Engaging Science, Technology, and Society

Science & Dissent: Alternative Temporalities, Geographies, Epistemologies

KELLY MOORE
LOYOLA UNIVERSITY CHICAGO
USA

BRUNO J. STRASSER
UNIVERSITY OF GENEVA
SWITZERLAND

Abstract

The analysis of dissent, or the mobilization of scientific claims to challenge existing political arrangements, has a long history in STS and was central to the formation of the field of STS itself and its current contours. Based on a conference that sought to bring together analysts and activists from around the world and from varied disciplines, this collection illuminates new temporal, geographic, and epistemological lenses through which scientists and other people have creatively challenged relationships of power. First, by attending to long-past practices and to the long-term development of styles and forms of dissent and resistance in Latin America, South Asia, Africa, Europe, and the USA, contributors show how geography and situated forms of politics are mobilized in scientific dissent. Second, contributors also examine how political arrangements shape the ways that the movement of bodies, as well as their sensory qualities, are central to many forms of technoscientific dissent. A third focus, on epistemic politics, demonstrates how building parallel or alternative structures and systems of knowledge can destabilize power arrangements, even when those systems are not mobilized to make formal legal or administrative challenges.

Keywords

dissent; radical science; public participation; citizen science; counter-expertise; social movements; embodiment; temporality; geography

Introduction

Around the world and in varied ways, individuals and organized groups have increasingly mobilized scientific knowledge and methods for their own ends since the 1970s. As governments rely more and more on scientific knowledge and technical expertise to develop and justify policies (Jasanoff 2016), organized opposition has used science, orthodox or not, to inform dissent. Scientists, including STS scholars and other social scientists (Martin 1993; Woodhouse et al. 2002), are participating in these projects as well, playing roles that draw from varied national and transnational histories of epistemic politics, rather than from professional roles narrowly understood. These forms of epistemic and political action can be characterized as dissent: organized and visible opposition to existing technopolitical arrangements. Here, dissent does not include all "contrarian science," although it sometimes emerges from it (Delborne 2008). Some examples

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To email contact Kelly Moore: kmoore11@luc.edu.

of contrarian science challenge scientific consensus without challenging dominant technopolitical arrangements, either because they are restricted to scientific issues with little current technopolitical implications (i.e., controversies over gravitational waves) or because they actually support current technopolitical arrangements (i.e., climate change deniers). Although it can be important methodologically to treat "symmetrically" contrarian science that challenges or that supports actual technopolitical arrangements here, in line with the literature of Social Movement Studies, we restrict the notion of dissent to the former. Dissent is a challenge to dominant scientific *and* political consensus.

Science and dissent is well-traveled territory in STS today. This rich body of work has evolved around three lines of inquiry. The first looks at how "citizens"—as a particular category of people—interact with formal political rules and regulations (Irwin 1995; ibid., 2001; Arancibia and Motta 2018; Chen 2011; Ottinger 2014; Jobin and Tseng 2016; Kimura and Kinchy 2016; Kim, Kim, and Song 2020), and traces how scientific claims and standards intersect in formal settings such as the courtroom, the legislature and the boardroom (Jasanoff 1995; ibid., 2010). Other studies are more centrally focused on how scientists dissent from peers around public political issues (Frickel 2004b; Moore 2008; Oreskes and Conway 2010; Bridger 2015; Schmalzer, Chard, and Botelho 2018; Väliverronen and Saikkonen 2020). Finally, a more recent body of work has delved deeply into how alternative data are generated and used by communities (Wylie et al. 2014; Fair Tech Collective 2020; Jobin and Tseng 2016).

This special issue emerged from the Science & Dissent Workshop, held at the University of Geneva, Switzerland. It drew together activists and analysts who studied dissent in different time periods and different parts of the world with the primary aim to identify new ways to understand science and dissent by bringing together scholars with heterogeneous geographical and temporal intellectual starting points. Too often, dissent in STS has been framed in terms of Western and Northern ideas about politics, epistemic systems, and the social positionality of scientists, even when there are different starting points that would seem to offer other possibilities. Because much of this scholarship, explicitly or not, aims to address a current problem, approaches tend to be presentist and focus on the shorter term. A second aim of the conference was to learn about how activists have used STS knowledge and practice in their own work.

That we are asking these questions today is no accident. The assaults against environmental health regulation in the United States since the 1980s (Fredrickson et al. 2018), and the growing concerns over climate change and toxic environments in other parts of the world have made the issue of science and dissent particularly visible. In an increasing number of places around the world, individuals have been left to carry the burden of technoscientific infrastructures, such as ensuring good health and safety after Chernobyl (Kuchinskaya 2014; Petryna 2013), and measuring food radioactivity in post-Fukushima Japan (Kimura and Kinchy 2016). There is thus an urgent practical importance to understand the means by which dissent is carried out, and how it comes to be effective, or neutralized.

