

Sensors and Sensing Practices: Reworking Experience across Entities, Environments, and Technologies

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Abstract

This editorial examines how sensing practices are transforming through proliferating sensor technologies and altered sensing relations. Rather than engage with sensing as a project of the human mind or body as usually delineated within sensory classifications, this overview of sensors and sensing practices documents how sensing entities are emerging that are composed of shifting ensembles of multiple humans and more-than-humans, environments and technologies, politics and practices. By decoupling sensing from its exclusive human orientation, the editorial and collection demonstrate how reworked approaches to sensing make it possible to tune in to how involvement with environmental problems unfolds and endures. The collection asks how sensing practices might be crafted that attend to the distributed and accumulative inequalities of environmental problems

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and to speculate toward differential collectives for addressing environmental crisis and change.

Keywords

sensors, sensing practices, environmental change, environmental collectives, environmental politics, politics of sensing

Sensing is a topic that has been extensively discussed across multiple fields of study. Usually, some version of a cognizing human is at the center of work on sensing, where a particular delineation of the five senses is the organizing logic for making sense of the world. Indeed, there is no shortage of research on the five human senses, both within science and technology studies and farther afield, as well as works that employ the five senses as an organizing trope. With these works, sensing is tied to particular types of human embodiment, engagement, and experience. However, there are many more sensing entities and modes of experience that are now coming into view, from computational sensors that monitor environmental pollution, to organisms that sense and bio-accumulate environmental toxins, and satellites that remotely sense aquifers.

The focus in this special issue is on the proliferation of sensors, sensing entities, and sensing practices that become evident through distinct encounters with changing environments. “Sensing practices” is a term we have developed to capture these changing formations of experience. It is an analytical device for thinking through how experience and relations are reworked across entities, environments, and technologies. Rather than reinscribe the classification of “the senses” from a universal human reference point, this collection seeks to disrupt and transform sensing away from a classificatory and exclusively human project. The contributions in this collection unsettle these ways of organizing sensing. In their different ways of grappling with an array of sensing entities, practices, relations, and milieus that are concretizing as experiencing assemblages, the texts in this collection ask how distributions of experience have concrete political effects that are also collectively felt.

Sensing practices has been a guiding concept within previous research on environmental sensing technologies that have informed the Citizen Sense research project. From sensing experimental forests (Gabrys 2012) to animal hackers (Pritchard 2013, 2018) and programmable earths (Gabrys 2016), we have suggested that it is possible to investigate how modes and

relations of experience might be differently configured and toward alternative political collectives and a/effects. How might environments and environmental problems open up, for instance, beyond the usual designation of a dilemma to be solved, when the many experiencing entities, their modes of involvement, and influence on one another are taken into account? This is a more cosmopolitical way of understanding processes of environmental sensing, and here we draw on Stengers (2011a) to consider how these modes of experience are also ways of making worlds.

Just as the entities, relations, and practices of sensing shift, so too do the formations and processes of sense—that which is sensible and senseable—change. While our previous work within the Citizen Sense research project has indicated how these shifts in sensing practices are significant for the ways in which they rework environmental entities and relations (Gabrys and Pritchard 2018), in this special issue, we zoom in on the specific details of these new entities and relations by attending to specific sites and distinct modes of sensing practices. What such an investigation reveals is the plurality of sensing practices, together with the expanded environmental collectives that are involved in sensing and indicating environmental change. How are environmental collectives constituted, and how might we begin to understand them through their sensory and experiential registers? The philosopher Alfred North Whitehead (1929) suggested one entry point through his project of expanding the contours of experience beyond human reference points to the experiences of all entities, as they take up, transform, and express the conditions of their experiencing. This is a radically different way of understanding the work that experiencing does by connecting subjects to their environments and to societies of other entities with which experiencing takes place. These are collaborative modes of sensing (Gabrys 2012), which are radically distinct from the usual ways of encountering the problem of how (universal and individual) humans make sense of the world.

