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Undone Science and Counter-Expertise: Fighting for Justice in an Argentine Community Contaminated by Pesticides

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ABSTRACT

STS and social movement scholars have shown the importance of ‘getting undone science done’ to advance the goals of social movements fighting environmental health injustice. The production and mobilization of counter-expertise, meaning the reliance on expertise, broadly construed, to contest regulatory decisions based on scientific knowledge, must be further analyzed by differentiating among types of expertise and strategies to mobilize them. In social mobilization against the unrestricted use of pesticides in Argentina, the affected community in Ituzaingó Anexo developed three types of expertise. The community first drew upon its own local knowledge of cases of illness and, as lay people, produced the first epidemiological map of this area. Then, they enrolled scientists and NGOs as allies to jointly learn about pesticide contamination as an explanation for illness. The enlisted scientists produced new knowledge by conducting environmental and epidemiological studies. Finally, sympathetic public health authorities, legal experts, and a district attorney designed a successful legal strategy to stop fumigations in that area and enforce local regulations. The case confirms the importance of producing undone science, and shows that its effectiveness can be explained by intertwined strategies deployed by a triad of lay/local, scientific, and legal experts to overcome the expertise barrier.

KEYWORDS

Health-environmental justice; undone science; social movements; expertise; pesticides; Argentina

Introduction

Our low social status makes us suffer from multiple factors of degradation and environmental pollution that directly affect our human rights. It is the same image in most villages which surround soybean fields. (...) The best protective and supportive mechanisms for the soybean complex are subtle dynamics of concealment and invisibility. Hence, our effort is to make the invisible visible. In the context of obscene profits from record exports, we will show the tragic consequences of this model of hunger and death. (...) Spraying with glyphosate, endosulfan, paraquat,

and other poisons has become a constant threat to many Argentines. How does the State care for its citizens when its children are killed in cold blood in the villages across the country? Who controls these technological packages? Who controls biotechnology? (Grupo de Madres de Córdoba, 2005)

Argentina is the third-biggest producer and exporter of genetically modified (GM) crops in the world (James, 2016). Since the 1990s, agribusiness elites have replaced old, extensive farming methods with a capital-intensive, new technological package composed of GM seeds, a broad-spectrum systemic pesticide (glyphosate), and no-till farming machinery (Bisang *et al.*, 2008) (Figure 1). Regulatory authorities classified this pesticide as having low toxicity; therefore, there were no restrictions on its commercialization and use in Argentina. The new technology did not promise a reduction of pesticide use, but rather promised to more quickly eradicate insects. In fact, pesticide use has exponentially grown since the adoption of GM seeds, in part because of the development of glyphosate-tolerant weeds (Pengue, 2005; Benbrook, 2012). Farmers used 317 million liters of pesticides in 2012, compared to 123 million liters in 1997 (Kleffmann & Partner SRL-Kleffmanngroup, 2013).

In the 2000s, communities affected by increased exposure to pesticides formed a movement for health and environmental justice and identified themselves as ‘sprayed peoples’ (*pueblos fumigados*). Fumigation refers to the method of applying pesticides on a large scale, which can result in pesticide drifting into areas outside of the intended area of application. The movement enrolled scientific and legal allies in order to counter the dominant discourse that asserted that the technological package, composed of GM seeds and pesticides, was socially beneficial. In 2005, a network of social movements¹ and communities launched a national campaign called Stop Spraying to record the previously underestimated toxic effects of glyphosate-based pesticides, map all affected localities,



Figure 1. Plane spraying pesticides. Photo: Stefan Krause, license: FAL, source: https://en.wikipedia.org/wiki/Agricultural_aircraft#/media/File:Gehling_PLZ106AR_Kruk_OTT_2013_D7N8976_004.jpg.

raise awareness, and motivate affected people to mobilize for the restriction of glyphosate use (Arancibia, 2013a, 2013b).

The campaign invited affected people from across the country to provide testimony and recruited rural physicians and scientists to provide evidence that pesticides cause illness (Motta and Arancibia, 2015). The campaign published all information in a book (Grupo de Reflexión Rural, 2009). The campaign released a manual on how to seek legal recourse against contamination from pesticides (Aiuto, 2006). Many judicial actions at the local level followed the publication of this manual (Aranda, 2009; Leguizamón, 2014; Rauchecker, 2015; Lapegna, 2016). Finally, new fields of study on pesticides emerged in Argentina, leading to publications, conferences, and organizational development. The number of papers on pesticides published by Argentine scientists on Scopus increased from 21 in 2005 to 90 in 2012. Additionally, national conferences were held, including one at the School of Medical Sciences at the National University of Córdoba in 2010 and three at the School of Medical Sciences at the National University of Rosario in 2011, 2013, and 2015. This network consolidated because of the launch of a national professional association called The Physicians of Sprayed Villages. The movement did not result in positive changes at the national level, but it had positive impacts at the local level in some cases, albeit with different degrees of success in redressing specific injustices.

Often, local authorities obstructed the claims of local communities by attesting to the safety of glyphosate-based pesticides on the basis of national regulations grounded in scientific evidence. Therefore, we sought to understand the strategies that activists seeking justice against pesticide contamination deployed in order to dispute knowledge claims about pesticide safety. How did they engage with expertise? What new types of knowledge were created and by whom? How was this new knowledge produced, and how could it be effectively deployed in activists' struggle to overcome injustice? To answer these questions, we traced the history of the community of Ituzaingó – a peri-urban neighborhood on the outskirts of Córdoba city surrounded by fields of GM soybeans – which played a leading role in the constitution of the sprayed peoples movement and became a nationwide example after a court case found that illegal pesticide spraying violated criminal law.

In this paper, we introduce our analytical perspectives; describe our methods and data; and present our empirical analysis, starting with an overview of pesticide regulation in Argentina and then discussing the three phases of social mobilization against pesticides in Ituzaingó based upon the salience of different types of expertise and strategies deployed to dispute knowledge claims about pesticide safety.