First, the papers in this thematic collection move beyond the presentism and short temporalities that social science inflected approaches to dissent have taken by including works that show how forms and outcomes of dissent are shaped by *long political histories*. By illuminating past forms of dissent, this thematic collection enriches our understanding of the range of possible ways that science and dissent have been and can be carried out. Second, challenging the overly cognitive approaches to science and dissent, we elaborate on STS dissent scholarship about the role of bodies as "sensors" in technological disputes, by showing how the *mobility* of gendered bodies, including those of scientists, matters in dissent. Finally, we also show that

the focus on formal political structures does not consider the many ways in which *alternative* epistemic and political systems operate alongside formal forms of dissent. In the past and in the current moment, scientific dissent is also operating as a set of social and epistemic reorganizations that are not aimed directly at corporations, governments, or scientific actors themselves, but rather at building parallel (or alternative) structures of knowledge, some of which drawing from artistic practices (da Costa and Philip 2008).

What we do not cover in this thematic collection is dissent that treats science and scientists as illegitimate political and epistemic actors. Flat-earthers and creationists, for example, are not discussed in this thematic collection, and nor are nationalist movements that challenge the origins of science (Subramaniam 2019). These are worthy topics, but outside the scope of a thematic collection that is focused on how scientists and their knowledges are mobilized in dissent.

Contributors to this thematic collection address these issues by attending to debates over science since the nineteenth century, in the realms of public health, agriculture, and environmental policy, that have taken place in Latin America, Western Africa, India, Europe, and the United-States, often informed by the transnational circulations of knowledge and people. They look at dissent as a set of actions mobilizing scientific knowledge, but also non-scientist allies, public opinion and sometimes heterodox methods and epistemologies. Before discussing these three themes, we present a brief overview of how the question of science and dissent has been addressed in the STS literature: controversy studies; local knowledges and structures of obfuscation and visibility; scientists as complex political actors; and the voluminous scholarship that treats science and dissent as a matter of "public participation."

Controversy Studies

Among the first and most influential approaches to the study of dissent were "controversy studies" carried out in the United States (Nelkin 1979; Martin 1991) and in Europe (Callon and Latour [1981] 2015; Callon, Law, and Rip 1986). In the 1980s, these analysts aimed to explain competing perspectives on technological projects and scientific facts, and how political systems and scientific institutions structured such debates. In moving beyond the then-current explanation for public criticisms of science and technology—ignorance and irrationality—the controversies approach placed liberal democracy and a scientific order that based authority on objectivity at the center of studies of dissent. At the same time, these forms of analysis tended to emphasize events or "moments" rather than endemic issues, to treat dissent as a matter of rights and perspectives centered on citizenship and interests, with scientists as intermediaries in debates, providing varied actors with authority and evidence to support positions.

In the early 1990s, Brian Wynne published a series of articles that provided a much richer understanding of how and why the structure of scientific knowledge and its control by powerful groups led to environmental damage. Using the case of fallout from Chernobyl and the experiences of Cumbrian (England) sheep farmers, Wynne showed that scientists' insistence that any damage was temporary was sharply contradicted by local farmer knowledge (Wynne 1998). Scientists relied on models that had no ability to take place-based evidence into account, nor any means of using farmer knowledge. The very structure of scientific modeling and the management of knowledge production and distribution by powerful groups meant that dissent was as much about the structures of knowledge as they were about the formal political systems in which they were embedded. Other STS scholars, such as Harry Collins, have resisted how self-fashioned progressive authors upgraded place-based evidence, experiential knowledge, or even technical

proficiency to the level of "lay-expertise" (Collins 2014). Studies of controversies and forms of expertise are highly valuable for drawing attention to the varied ways that actors may see an issue and how they can structure public political debates. Similarly, the emphasis on expertise has offered a way to consider how legitimacy and formal rules shape dissent, especially in the context of litigations (Jasanoff 1995; ibid., 2007), and the co-dependence between liberal democracy's social norms the state of scientific knowledge. Yet they also draw attention away from other critical issues in dissent, namely, that dissent is not always shaped by formal or highly visible rules, and that dissent is not always taking place in settings, such as courtrooms, where expertise is most valued.