Sensing practices as a concept captures the distinct approaches to undertaking research, which are emerging within science and technology studies and aligned fields. New methods are materializing through these practices that include experimental, practice-based, and participatory research. Sensing practices might also shift the traditional categories of expert, citizen, and participation to generate new approaches to science and technology studies. While our own work in the area of sensors and sensing practices has been percolating for over a decade (e.g., Gabrys 2007), we align this collection with ongoing research in science and technology studies that looks at different modes of experiencing across human and more-than-

human subjects. For instance, Tsing (2015) notes the ways in which sensing and listening to environments and environmental inhabitants can become a political act. Benson (2010) documents how environmental sensing practices in the form of tracking raises distinct questions about the scientists, organisms, and environmental relations that are under study. And Lehman (2018) documents how sensing practices for studying oceans becomes a way in which distinct oceanic relations and modes of governance are formed. While the focus of this collection is on environmental sensing practices, there are also many other sensing practices that scholars have documented, from sensors for tracking and targeting used in military applications (Suchman, Follis, and Weber 2017) to senses of toxicity and race as experienced through lead paint and lead poisoning (Chen 2012). By engaging with the proliferation and distribution of experiences, these works demonstrate how practices become a key way in which to make sense (cf. Citizen Sense, 2014-2015), as an ongoing and collaborative undertaking, rather than as a delineated exchange between human organs and external stimuli.

The work included in this collection further builds on the contributors' ongoing research into sensors and sensing practices, as the authors here also have previously developed key work that contributes to the formation of this area of study on sensing practices. Helmreich (2009, 2015) has undertaken extensive research on oceanographic sensing and sounding oceans, and his work has demonstrated how sensing is bound up with multisited instruments and ecologies of sensing practices. Ballesterio (2016) has considered the indeterminate ways in which aquifers are experienced, and how this indeterminacy influences the formation of publics. Christelle Gramaglia (Gramaglia and Sampaio da Silva 2012) has examined the ways in which organisms, as sentinels, not only signal pollution but also demonstrate how ecologies depend upon collective modes of sensing. Kuchinskaya (2014) has investigated the ways in which radiation, an ordinarily invisible phenomenon, becomes visible through particular sociopolitical engagements and actions, for instance, to prevent exposure or create new regulations. Lorenzo Pezzani and Charles Heller (Pezzani, Heller and Stierl 2017) have developed an approach involving "disobedient sensing" that uses ship-tracking technology to aid in the effort to expose human rights abuses to migrants crossing the Mediterranean Sea. And Howe (Howe and Boyer 2015) has suggested that different ways of sensing "wind power" can inform "a series of cosmologies, about how the wind makes people and what people make of the wind" (p. 36). This collection helps not only to connect these projects into a distinct field of sensing practices, it also

amplifies the conversation across different approaches to sensing practices that begin to resonate across multiple lines of inquiry.

This collection then develops a sustained engagement with sensors, sensing practices, and environments. Primarily situated within science and technology studies and focused on case studies that engage with environmental topics, this collection takes an interdisciplinary and sociologically informed approach to studying sensors and sensing relations that span locations from the Netherlands to Costa Rica, Northern Australia and Southeast London, Southern France and Fukushima, the Mediterranean Sea and Iceland. The contributions here engage with distributed modes of sensing across ocean waves and ship vessel tracking, radiation and air pollution, climate change and water shortages, conger eels and aquifers, as well as urban development and industrial pollution, in order to demonstrate and query the ways in which sensing practices give rise to alternative theoretical and practical alignments as well as possibilities for political engagement with environmental problems.

The articles included in this special issue bring a transdisciplinary approach to current environmental topics and forge new approaches to social studies of environments. Addressing and analyzing some of the most urgent contemporary environmental problems, from air pollution to climate change and ocean ecologies, the articles present rich empirical case studies that are also theoretically rigorous and which have implications for policy and activism. At the same time, this collection includes new research approaches that are participatory, practice based, and engaged with nonhumans. These research investigations further rework and transform engagements with what counts as a sensing entity or site of sensation. Included here are sensing practices undertaken through wave buoys and satellites, maps and stories, fish and microcomputers, Geiger counters and vessel-tracking platforms, melting ice and polar bears. Sensing practices do not settle into a singular fixed subject, entity, relation, or outcome. Instead, they become ways of articulating, animating, and operationalizing environmental collectives that are in the process of finding ways to live together in altered worlds. Sensing practices then give rise to a plurality of experiences and inhabitations, some of which are in opposition or which create contested approaches to environments.

