

Regulatory Science and Social Movements: The Trial Against the Use of Pesticides in Argentina

Florencia Arancibia*

In August 2012 a transgenic soy producer and a pesticide spraying pilot were sentenced to three years of conditional prison for potential pollution and harm to public health in Cordoba, Argentina. This was the first case of pesticide pollution judged by Criminal Law in Latin America and the verdict became a turning point in the struggle to regulate pesticides in Argentina. The trial was initiated by the movement “Madres de Ituzaingó” from a neighborhood surrounded by transgenic soy fields sprayed with glyphosate-based herbicides (to which GM seeds are resistant). They found an increase in cancer rates and made the nexus between their illnesses and glyphosate exposure. In this way, they challenged official “regulatory science”, which classifies glyphosate as a product of low toxicity, commercialized and used without restriction. Through in-depth interviews and ethnographic observation, I found that the ruling was an outcome of interconnected actions which included typical forms of protest, the production of “undone science”, as well as other actions involving expertise. *[Article copies available for a fee from The Transformative Studies Institute. E-mail address: journal@transformativestudies.org Website: http://www.transformativestudies.org ©2016 by The Transformative Studies Institute. All rights reserved.]*

KEYWORDS: Pesticides, Pollution, Social Movements, Regulatory Science, Undone-Science.

* **Florencia Arancibia**, Ph.D., is a post-doctoral researcher for the National and Scientific Research Council in Argentina. Her research areas include social movements, environmental controversies, risk governance, and social studies of science and technology. Her dissertation focused on new social movements in the arena of “regulatory science”, and novel relationships between activism and expertise. She has focused on campaigns for restricting the use of pesticides in GM soy producing Argentina and has published on this topic in various journals including *Technology in Society*. She holds a Ph.D. in Sociology from SUNY Stony Brook and was a Fulbright scholar and Inter-American Foundation fellow. Address correspondence to: Florencia Arancibia, National and Scientific Research Council, Argentina; Ciudad Autonoma de Buenos Aires, Argentina; e-mail: farancibia@fund-cenit.org.ar.

INTRODUCTION

In 1996, Argentina pioneered the adoption of genetically modified (GM) soy, and other varieties of GM seeds – corn, cotton – soon followed. The genetic manipulation made the seeds resistant to the herbicide Roundup, based on the chemical glyphosate. As a broad-spectrum, non-selective weed killer, glyphosate inhibits an enzyme in plants that does not exist in human and animal cells, killing all plant life except the crop. As a result GM soy seeds could be grown without any need to plow. The adoption of GM seeds in Argentina was surprisingly fast and widespread, and it marked a turning point (Vara 2005). Since then, the agricultural sector has embarked on a pathway of change in which intensive, high input commodity crop production has become dominant. Today Argentina is the third world producer of GM soy, after the US and Brazil; and is the world leader in soy oil (45% of the global market), and soy flour (43%) production. GM soy represents 25% of Argentine exports. Since 1996 the number of hectares under cultivation of GM crops has increased exponentially in Argentina, along with the growth of the use of glyphosate-based herbicides (REDUAS - Médicos de Pueblos Fumigados 2002).

While agrarian productivity levels increased; rural populations started to report an increase in the incidence of certain pathologies which they associated to the use of glyphosate. Simultaneously, a growing number of independent studies from various countries have revealed links between pesticide exposure and the reported illnesses: cancer, reproductive health ailments, including miscarriages, birth defects, infertility, delayed pregnancies (Antoniou and Fagan 2012, Arbuckle, Lin, and Mery 2001, Axelrad, Howard, and McLean 2003, Benachour and Séralini 2009, Dallegrave et al. 2003, Hardell, Eriksson, and Nordstrom 2002, Marc, Mulner-Lorillon, and Bellé 2004, Marc et al. 2005, Marc, Bellé, et al. 2004, McDuffie et al. 2001, Paganelli et al. 2010, Richard et al. 2005, De Roos et al. 2005, Seralini et al. 2012, Dallegrave et al., 2003).