Social Movements and Local Knowledge

The recognition that local knowledge was not systematically considered by scientists or other powerful groups has produced a rich body of work in STS, which demonstrates how and why people who are not scientists collect their own data or evidence about a science or technology problem. Alondra Nelson, for example, demonstrated that in the 1960s, the Black Panther Party acted on what their communities in urban Los Angeles, New York, and Chicago were increasingly aware: their health and safety had been abandoned by government officials (Nelson 2013). They collected their own evidence about malnutrition, asthma, lead paint and other problems affecting their communities. Phil Brown, coined the term "popular epistemology" to describe how communities in industrial areas, often led by women's groups, came to document health problems caused by toxics (Brown 1987; ibid., 1997). In doing so, they challenged standard epidemiological methods, like the Women's Health movement did in the previous decade (Kline 2010; Murphy 2004). STS analysts continue to analyze community data projects, such as those carried out by local people in Argentina to fight against the use of glyphosphate on soy (Arancibia 2016); indigenous American and First Nations groups that track environmental damage (Technoscience Research Unit 2022; United States Indigenous Data Sovereignty Network 2022); groups that "rescue" data and build their own databases (Environmental Data and Governance Initiative 2020); and groups that use digital tools to document environmental harms from fracking (Wylie 2018). These local knowledges are critical in articulating problems, and in proposing and carrying out solutions (Agrawal, Chhatre, and Hardin 2008; Peluso 1995; Harding 2011).

These practices can upend taken-for-granted ideas about what evidence is, what counts as a cause, and how data should be collected (Brown and Mikkelsen 1997; Nash 2007; Powell et al. 2011; McCormick 2009; Frickel and Vincent 2011). However, studies of how assumptions and rules about what counts as relevant evidence, like the focus on controversies, have tended to draw STS attention to legal systems of redress (Jasanoff 1995), while having less to say about other means of contestation. This scholarship has also challenged how scientists tended to see evidence: that which is collected in a limited number of "truth spots" (Gieryn 2002), and that which is filtered and purified by traveling through machinery and other technologies, making distance between bodies and senses, and statements of truth (Boudia and Jas 2016). Thus, as analysts interested in local knowledge have shown, bodies as "damage sensors" thus play a key role in scientific dissent (Epstein 1998; Brown and Mikkelsen 1997; Liboiron, Tironi, and Calvillo 2018). As we discuss later, bodies, including scientists' bodies, can be used in scientific dissent in more varied ways and the borders between scientists and local knowledge can be far more porous than earlier studies have assumed.

Social Movements and Scientific Dissent

In the United States and Europe where studies of science and dissent originated in the 1980s, a major focus has been on the role of the scientist as authority and broker in scientific controversies, for example in the debates over the risks of nuclear weapons and other Cold War technologies (Nelkin and Pollak 1982). In the 1990s and beyond new scholarship documented that scientists played much more varied functions in controversies over science and technology. Scott Frickel, for example, showed that in the 1960s, toxicologists played a major role in documenting the health problems caused by radiation, but few were highly visible in public (Frickel 2004a). This "shadow organizing" protected them professionally but circulated critically important evidence that countered the US government's assertions that many forms of radiation were safe. Steven Epstein, too, showed that medical scientists played varied roles in the AIDS movement, again in the USA, with some strongly dissenting from mainstream views, and assisting AIDS activists in setting up their own drug trials and treatment systems (Epstein 1998). One of the most important studies of successful scientist-community alliances was Barbara Allen's (Allen 2003), who showed that short-term, as-needed partnerships, were critical to the ability of environmental justice activists in Alabama (USA) to achieve some modicum of success. Jason Corburn (Corburn 2005), also addressing the relationship between scientists' and community knowledge in social movements, placed greater emphasis on the role of community knowledge in these partnerships. In these different cases, scientists were sometimes already involved in social movements, sometimes they only became so through their research on a particular issue, while remaining firmly within the scientific mainstream.

The tumultuous 1960s and 1970s have been a rich area of study of the intersection of science and social movements. The civil rights, women's health, anti-nuclear, peace, and environmental movements all challenged dominant technoscientific arrangements as well as scientific consensus (Moore 2008; Kline 2010; Egan 2007; Nelson 2013). In a study of how scientists responded to the militarization of science during the Cold War, Kelly Moore showed that scientists critical of that relationship acted in varied ways: they informed publics about dangers from radiation, they acted as "conscientious objectors" to military research, and they studied and drew attention to how warfare, capitalism, racism and sexism were intertwined in science (Moore 2008; Schmalzer, Chard, and Botelho 2018).