In the first article in the collection, "Reading a Wave Buoy," Stefan Helmreich (2019) engages with sensing practices through tracing the media ecology of the wave buoy. Describing a visit to the Datawell company in the Netherlands, he explores the distinct sensing capacities of the Directional Waverider buoy. This measurement technology, which monitors waves,

provides sense data that undo the usual ways of understanding experience as a phenomenological encounter. Instead, the wave buoy is a material technology that is comprised of plastic, liquids, metal, sensors, and communication technologies that create a network for detecting wave height and direction, as well as possible storm surges and floods. Helmreich suggests that on one level, wave buoys are “nonhuman sensory organs for apprehending the ocean.” Yet, on another level, they also generate social and political relations that exceed oceanographic study and point to ways in which the seas can be spaces of inequality, injustice, and exploitation. The sensing practices that materialize here are not merely ones that measure and describe wave characteristics but also that intersect with maritime institutions and politics and so signal distributed oceanic sensing practices.

If wave buoys provide ways of sensing and measuring waves and ocean spaces through situated liquid technologies, then remote sensing of aquifers generates a different way to encounter sensing practices as they traverse radically remote and invisible terrains. In “Touching with Light, or, How Texture Recasts the Sensing of Underground Water,” Andrea Ballesterio (2019) examines the dynamics and sensing practices that unfold when community members are concerned about potential privatization and high rates of extraction of water from aquifers in Costa Rica. Public agencies propose that Landsat-based remote sensing of aquifers and underground water resources can be a way to address these environmental conflicts. Working with the unique ways in which cavers explore underground space as a sort of seeing touch, Ballesterio describes how Costa Rica’s subsurface water becomes evident through water shortages, water pollution, remote sensing technologies, development politics, and new sensing relations. Subsurface water erupts to the surface through conflicts over water and through attempts to grapple with the “sensorial combinations” that bring water conflicts to greater public attention. Sensing practices in this context involve new co-becomings of sense, where sensing puts in motion “conceptual resources that blur any radical separation between abstract knowing and embodied sensing,” as Ballesterio argues. This is ultimately an expanded, rather than reductive, understanding of the work that sensing does across entities, technologies, and environments and which, similar to Helmreich, exceeds a phenomenological rendering of the senses as residing only within a human register.

In a time of climate change, water shortages are becoming increasingly evident as a pervasive environmental problem. How water is sensed, monitored, and measured can involve not just practices of remote sensing technologies and transformed ways of detecting water resources but also a

plurality of ontologies for making sense of water relations. In “Asymmetries and Climate Futures: Working with Waters in an Indigenous Australian Settlement,” Michaela Spencer, Endre Dányi, and Yasunori Hayashi (2019) discuss a plurality of ways of engaging with water when anticipating the absence of water due to climate change. Describing Aboriginal and scientific encounters with water and water loss, these authors examine how attempts to conserve water draw on much different technologies and ontologies when encountered through water research and public utilities or through Indigenous Australian water practices. The plurality of these ways of encountering and accounting for water is crucial since they create practices of seeing, telling, and mapping water that these authors suggest are also productive of different forms of political work and different ways of “crafting climate futures.” In order for these climate futures to involve a diverse range of sensing subjects and worlds, so too do sensing practices need to account for the asymmetrical ways in which environments are experienced, inhabited, and looked after.