In summary, we show how the activists initially drew upon their local knowledge of cases of illness in the neighborhood in order to request action from local

authorities. After they were ignored, they enrolled scientists and NGOs as allies and learned about pesticide contamination to explain their illnesses. The enlisted scientists produced new knowledge by conducting environmental and epidemiological studies. The movement used these scientific findings to successfully lobby the local government to enact protective ordinances that restricted the use of pesticides in the area. However, when farmers consistently violated the new rules, sympathetic public health authorities and legal experts developed legal strategies in order to provoke the judiciary to enforce the rules. Legal experts designed a novel legal strategy and won a trial that stopped illegal fumigations in the area, punished violators, and questioned the rationale behind the bureaucratic rules and regulations that governed the safety of pesticides.

Undone Science and Counter-Expertise in the Fight Against Environmental Injustice

Environmental health injustice is a structural problem (Cohen and Ottinger, 2011); indeed, the association of illness with environmental causes has been a key factor in the emergence of the environmental justice movement. The structural causes for these health and environmental inequalities relate to industrialization and its associated socio-political institutions and scientific practices. The problem characterization is threefold. First, environmental hazards and pollution worsened as industrialization increased. The distribution of pollution as a result of siting decisions for hazardous facilities made by authorities and industries shaped historical patterns of spatially segregated social inequality. Second, professionals with training in science and engineering gained cultural authority; their knowledge not only generates economic wealth but also forms the basis of political decision-making related to the use and regulation of these technologies (Cohen and Ottinger, 2011). Third, scientists and engineers are then paradoxically called upon to assess the risks and negative impacts of scientific and technological development (Beck, 1992).

Concerned with the democratic implications of expert authority (Habermas, 1990), STS scholars have problematized the depoliticization of the regulation of technologies (Moore *et al.*, 2011). While governments emphasize scientific neutrality as a source of objective assessment (Hess, 2007), the institutional underpinnings of what Jasanoff (1990) called ‘regulatory science’ allowed industry to influence the production (or lack thereof) of the scientific knowledge that underpins regulations. The dilemma is that the shortcomings of regulatory science can only be illuminated by alternative scientific evidence – and such evidence is usually lacking. This leads to the problem of ‘undone science,’ meaning knowledge that systematically is not produced that would be helpful to a social movement or civil society organization working to promote change and/or resist policies that they view as harmful (Woodhouse *et al.*, 2002; Hess, 2007, 2015a, 2015b; Frickel *et al.*, 2010).

The undemocratic and unjust implications of expert-based decision-making and regulatory science have motivated social movements and civil society organizations to mobilize for procedural change. The understanding of science and expertise as a set of social practices conducted by social actors has provoked not only activism on techno-scientific issues and novel encounters between social movements and experts, but also a research agenda on the transformative potential of encounters between social movements and experts (Epstein, 1996; Hess, 2007, 2015a, 2015b; Parthasarathy, 2010; Cohen and Ottinger, 2011). As Cohen and Ottinger (2011) argue, expertise can contribute to environmental injustice, but it can also provide resources to overcome it. However, these resources are often lacking because of the problem of undone science.

STS research has termed the contention surrounding and challenges made to science-based political decisions as ‘counter-expertise.’ However, the concept has different meanings in the literature. Some authors define counter-expertise as a strategy deployed by conventional experts and professionals committed to progressive social change, who act as part of advocacy groups or as allies to social and environmental justice movements (Fischer, 1990; Fortun and Cherkasky, 1998; Cohen, 2006; Taylor, 2009). The strategy involves producing scientific knowledge that foregrounds new evidence, different interpretations of data, or new methods. Other authors use counter-expertise to refer to non-scientific, locally produced, and empirically based knowledge (Pfister and Horvath, 2014; Egert and Allen, 2017). Similar understandings of counter-expertise have referred to terms such as local ordinary knowledge (Fischer, 1990), farmers’ knowledge (Wynne, 1992), and peasant expertise (Heller, 2002).

For the first type of counter-expertise, achieving justice depends on the transformation of science to meet democratic and socially and environmentally sensitive outcomes, which would require changes to the scientific agenda, research questions, methodologies, and who and what is included in scientific research (Allen *et al.*, 2017). For the second type of counter-expertise, justice is a matter of blurring traditional expert boundaries, contesting scientific authority, and recognizing other types of knowledge as a basis for decision-making.

Building on this literature, we understand counter-expertise to be efforts to redress environmental injustice that rely on expertise, broadly construed, to contest regulatory decisions that are based on scientific knowledge. This definition aims to encompass existing definitions of counter-expertise and to provide an analytical framework that is open to empirical variation, because what counts as expertise differs according to the context and case. The struggle for justice involves differential knowledge claims and knowledge production processes, as well as other strategies to influence power-laden decision-making.

Our analysis differentiates between the strategies and the subjects of counter-expertise. First, which strategies do activists deploy to dispute knowledge claims and counter science-based regulatory decisions that result in environmental injustice? Second, who disputes the claims about safety made by regulatory

science by relying on or claiming some sort of expertise, and what type of expertise do they deploy? To answer this, we provide a non-exhaustive typology consisting of scientists, laypeople, and lawyers.

We draw upon Parthasarathy's typology of four strategies used by activists to overcome the expertise barrier. According to Parthasarathy (2010), the expertise barrier is 'the formal and informal rules of a science and technology policy-making domain which make it difficult for those without technical expertise to engage as equals' (p. 355). The first strategy refers to situations in which outsiders deploy established scientific knowledge in order to assert their legitimacy to participate in a discussion by allying themselves with experts and learning scientific concepts. This resembles what Epstein has called 'expertification' (Epstein, 1996, p. 13), in which activists establish claims of credibility to speak about scientific issues. Second, activists might introduce new kinds of facts and new definitions of what counts as fact and evidence in a policy domain. In doing so, they reinforce the evidence-based character of decision-making, while expanding the scope of issues deemed relevant for decision-making and claiming expertise in these new areas.