However, the claims of those groups were almost entirely ignored by Argentina's regulatory, health and science and technology systems. In fact, all of these systems have played a key role in facilitating agricultural intensification, and further agro-biotechnological development. By the time that GM soy was approved (1996), glyphosate was already used for other purposes. Approved by the National Service of Sanitation and Food Quality (SENASA) in 1977, it was revalidated in 1992 as a product of "low toxicity, implying no risk" adopting a special

classification of the World Health Organization which only considers lethal damage at acute levels of exposure (defined by the methodology DL 50)¹. Based on this classification, no restrictions to the commercialization or use of glyphosate were determined in Argentina. The toxicological classification by SENASA never changed and no epidemiological or toxicological studies were conducted by the Ministry of Health in order to assess the non-lethal effects of glyphosate at chronic exposure reported by rural populations and social movements.

Even if protests were dissipated without impacting national regulations, some promoted new protective measures that restricted the use of glyphosate-based pesticides at the local level. Even if at the national level there was no change, some progress has been made at the local level². A set of regulations to fill the gaps in the national regulatory framework have been enacted by municipal and provincial legislators (Vara, Piazz, and Arancibia 2012). These new laws and ordinances have established “pesticide-free zones” around populated areas and restricted ground and aerial spraying of pesticides including glyphosate based herbicides. However, the enforcement of the new laws and ordinances has proved very difficult, as the surveillance capacity of the police is almost nonexistent and penalties for infractions are hard to implement. In this context the province of Córdoba can be considered kind of an exception. Facing similar social movements’ claims as other GM soy producing provinces, it presented more number of new restrictive municipal ordinances (with stronger limits to glyphosate sprayings), as well as the first (and only) case of criminal punishment for violators.

How can at-risk communities promote the implementation of protective regulations for new technologies? Which contentious actions do they have to pursue? This paper addresses these questions and contributes to this discussion by analyzing the struggles that between 1996-2012 led to the first penal condemnation for violations of regulations restricting the use of glyphosate. My hypothesis is that in order to implement new restrictive regulations, communities at risk must create enduring protest organizations allied with sympathetic “experts” and carry out a complex array of interconnected contentious actions -which include but are not limited to the production of “undone science” (Hess 2007 and Woodhouse et al. 2002). In order to answer to these questions and evaluate my hypothesis, I conducted a case study combining in-depth interviews with ethnographic observations. Even though many scholars have analyzed social movements against GM crops in Latin America (Bravo, 2010, Fitting 2011, Kinchy 2006, Klepek 2012, Newell, 2008, Otero, 2008,

Pearson, 2012), as well as adaptation processes (Lapegna 2014), conflicts regarding the regulation of pesticides which GM seeds are modified to resist, have been understudied.

THE “SCIENTIZATION” OF REGULATORY POLITICS AND NEW FORMS OF PROTEST

In a global knowledge economy, political decision makers seek scientific advice to analyze the risks and benefits of new technological developments in order to design accurate regulatory frameworks (Moore et al. 2011). However, the type of knowledge produced for regulatory purposes is quite different from basic science. Jasanoff (1990) has called this kind of research *regulatory science* (1990), and showed how flaws in the production process can determine conclusions which are based on incomplete data, or co-opted by powerful stakeholders. Generally new technologies are released to the market even when the levels of risks are unknown (Hess 2010, Frickel et al. 2010), and approved technologies produce unpredicted and detrimental effects for both public health and the environment. Unfortunately, impoverished communities are often most affected by the side effects of technological development. This is what Beck (2008) calls a “global inequality of risk”: a radical asymmetry between those who take the risks and profit from them, and those who are assigned to them, suffer the “unforeseen side effects” of the decisions of others, and perhaps even pay with their lives. Often it is the case that the danger is exported geographically to countries, or regions whose elites see a selfish opportunity, and whose populations have no means to resist the adoption of a hazardous technology.

Since regulatory frameworks are based on scientific assessments, communities exposed to technological hazards can only prove the flaws and shortcomings of regulatory science through alternative scientific evidence. However, such evidence is usually lacking, and that leads to the problem of what Hess (2007) and Woodhouse et al. (2002) call “undone science”. The concept denotes absence of scientific research that social movements or civil society organizations discover when attempting to make epistemic claims in the political field – such as the safety of a new technology or an industrial process. In other words, it is the absence of knowledge that could help a social movement or civil society organization to resist policies that are not beneficial and thus promote change.