Continuing on the theme of water, but turning to the organisms that inhabit and signal the quality of water, Christelle Gramaglia and François Mélard (2019) investigate how organisms become sentinels for sensing environmental change and toxicity. In their article, “Looking for the Cosmopolitical Fish: Monitoring Marine Pollution with Anglers and Congers in the Gulf of Fos, Southern France,” the authors discuss how a participatory biomonitoring project documented marine pollution through a different type of sensor: a bioindicator fish, the conger eel. The process of agreeing upon this particular bioindicator organism within the monitoring community, however, was not straightforward. Instead, distinct environmental and research collectives came together in ways that expressed the specific ecological relations that were at stake. In this way, the conger became a cosmopolitical fish. Rather than rely on analogue or digital sensors alone to document the water quality, the fish were mobilized to study the lived environmental conditions of the Gulf of Fos—over time, and as they influenced fishing practices and maritime life. This different sensor then produced transformed sensing practices and relations that generated “new knowledge by other means,” which in this case could even be used to examine and challenge the permits given to polluting industries.

The different types of sensors—whether organismal or computational—that can be used to indicate environmental change are productive of different modes of sensing not just in relation to types of sensors but also through the diverse practices that they organize and operationalize. In “Breakdown in the Smart City: Exploring Workarounds with Urban-sensing Practices

and Technologies,” Lara Houston, Jennifer Gabrys, and Helen Pritchard (2019) describe the practice-based research project, Citizen Sense, which in part investigates the claims made about computational sensors, and how these are meant to unleash a seemingly utopic smart city. The authors consider how situated sensing practices of working with air quality sensors in a DIY community monitoring network give rise to different ways of understanding and operationalizing computational urbanisms. By describing how “work-arounds” materialize in the process of setting up and working with citizen-sensing technologies in the form of air quality monitors, these authors suggest that along with sensing technologies frequently breaking down or requiring fixes, the usual monolithic and universal discourse of the smart city also breaks down. These practices involve not only setting up and sustaining citizen-sensing technologies but also require attending to multiple different concerns and community initiatives that work toward more livable cities. By working around the smart city as a version of urbanism, this research demonstrates how more connected environmental collectives and sensing practices could materialize.

Continuing on the topic of DIY investigations of environmental pollution, Olga Kuchinskaya’s (2019) commentary, “Citizen Science and the Politics of Environmental Data,” examines how different sensing practices for detecting radiation after nuclear accidents generate distinct engagements with environmental data, which have very different stakes and political alignments. She compares how the Safecast group, a volunteer citizen-science network using DIY radiation monitors, responded to the Fukushima Daiichi accident in 2011, and how the Belrad group, a nonprofit focused on radiation safety, responded to the Chernobyl accident in 1986. Although each group had as its focus the use of environmental data to make radiation more visible as a public problem, the groups diverged in their different understandings of how political—or not—such data might be in its collection, analysis, and communication. Safecast focused primarily on setting up open-source hardware and software. The data that their bGeigie sensor devices produced were perceived to be “apolitical,” as the group states and Kuchinskaya documents. The relative safety of exposure levels and different modes of analysis were largely left aside, and Safecast’s focus was on gathering “raw data.” Contrasting this approach with Belrad, Kuchinskaya documents how data were approached as political from the outset of this organization, where “Belrad’s data collection was inseparable from its advocacy.” Not only were data mobilized to educate publics about safety and exposure levels, but also they were used to contribute to decontamination and protection measures. Visibility, or making environmental

data visible to document environmental problems, can generate differing political engagements, some of which might even disavow a project of political advocacy. Seemingly similar approaches to data and sensing practices can then have much different effects. At the same time, invisibility refers less to not knowing about pollution and refers instead to how “those who are most affected are ignored and disempowered in the process of knowledge production.” Different sensing practices in this way demonstrate the uneven power arrangements that make sensing palpable and possible.