A third strategy is to introduce new logics of policy-making, and new ways of valuing evidence and expertise, given the diversity of possible rationales, values, or policy cultures, including precautionary policy cultures and risk-tolerant policy cultures (Wynne, 2001; Jasanoff, 2004; Levidow *et al.*, 2007; Suryanarayanan and Kleinman, 2013). Parthasarathy highlights the dispute between the linear model of innovation, in which basic research leads to application which results in autonomic social benefit, and an alternate model in which the societal benefits of scientific research must be empirically proven. Fourth, by criticizing bureaucratic rules, activists raise the question of whether decisions are made in the public interest. Their concerns might include issues of participation, transparency, and accountability, as well as the definition of priorities. The last two strategies point to what Cohen and Ottinger (2011) have identified as the transformation of power relations in order to achieve environmental justice.

The second strategy engages with the production of new knowledge and can involve doing undone science. Different actors participate in the production of new knowledge, and we consider it useful to distinguish between laypeople and scientists. Often, scientists produce undone science with varying degrees of involvement with activists. Scientists might be exploring and transforming science in the direction of environmental justice by promoting new research agendas and sub-fields within established scientific disciplines, rather than through participating in a social movement (Moore, 1996; Moore and Hala, 2002; Frickel and Gross, 2005; Frickel, 2006; Frickel and Moore, 2006). Here, the expertise produced and mobilized is scientific expertise.

However, scientists can also become actively involved in environmental justice struggles and either subtly or overtly partner with a social movement to conduct independent studies on the health or environmental situation of a

mobilized community (Allen, 2004; Frickel, 2011; Moore *et al.*, 2011). In some cases, scientists co-construct research with the community to produce alternative studies based on local understandings of health and environmental problems, or to develop other methods of representing illness and pollution (Cohen and Ottinger, 2011). This leads to novel relationships between scientific expertise and lay/local expertise (Arancibia, 2016).

In fact, communities and lay activists also produce local knowledge about their situation. Drawing on their own experiences of harm, communities often raise awareness about an environmental problem and collect evidence about illness and contamination. Then, they might call upon sympathetic scientists to continue the research with them – which entails translating and embedding the raw data into scientific formats – or they might continue on their own. Either way, when local communities generate new, locally-situated knowledge about their own bodies and environments, they can challenge the safety claims of regulators, scientists, and industry typically based on older, non-local knowledge.

Examples of community-based research include popular epidemiology, citizen science, street science or participatory research (Brown, 1987, 2007; Irwin, 1995; Singleton and Legator, 1997; Fischer, 2000; Kroll-Smith and Floyd, 2000; O'Rourke and Macey, 2003; Corburn, 2005; Brown *et al.*, 2006; Ottinger, 2010; Allen *et al.*, 2016). Sometimes scientists lead the research; other times communities lead. However, in all of these cases, scientific expertise is intertwined and combined with lay/local expertise.

The production of undone science *per se* is often not enough to overcome the expertise barrier, because governments could still ignore the new scientific findings or substitute them with contrasting evidence (Fischer, 1990). There is much still unknown about the degree of change that the production of undone science can yield and the factors that facilitate or limit such change. This relates to Parthasarthy's other two strategies necessary to overcome the expertise barrier that point to the rules governing decision-making and how they are enacted. Other types of expertise, aside from scientific expertise, might be necessary.

One study that illustrates why doing undone science is insufficient for causing regulatory change, discusses how beekeepers in France, who believed that pesticides were causing mass honey bee die-offs, successfully convinced regulators to remove pesticides from the market, whereas beekeepers in the United States did not (Suryanarayanan and Kleinman, 2014). These divergent outcomes cannot be explained by a difference in knowledge production since both groups of beekeepers enrolled scientists, promoted the execution of new studies, and used emerging scientific findings to back their claims. Rather, the strategies of resistance differed. French beekeepers organized a cohesive social movement characterized by sustained and disruptive direct action – such as street protests, political demonstrations, legal actions, media and public

relations campaigns, and lobbying efforts – while US beekeepers did not. Therefore, the lesson for environmental justice activism is to be attentive to different types of collective action as well as to different types of expertise deployed within movements.

Like scientists, legal experts can be part of the professionalization of social movement organizations or can be powerful, external allies. Social movement theory categorizes legal challenges under ‘contained action,’ rather than ‘disruptive action’ (Tarrow, 2011). According to McCann (2006), to achieve positive outcomes, legal mobilization often needs to be combined with protest mobilization, media-targeted actions, and lobbying activities. Legal structures can constrain agency. In contrast, social movements can use legal processes to shape the structures of social life. ‘Legal knowledge thus can matter as both ends and means of action; law provides both normative principles and strategic resources for the conduct of social struggle’ (McCann, 2006, pp. 21–22). Legal mobilization can be used as a means ‘to transform, or to reconstitute, the terms of social relations and power’ (McCann, 2006, p. 22).

Science-based legal advocacy organizations have been important allies of environmental justice movements (Hoffman, 2011; Lapegna, 2016; Motta, 2016). In a division of labor, scientists identify undone science or weak regulations and conduct investigative scientific work to support legal cases, while lawyers file lawsuits or threaten to do so when industry or regulators fail to follow the rules. Legal epistemologies can play a key role in adjudicating competing science-based claims, but drawing upon legal expertise might constrain the dispute to the realm of legal-administrative procedures, rather than opening it up to scientific knowledge claims (Bonneuil and Levidow, 2012). Barandiaran (2016) describes how legal technical criteria – or legal expertise – replaced scientific expertise as the force that injects competence and objectivity into environmental decision-making in Chile. Chilean lawmakers used legal rules as science has been used elsewhere, as a ‘neutral’ voice separated from politics that legitimated decisions. This literature points to a need to further explore the role of legal expertise in the production of undone science and in the mobilization of the new scientific findings.