While the growing influence of neoliberal agendas further embeds science and engineering with capitalist production (Ottinger & Coehn

2011), citizens are increasingly excluded from decision making processes regarding regulatory politics and development pathways. Politics are going through what Moore et al. (2011) called a process of “scientism”. Policy and regulatory frameworks tend to be based on the authority of science: decisions are presented as “technical” or “scientific” instead of “political”, and hence are not open to public democratic debate. The “expert class” gains status and authority, while democratic debate is restricted or eliminated (Jasanoff 1990).

In this context, new forms of collective action and grassroots participation in the scientific arena have begun to emerge producing novel relationships between experts and social movements (Moore et al. 2011). A new stream of scholarship interested in the intersection of science, technology and social movements addressed this topic through different studies (Brown et al. 2001, Brown & Zavestoski 2005, Brown et al. 2006, Brown 2007, Corburn 2005, Fischer 2000, Frickel et al. 2014, Frickel 2010, Frickel 2011, Hess 2004, 2010, Hilgartner 2001, Irwin 1995, Moore 2008, O’Rourke & Macey 2003, Kroll-Smith & Floyd 2000, Woodhouse, Hess, and Breyman 2002). This interesting body of literature highlighted the need of “getting undone science done” and focused on the various efforts of social movements and sympathetic-experts to do it. However, I consider that even if producing “undone science” is always a critical first step in challenging regulatory science, making these findings “official” and using them to change current regulatory frameworks requires further actions by social movements and experts (Arancibia 2013a). In this case I tried to test this idea, as well as identify other contentious actions involving expertise which might complement the production of “undone science” (unobserved or under analyzed by the literature).

THE STRUGGLES

MADRES DE ITUZAINGÓ: MAKING THE INVISIBLE VISIBLE

One of the first attempts at challenging the science-based regulations for agrochemical commercialization and use in Argentina involved a group of mothers from a suburban neighborhood bordering soybean farms in the city of Cordoba, who came to be called the Mothers of Ituzaingó. They started to talk about illnesses associated with glyphosate at the beginning of the decade (2000s), while trying to change local regulations for its use in close proximity to their houses.

The mothers identified an unusual increase in local cancer rates and associated it with the rise in the use of agrochemicals. Their struggle

started at the end of 2001 when one woman, Sofia, was puzzled by the fact that many women in the village began wearing headscarves and many children were using chinstraps. For almost four months, she went door to door with other mothers collecting data on medical diagnoses, writing a list and drawing a map showing the location of each ill person. The mothers presented the list and the map to the Provincial Ministry of Health and requested official studies of soil, air and water. As more mothers started to join the group, they met regularly and organized demonstrations. After a local TV channel showed one of the many demonstrations in the streets of Ituzaingó, the Provincial Ministry of Health received the group of mothers and promised to conduct an interdisciplinary environmental study on 150 cases; the study was carried out immediately. However, according to the mothers, not all the cases were fully investigated by the official study.

Helped by human rights lawyers and the Foundation for Environment Protection (FUNAM), the mothers presented their individual cases (38 penal complaints) to the legal federal court at the end of 2002, asking for a restriction of agrochemical spraying in residential areas in the Province. They also presented a petition to the local city authorities (Consejo Deliberante de la Municipalidad de Córdoba) to ban the spraying of agrochemicals close to their houses. A municipal ordinance was issued declaring a health emergency in their neighborhood and two ordinances prohibited ground and aerial spraying within 2500 meters of Ituzaingó's urban areas until the health emergency situation was suspended (N. 10505, 10590). In 2004, a Provincial Law (9164) for regulating the use of agrochemicals passed, establishing a 500 m. limit for the use of some agrochemicals (glyphosate not included).

However, farmers did not obey the provincial law or the municipal ordinance. After the mothers complained, the government promised to establish 24-hour police surveillance, but according to the mothers "the police have always been absent." Having found no redress among local political authorities, the mothers decided to go further: ask for protection in the judicial system and address national political authorities.

