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Environmental Data Power

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Introduction

Data practices are at the heart of contemporary understandings of environmental change, yet the infrastructures that underpin them are also increasingly understood to have their own significant environmental impacts. In this chapter, the contributors address the issue of the relationship between data and the environment, through explorations of environmental sensing, data-driven representations of climate change, and the environmental impacts of data centres. In the contributions, we are interested in exploring the different entanglements of data and the environment. Specifically, we look at how power dynamics come into play along the journey from environmental sensing practices, through to data modelling and representation, and data storage and processing in data centres.

Across each of the chapter sections, co-authors variously engage with the contours of data, their diverse physical manifestations, their representations, their affects, and the epistemologies they materialize, reproduce, and map onto in environmental and planetary contexts. We ask: how does 'environmental data power' as a concept operate across each of these registers? To answer this question, we articulate not only how data power takes shape in relation to and via environmental contexts, but also how data technologies, economies, and practices organize and make legible the planetary through these particular affects, epistemologies, and geographies.

The first section by Brodie examines how datafication and its relations to the environment extend beyond how the environment is understood through digital technologies – it is also increasingly organized by the material infrastructures required to sustain digital economies. Data centres represent concentrated sites at which the data relations of digital capitalism coalesce and take shape, whether in the form of cloud computing or the structural organization of emerging energy systems. Energetic data power, as Brodie's section articulates, demonstrates how multinational tech companies are grafting digital business models onto energy transitions, exacerbating inequalities within the regimes and infrastructures of decarbonization at the data/energy nexus. Against this, scholars and activists need to understand struggles around data power as at the same time resource struggles at the cutting edge of new material extraction and distribution networks – from data centres to smart grids to wind farms.

We then move on to Halkort's piece which speaks most strongly to the material entanglement of digital infrastructures and their wider social and natural environment that runs through this chapter. What she shows is how the ever more pervasive architecture of environmental sensors and Earth observation technologies at sea create new conflicts over how to distribute solidarities between humans and non-humans in the face of competing pressures – that is, climate change, depleting energy resources, extreme weather events, pandemics, or war. It is in relation to this planetary crisis that the Mediterranean provides an instructive case study to unpack the uneven ways digital infrastructures are mobilized in response to risks of death and extinction and how this uneven distribution is normalized up to a point where it operates silently and imperceptibly in the background. Drawing on the notion of touch as her main analytical device, Halkort wants to bring these hidden, figural tactics back into view and make them addressable as ethical challenges, both for critical scholars and those managing these infrastructures alike.

Next, Gkotsopoulou and Quinn's contribution explores citizen science projects and their relationship to empowerment through information transparency. They consider the ways in which citizen science is shedding a new light onto traditional scientific research practices, comprising the definition of processes, the inclusion of research participants, as well as the designation of interim and end-goals including policy making. In particular, the amount of data generated in citizen science projects with environmental causes is immense, originating from various and diverse sources, and to ensure data quality, a groundwork of bottom-up principles in combination with the provision of transparent definitions and accessible information is necessary. To investigate empowerment through information transparency, they look into the methods deployed by a specific EU project, SOCIO-BEE.

Hoyng then joins the discussion with a section on how carbon metrics quantify emissions and aid algorithmic modelling of the changing climate. Hoyng's essay probes the ambiguous role of uncertainty in metrical, algorithmic representation and problematizes it by unpacking the tension between what she calls the logic of 'if/then' and the mode of 'what if'.

Whereas policy instruments simulate and calculate the consequences of our actions/inaction following the structured logic of 'if/then', the speculative, experimental mode of 'what if' underpins climate modelling as a practice. Data power shows itself in the ways in which metrics construct, produce, enable, and constrain, while they seemingly only measure their empirical referent. Yet, while casting certainty and accuracy, carbon metrics tend to erase uncertainty. While precise calculation enables us to act and address the climate crisis in certain ways, this comes at the expense of accounting for the real challenge, namely acting in the face of uncertainty.

Our final section, by Fratczak, focuses on climate change data visualization (data vis) as a case study that offers a means of exploring how graphs, charts, and maps can encourage people to think – and feel – differently about urgent social issues and mobilize them to act. It centres around the power of data vis in climate change communication and challenges the prevailing assumptions that data vis primarily conveys knowledge and rational arguments. The essay advocates for the recognition of emotions as a crucial element in engaging with data vis and mobilizing individuals in datafied democracies. It underscores the importance of inclusive practices in the design of data vis, ensuring that vulnerable groups have equal access to data and opportunities to shape datafied societies.