In sum, to fight environmental injustice, activists attempt to break the expertise barrier by relying on scientific knowledge as well as other types of expertise. Drawing on cumulative findings in the literature, we identified three types of expertise that can be deployed and mobilized to influence decision-making on the health and environmental effects of technologies: lay/local expertise, scientific expertise, and legal expertise. While the relationship between the first two types of expertise has been widely explored, the relationship and articulation among this triad of expertise still requires further research, particularly in cases in which it relates to undone science. Our paper aims to advance knowledge on this issue, and, thus, to contribute to the literature on social movements and undone science.

The Neighborhood of Ituzaingó Anexo

Ituzaingó Anexo is a neighborhood on the outskirts of Córdoba City, surrounded by GM soy fields. Situated 8 kilometers from the city center, with 6000 inhabitants, Ituzaingó is over 60 years old and lacks basic public services such as water, sewage, electricity and paved roads. Mobilizations against pesticides have involved many other rural and peri-urban communities in Argentina. However, Ituzaingó is an emblematic case as it was the first node of resistance in the country and the first place where restrictive regulations for the use of pesticides were enacted and enforced. While many municipalities enacted ordinances restricting the use of pesticides, the enforcement of these ordinances has been difficult because the surveillance capacity of the municipal police is very weak and penalties for infractions are hard to implement. Ituzaingó offers an interesting case for observing successful strategies for fighting environmental injustice, including developing and mobilizing a triad of expertise consisting of scientific expertise, lay/local, and legal expertise.

Between 2001 and 2013, we collected and analyzed different types of data to study Ituzaingó, including primary data collected from archival research, newspaper articles, documentary sources, movements' campaign documents, ethnographic observations, and individual in-depth semi-structured interviews with activists and their allies, as well as secondary literature. The interviews focused on themes such as the history of activists' involvement in the issue; their demands and forms of action; their allies and coalitions; their interpretations of the problem and proposed solutions; the perceived outcomes of their campaigns and their major obstacles; and their relationship to the media, the authorities, and their opponents. Both authors conducted fieldwork and interviews for our doctoral theses. We interviewed members from the movements including *Madres de Ituzaingó* ($n=4$), *Grupo de Reflexión Rural* (GGR) ($n=3$), *Unión de Asambleas Ciudadanas* (UAC) ($n=2$), the NGOs *Semillas del Sur* ($n=1$), CEPRONAT ($n=1$), *Red de Acción en Plaguicidas* (RAPAL) ($n=1$); doctors ($n=3$); and scientists ($n=3$) that were part of the network Stop Spraying Córdoba, doctors and scientists from other provinces ($n=12$); and provincial and municipal authorities from the executive, legislative, and judiciary powers in Córdoba ($n=4$). We conducted fieldwork throughout 2012 and 2013 (Motta in February to March of 2012 and July to August of 2013 and Arancibia in July to August 2012 and the entirety of 2013). Motta observed the court case on Ituzaingó in Córdoba on 7 August 2012, and Arancibia attended the final ruling on 21 August 2012. For the purposes of this article, we focused on data relevant to the broader issue of counter-expertise, including the types of expertise and strategies used in their fight against environmental injustice and instances of the production of undone science.

The Regulation of Pesticides, Undone Science and Environmental Injustice in Argentina

Environmental issues are regulated in Argentina at four jurisdictional levels: national, provincial, municipal, and Autonomous City of Buenos Aires. The national government establishes minimum regulatory requirements, while each province defines the specific requirements. The national government, through the Servicio Nacional de Sanidad y Calidad Agroalimentaria (National Food Safety and Quality Service or SENASA), is responsible for the approval, registration, toxicological classification, and commercialization of pesticides. The provincial and municipal governments regulate the use of pesticides. This means that only the national government – through SENASA – can ban or restrict the commercialization of a pesticide on the basis of scientific arguments (regulatory science), while only provinces and municipalities can limit usage on the basis of actual agrarian practices, through provincial laws or municipal ordinances. The control and enforcement of any environmental norm is also decentralized and depends on provincial decision-making, as the police are under the provincial administration.

Since the 1960s, pesticides have been widely used in the country, and regulations have been informed by regulatory science. On the basis of the World Health Organization's classification of pesticide use as low risk, neither SENASA nor the provincial and municipal governments restricted the commercialization or use of glyphosate. SENASA approved glyphosate-based pesticides in 1977, and revalidated them as safe in 1992. The World Health Organization's toxicological classification, based on lethal toxicity, measures mortality after short-term exposure and distinguishes instantly lethal from non-instantly lethal chemical substances. However, it does not take into consideration long-term exposure, which is experienced by the rural and peri-urban communities where pesticides are sprayed. Therefore, this methodology does not consider the full spectrum of toxicological health impacts on these communities in Argentina (i.e. sub-acute lethal, long-term lethal, acute sub-lethal, chronic sub-lethal).

Lay Activists, Local Expertise and Popular Epidemiology in a Contaminated Community

At the beginning of the 2000s, a group of women were puzzled by the fact that many women were wearing headscarves and many children were using chin-straps in Ituzaingó. They began exchanging thoughts and concerns and conducted a survey to identify and count the exact number of ill neighbors. A member of the *Madres de Ituzaingó* stated in an interview in 2013:

I began to see that there were many men and women with masks and scarves. (...) I realized that it was because children had leukemia and women lost their hair due to

chemotherapies. And I thought, ‘I have to do something (...) I had lost my daughter, (...) ‘How come?’ (...) We did a survey. We worked for three or four months’.