At the same time, in order to prove the existence of these illnesses, they decided to conduct their own independent survey with the help of local physicians. This was the first attempt to develop new scientific evidence through popular epidemiology (Brown and Mikkelsen 1990). The report, published in 2005, demonstrated about 200 cases of cancer among 5000 inhabitants (Grupo Madres de Córdoba 2005). The report ended with a declaration from the mothers:

Our low social status makes us endorse multiple factors of degradation and environmental pollution that directly affect our human rights. It is the same image in most villages surrounding soybean crops fields. (...) The best protective and supportive mechanisms for 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 and evasion of taxes (retenciones), we will show the tragic consequences of this model of hunger and death. (...) Spraying with glyphosate, endosulfán, paraquat and other poisons has become the constant threat of many Argentines. How does the State care for its citizens when the children are killed in cold blood in the villages across the country? Who controls these technological packages? Who controls biotechnology? (Grupo Madres de Córdoba 2005).

The provincial Ministry of Health wanted physicians from a provincial hospital to test the results of the Mothers' report. Despite the fact that the physicians sent by the Ministry considered the numbers in the report accurate, the Ministry of Health said that there was not enough evidence of causal association between the development of diseases and the use of agrochemicals. In 2004 the mothers travelled to the capital city, Buenos Aires, to address the National Ministries of Human Rights, Environment, and Health. There, they contacted national deputies to design and present to the National Congress a National Law to ban spraying in any area within 2500 m. of urban areas surrounding farms across the country. In Buenos Aires the mothers were also able to contact and build solidarity networks with other organizations that got involved in their struggle targeting national authorities.

To summarize, because the local regulations that the mothers wanted to change were based on regulatory science (Jasanoff 1990), the first step in their struggle was to challenge it. In this way, the mothers had to find a way of producing undone science and they did it through popular epidemiology (Brown and Mikkelsen 1990). Their struggle was mainly played at the local level –their main goal was to prevent the spraying of glyphosate over and in the proximities of their houses- but their initiative had interesting consequences at the national level. Even if the mothers did not reach their local goal until many years later (helped by confluent factors and the mobilization of other social movements and experts), building alternative epidemiological

data in order to press political authorities turned to be an innovative and powerful contentious performance (Tilly 2008). Rural physicians and other social movements in different locations across the country emulated it later; and the data produced by all of them became a useful tool for influencing public opinion and promoting changes in provincial and national regulations on the use of glyphosate.

“STOP THE SPRAYING”

One of the groups that the mothers met in their trip to Buenos Aires was Grupo de Reflexion Rural (GRR). GRR was founded in the mid-nineties by intellectuals from different disciplines (social sciences, agronomy, and economics) as a space to debate the impacts of global capitalism in the country. From ecological and critical perspectives, the group opposed the agricultural model based on the export of transgenic commodities as a new form of dependency. GRR supported the Madres de Ituzaingó's national campaign against pesticide use in urban populations in 2005 and founded a campaign called Stop the Spraying. The campaign was supported by other social and environmental NGOs such as the Center for the Protection of Nature (CEPRONAT) of the city of Santa Fe, and several others of the Provinces of Buenos Aires, Cordoba and Entre Rios as well as Union of Citizen Assemblies (UAC). The aim of the Stop the Spraying campaign was to promote the organization of neighbors in soy-surrounded areas across the country in order to resist the new agro-productive system that, according to GRR, was causing severe health and social problems. It is interesting to notice that this campaign aimed not only at changing the science-based regulations on the use of agrochemicals but also at resisting the complete agricultural model of the bioeconomy. GRR criticized the idea that introducing biotechnology in agriculture would lead to further national development and growth. They said that their fight was not for a simple ban in the use of agrochemicals, but for the foundation of a new agrarian model of production based on agro-ecological principles.

One of the first steps of the national campaign was to build new alternative scientific evidence. As the group of mothers has already done, GRR collected data regarding the associated illnesses in a collaborative effort between rural neighbors and experts; just as the mothers had done, GRR was constructing a popular epidemiology. But this time, the research covered many provinces (Buenos Aires, Santa Fe, Entre Ríos, Córdoba) and included data from patients, medical records, as well as studies on soil and water. As a result, in January 2009 the book

Fumigated Peoples was published. The book was presented in September 2009 at the second Fumigated Peoples meeting organized by UAC at San Lorenzo, Province of Santa Fe. The book did not follow an academic format, and was designed to be available in non-expert bookshops so it could reach a massive public audience. Also, the empirical studies were used to support GRR's legal demands that the National Supreme Court suspend the use and marketing of agrochemical products across the country. The petition also requested that certain national institutions be incriminated as the "drivers and / or supporters" of agribusiness: SENASA, the National Institute of Agricultural Technology (INTA) and the Ministry of Agriculture.