In putting together these case studies, which variously speak to the power exerted by and through the intersections of data and the environment, we hope to add to a growing conversation about data and environmental justice. Building on and in conversation with the formative and emerging work of scholars such as Jennifer Gabrys (2014), Mél Hogan (2018), Sebastián Lehuedé (2022), Jenny Goldstein and Eric Nost (2022), Alan Irwin (1995), and Janis L. Dickinson and Rick Bonney (2012), we show in this chapter that environmental data power is also a tool that can be wielded by communities, activists, and political groups towards environmental justice, whether that means disrupting powerful circulations of digital technologies or identifying key points at which to intervene and even seize data power. As environmental justice becomes a moral imperative for scholars of digital media and technology in the midst of deepening climate crisis, so must we align with the principles and actions of data and environmental justice (see also Vera et al, 2019). Utilizing these practical tools and building coalitions across data and environmental justice struggles, we can identify sites through which to build transformative relations of environmental data power.

Energetic data power – Patrick Brodie[3]

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In this short excerpt, I will reflect on what I call the 'energetic data power' becoming embedded in infrastructural systems in Ireland at the intersections of data and renewable energy. Most of my recent research has looked at the data centre industry, and specifically its huge expansion in Ireland (Brodie 2020a, 2020b, 2021; Bresnihan and Brodie 2021, 2023). Sharae Deckard, an environmental humanities scholar, expanding on the work of Jason Moore, argues that the financial mechanisms that have attracted and maintained multinationals here mean that FDI 'organizes nature' in Ireland (Deckard, 2016). She was speaking financially, and via spatial and property development, but in the case of big tech, their infrastructures metabolize with the wider infrastructural systems in which they rely and partake. Data centres act as tools and infrastructures of resource-making in a number of ways – from the types of data they process and the ways they do it in the refining of data-as-resource via data extractivism (see Taffel, 2021), to the physical, mineral, water, and energetic inputs required to construct and run them (see Hogan, 2015; Lally, 2019), which are extracted from land and atmospheres surrounding the facilities and via global supply chains that extend far beyond Ireland.

Their primary resource impact and operational capacity, though, is through electricity use. In 2021, data centres used 14 per cent of the country's grid capacity on a daily basis, as compared to the 12 per cent used by all rural homes combined (see Carswell, 2022). This obviously points to huge inequalities in how energy systems are being used and developed here, especially during an interlocking energy crisis and low-carbon energy transition. The resource-intensivity of data use is largely eaten up via these facilities, whether in the form of what they draw directly from the grid, the battery backups that they charge (also from the grid, but stored in lithium batteries), or the diesel-powered generators they keep on-site in the case of grid failure. All this while folks struggle to afford heat in their homes.

But none of this is to mention the ways in which data centre providers are posing themselves as essential to grid transformation in more entangled ways, demonstrating the backdoor privatization of aspects of utility systems – delivering refined resources for lives and livelihoods through infrastructures – that big tech companies are able to graft onto (see Velkova, 2021). Data centres are at the forefront of the transformation of the Irish energy system, including the state incentivization of corporate power purchase agreements to develop wind and other renewable energy. AWS, for example, has purchased power from four wind farms across Ireland, one of which, the Meenbog Wind Farm in Donegal, was the site of a catastrophic peat landslide in 2020, demonstrating the ecological entanglements with rural places apparently far from the site of the ostensible data infrastructure. Microsoft abruptly announced in 2022 that they had purchased 900 MW of renewable energy in Ireland through these schemes (O'Brien, 2022). These corporate power purchase agreements (CPPAs) act as offsets in the absence of direct energy provision for their data centres, essentially also guaranteeing low prices for electricity into the future.