The survey consisted of a simple questionnaire on the health situation of each member of the household. In a population of 4870 inhabitants, the women found 107 cases of illnesses, including cases of: leukemia (9), Hodgkin’s lymphoma (2), other types of cancer (7), lupus (3), purpura (3), hemolytic anemia (2), anemia (12), and skin disorders (9) (Carrizo and Berger, 2008; Voz, 2012). The women also drew a map that illustrated the distribution of these cases and found that the majority of them were concentrated within four blocks of GM soy farms (Figure 2). Those who were ill were unaware of the cause of their illnesses, but they thought it might be environmental pollutants. In February 2002, the women presented the list, the map, and a letter signed by 300 neighbors to the provincial Ministry of Health (Vecinos, 2002), requesting public recognition of an alarming public health situation and immediate action to determine the cause(s). At that time, the provincial government had no information regarding the existence of any disease cluster in the area and did not react to their claims (Carrizo and Berger, 2008). The government did not consider the data collected by the *Madres* as valid evidence.

In order to be heard by the authorities, the group of women organized protests and demonstrations in the streets, with the participation of women with scarves and children with chinstraps. They drew more neighbors into their struggle. They held protest banners that said, ‘Help us, we have cancer’ (Interview with a member of *Madres de Ituzaingó*, 2013). When radio reporters asked who they were, they started to call themselves the Mothers of Ituzaingó (*Madres de Ituzaingó*). As one of them explained, ‘We tried to get the people together. Alert them, tell them that something was wrong, that all we can do is go out into the streets’ (Interview with a member of *Madres de Ituzaingó*,



Figure 2. Epidemiological map made by the neighbors. Source: INFOBAE, <https://www.infobae.com/economia/rse/2017/06/19/lluvia-de-veneno-en-cordoba-cuando-la-soja-hizo-inhabitable-a-un-barrio/>, authorized reproduction.



Figure 3. Protest by Madres de Ituzaiñgó. Source: Red Nosotras en el Mundo, <http://www.rednosotrasenelmundo.org/Madres-de-Ituzaiñgo-15-años-de>.

2013). However, authorities kept ignoring their claims and said that they were just a ‘bunch of crazy women’ (Interview with a member of *Madres de Ituzaiñgó*, 2013) (Figure 3).

In sum, in this first phase, a group of neighbors raised awareness about an environmental problem that they believed was causing severe diseases in the neighborhood. In order to be heard by authorities, their first strategy was to introduce new kinds of facts. They produced local/lay knowledge on their health situation through conducting community-based research, documenting and reporting illness, as well as organizing a movement and mobilizing in the streets. However, none of these actions provoked reactions from authorities.

Scientific Expertise in Environmental and Epidemiological Studies

The *Madres* thought that they were not being recognized as a group with credible knowledge on their own experiences of harm, so they reached out to scientific experts. They contacted Raúl Montenegro, a biologist and the director of the environmental NGO *Fundación para la Defensa del Medio Ambiente* (Environmental Defense Foundation or FUNAM). FUNAM is an NGO with a strong profile in urban planning and environmental health, which since 1992 has supported communities by developing environmental studies and educational initiatives.

By deploying his scientific expertise, Montenegro contributed to the movement in different ways. One of the first contributions was to deliver public talks on environmental contamination in the neighborhood (the first in April 2002 and the second in June 2002). These talks not only raised awareness on the environmental health situation of Ituzaiñgó but also deployed established expertise by training the movement’s participants on the language and concepts of environmental studies. Second, Montenegro hypothesized that pesticides were one cause of the environmental-health problems experienced in Ituzaiñgó.

Montenegro considered whether the disease cluster could be caused by a ‘cocktail’ of pollutants that included pesticides, heavy metals, and polychlorinated biphenyls (PCBs), which are a class of synthetic organic chemicals used in electrical transformers. His third contribution was to join the movement’s push to pressure local governmental authorities to conduct environmental studies to determine which pollutants were present in the neighborhood.

At the same time, the *Madres de Ituzaingó* continued with their direct actions. When a local TV channel aired one of their street demonstrations, the provincial minister of health met with them and promised to conduct an environmental study of the water and soil (called Regulatory Science’s Study 1), as well as an epidemiological study (called Regulatory Science’s Study 2) (Carrizo and Berger, 2008). In April 2002, a councilman proposed an ordinance to be voted on by the Municipal Legislature to declare a ‘public health emergency’ in the neighborhood, which was approved in June 2002 (Ordinance 1050). The official recognition of the reported environmental-health problems was the first positive outcome of the movement. In July 2002, in a press conference, Montenegro reported that the agency in charge of Regulatory Science’s Study 1 was hiding the results of the soil study, which showed that pesticides existed in all of the samples at higher levels than accepted standards (Montenegro, 2002). The minister of health denied this, stating that the levels of pesticides were below the limit established by the law, but the Ministry of Health did not make the findings publicly available (Interview with Montenegro, 2013). In response, Montenegro and the *Madres* started an independent environmental study of soil and water in November 2002 (Independent Study 1) with the support of the National University of Córdoba and FUNAM (Carrizo and Berger, 2008). This was the second attempt to conduct undone science on the neighborhood’s environmental pollution, and this time a scientific expert led the study.

At the end of that year, with the help of human rights lawyers and FUNAM, the *Madres* requested that the federal court of the Province of Córdoba restrict pesticide spraying in the proximity of residential areas in the province and immediately ban spraying in Ituzaingó. It was the first time that the *Madres de Ituzaingó* implemented a legal strategy, and they partnered with lawyers who mobilized legal expertise, although without immediate results. In January 2003, the results of Regulatory Science’s Study 1 were presented at a public conference and confirmed the presence of pesticides and heavy metals in water wells above accepted levels. The public health authorities then gave the neighbors a water pump to connect the neighborhood to the piped water supply (Carrizo and Berger, 2008). That same month, the municipal legislature enacted two protective regulations: Ordinance 10590, banning ground pesticide sprayings, and Ordinance 2589, banning aerial pesticide sprayings until the public health emergency was suspended. These were important positive outcomes, despite the fact that no enforcement existed.