To summarize, the Stop the Spraying campaign changed the level of struggle in three different ways: 1. the political scope was wider (the claim was a radical change of the agrarian productive system, not only challenging regulatory frameworks); 2. the geographic reach was broader (different villages across the country were included); 3. many experts got involved (for example, rural physicians). In terms of outcomes, even if the campaign did not accomplish its main goal yet, it produced a lot of empirical alternative data, built a national advocacy network and helped legal actions carried on by GRR and later on by different actors across the country. The main accomplishment was to develop strong links between experts and local communities as well as among local communities spread across the country. This became an important tool for supporting and coordinating the mobilization of small and isolated rural communities.

THE EXPERIMENT ON EMBRYOS

In April 2009, the front page of an Argentine popular newspaper published new experimental findings by Dr. Andrés Carrasco proving that glyphosate causes malformations in embryos. Interviewed by the newspaper, the embryologist from the National Commission of Science and Technology (CONICET) and head of the Molecular Embryology Lab at University of Buenos Aires provided technical details, and said that further studies should be conducted immediately to analyze other damages caused by glyphosate while precautionary regulations should ban or at least strongly limit its use in populated areas surrounding soy fields. In the interview, he publicly complained about the complacency of the global scientific system with private corporations: "Science is urged by powerful economic interests, and not by the quest for truth and the welfare of the people" (Aranda, 2009). The same

results were published by an international journal of toxicology (Paganelli, Gnazzo, Acosta, López and Carrasco, 2010) one year later.

Even if Carrasco's findings were not the first experimental results on detrimental effects of glyphosate on public health, previous experiments published in scientific journals in English or French were pretty inaccessible for lay populations in rural Argentina. In contrast, Carrasco tried to make his findings easily accessible to as many people as possible. The fact that the experiment was conducted by an Argentine physician from a national university, and that it was published in Spanish in an oral interview for a massive national newspaper made a difference. Despite the fact that Carrasco was not a member of the groups organizing the Stop the Spraying campaign, his actions were in some ways complementary with it. His research agenda was influenced by the ongoing scientific- political disputes around glyphosate: "I thought that I definitely should do something about this after reading the Madres' problems" (Interview, 2009).

The first public response to the results came from government officials who underestimated the embryologist's claims and argued that his results should not be considered more than a private communication of preliminary data on a work in progress instead of proven scientific evidence of a study commissioned by CONICET. They questioned the scientific validity of the results, due to the fact that they were first published in a massive newspaper instead of a scientific journal. They also defended the use of glyphosate-based herbicides and highlighted that the Ministry of Agriculture approved its use a long time ago "based on worldwide experiences" (Baraño in Huergo 2009). It is interesting to see that this criticism is being uttered on a TV show. The importance of media as an arena for debate for all parties involved in the regulatory science controversy is clear. And this proves that when social movements of lay people step into these types of expert debates, they force a de-facto democratization of the decision-making processes (regardless of the success they obtain in their claims of change).

Right after the Minister's TV appearance, more than 600 intellectuals and scientists, as well as international NGOs and Indigenous movements produced a manifest supporting Carrasco and demanding a real detachment of science from lucrative interests and international corporations. The same day, the National Peasant Movement Via Campesina Indígena issued a statement supporting Carrasco.

Three days after the results of the experiment were published, the Environmental Lawyers Association filed an appeal before the Supreme

Court requesting the suspension of commercialization, sale and application of glyphosate in the entire country based on the new experiment as well as previous national scientific studies. They placed responsibility on the national executive government, as well as the provincial governments of Buenos Aires, Cordoba, and Santa Fe; they also pointed to Monsanto. The appeal was based on the precautionary principle stipulated by Article 4 of National Environmental Law (the absence of scientific proof or information should not be used as a reason for postponing effective measures to prevent environmental degradation) and article 14 of the National Constitution.