Largely ignored by STS scholars until recently, there is a long tradition of scientists explicitly engaging with public political issues, that pre-dates the social movements of the 1960s. During the Enlightenment and well into the nineteenth century, scientists engaged in countless public political controversies on topic as different as immunization against smallpox in the 1720s and the protection against industrial pollutions in workshops in first-half of the nineteenth century (Fressoz 2012). In this thematic collection, Melanie Kiechle's study of nineteenth century chemists' contribution to mapping urban pollutions, explores some of the role played by scientists in tackling—and creating—social issues. The construction of a unified scientific community working for the progress of humanity is largely an artifact of the late nineteenth century (Carnino 2015). In the 1930s, Marxism-inspired scientists begun to challenge this view, especially in the UK and in France, and to engage in public political issues (Werskey 2007). Even in the United States, although scientists mostly avoided politics or espoused conservative views, they elected in 1938 the physiologist and socialist activist Water B. Cannon as president of the American Association for the Advancement of Science (AAAS), following a series of "Science and Society" symposia organized the previous year (Kuznick 1987). Studies of these periods challenge the idea of the value-neutral scientist,

although they still remain centered on a model of scientists as people normally in their labs, and only occasionally participating in political debates. In this thematic collection, we extend the scholarship that elaborates on the complex roles that scientists can play in scientific dissent.

STS and Public Participation

STS scholars have paid close attention to the rise of participatory modes of governance in the late 1990s. This growing STS literature was, at first, mostly supportive of the new participatory mechanisms which promised to offer a welcome corrective to the limitations of earlier models of science and society relationships based on the "deficit model," as STS scholars characterized it (Callon, Lescoumes, and Barthe 2001). Their pointed critiques of specific participatory mechanisms, especially top-down ones, mostly aimed at making them better and more "democratic" (Felt and Fochler 2010; Wynne 2006). These discussions on the merits of participation were not restricted to academic circles. Indeed, leading STS scholars played a crucial role in producing policy reports which served to legitimate the deployment of participatory mechanisms at the national and supranational levels (Macq, Tancoigne, and Strasser 2020). At the same time, critical voices pointed to the "pressing need to move away from the orthodox science and technology studies (STS) defense of public participation and citizen-science engagement," as exemplified by the early work of Alan Irwin (Irwin 1995) and others, "towards an analytically skeptical (but not dismissive) perspective on the 'new' mode of scientific governance" (Irwin 2006, 300). Importantly, some of these authors have tried to link more explicitly to STS—with its focus on epistemic issues, and Social Movement Studies—with its focus on diverse meanings and democratic processes (Welsh and Wynne 2013).

A rich STS literature has now shown how the "participatory turn" in science (Jasanoff 2003), whether it be deliberation about techno-scientific issues or the production of techno-scientific knowledge itself by lay people, is changing how expert scientific knowledge plays out in the public and policy spheres. Analysts have shown that citizen mobilizations can identify and sometimes fill in the gaps of "undone science," for example (Frickel et al. 2010; Hess 2016). The present issue moves away from these important empirical studies about the current proliferating participatory mechanisms (including "citizen science") and their limitation in addressing a perceived lack of trust in science. In India and Columbia, as we show, participatory and dissenting science projects have longer and alternative histories that were shaped by developmentalist logics (Prasad and Quet 2022; Hernández Vidal and Moore 2022). These logics become particularly visible when taking into account a "long view" on science and dissent.

The Virtues of the Long View

The present thematic collection of *Engaging Science, Technology, and Society* reexamines the issue of science and dissent along three themes. One of the most conventional ways to study scientific dissent is to analyze interactions between contending groups as they are mediated by political and economic institutions. These institutions include professional associations, courtrooms, legislatures, state agencies, and NGOs. Many of these studies are situated in the present, and treat extant rules for evidence, standards, and standing as the key arbiters of a debate, although most track historical origins of a conflict. The papers in this thematic collection, however, extend scholarship that seeks to understand the form, content, and actors around dissent over longer periods of time, and to locate its histories of technoscience and resistance. The value of this approach is twofold: refusing to see dissent as a reaction to a specific harm, instead allows us to

highlight continuities and dynamics, in forms of action, topics, structures of conflict and the meanings of particular problems as well as their solutions. Instead of focusing on "types" of dissent or static rules that shape the outcome of dissent, like Delborne (2008), traces dissent and resistance as longer-term projects with varied cultural meanings, undercutting the focus on "wins" or "losses," since changes in law, economy and personnel can easily modify a given outcome.

A second reason for attending to temporality is that it captures a much wider range of dissent than presentism that truncates imagination and possibility, and limits our understanding of how power is challenged and redeployed. Similarly, anticipations of futures, often foisted upon people in situations where they are insecure and must develop survival strategies, can leave little space for historical possibilities and origins. The immediate—the meltdown, the spill, the toxin, the referendum—can be acute and proximate issues that people have to try to solve with what tools they (and their academic and other) allies have available to them.