At the end of 2003, the results of three studies became public. The preliminary findings of the environmental Independent Study 1 were published (Montenegro, 2003) and showed that the neighborhood was exposed to a cocktail of pollutants, including pesticides. It was from this moment that the *Madres* exclusively focused their struggle on opposing the use of pesticides. Some results of the Regulatory Science's Study 2 conducted by the Ministry of Health were leaked, and these results confirmed a cancer cluster of 109 cases within the area. However, the official report was never published. A few weeks later another epidemiological study (Regulatory Science Study 3), conducted by a team from the National University of Córdoba at the request of the Ministry of Health, reported only 40 cases and concluded that the environmental condition of the neighborhood was normal. Based on the results of the latter study, the Ministry of Health declared that everything was fine, and there was no need for any protective policy (Carrizo and Berger, 2008).

In December 2003, a new municipal government took office and the *Madres* found an ally in the new municipal Sub-Secretary of Health Horacio Barri. He opened the Primary Health Clinic, UPAS 28, in Ituzaingó, under the coordination of a clinical physician named Mario Carpio. He partnered with the *Madres*, and together they initiated a new, independent epidemiological study (Independent Study 2) in a second instance of community-based research. The results showed 70 more cases of cancer than the first survey that the *Madres* conducted in 2001 showed (Grupo de Madres de Córdoba, 2005). The findings of the study were published in 2005 and ended with the declaration from the *Madres* quoted in the beginning of this article. As the minister of health did not accept the scientific validity of these results (Interview with Montenegro, 2013; Interview with a member of *Madres de Ituzaingó*, 2013), Barri requested in March 2004 that a famous epidemiologist, Edgardo Shinder, conduct a comparative epidemiological study of Ituzaingó and two other neighborhoods (Independent Study 3).

However, the support of the municipal sub-secretary of health was not enough to counterbalance those who wanted to silence the *Madres*. In fact, as the production of new evidence on the alarming public health situation of the neighborhood grew and could no longer be ignored, the government explicitly obstructed and boycotted the production of more undone science through different means (Fischer, 1990). In a February 2006 press report, Shinder told the press that he could not finish the epidemiological study because of political pressures and personal threats. His preliminary findings showed that the neighborhood's public health situation was catastrophic, and the government should immediately relocate its inhabitants. The yearly rate of stillborn deaths in Ituzaingó was 19.8 in 1000, while in the control neighborhood it was 8.9. Moreover, the yearly death rates in Ituzaingó were 3.18 compared to 2.30 in the control neighborhood. In a letter he sent to a journalist, later published online, Dr Schinder said:

For the moment, I prefer not to give the names of those who have hindered my work and threatened me. I was unable to go any further in determining the possible mix of pollutants that have caused the current epidemic, precisely because of these difficulties mentioned above. The most important conclusion is that the problem exists and continues. (Shinder, as quoted in Díaz Romero, 2008)

By that time, both the sub-secretary of health and Carpio also became target of pressures and censorship by the Ministry of Health and the municipal secretary of health, and they were eventually removed from their offices in 2006. In Carpio's words:

I was left alone. They took me out. I immediately thought about our epidemiological study. It never got published – because it was really bad news. (...) I thought this demotion was a way to shut me, the 'crazy guy,' up. This was an attempt to silence someone reporting what nobody wanted to hear. Right after what happened to Shinder? Yes, obviously. (...) Well, there was an agreement there ... authorities had told us, 'Stop fucking around with pesticide issues because the whole country is going to explode.' (Interview with Carpio, 2013)

In the meantime, in 2004, the *Madres* traveled to Buenos Aires, where they met the Grupo de Reflexión Rural and jointly launched the national campaign called Stop Spraying, which was described in this article's introduction (Figure 4). In short, throughout this period, the *Madres* and their allies engaged in a diverse set of actions: direct action (mobilization in the streets), legislative action (bill projects), and legal action (judiciary litigation). At the same time, they attempted to overcome the expertise barrier by deploying existing expertise (Parthasarathy, 2010: strategy 1) and emphasizing the introduction of new kinds of facts (Strategy 2). This resulted in the production of different types of undone science: one environmental study on soil and water and one epidemiological study on illness in the neighborhood. However, a third study was aborted. In terms of outcomes, three new ordinances were enacted that recognized the problem the *Madres* reported and restricted the use of pesticides in the area. However, the regulations were consistently violated, and the government found different ways of disregarding



Figure 4. Gathering of the STOP the Sprayings Campaign. Source: Colectivo Paren de Fumigar Córdoba, <http://parendefumigar.blogspot.com>.

the production of undone science, first by ignoring it, and then by challenging it by producing contrasting new evidence, and finally by actively obstructing and boycotting its production.

Science in the Courts: Legal Experts Challenge Regulatory Science

In 2006, municipal authorities changed, and the *Madres* requested a meeting with them. Barri, their ally, was back in the government serving as the secretary of health, and the new sub-secretary of health, the physician Medardo Ávila Vázquez, was touched by the *Madres*' story. He started to participate in the Stop Spraying Córdoba meetings and became another scientific expert supporting the national campaign. He led the organization of the first 'Conference of Sprayed Villages' at the National University of Córdoba.

