lead to a progressive politics of human–non-human relations beyond the capitalist critique?

The six papers that make up the special issue take us forward in answering these questions in a myriad of ways. The paper by Roberta Hawkins and Jennifer Silver, *Following Miss Costa: Examining digital natures through a shark with a Twitter account* (this issue), explores a case where social media merges with marketing to redefine marine science. The Ocearch platform they investigate enables users to track individual marine species, including sharks like Miss Costa (named after a sponsoring brand of sunglasses). People often develop affective relationships with these animals, though, in advancing a commodification of nature, the platform appears to cultivate such relationships mostly for fundraising rather than affective or educational purposes. The paper by Hira Sheikh, Peta Mitchel and Marcus Foth, *More-than-human smart urban governance: A research agenda* (this issue), offers optimism about new ways smart cities can sense and account for more-than-human subjectivities. Rather than smart cities as projects that necessarily instrumentalize nature, Sheikh et al. point to opportunities where urban governance can utilize digital tools to include and involve the more-than-human world.

Other papers in the issue investigate how digital technologies draw on, reinforce, alter, or counter discourses and ideologies of nature. Juan Astaburuaga, Michael E. Martin, Agnieszka Leszczynski and JC Gaillard, in their paper *Maps, volunteered geographic information (VGI) and the spatio-discursive construction of nature* (this issue), explain how TripAdvisor and similar tourism platforms perpetuate popular media discourses of nature as pure and remote. In constructing nature as pristine, grandiose, sublime and wild, these discourses secure the aesthetical as an ontological quality of nature. Maroš Krivý, in *Digital ecosystem: The journey of a metaphor* (this issue), illustrates how the environmental science metaphor of ‘ecosystem’ serves digital technology development, in turn legitimating the use of such technologies in environmental management. Krivý, uncovering the ideological role of ‘ecosystem’ as a future imaginary, explains how “having helped legitimize the once-outlandish claim that (digital) technology exhibits the same properties as biophysical ecosystems, ‘digital ecosystem’ has in turn been used to lend legitimacy to the wishful thinking that data and digitalization alone can put the planet on an environmentally sustainable path.” The coming together of the words ‘digital’ and ‘ecosystem’, as a privileged nature-based metaphor of digital capitalism, in effect become an agentic discourse in the worlds of business and policy.

Yet other papers emphasize material and political dimensions of digital natures, not just their discursive and ideological characteristics. They ask how an engagement with digital practices and technologies inform how and to what end both nature and territory are controlled, governed, or appropriated. For instance, Eliot Tretter and Ryan Burns, in *Digital transformations of the urban–carbon–labour nexus: A research agenda* (this issue), illustrate how digital technologies craft resources out of socio-environments. Their work asks a number of questions around how the digital is transforming the nexus between cities, extractive energies, and labour, pushing smart city research to connect with the extractive hinterlands of digital urbanism. Finally, the contribution by Sylvia Cifuentes, *Co-producing autonomy? Forest monitoring programs, territorial ontologies, and Indigenous politics in Amazonia* (this issue), discusses how digital platforms for forest monitoring are used by Indigenous organizations as tools for territorial defence. Cifuentes’ argument is that this defence is founded on ‘integral territorial ontologies’—a repurposing of technology that incorporates “the agency of natural and supranatural beings, and [gives] evidence of the territorial relationships among human and more-than-human beings that are at the basis of ancestral knowledges and practices”. Yet at the same time these political promises grounded in ontology, are limited by risks associated with data practices, such as open data and digital mapping, that produce understandings of territories as ‘spaces with strict boundaries and exclusive rights’ in ways that also threaten Indigenous practices.

As seen in the pages above, contemporary research on digital natures advances scholarly understanding of the epistemological, ontological, and political dimensions of digital natures, illustrating the extent to which digital natures move beyond representation. As future research homes in on the ontological implications of reconceptualising nature through hybrid and more-than-real digital entanglements (c.f. Taffel, 2019; McLean, 2020; Turnbull, Searle et al., 2023), we suggest that work remains to be done to make sense of the political openings and closures emerging from these new ways of being. Critically, taking cue from a recent history of ontological reimaginings of the technology–society boundary, we might ask: if the forms of hybridity advanced by ontologically informed perspectives, such as Haraway’s cyborg, were a vehicle for progressive politics, then are they getting enough traction today? Perhaps the



missing question is around the need for new languages; a new vocabulary of hybridity and entanglement beyond or alongside cyborgs, technonatures, or digital organisms. What is clear is that, if it ever could, nature can no longer be thought apart from the digital.

### **Acknowledgements**

*A very special thank you to the authors of the six papers included in this special issue. In addition, several other scholars were involved in the workshops and discussions—our thanks extend to them: Corrine Armistead, Karen Bakker, Luke Bergmann, Noëlle Boucquey, Simin Davoudi, Luke Fairbanks, Miranda Iossifidis, Alex Liebman, Larry Lohmann, Carl Olsson, Bronwin Patrickson, Agata Marzecova, Kevin St. Martin, Shanti Sumartojo, and Jim Thatcher. Our thanks also go to Sophia Maalsen, Sam Kinsley, and Jessica McLean, as editors of the journal, for their continued support. Finally, we would like to remember and commemorate the contributions of Karen Bakker, whose thought leadership over the coming together of environmental and digital geographies was so prominent in advancing the debates outlined in this SI.*

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