Prasad and Quet (2022) offer the longest view in this issue, and in doing so, they present a distinctive analysis of how Gandhi's anti-colonialist movement encouraged the use of technology, first in the form of spinning wheels that were used by rural and urban people. They show that Gandhi's teachings placed value on practical epistemologies and solutions that were available to rural people, combined with modernist technoscientific solutions, to address the needs of the poor. These "barefoot doctors," they show, played a key role in the emergence of an ongoing People's Health Movement that has been active since the 1960s. They demonstrate how these networks of scientists and healthcare providers came to know of each other and share knowledge through the publication *Medico Friends Circle Bulletin*. It became a major source of debate and solutions to problems ranging from the Bhopal disaster, food-related diseases, and toxics. Scientists and medical professionals were thus not "allies" of a particular substantive movement, but rather were extending the practices of a larger political project in which science and technology were used for the benefit of ordinary people. Using a colonial starting point, they offer a very different image of the role of scientists and engineers than studies based on apolitical scientists operating as "allies" or "brokers" for a particular movement.

Topçu's study in this collection (Topçu 2022) of how the French government responded to and shaped scientized dissent in the French anti-nuclear movement demonstrates first, that "scientized resistance" takes multiple forms over the course of a movement, and second, that this reshaping is dependent in part on how the French government responded to citizen scientized dissent. Topçu shows that from the 1970s onward, scientized dissent took four forms that were sequentially shaped by the government's response to the previous form: 1) deficit model, 2) the co-information model, 3) the co-expertise model, and 4) the co-management model. Each model describes relationships between critics and the state and how scientized knowledge is to be used. The French state responded, for example, to the early criticisms that technocratic governance of nuclear power failed to take into account moral and political issues, but doing just that—creating an architecture of languages of care and morality that came to coexist with technological management. Subsequent cycles of protest (Tarrow 1993) demanded more from scientized management of nuclear power, generating more iterations of stabilizing and neutralizing government response. Rather than use this evidence to suggest that scientized approaches to dissent are failures, or more problematic than other methods, Topçu shows that to the extent that there is a "coexistence of outsiders, insiders, expert activists, experts who refuse to play the activist role, radical

opponents, and the more moderate scientific critics, who together are able to form the movement," scientized dissent can be more powerful than when it is mobilized alone. Her long view thus provides a sense of how states control technical dissent, and how heterogenous tactics and approaches can make government responses to scientized dissent more challenging to defuse. Thus, countering the tendency to look at social movement dissent as a series of choices by activists, she centers the skillful government responses that shape the fate of scientized dissent.

Histories of dissent almost always start with cases in which citizens and governments have quite different interests; it is commonplace for contemporary studies, for example, to show how much governments favor industry in contestation over toxics. Kiechle's study of how chemists and citizens worked through newly established health boards as sensory equals, despite class and other social differences, in the nineteenth century New York City effort to limit olfactory pollution from industry provides an essential counterpoint (Kiechle 2022). She shows that "scientists and citizens recognized a continuum of knowledge in which scientific (often quantitative) reports were *supporting* evidence rather than privileged, objective, or definitive measures on which boards of health based their decisions." As a political medium, emerging health boards gave chemists, citizens, and physicians the authority to measure and address olfactory complaints. They replaced the police, who were previously responsible for addressing olfactory complaints governed by nuisance laws. As health boards became established in local governments, however, it was scientific analysis, not the sensory inputs of citizens that came to govern olfactory pollution. Kiechle's analysis, like those of Topçu, Prasad and Quet, and Strasser, foregrounds the way that historical and long-term analysis can expand STS knowledge of the forms that dissent takes and the fate of varied approaches. They also illuminate the ways in which pasts shape how dissent unfolds at any particular moment, tracing the logics, assumptions, skills and capacities of actors, and how their actions and behaviors come to form or truncate possibilities for the present and future.

Embodied Knowledge

The long view adopted in this issue brings forward the importance of embodiment, our second theme. Bodies have been shown to be especially important as sensors enabling challenges to the narrow epistemics of traditional and entrenched scientific methods that have, since the late 19th century, been built upon distancing bodies from scientific subjects via technologies. Feminist, labor, and critical race analysts, for example, have demonstrated that communities often notice harms from toxins via embodied experiences (Brown and Mikkelsen 1997; Kenner 2018; Sánchez Barba 2020; Nguyen 2020). Methods of documenting and analyzing embodied harms and experiences are increasingly widespread, and often supported by low-cost, easily available, distributed, and learned technologies (Ottinger 2009; ibid., 2014; Hoover 2017; Wylie 2018).