In August 2010 physicians from the rural villages in GM soy-producing provinces held a meeting at the School of Medical Sciences in the province of Cordoba. It was the first time that a national university hosted an official conference on such topics as agrochemicals and public health. Molecular biologists, geneticists, epidemiologists, endocrinologists, and other experts like Carrasco presented empirical data on this issue. This meeting was the founding moment of a social movement exclusively composed by experts. The University Network for Public Health and Environment Physicians of Fumigated Villages became a formal network of physicians and experts that worked together towards a shared goal: to link, coordinate and enhance scientific research, health care, epidemiological analysis and the promotion and defense of the right to collective health, performed by different teams working in 10 different provinces of Argentina. With more than twenty professionals actively involved, the network created a webpage to communicate national and international scientific news on issues related to the use of agrochemicals as well as publish collective statements on concrete national policies regarding agrarian biotechnology. They published the report of their first meeting as a book and organized a second meeting the year after at the National University of Rosario, in another GM soy producer region.

In May 2010, the forest engineer Claudio Lowy supported by the National Ecological Action Network, the Union of Civil Assemblies, Red Alternativas a los Plaguicidas en América Latina (RAPAL) and the Association of Environmental Lawyers, among others, sent a request to the Ombudsman's office with 10,000 signatures asking intervention to change the toxicological methodology for the classification of agrochemicals. For the first time, the struggle questioned what apparently only experts in toxicology could question: the scientific methodology used to determine the risk of chemicals use on human health. For the first time, social movements and NGOs directly targeted

the local and global organizations producing the regulatory science for the bio-economy: the World Health Organization and SENASA. Finally, the Ombudsman agreed with the request and formally solicited a change in the toxicological methodology to the National Ministry of Agriculture. As the Ministry did not take any concrete action, the Environmental Association Lawyers filed a new lawsuit in 2011 against the executive government. The lawsuit demanded an urgent change in the toxicological classification of agrochemicals as well as the declaration of a national state of health emergency, based on the scientific data of the report published by the University Network for Public Health and Environment-Physicians of Fumigated Villages.

THE TRIAL AND AN OPEN-ENDED STORY

In January 2009 a GM soy producer and a pesticide-spraying pilot from Ituzaingó were banned from spraying pesticides by writ of “amparo”³, and in August 2012 they were sentenced to three years of conditional prison for pollution and potential harm to public health. Córdoba became the only province of the country in which violations to glyphosate based herbicides restrictive rules received a criminal punishment. This was the first case of pollution judged by Criminal Law in Latin America, and it became a strong legal background for future similar complaints in Argentina.

Even if the final verdict of the trial was received differently by activists, the trial was won and the positive consequences were many: a. science proving pesticide related illnesses was officially legitimized by the judiciary; b. the case became a strong legal background for future similar complaints in Argentina; c. new ordinances restricting the use of pesticides were enacted within the province of Córdoba - with higher limits to pesticide sprayings than in other provinces on average; d. stronger controls were implemented by the local government in order to enforce the provincial law of agrochemicals as well as municipal ordinances.

This was the result of a complex chain of actions and strategies developed during the previous years at both local and national levels. First, social movements and sympathetic scientists had to initiate a litigation process against rural producers who violated the limits to pesticide sprayings stipulated by municipal ordinances N. 10505, 10590 and 2589 in Ituzaingó (judiciary litigation). Second, the prosecutors in charge had to be convinced about accepting the complaint and initiating a trial. Sympathetic scientists provided the

prosecutors the main scientific evidence on pesticide related illnesses, and defended their legitimacy (communicating and advocating new findings). Aside from presenting the scientific evidence, the network of experts also persuaded the prosecutors to take urgent action in a series of personal meetings (lobby). Interestingly, the court prosecutor, Novillo, was already aware of the problem of pesticides before receiving the complaint, thanks to the long term previous mobilization led by the Madres de Ituzaingó (mobilization). Third, the judges had to be convinced about condemning the accused. The authors of some alternative science studies (offered by the complainants as evidence) presented their results orally in court, in order to demonstrate the existence of pesticide-related illnesses (advocating new findings).