The overwhelming of Dublin's grid was finally acted upon by Eirgrid in 2021, by recommendation of the Commission for the Regulation of Utilities, with a de facto moratorium on new data centre grid connections in Dublin. The recommendations, however, were not to halt data centre growth entirely, and as of late 2022 there were apparently 21 new data centres in planning outside of Dublin (Moss, 2022) and 11 facilities in Dublin bypassing the grid by connecting to gas networks (Swinhoe, 2023). In light of these ongoing issues, data centres are being proposed by state and corporate supporters as potential grid solutions providers due to their on-site energy infrastructures, including batteries, in order to absorb excess intermittent renewable energy capacity – ensuring 'grid flexibility' by absorbing power and selling it back to the grid (Paananen and Nasr, 2021; Roach, 2022). Microsoft in particular has tested this model in Ireland and plans to export it elsewhere in their data centre fleet (Roach, 2022). When you also take into account the cloud-based technologies for forecasting, monitoring, and measuring energy availability and use along the supply chain of the grid, by companies such as Siemens and GE, the implications of big tech involvement in the operation and delivery of these systems introduces difficult questions about the administration of public utilities by multinationals – whether considering the potential for a tech downturn, or simply in the extractive systems designed to maintain the energy status quo via techno-solutionism.

As the above cases demonstrate, there are huge implications for land and infrastructure in these energy transitions, especially in the backdoor privatization and land-grabbing that are coming in this new resource rush for renewables, not to mention the land and resources required for the basic construction and functioning of data infrastructures. By mapping the myriad implications of big tech's role in Ireland's climate-driven energy policies, we can better understand how territories and environments are being enrolled into these emerging systems, even apparently far from typical imaginations of data-intensivity. Each of these sites can also crucially be understood as key points of resource struggle around the expanding and transforming relations of data power.

Just sense: on the tactility of vision in the Mediterranean Sea – Monika Halkort

The combined impact of climate change, loss of biodiversity, industrial waste, and noise pollution have established the world oceans as a critical platform for anticipating risks of premature deaths and extinction. It transformed coastal waters and the high seas into highly instrumented spaces, where the boundaries between social, technical, and biological intelligence, sensory registers, and communication are becoming ever more blurred (Gabrys, 2019). An extensive array of drifting sensor points, underwater gliders, and Argo floats are currently roaming the seas for the purpose of observing rising sea levels, oceanic temperature, salinity, and ocean currents. They are supported by coastal webcams, Earth observation satellites, and remotely operated underwater vehicles (ROVs, AUVs) or hydrophones, that enable scientists to monitor and document critical changes in the marine ecosystem in next to real time (Gabrys, 2019).

Increasingly these environmental platforms are also mobilized for military purposes and maritime surveillance, further fuelling logistical fantasies of rendering the sea knowable, governable, and transparent. Both NATO and the EU coastguard and border security agency FRONTEX draw on a wide spectrum of real-time tracking and monitoring devices, including the Automated Vessel Identification System, high-frequency radars, underwater sonars, and satellite imagery, to create a matrix of situational awareness for policing the Mediterranean Sea.

In my previous work (Halkort, 2021, 2022), I have shown how this convergence of military and scientific intelligence implicates planetary infrastructures of Earth observation in racialized politics of risk and securitization in the face of competing pressures. In the short space available here I want to emphasize the material agency of instrument platforms in this process, drawing on the notion of touch to unpack how environmental sensors configure oceans, environments, and bodies into 'matters of concern'.

To raise the question of touch in relation to sensory media, is not to insist on the idea of touch as privileged or unmediated access to the world imbued in the tactility of the body or the skin, but rather to make room for interrogating the inherent ambivalence of sensibilities afforded by technical mediation that both open up new possibilities for engaging with neglected perceptions while at the same time allowing for new modes of abandonment and exclusion, silencing, and erasure in our engagement with non-human others and worlds.

A brief look at how machine sensors read and interact with natural environments may help to explicate this point. Two of the most important measures in climate research are temperature and salinity – the degree of salt in water. Both indicate the density of water, which regulates how ocean currents circulate from the tropics to the poles critically affecting global warming and climate change (NASA, 2009). To measure salinity concentrations, the subatomic particles of the seawater (electrons) interact with electrodes on sensors, using the electromagnetic radiation of sea surfaces and electrically charged particles of the water (ions) as their primary medium (Aquaread, nd). The drop in voltage between the two sensor electrodes gives a measure of resistance, indicating the concentration of ions in the water, which can be converted into a measure of salinity. The higher the concentration of ions, the higher the salinity of the water (Aquaread, nd). Hence, what sensors in fact measure is not the amount of salt in the water as such, but the electromagnetic activity running through it, converting it into numerical data that can be processed in machine-readable form.