Embodied knowledge is also itself a form of challenge to extant scientific epistemologies that privilege disciplined senses, particularly vision. Western, and now globalized forms of science, rely on sensing technologies that force specific ways of knowing via technologies that disallow the richness of embodied sensing, which, in scientific dissent, can be more complex, diffuse, and intermittent than scientific grids, graphs, and meters allow (Carroll 2006). Thus, embodied sensing is profoundly different from sensing through cheap DIY sensors, championed by advocates of "citizen science" and public participation, which often replicates orthodox scientific epistemologies (Strasser et al. 2019). Moreover, sensing, as a social process, is culturally varied and historically specific (Kleinman and Kleinman 1994;

Daston and Lunbeck 2011; Spackman 2020) and, as historians of science recognize, varies from person to person; thus the need for instruments that discipline the senses, such as microscopes and "scent" sensors. As other writers have shown, however, citizens can provide knowledge that is sometimes as accurate as the sensors, as Mayer, Berstrand, and Running (2014) showed in their study of citizen reports of hydrocarbons in fish following Hurricane Katrina in 2005.

Activists also dramatize embodied experiences as means of drawing attention to problems, as analysts of the Bhopal gas disaster (Mukherjee 2016), AIDS (Epstein 1998), breast cancer (McCormick 2010) and toxic waste on indigenous land (Hoover 2017) demonstrate. The source of credibility of embodied knowledge is vastly different from that of standard scientific knowledge. Instead of relying on the authority of the scientific institution and on epistemic ideals of quantification, precision and objectivity, embodied knowledge draws its power from the force of personal testimony. In that sense, the intimacy of the felt experience gives it an immediacy that is hard to discount—particularly when paired with direct action, such as the "toxic lunch" demonstrations in Bhopal in 2009, when demonstrators invited government and industry officials to eat a meal containing the chemicals that official reports had deemed safe (Mukherjee 2016). Embodied knowledge is a particular form of knowledge that can empower those who do not have the resources required to produce experimental knowledge relying on expensive instrumentation or on highly technical forms of expertise. As the state increasingly relies on expert knowledge to make and justify decisions, it has made it more difficult for those who cannot easily produce and access such expert knowledge to be heard (Shapiro, Zakariya, and Roberts 2017). Their embodied knowledge can easily be brushed aside as "subjective" or even re-appropriated for opposite ends (Jasanoff 2002; Fiske 2018).

The collection of papers in this thematic collection extends our knowledge of embodiment in science dissent in two ways: by demonstrating the role of mobile embodiment in scientific dissent, and in augmenting how gendered embodiment can serve as a means of disrupting technoscientific projects. Bruno Latour and others have demonstrated that scientific knowledge becomes powerful to the extent it can travel unchanged, becoming an immutable mobile, an artifact that is moved from place to place in an epistemological and social chain (Latour 1999). One way that claims become powerful is by becoming embedded in ever more chains. In situations of scientific dissent, mobile knowledge—that is, shared knowledges of harm and repair—play a key role in building similar chains.

As Martha Conde and Mariana Walter (2022) show in this collection, it is not just the mobile knowledge itself that matters, but the very movement of embodied people who carry and share knowledge. In their study of contestations over the harms from uranium and gold mining in Namibia, Niger and Argentina, they show that two scientists, hydrologist Robert Moran and nuclear engineer Bruno Chareyron, played a major role in co-producing knowledge with local groups. One of their critical insights is that the knowledges about harms and strategies was coproduced by local groups and scientists. Their case studies demonstrate that the forms that hybrid knowledges took at any of the sites were deeply shaped by Moran and Chareyron's travels. Over the course of their careers and work, they moved from site to site, carrying knowledge of problems and solutions with them. Conde and Walter show that wherever they went, these scientists produced a kind of knowledge that was neither formally scientific nor exclusively local. They also show that because these scientists had traveled to other sites they could make trans-site comparisons producing credibility in the eyes of the targets of dissenters. In this way, Conde and Walter show that hybrid

knowledge is made not just by deep local experience, but through the physical movement and presence of the scientists.