Proving the veracity of alternative was the legal keystone to win the trial. But this was a long-term struggle of which the last battle was fought in the court. In other words, this required huge efforts from many actors (activists and experts). Despite the growing number of studies supporting a causal relationship between the illnesses and pesticide exposure, their validity kept being challenged by various power holders and experts working in public offices or private agribusiness firms. During the period 2005-2012, more studies were conducted in Ituzaingó proving pesticide-related illnesses. Most of the times the results were challenged and silenced by governmental authorities, and their authors were met with hard reprisals -censorship, reprimands, punitive transfer, demotion, and threats (Martin 1999). During the two months of the judiciary process, mobilization in the streets of Córdoba City gained momentum. The Madres together with the urban popular assembly Stop the Sprayings Córdoba, student movements and social movements that came from other provinces, organized an array of contentious actions in front of the court, and the streets of Córdoba City (mobilization). At the same time, the national network of experts organized an array of activities within the National University of Córdoba (talks, workshops, conferences, etc.) communicating and supporting the validity of alternative findings.

Both mobilization and advocating alternatives worked to keep public attention focused on the issue and press the judges to make a favorable decision. In summary, the ruling and its positive consequences can be explained by the intertwined actions led by social movements from Córdoba and an emerging national network of experts.

DISCUSSION

This case study focused on the dynamics of bottom-up initiatives to change the science-based regulatory frameworks for the use of pesticides. We can see how complex struggles take place in that boundary zone between basic science and policy -regulatory science- where all the different parties mentioned above can interact and clash, and where every issue always has to be tackled on two fronts at once (lay/expert, facts/rights, science/law, etc.).

The case of Cordoba showed that often the production of “undone science” is not enough to change regulatory politics. The results of alternative studies proving regulatory science wrong were available for all the grassroots movements of Argentina, however only in Córdoba were they able to use them to implement new protective regulations and punish violations. A more complex set of interrelated contentious actions is required. Rural populations have to get together and create grassroots organizations able to mobilize other people in order to express their claims and exercise some sort of leverage on government institutions: Madres de Ituzaingó were the first, followed by many local groups of Stop the Spraying and Union of Popular Assemblies. These organizations have to be quite strong in order to survive long periods of time, as legislative processes tend to be relatively slow. But organization is not enough. New ways of acting had to be developed as traditional repertoires of actions (like demonstrations, road blockage, and rallies) are not enough. They have to legitimize their claims scientifically building partnerships with scientists and physicians for them to conduct alternative studies. At the same time, experts need to express from inside scientific institutions their own disagreement with the scientific basis of current regulations. They have to create new research lines and projects as well as publish new results challenging existing studies that determine the official toxicological classification of agrochemicals. Experts also have to coordinate their actions with grassroots social movements: engaging in popular epidemiology; working towards the spread of scientific results; helping environmental lawyers include scientific data in lawsuits; and giving public speeches in demonstrations and conferences across the country. Some of them even have to become active members of grassroots social movements.

CONCLUSION

The positive local outcomes in Cordoba resulted from the complex coordination of local and national collective efforts of lay people and

experts. Many things had to be lined up in order to produce local changes in regulations: a finding done with an experimental-animal model and some epidemiological or clinical evidence; both testimony from experts and the affected lay people; people mobilized in the streets, experts mobilized in national professional settings; and legal procedures in the Courts. Different targets had to be addressed at the same time: public/politicians were one relevant audience, but also professionals (doctors), expert regulators as well as basic scientists at multiple locales.

To summarize, this study found that a complex repertoire of struggle has to be developed to make epistemic claims -such as claims about the safety of GBH- and change regulatory frameworks for pesticides and agrarian biotechnology. By breaking this repertoire down in full detail, I saw that the literature was right about the need of producing “undone science”. But I also found that this is not enough and needs to be complemented with an array of other actions in order to reach change. These other actions include typical forms of protest -like mass action in the street, mobilization and lobby- as well as other novel forms of collective action involving expertise like communicating and advocating new findings.