The ways ocean sensors communicate with their environment powerfully evokes the physicality of touch as a mode of contact and connectivity in cross-modal encounters, where seeing/sensing is never separate from direct engagement with the materiality of objects or environments observed. As Karen Barad (2012: 206) reminds us, from the viewpoint of quantum physics, touch is above all a figure of repulsion and withdrawal – the effect of electromagnetic interaction between particles communicating at a distance, pushing each other away. Hence, what we actually feel, in a touching sensation, is not the caressing sensation of a beam of sunlight or a body, whose touch we may seek, but rather the electromagnetic repulsion between the electrons of the atoms that make up the human body or the entities we touch. Touch in this sense always involves both a connection and a separation – 'a spacing in contact' (Nancy cited in Butchart, 2015: 223) – where the boundaries that hold entities in communicative relation are simultaneously experienced and marked.

From a feminist viewpoint these 'spacings' carry ethical resonance (Haraway, 2007; La Puig de Bellacasa, 2017). They demand a skilful recognition of the multifaceted risks, vulnerabilities, and collective reciprocities at stake in the ability to touch and being touched by human or non-human others and to remain curious about what happens in the contact zones established by touch (Haraway, 2007). Relayed back to the tactile vision afforded by remote sensors this implies attending to the multiple gaps, blind spots, and misrecognitions that come with the expansive field of sensibility afforded by machine vision as they convert lived and embodied phenomena into data signals and machine-readable forms.

In the specific context of the Mediterranean, as I have shown (Halkort, 2021, 2022), these perceptual possibilities are currently mobilized in a highly selective and exclusionary manner. This has created a situation where technologies, originally designed for border protection and maritime surveillance, are put to use for the protection of endangered species, while thousands of migrants are left to die in the same waters, without anyone noticing or responding to their call. This split recognition of risks and emergencies is indicative for the ways digital infrastructures enrol new spaces for validating and evaluating life on the level of data proxies, as a direct result of how they are modelled in data and how they are algorithmically codified.

Fair environmental data power – Olga Gkotsopoulou[4] and Paul Quinn[5]

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From the colossal citizen science projects organized around the globe by NASA[6] to smaller, local or district-based initiatives, more and more research depends on the collection and processing of data achieved through citizen science channels. This is particularly true for data relating to the environment within the aim to better inform environmental policies and laws, enhance scientific outcomes for further research, and study and promote scientific literacy and innovation as well as science communication.

In this brief passage, we look into the field of environmental observation and action which includes several diverse citizen science initiatives. We take as an example, a selected EU citizen science project for environmental action, specifically with respect to air quality (SOCIO-BEE).[7] The citizen scientists will be encouraged to collect data about air quality in their urban neighbourhood, to observe the increase of pollutants in the air or the spread of smog, so as to raise awareness within the local communities and inform actions at formal level. Those different types of data coming from citizen scientists, will feed into further research; this research will subsequently feed into specific scientific outcomes; and the outcomes will feed into evidence-based decision-making at municipality level, with sustainable impact.

Citizen engagement is a top priority in the European Union (EU)'s agenda, to enhance community involvement and participation in policy making through the generation, fair sharing, and processing of data. To establish a data-sharing 'culture' and improve data infrastructure, the EU calls, through its 2020 European Strategy for Data, for more sustainable data economy models, featuring data altruism schemes. Based on it, it invests heavily in data law initiatives with the review or repealing of older legal instruments and the negotiation and adoption of new.

Part of citizen engagement is citizen science; in other words, the participation of the public in scientific research, either with the help of, or outside, institutions traditionally regarded as scientific. That said, one first challenge to overcome is that even though there have been many efforts to define citizen science, there is not one commonly agreed definition. In line with the definition included in the *Oxford English Dictionary* in 2014, citizen science is to be understood as 'scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions'. A more traditional view on citizen science is that of Irwin (1995), which describes citizen science as a movement to democratize science. A more recent approach is that by Groot and Abma, who regard citizen science as 'an umbrella term that applies to a wide range of activities that involve the public in science' (Groot and Abma, 2022). In a nutshell, to highlight the diversity of citizen science initiatives, it is important to mention the different types that exist depending on the role assigned to the citizen scientist (Nierse, 2019), that can be categorized in the following: consultation, collaboration, and control. To add more complexity, there are different types of research projects depending on the level of engagement (Bonney et al, 2015), including data collection projects, data processing projects, curriculum-based projects, and community science ('co-created') projects.