Nathalia Hernández Vidal and Kelly Moore similarly show that embodied, mobile knowledge is critical in the struggle to create territories free of transgenic seeds in Colombia. There, *campesinos* travel to irregularly scheduled seed schools in various parts of the country, where they bring their own seeds not owned by corporations, and show others how to grow them, what they are used for, and what they mean to communities. The schools are both practical, social and political. Participants often use pictures and drawings to convey these social and epistemic meanings. Unlike the maps and images that corporations use to impose knowledge about transgenic seeds, participants do not circulate their images outside the community, and there is no central repository for them. When the schools end, participants carry the practical knowledge with them at an embodied level: they come back to their communities, and show and tell others about what they learned. In this way, their mobile knowledge travels and hybridizes with embodied knowledge of other communities. Unlike Collins' assertions about tacit scientific knowledge (Collins [1981] 1992), the aim of the *campesinx* practice is to disconnect embodied knowledge from formal scientific seed knowledge that is commodified and circulated in ways that *campesinex* do not control. Both of these articles thus point to the mobility of scientists as embodied people as a means of distributing embodied knowledge.

A second way that embodiment matters is that it can play a role in treating bodies themselves as means of challenging power, as Strasser (2022) shows in this thematic collection, in his study of antinuclear protest and masculinities. Direct action, generally speaking, is a process whereby activists use the physical presence of their bodies, its ability to give rise to various emotions, its strength to destroy, and its inertial resistance, to change the meanings and perceptions of the contested institutions. Embodiment makes visible the potential physical harm that dissenters attribute to these institutions and that the confrontation of data by experts renders invisible. Embodiment is always gendered and thus reflects the gendered assumptions of dissenters and their audiences. The dissenter's bodies on the ground during a "die-in" tell a different story from those throwing projectiles at uniformed men. But even when strategies of dissent sideline the bodies of the dissenters and focus on empirical data to make their protest seem objective and scientific, the embodied dimension does not disappear. The empirical data produced by counter-experts, as well as by official experts, did not play out as a cold confrontation of abstract data, but was cast in explicitly bodily (and sexual) terms by the actors, as a virile confrontation of "men against men." Data was always embodied, personal and political at the same time.

Parallel Systems

The third theme addressed in this thematic collection is that dissent is unfolding in ways that do not look like direct confrontation, but rather, create parallel knowledge systems that can intersect with dominant logics, be used in direct challenges, or grow in their own way. They have little to do with the increasingly fashionable "citizen science," which only considers dissent within the existing scientific framing of relevant issues and valid evidence (Strasser et al. 2019). In the Science and Dissent conference, on the other hand, scholars and activists, including Shannon Dosemagen (Public Lab, USA), Dinesh Abrol (Institute for Studies in Industrial Development, India), and Muki Haklay (University College London, Extreme Citizen Science) presented their work in the organization of parallel systems of knowledge production. Participatory and

alternative mapping projects, for example, taking advantage of low-cost and easy to use technologies to enable communities to make harm visible in places, at times, and at scales that matters *to them*. Public Lab, an NGO founded in the wake of the Deepwater Horizon oil spill in the Gulf of Mexico in 2010 has precisely followed his strategy. It produced a cheap aerial mapping kit containing a weather balloon allowing citizens to take photographs from skies with a standard digital camera. The images could be uploaded on the Public Lab website to reconstruct a map of the oil spill along the shore, wherever it mattered most to the citizens. As Public Lab explained: "we were not trying to duplicate the satellite or flyover imagery. Instead, we were helping Gulf Coast residents to use balloons, kites, and other simple and inexpensive tools to produce their own documentation of the disaster and hoping that such data collection will continue to support environmental research, policy, and regulatory changes in the coming years." In short, the goal of their participatory mapping exercise was to "tell a different story" (Public Lab 2016).

Similarly, the peoples' science movement in India, as Dinesh Abrol highlighted, resisted the uncritical importation of Western technologies in the name of modernist developmental agendas, favoring instead the promotion and development of indigenous technologies development. These technologies and systems of expertise have continued to exist in parallel to the main institutionalized systems of knowledge (see Prasad and Quet's contribution to this thematic collection). But such parallel systems of knowledge are not restricted to the Global South's resistances to developmental agendas, but exist in the United States as well, or in the center of London. As Muki Haklay discussed, projects organized in the greater London to produce community-led maps challenged the standard reliance on GIS and other digital tools, and highlighted he importance of the use of paper maps, that allowed the participatory mapping projects to be more inclusive and produce alternative outcomes. These examples show how alternative mapping can challenge the long-standing use of maps to mark off territory for political purposes, enabling extraction and settlement in ways that are often invisible, but highly consequential for those most affected (Alatout 2014).