In February 2008, the physician in charge of the health clinic in Ituzaingó asked Ávila Vázquez to report an aircraft spraying pesticides over two farms, nearby houses, and the clinic itself, which breached the municipal ordinances. In response, Ávila Vázquez, in agreement with the *Madres*, filed a legal complaint reporting an unidentified aircraft spraying pesticides on the two fields. Ávila Vázquez requested help from an environmental lawyer, Darío Ávila, who quickly became an ally of the movement. This was the first time that a government health authority initiated legal actions on behalf of the community and requested that the judiciary punish someone who violated the rules restricting the use of pesticides. When the district attorney, Carlos Matheu, received the complaint, he had not been previously informed about the issues surrounding pesticides. When he read the scientific studies – many of which experts who supported the stop spraying campaign had produced – and spoke with the Sub-Secretary of Health, he was convinced that the *Madres*' claims were legitimate. He went through a process of (scientific) expertification (Epstein, 1996). He stated:

When I received the complaint, I was shocked and began to study. What is this? Someone can just dump poison and it poisons people? Is this allowed? ... I read everythingo ... teratogenic effects, carcinogenic effects, neurotoxicity, genotoxicity ... and after a few weeks I was totally convinced. And I thought: I need to find a good legal strategy. (Interview with a Matheu, 2012)

Matheu conducted a raid on the fields of the accused perpetrator. He found residues of the pesticides glyphosate and endosulphan and identified the owner of the aircraft. Based on these findings, on 18 May 2011, he initiated the prosecution of the pilot and the two landholders for breaching Municipal Ordinances 10505, 10590 and 2589. Matheu became another expert ally who greatly contributed to the movement by deploying his legal expertise. In fact, the legal strategy that he designed was a critical part of how the trial was won. He framed the case as a violation of the national Hazardous Waste Law, which is punishable under the Criminal Law (article 200). This type of framing was a novel approach in the conflict on pesticide use in Latin America.

After various courts refused the case, it was accepted by the court prosecutor, Alejandro Novillo, in November 2011. He had already read about the *Madres'* demonstrations and the scientific evidence produced by national scientists. Deploying his legal knowledge, he became a key partner of Matheu and the movement. On 12 June 2012, the public hearings began and sessions were held over the course of two months. During these months, mobilization in the streets of Córdoba gained momentum, organized by the *Madres*, Stop Spraying Córdoba, student movements, and activists from other Stop Spraying assemblies who came from various locations of Argentina (Figures 5 and 6). At the same time, scientists and experts organized talks, workshops, and conferences at the National University of Córdoba communicating their scientific findings on the effects of pesticides.

In court, more than 40 witnesses testified, including experts from different locations throughout the country who had produced scientific knowledge on detrimental effects of pesticides (Figure 7). Matheu and Novillo requested the judges consider their findings as valid evidence and punish the accused. In addition to serving justice in the case of illegal spraying, the district attorney and the court prosecutor aimed to influence the structural causes of the problem by requesting that the judges deliver recommendations to federal



Figure 5. Call to attend a session in Courts on 11 June 2012 in support of the legal case. Source: Colectivo Paren de Fumigar Córdoba, <http://parendefumigar.blogspot.com>.



Figure 6. Calls to march on 19 July 2012 in support of the legal case. Source: Colectivo Paren de Fumigar Córdoba, <http://parendefumigar.blogspot.com>.



Figure 7. Sofia Gattica, leader of *Madres de Ituzaingós*, shows on the map the distance between airplane spraying and their homes during the legal case. Source: <http://www.juicioalafumigacion.com.ar>, Creative Commons.

authorities to change both the logic behind and the bureaucratic rules of regulatory science and policy.

Therefore, they engaged in strategy number 3 of Parthasarathy's typology, namely, challenging the established logics of regulatory policy and the types of facts relevant to it using two strategies. First, they invoked the precautionary

principle by requesting the inversion of the burden of proof. Polluters would have to prove that their actions are safe, rather than communities being required to prove that pesticides are unsafe. In addition, they suggested that SENASA reclassify all toxicological products, taking into account not only acute but also chronic exposure. Second, the prosecution deployed strategy number 4 of Parthasarathy's typology, i.e. targeting bureaucratic rules. They did so by recommending the enactment of a new unified regulatory framework for the approval, registration, toxicological classification, commercialization, and use of pesticides, in place of the decentralized system for pesticide regulation. They also required new rules for how to produce regulatory science. As part of Strategy 4, they requested that the national Ministry of Health submit a National Bill on Pesticides to Congress, prohibiting aerial spraying and setting uniform limits to terrestrial spraying in the entire national territory, as well as ensuring that the analytical toxicological studies used for policymaking are conducted by official state laboratories or federal universities that are independent of industry interests.

The *Madres* and Vázquez won the case. The owner of one of the fields and the worker-pilot who sprayed the pesticides were both found guilty of pollution and potential harm to public health and were respectively sentenced to four and three years of house arrest. However, the court absolved the owner of the other field because of lack of evidence, and the judges rejected the district attorney and court prosecutor's request that they deliver policy recommendations to the federal government. Despite these limitations, the social movement considered the verdict to be a crucial and positive outcome. This was because the prosecutors defined pesticides as hazardous waste, and had therefore convincingly established that pesticide use not only can cause harm but also that this harm can be legally defined and punishable under the existing criminal law.

The verdict had other positive consequences. First, a federal court accepted as valid the scientific evidence produced in the country on the negative impacts of pesticides on public health (i.e. the production of undone science). Second, the case set a strong legal precedent for enforcing municipal ordinances. In fact, after the ruling, many municipal authorities enacted new ordinances restricting the use of pesticides within the province of Córdoba and implemented stronger controls to enforce them.

Conclusion

Previous work that engaged literatures of STS and social movement studies has looked at knowledge generation that contests existing accepted scientific knowledge, deemed as a necessary step in overcoming situations of environmental injustice. Building on this literature, we identified diverse forms of counter-expertise and suggested that it could be understood as efforts that rely on expertise in a broad sense to contest regulatory decisions on the basis of scientific

knowledge aimed at redressing environmental injustice. With our case study, we intended to contribute to debates about how counter-expertise can be produced and mobilized within the transformative politics of social movements (Cohen and Ottinger, 2011).

Our work has focused on the problem of undone science, as conceptualized by Hess (2007), on the negative health and environmental effects of pesticides reported by rural and peri-urban communities in Argentina. The problem can be traced to the exclusion of long-term effects and multiple exposure to toxics in existing regulatory science (Jasanoff, 1990). We analyzed not only how and by whom undone science gets effectively done but also, and equally importantly, how new knowledge is produced to influence specific struggles against environmental injustice. This is critical because the production of undone science is often not enough to foster change.