The SOCIO-BEE project includes the study of law, policy, and ethics of data flows in environmental action as an indispensable component by scratching upon the layer of data management, from its conception through research design until its interpretation into a plan and its communication to the citizen scientists in a four-way structure. First a Data Management Plan and an Ethical Commitments Strategy were developed for the project consortium to lay down the threshold legal and ethical requirements and to provide clarity about the data flows and processes from the beginning until the conclusion of the project. Second, a Protocol for Citizen Scientists was developed in cooperation with citizen science experts coming from different fields which sets out the bottom-up principles for the project participants. It functions as a research protocol based upon co-creation and interdisciplinary cooperation, promoting principles of data quality and respectful participation. Third, the knowledge achieved on these matters is being openly shared through the Knowledge Powerhouse for Citizen Science on Law and Ethics,[8] a publicly available repository with a wealth of resources. A final pillar is the provision of accessible information to all research participants, including data subjects, in the project.

All in all, we argue that for power based on environmental data collected or processed within the citizen science context to be fair: (a) light must be shed upon the existing and applicable legal framework on citizen science and research data management as well as the ongoing discussions in the EU; (b) citizen scientists must be emboldened with accessible information with respect to their participation in research processes; and (c) the challenges posed by the ambiguity around the concepts of citizen science, scientific research, as well as new emerging terms such as data altruism, must be acknowledged and taken into consideration when designing and executing citizen science projects, for instance through the standardization of citizen science for high-quality participatory research. An instance of such effort could be the 10 Principles of Citizen Science by the European Citizen Science Association, which provide a groundwork in the form of a *Wegweiser* for citizen science projects in Europe.[9]

Counting carbon, accounting for uncertainty – Rolien Hoyng[10]

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Carbon metrics quantify emissions in support of algorithmic modelling of the climate, or rather, the interactions between planetary ecosystems and human action. This essay probes the ambiguous role of uncertainty in metrical, algorithmic representation of the climate. I problematize this ambiguity by unpacking the tension between what I call the logic of 'if/then' and the mode of 'what if'.

From United Nations' COP conferences to carbon tracking apps, responses to the climate crisis rest by and large on quantifying emissions. Carbon acts as a metric (CO_2) rendering different greenhouse gases equivalent in terms of their potential to warm the planet, and so it provides a framework for conceiving pollution (Whitington, 2016). Building on the standardization and quantification enabled by this metric, carbon counting aids the policy instrument of the carbon budget which calculates how much more we can burn, so to speak, before we encounter a threshold – be it 1.5 °C or 2.0 °C. It furthermore underpins simulation in Integrated Assessment Models (IAMs) that incorporate various parameters and proxies representing factors such as the global economy, energy usage, and land and climate systems. These socio-ecological models present algorithmic simulations of the consequences of our actions/inactions, following logics of if/then (Bucher, 2018): 'if this' (policy/behaviour), 'then that' (temperature increase/decrease).

As Brighenti (2018) argues, metrics tend to affect the state of things under observation, and here the metric both enables and delimits prevailing forms of climate action. Yet, despite the appearance of empiricalness and accuracy, carbon counting is often speculative in practice. For instance, not only actual exhaust is counted but also the potential absorption, or intake, by carbon sinks. Such sinks include reforestation projects, involving bacteria experiments as well as technological innovations in carbon capture, even if these technologies do not yet exist or their effectiveness has not been proven so far. In the case of 'green' projects, negative emissions are hypothesized as virtual (not-actualized, not-in-fact-happening) exhaust is rendered as a quantity that can be sold and bought so that, while someone is 'saving' pollution, someone else can buy a licence to pollute. So, carbon trade and offsetting form markets around the right to pollute as a scarce resource.

Moreover, whereas instruments such as carbon budgets and IAMs imply a planet reduced to the metric of carbon and the structured logic of 'if/then', the mode of 'what if', which underpins climate modelling as a practice, probes the planet and human involvement in it in a speculative manner. The notion of a changing climate is constituted by complex models of proxies, speculations, and conjectures. As with Bowker and Star's (1999) infrastructural inversion, a model may seem an object, but look again and all you spot are situated practices of modelling through constant tweaking and recombining different models. The suggestion of an objective system, abiding by logics of 'if/then', dissipates in experimental and speculative practices conducted in the mode of 'what if': what if conditions are as such and such, what if there is a relation, what if weights are as such and such. The problematic of 'what if' becomes, for instance, evident in the use of 'ensemble' techniques in climate change modelling, which rather than deploying only one method of computation combine a range of methods by tweaking either initial conditions, models, or their parameters. The experimental and speculative mode of 'what if' responds to planetary uncertainty and instability – call it 'agency' (Chakrabarty, 2021) – which become increasingly palpable as what are supposed to be unlikely 'black swan' events begin to feel like the norm itself: the unpredictable becomes the expectable. Now, can we talk about a climate budget, which assumes a relatively stable ontology, plus known thresholds and tipping points? Even the notion of 'climate risk', which figures in policy and insurance, evokes a probabilistic ontology in which chance can be calculated, rather than an open (anti-)system consisting in planetary instability, provoked by the climate crisis.