Alternative systems are not restricted to participatory mapping. Across the world, farmers have challenged the privatization of seeds by creating their own modes of seed selection and exchange. These systems produce alternative knowledges that operate outside of the systems epistemological control implemented by global trade laws (Demeulenaere 2014; Phillips 2016). They are not the same as local knowledges that feed into legal confrontations, as earlier generations of STS scholarship have emphasized. Instead, these knowledges travel in different ways, and are made robust in some cases precisely because they are not deeply concentrated in articles, legal documents and other systems that make them susceptible to being coopted, a process that Sezin Topçu highlight in this thematic collection (Topçu 2022). Nathalia Hernández Vidal and Kelly Moore's analysis (2022) of seed schools in Colombia illustrates this form of dissent: forms of knowledge exist in networks that are not accessible to seed companies or the government. These forms of knowledge sharing, they demonstrate, extend histories of political organizing in rural areas that depended on secrecy in order to avoid violent suppression by landowners, governments, and paramilitaries. The importance of maintaining the vitality of these systems extends beyond local resistance. Repression or ignorance of local knowledge/expertise can hamper the ability to address local and translocal crises, as Suryanararayan and Kleinman (2013) showed in their study of how beekeeper knowledge about colony collapse disorder was systematically kept out of research about the problem by agribusiness and government agencies (ibid., 2013).

Similarly, Shambu C. Prasad and Mathieu Quet's analysis of the people's health movement in India shows that while scientists themselves were publicly debating health issues and sharing knowledges, in their publications, it was on the ground that hybrid forms of healthcare took form and thrived. In some cases, these parallel forms—though scientists start out to operate away from systems of power—can have profound effects on them, nonetheless. These parallel forms, we argued, have been less central in STS studies of dissent, which have tended to focus on how local knowledge is used for direct legal or other formal challenges. But as the studies of self-help in the women's health movement on the 1970s have shown, alternative systems of knowledge can co-exist alongside orthodox epistemologies (Murphy 2004; Kline 2010). They can also produce alternative views aimed at mainstream audiences, such as *A New View of The Women's Body* (Federation of Feminist Women's Health Centers 1981), published by the Federation of Feminist Women's Health Center, which popularized the findings of the self-help movement. With the hindsight of almost half a century, this example serves as a good reminder of how powerful and transformative alternative systems of knowledge can be. We hope that the present issue will contribute to expand this perspective to other sectors.

Conclusion

Overall, the papers in this thematic collection help us think differently about the role of scientists in dissent. First, they show that we shouldn't think of scientists in dissent as apolitical providers of empirical data, statistical expertise, or technical knowhow for lay activists. Scientists can productively be understood as "citizen scientists," not in the current understanding of the term that emphasizes the role of citizens as lay people producing scientific knowledge (Cooper 2016), but in the original sense used since the 1940s, where scientists see their professional role as being directed by their concerns as citizens (Strasser et al. 2019). This was, in part, the project of Science for the People, and other radical science movements of the 1960s and 1970s (Moore 2008; Schmalzer, Chard, and Botelho 2018). The rich work on public participation in science (and "citizen science"), to some extent, implicitly reaffirms the view that politically motivated research belongs exclusively to "citizens," while professional scientists remain politically neutral. But as the papers in this thematic collection show, a number of scientists were engaged in politicized issues, without undermining their commitments to the norms and values of their profession or their identity as scientists.

Second, scientists should not be considered axiomatically as political actors, but their role as political actors should always be an open empirical question. Situating these actors in specific historical contexts and paying attention to their mobility can reveal to what extent their research is part of personal political commitments and concerns with particular issues. It is by paying attention to both, the biographical and the contextual, that one can make visible to what extent their research is political. It is also by paying attention, not just to the "data" and "evidence" they produce, but also to the legitimacy they give to alternate forms of knowledge, such as embodied knowledge, that one can understand how they may empower dissent.

Third, this thematic collection highlights one specific role of scientists in dissent: making harm visible. In addition to their role as knowledge brokers and as weighing on existing issues by providing data and expertise, scientists have often brought such issues to the fore in the first place. With *Silent Spring*, Rachel Carson did not weigh on the issue of the harm caused by the use of DDT, she *created* the issue. Politically and morally motivated (or not), research conducted by scientists often contributed to creating the

landscape of dissenting techno-scientific issues. Yet, it is not that nobody had noticed these harms and injustices before, as the examples of pollution in Love Canal and Woburn make clear (Blum 2008; Brown and Mikkelsen 1997). But scientists were able to contribute significantly to turning resident's concerns into public matters by casting them in the language of science.

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Author Biography

Kelly Moore is Associate Professor of Sociology at Loyola University Chicago, USA.

Bruno J. Strasser is Professor of History of Science, Technology, and Medicine at the University of Geneva, Switzerland, and Adjunct Professor, Yale University, USA.

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