In this way, sensing practices could even be understood to produce *countersensing* practices that can be used to challenge existing approaches to different socioenvironmental problems such as migration. In “AIS Politics: The Contested Use of Vessel Tracking at the EU’s Maritime Frontier,” Lorenzo Pezzani and Charles Heller (2019) describe a particular vessel-tracking system, automatic identification system (AIS), that has been used to track ship traffic to prevent collisions but which has become a technology for monitoring ships carrying migrants to Europe. Here, a monitoring and detection technology transforms in the context of emerging issues related to migration across the Mediterranean Sea. AIS transforms through sensing practices that both document the movement of migrants for purposes of governance and control, as well as for counterpurposes of data activism and human rights. As this sensing technology is taken up and put to different uses—or as these authors suggest, appropriated—the range of possible uses also proliferates through remote sensing practices that influence “who can move and in what condition, thereby shaping the contentious force field of migration.” The authors describe their own practice-based research within this area through their initiative, Forensic Oceanography, which makes use of this sensing technology and data to contest “the exclusionary nature of borders, and the mass dying of migrants at sea to which it leads.” In parallel, the authors recognize that by working with sensing practices that appropriate vessel-tracking technologies, they are also ambivalently situated “within the global datascape constituted by AIS and other data.” Yet, as hundreds of millions if not billions of people are projected to be displaced in this century due to environmental stresses from the climate crisis, migration and “disobedient” sensing practices will only continue to grow in importance.

As this collection demonstrates, asymmetries are evident in the differing uses of sensing technologies, as Pezzani and Heller’s work indicates, and they are evident in the ways in which the plural ontologies of water and water loss are navigated, as Spencer, Dányi, and Hayashi document. As Cymene Howe (2019) suggests in her article, “Sensing Asymmetries in Other-than-human Forms,” these asymmetries are present in different

practices of sensing the melting of ice in the North, particularly in Iceland, due to climate change. Different entities, including more-than-humans, sense and are affected by the loss of the cryosphere, and these modes of sensing are bound up with the making and unmaking of worlds. Howe investigates how humans and more-than-humans are caught up in the melting of Arctic landscapes, from the loss of the ice sheet in Greenland, to the death of polar bears, and the loss of sea ice. Asymmetry describes how different ways of being in and experiencing worlds—in other words, different sensing practices—can make present much different environmental relations that are under threat. These asymmetries are important to tune in to since they remind us what worlds are at stake and what worlds are being lost through catastrophic changes in climate. As Howe writes, “sensing by other means entails sensing through others’ means and beyond the human sensorium.” Such practices can generate transformed ways in which to respond and demonstrate responsibility to these changing worlds, within and beyond the usual registers of sense (cf. Yusoff 2013).

As these compelling and richly detailed accounts of the plurality of sensing practices demonstrate, different modes of sensing and experience provoke not just different ways of being in and for worlds, they also demonstrate that different worlds and environmental relations are at stake. Far from an account of “the senses” as fixed in the usual human-focused classificatory framework, here are modes of feeling, caring, experiencing, observing, documenting, expressing, and struggling for and with environments and subjects that the term, “sensing practices,” more adequately captures. These contributions to the “Sensors and Sensing Practices” special issue differently but relatedly consider how diverse environmental collectives come into being through distinct ways of sensing environmental problems. These practices are not just ways to rework the data and evidence that might be brought to bear on environmental problems. They are also ways of creating sensing entities, relations, and politics, which come together through particular ways of making sense of environmental problems (cf. Gabrys 2018). These collective ways of feeling and responding to environmental problems then also indicate the ways in which worlds are made and sustained, as well as the worlds that are lost when these relations are severed (cf. TallBear 2011).

The sensors and sensing practices that are put in motion in the different contributions to this collection demonstrate how different ways of becoming involved in and attached to environments and environmental problems are organized (cf. Stengers 2011b). From wave buoys to vessel tracking, remote sensing and storytelling, conger eels and Arctic organisms, air

pollution sensors and radiation sensors, many different formations of citizenship, political engagement, expertise, and earthly inhabitation are cultivated here. The theme of sensors and sensing practices then advances approaches to both theory and practice, analysis and narrative, scientific investigation and activism, which resist an easy division into modes of investigation, or a routine delineation of sensing subjects and relations. Instead, as this introduction has emphasized, new collaborative and collective ways of sensing materialize that contribute to distinct and transformed worlds. These worlds are made through sensing practices that unfold—as processes—through shared inhabitations and experiences (Gabrys and Pritchard 2018). We then suggest with this collection that a body of research on sensors and sensing practices is coming together to provide a rich resource for science and technology studies and aligned fields. This area of study, furthermore, can help to inform new theoretical and practical investigations into world-making practices and relations and for strategies of sensing otherwise.

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