The logic of 'if/then' and the mode of 'what if' are at tension. To understand the politics and consequences of this tension, and the ways in which they play out in particular situations, requires thinking critically about environmental data power. Carbon counting in the context of policy and trade assumes a planet with a rather stable ontology, a system that is more or less fixed, revolving around logics of 'if/then'. Data power shows itself in the ways in which metrics construct, produce, enable, and constrain, while they seemingly only measure their empirical referent. Yet, while casting certainty and accuracy, carbon metrics in the context of the climate crisis often perform a double erasure: they efface the speculative nature of the practices that they support as well as of our understanding of the planet more generally. My point is not to critique data-centric and metric-based epistemologies of the climate crisis for their inaccuracy but to question the idea of accuracy itself, as it erases the uncertainty that primarily qualifies the predicament of climate chaos. The precise calculations in support of trade, offsetting, and risk industries enable us to act and address the climate crisis in certain ways, but at the expense of accounting for the real challenge, namely living with, and acting in the face of, uncertainty.

The power of data vis: emotional responses to climate change data visualizations – Monika Fratczak[11]

There has been a huge rise in the visual communication of data and information in the form of data visualization (data vis) in everyday social life and on social media. Politicians, designers, activists, and campaigners increasingly use data vis in topics ranging from climate change and elections to COVID-19 distribution and social inequalities, hoping that it is an effective tool not only in communicating information to the public and reaching a variety of recipients but also in mobilizing them to undertake the actions they deem necessary. In this context, understanding the role emotions play in engagements with data vis about climate change is especially important because emotions are vital components of making sense of data, as a number of practitioners and scholars argue (such as Kennedy and Hill, 2018; D'Ignazio and Bhargava, 2020; Gray, 2020). Moreover, Nærland (2020) suggests that data vis enables and mobilizes people to function as citizens and take part in political debates or everyday discussions.

However, to date, most existing studies on engagements with data vis have been carried out from a computer science or psychological perspective. These studies have primarily focused on the capacity of data vis to convey knowledge, its efficiency, or comprehension, or its ability to persuade audiences through rational arguments (see Haroz and Whitney, 2012; Haroz et al, 2015; Borkin et al, 2015; Harold et al, 2020). This may be due to an assumption that data, and thus data vis, are objective reflections of knowledge and do not make much of an emotional impact, unlike other visuals, such as emotive images (see, for example, Climate Outreach's project and research, 2021). Therefore, the purpose of data vis is often seen as a tool that allows recipients to independently explore data and draw empirical conclusions. In these processes, emotions do not play a significant role.

In contrast to this assumption, my research considers emotions as a central aspect of social and political experience (Ahmed, 2004; Wahl-Jorgensen, 2018) and a vital aspect of people's engagements with data and data vis (as seen in Kennedy and Hill, 2018). My study offers insights into diverse individuals' emotional responses to data vis about climate change through a sociological lens and considers whether and how these emotional responses may subsequently prompt political participation in different national and geographic contexts. It employs a comparative mixed qualitative methods approach, incorporating visual analysis of 13 data vis about climate change published on Facebook, Twitter, and Instagram, nine semi-structured interviews with ten data vis professionals from six organizations who design, commission, and/or disseminate data vis about climate change on social media, 34 semi-structured interviews and 13 follow-up interviews with diverse social media users who responded to the data vis about climate change disseminated on Facebook, Instagram, and Twitter by Carbon Brief, Climate Science, Greenpeace, and the World Wildlife Fund, organizations from the UK and Poland.

In this study, I argue that data vis can be seen as what I have called an 'emotional repository' of dynamic and complex emotional experiences. These emotions play an important role in mobilizing people to participate in datafied democracies, more often on an individual and daily level, and less frequently on a collective and public scale. However, the ways in which emotions motivate participation can differ depending on national and geographic contexts and other demographic characteristics. Furthermore, unequal emotional engagement with data vis and mobilization or lack thereof, can result from different national contexts and other demographic and social factors. My findings suggest that some demographic, often vulnerable, groups may be discriminated against in data vis practices, as suggested by D'Ignazio and Bhargava (2020). This discrimination may be the reason why some individuals do not emotionally engage with data vis about climate change, do not pay attention to them, and are consequently not mobilized by them.