Our analysis began with Parthasarathy's conceptualization of the expertise barrier and the typology of four strategies that activists deploy to overcome it (2010). We extended her typology by further differentiating among types of expertise deployed within these strategies according to the actors involved: lay activists, scientific experts and legal experts. To do so, we drew on cumulative research that describes how lay people produce local knowledge about their own situations and raise awareness of an unrecognized environmental problem, how scientists produce new knowledge that serves environmental justice goals, and how novel and productive relationships between scientific expertise and lay/local expertise are developed. We also draw on an incipient line of research that explores how legal mobilization and legal expertise unfold within environmental health conflicts.

Our case study about the struggle of a contaminated community against pesticide spraying confirms the importance of producing undone science to fight the negative effects of a technological package, as identified in the literature. We also found that, similar to other movements that succeeded in influencing regulations or redressing injustice (Suryanarayanan and Kleinman, 2013), the production of new knowledge was not the only strategy the movement deployed to overcome the expertise barrier. Rather, aside from direct, contentious action and typical action repertoires commonly used by social movements, the community engaged in the four strategies described by Parthasarathy; and the three types of expertise together each played a key role, including lay/local expertise, scientific expertise, and legal expertise. In fact, the production of new evidence on the negative effects of pesticides involved both lay/local expertise and scientific expertise; at the same time, legal expertise was critical to successfully mobilize the new scientific knowledge in the courts and dispute regulatory science.

The first step that the movement that became known as the *Madres* of Ituzaingó took to raise awareness about an environmental problem that they believed was causing severe diseases in the neighborhood was the production

of their own evidence on their health situation through a survey and a map that showed a disease cluster in proximity of agrarian fields. The *Madres* implemented Parthasarathy's second strategy: they introduced new facts on the basis of their local/lay expertise. As local governmental authorities ignored the evidence produced by the *Madres*, they engaged in Parthasarathy's first strategy – deploying established expertise – while investing in advancing in the second strategy. The *Madres* partnered with local scientific experts, who trained them in the technical language of environmental studies, hypothesized that pesticides caused the environmental health problems in Ituzaingó, and initiated a series of scientific studies in the neighborhood.

A number of efforts to collect evidence and produce interpretations on the effects of pesticides characterized this period, as both sides in the dispute, the neighbors and the governmental authorities, enrolled experts and research institutions. This resulted in the production of previously undone science that discovered high levels of pollution, pesticide contamination above accepted levels, and a cancer cluster. Even though authorities referred to alternative negative results to continue denying the problem, the production of undone science played a critical role in supporting the *Madres'* claims and promoted the enactment of new local ordinances that restricted the use of pesticides in the area. As more undone science was about to be done to confirm the situation of health and environmental contamination in Ituzaingó, the limits of the strategy of the provincial and municipal authorities (i.e. to reject the findings and order other studies that could yield negative results) became clear. Instead of a battle in the terrain of knowledge, those with vested interests in hiding the problem managed to stop undone science from being done. They threatened scientists committed to the epidemiological study in progress and, when this was not enough, they dismissed its leaders and the authorities that hired them.

In this context, and as the new ordinances were constantly violated, the *Madres* partnered with a network of various social movements, and together, they launched Stop Sprayings, the first national campaign against the use of pesticides. The campaign fostered grassroots mobilization across the country, led to the emergence of a national scientific field on health and environmental impacts of pesticides, and promoted the creation of a network of mobilized experts. All of this helped the local struggle in Ituzaingó.

In fact, one of the experts who joined the national campaign was the subsecretary of health of Córdoba City, who became key ally of the *Madres*. Together with a lawyer, a district attorney, and a court prosecutor, he carried out a novel legal strategy that punished violators of local restrictive ordinances and stopped the sprayings in the neighborhood. Through the judicial process, the movement and their allied scientific and legal experts deployed the first two strategies described by Parthasarathy, while engaging in the third and fourth strategy. The district attorney and court prosecutor challenged the rationale behind regulatory science on pesticides by requesting a new precautionary approach to

regulatory frameworks, as well as a different toxicological methodology to measure impacts. The attorney also questioned the bureaucratic rules governing the safety of pesticides by requesting new national rules for the approval, registration, classification, commercialization, and use of pesticides.

The court case was successful in stopping a particular instance of environmental injustice and influenced many other cases of contaminated communities. But it did not have the power to change the rationale behind pesticide contamination, nor the bureaucratic rules of national regulatory policy related to pesticides – not to mention the agrarian model that relies on a technological package consisting of genetically modified seeds resistant to pesticides. It was nevertheless widely regarded as a landmark decision because the central point of contention was the definition of pesticides. Previously their misuse was characterized merely as a violation of administrative law, but now they were defined as hazardous waste upon release into the atmosphere, and therefore a threat to public health – a criminal act. (For the differences between illegal corporate behavior and corporate crime, see Baucus and Dworkin, 1991). The case shows the importance of utilizing courts and legal actions to mobilize new findings produced by counter-experts, as well as the intertwined roles played by local/lay, legal, and scientific expertise to fight environmental injustice.

Note

1. Grupo de Reflexión Rural (Rural Reflection Group, GRR), Unión de Asambleas Ciudadanas (Union of Citizen Assemblies, UAC); the environmental NGO Centro para la Protección a la Naturaleza (Center for the Protection of Nature, CEPRONAT) from Santa Fé; Red de Acción en Plaguicidas y sus Alternativas en América Latina (Action Network on Pesticides and their Alternatives for Latin America; RAPAL); and many other social movement organizations from the provinces of Santa Fé, Buenos Aires, Córdoba, and Entre Ríos joined the campaign.

Disclosure Statement

No potential conflict of interest was reported by the authors.

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