By providing empirical insights into the emotional significance of data vis, my research challenges two assumptions. First, the assumption that understanding data vis about climate change is the main prerequisite for mobilizing people to act, as many studies focusing on the capacity of data vis to convey knowledge and persuade audiences through rational arguments have shown. Second, the assumption that emotive imagery, such as photos of the negative consequences of climate change, may be more effective means of engagement than data and data vis. While researchers and activists have emphasized the use of emotive images such as photos to engage people with climate change issues (see Leiserowitz, 2006; O'Neill et al, 2013; Metag et al, 2016; O'Neill, 2020), there is no equivalent recognition for data vis. Therefore, higher priority should be given to data vis, with greater recognition of the emotions they can trigger, as these emotions can be the only way for many vulnerable groups to access data and participate (or not) in datafied societies.

Conclusion

In environmental contexts, data have frequently acted as a way of knowing and accounting for environmental changes and transformations, whether towards conservation, development, or other human-centred activities. Across this chapter, however, we have demonstrated that data are far more than a way of understanding and ordering the world – their technologies and infrastructures act upon existing institutions, spaces, and environments. Crucially, this occurs unevenly, and requires thoughtful and critical engagement with sites of data operations in order to re-route data power towards more just and equitable alternatives. Data power is not only wielded and enacted by powerful institutions, it is, and can be further disrupted, challenged, and taken back by a diversity of actors across the contexts studied here.

One provocation we may make here is to ask how we can extract data from their most frequent utility within inequitable and environmentally unsustainable development, profit, and capitalist accumulation applications. As each of these contributions demonstrates or evokes in different ways, data power is frequently instrumentalized towards ostensibly environmental goals that may be at odds with existing and more careful relations to the environment. By extricating environmental data power from the institutions and infrastructures whose strategies have long harmed and degraded the environment and reproduced environmental inequities and injustices across history, researchers and activists are, and have been, able to redirect environmental data power towards community- and justice-centred alternatives to (big) data capitalism and its imbalanced environmental relationships. In this way, we hope that this chapter presents not only critique of environmental data power exerted and exploited by powerful data actors, but points towards careful ways forward at the practical intersections of environmental and data justice.

DISCUSSANT RESPONSE

Environmental data power towards environmental data justice – Eric Nost[12]

The brief reports assembled here give us a sophisticated sense of how environment and data intersect in the world today. These intersections are epistemological in the sense that how we know the environment is increasingly mediated through datafication, as well as material, in the sense that data infrastructures such as server farms and sensors are immersed in flows of energy (electricity) and matter (for example, rare earth metals). What is at stake is how we individually and collectively come to know our world and harm, care, or otherwise relate to it.

Each contributor makes their own unique addition, but the overall picture is clear: we cannot keep thinking about data in the ways we are used to. Data technologies are far from neutral tools, but sites of struggle over futures; they may be powerful, but they are not without their limitations; they are not just instruments of rationality, but derive much of their power from their appeal to our emotions; they do not float around as disembodied objects, but are situated in the world; far from immaterial, they help us sense through their physicality. Not virtual, they are 'more than real' (McLean, 2019).

My own work on data, society, and environment leads me to think about three elements of environmental data power. First, I want to be careful about binaries that divide the material and the epistemological. We know that knowledge is power, driving a datafication that has all sorts of interesting philosophical and political economic dimensions. Knowing nature from satellite imagery is undoubtedly different from knowing it through long-term field work or life experience (though *how* different and to what end is another question). Knowing nature through data that circulate quickly and widely is probably more amenable to capital accumulation than nature as known (or felt) through unwieldy individual accounts. My point is simply that we should not stop here, as these epistemologies imply physical outcomes on the landscape. For instance, when we turn to data technologies to tell us about future sea level rise and storm surges, we are led to outputs that reflect the conditions of that data – their scope, their producers' interests, and so on. In turn, these outputs reshape the world in very concrete ways by influencing which places see investments in climate adaptation (Nost and Colven, 2022). More broadly, Gabrys (2020) illustrates how datafied environments such as smart forests are increasingly thought of *as* technologies (for addressing environmental and climate change), leading to their material expansion across rural and urban spaces.

Second, it is worth making explicit what we mean by 'power' in environmental data power – where is it found and what are its limits? Do we focus on the dominant and seemingly unstoppable forces of extractive platform capitalism, or emphasize its glitches (Leszczynski, 2019)? What forms of resistance do we look for – the individual, the collective, the productive (Ettlinger, 2018; Thatcher and Dalton, 2021)? In the vein of glitches, Halkort reminds us of the importance of 'attending to the multiple gaps, blind spots, and misrecognitions' within data and data technologies. Data's emotional dimensions may not represent a glitch (Fratczak notes they are features not bugs), but attending to them too reflects a similar feminist understanding of power as multiple and embodied. Critics of datafication may take for granted – or at least not trouble – the idea that data registers as rational when lamenting how it reduces relations to numbers. This misses the other emotional registers that give data their power. As Nelson et al (2022) ask, 'How [do] digital technologies affect the everyday experiences, emotions, and sensations of socio-ecological relations?'

Third, we should wonder what environmental data power is for. At the moment, it is certainly wielded for extractivism, profit, and surveillance, but also for sustainability, community, and I would emphasize, justice. I would argue that the call for a coalition between data and environmental justice struggles leads us to questions at the heart of what colleagues have called environmental data justice (EDJ) (Dillon et al, 2017; Vera et al, 2019; Murphy, 2022). What is at stake in centring data that misrepresent people and places through bias or absences? What is possible and just to do with existing data, and what do empowering data infrastructures look like? Here, I would recall the data ethics refrain that 'data are people', which Thatcher and Dalton (2021) cleverly turn into a call for collective action towards sovereignty: 'Our data are us so make them ours.' In my mind, EDJ echoes this, but reminds us that we should think critically about the relations that constitute 'us' – not everyone is in the data or has the capacity to hold them. Environmental data power then means building the power to both rectify this, mitigating harm, while also de-centring the datafication processes that make it consequential in the first place.

Authors' response to discussant

Nost's points here are extremely welcome and pertinent – we are especially inspired by his insistence on maintaining the intricate entanglements between the epistemological and the material. In different ways, each contribution demonstrates that, in the context of environmental data especially, the material formations under discussion – whether technologies, infrastructures, environments, or institutions – are all co-constituted by the epistemological grounding and ideological contexts behind these different projects.

However, to brush against the grain slightly, the issue with centring beneficial, just, and 'ethical' data-driven applications, however much they can be directed towards justice (and especially in place of sustained critique), is that there is not a shortage of discussions surrounding ostensibly 'positive' uses of data technologies. Media, funding, and policy attention is extremely focused on ethical artificial intelligence (AI), technology for good, citizen science, and other mechanisms by which community power and engagement can be, at best, directed towards projects that benefit particular philanthropic interests and, at worst, co-opted towards more instrumental and profit-driven ends.

There is, however, a shortage of engaged critique of techno-solutionism and its embeddedness within environmental practices, especially in the public sphere. Putting more sustained and persistent critiques into the world, especially when aligned with practice that truly decentres these logics, is at this point just as important as identifying potential points to apply hope and form more just templates. Unfortunately, many of us as researchers are tied into funding structures and mechanisms which are built for such co-optation, as universities are by no means neutral actors in environmental data politics (for great, critical reflection on this double-bind, see Liboiron, 2021). By necessity, environmental justice organizations and researchers are usually stuck using certain kinds of technologies, infrastructures, and funding of green capitalists to do their work, and we need continual reflection on what this means for relationalities across research, data, and more-than-human ecologies. While we need to accept and acknowledge the inescapability of double-binds, critique may still be our most powerful weapon for identifying the points at which environmental data power may be seized towards a truly transformative environmental data justice, which will come, as Nost reiterates, by 'de-centring the datafication processes that make it consequential in the first place'.

Notes

1. Discussant
2. Facilitator
3. University College Dublin

[4] Vrije Universiteit Brussel
[5] Vrije Universiteit Brussel
[6] See: https://science.nasa.gov/citizenscience
[7] See: https://cordis.europa.eu/project/id/101037648
[8] See: https://socio-bee.eu/?page_id=697
[9] See: https://ecsa.citizen-science.net/2016/05/17/10-principles-of-citizen-science/
[10] Lancaster University
[11] University of Sheffield
[12] University of Guelph, Canada

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