Scientific proofs showed to be an extremely important resource for SMs’ actions, but making them “official”, incorporating them into regulatory frameworks and using them to effectively change agrarian practices required further contentious actions that involved both SMs and experts. The production of “undone science” is critical for challenging official regulatory science but movements and experts have to be strategic in making these new findings visible, advocate for them, and counter delegitimizing criticism. This has to do with the other side of undone science: those subtle mechanisms set out in order to “keep it undone” or “silence” it once it gets done.

I consider that the literature did not analyze reprisals and punishment in depth, neither defensive strategies developed by scientists in order to overcome attacks, achieve official recognition of their research and use it to change policy. This is a critical issue that requires further and acute analysis. I tried to make efforts to fill this gap by paying special consideration to the strategies developed towards reaching official recognition (in this case by the judiciary).

Instead of trying to identify the main contentious action required to influence technological risk governance I encourage scholars to keep working to describe the complex repertoire of the many complementing actions required to change technological risk governance and understand

how it can be implemented. This will be an important contribution to the emerging field of science, technology and social movements; as well as a critical input for activists fighting environmental health injustice.

REFERENCES

- Antoniou, M., & Fagan, J. 2012. GMO Myths and Truths genetically modified crops, (June).
- Arbuckle, T. E., Lin, Z., & Mery, L. S. 2001. An exploratory analysis of the effect of pesticide exposure on the risk of spontaneous abortion in an Ontario farm population. *Environmental Health Perspectives*, 109 (8), 851–7. <http://dx.doi.org/10.1289/ehp.01109851>
- Axelrad, J. C., Howard, C. V., & McLean, W. G. 2003. The effects of acute pesticide exposure on neuroblastoma cells chronically exposed to diazinon. *Toxicology*, 185(1-2), 67–78. [http://dx.doi.org/10.1016/S0300-483X\(02\)00592-9](http://dx.doi.org/10.1016/S0300-483X(02)00592-9)
- Arancibia, F. 2013a. Challenging the bioeconomy : The dynamics of collective action in Argentina. *Technology in Society*, 35, 72–92. <http://dx.doi.org/10.1016/j.techsoc.2013.01.008>
- Arancibia, F. 2013b. Controversias científico-regulatorias y transgénicos en la Argentina . In T. Molina & M. Vara (Eds.), *Riesgo , Política y Alternativas Regulación y la Discusión Pública* . Buenos Aires, Argentina: Prometeo.
- Beck, U. 2008. World at Risk: The New Task of Critical Theory. *Development and Society*, 37(1), pp.1–22.
- Benachour, N., & Séralini, G.-E. 2009. Glyphosate formulations induce apoptosis and necrosis in human umbilical, embryonic, and placental cells. *Chemical Research in Toxicology*, 22(1), 97. <http://dx.doi.org/10.1021/tx800218n>
- Bravo, A. L. 2010. *Los Señores de la Soja. La Agricultura Transgénica en América Latina*. Buenos Aires: CLACSO
- Brown, P. 2007. *Toxic exposures: Contested illnesses and the environmental health movement*, New York, US: Columbia University Press. <http://dx.doi.org/10.7312/brow12948>
- Brown, P. & Mikkelsen, E. 1990. *No safe place: Toxic waste, leukemia, and community action*, Berkley, Los Angeles, US: University of California Press.
- Brown, P. & Zavestoski, S. 2005. *Social Movements in Health*, Wiley.
- Brown, P. et al. 2001. A gulf of difference: disputes over gulf war-related illnesses. *Journal of Health and Social Behavior*, 42(3), pp.235–257. <http://dx.doi.org/10.2307/3090213>

- Brown, P. et al. 2006. "A Lab of Our Own": Environmental Causation of Breast Cancer and Challenges to the Dominant Epidemiological Paradigm. *Science, Technology & Human Values*, 31(5), pp.499–536. <http://dx.doi.org/10.1177/0162243906289610>
- Brown, P. 1987. Popular Epidemiology: Community Response to Toxic Waste-Induced Disease in Woburn, Massachusetts. *Science, Technology & Human Values*, 12(3), pp.78–85.
- Corburn, J. 2005. *Street science. Community knowledge and environmental health justice*. Cambridge, Massachusetts, US: The MIT Press.
- Dallegrave, E., Mantese, F. D., Coelho, R. S., Pereira, J. D., Dalsenter, P. R., & Langeloh, A. 2003. The teratogenic potential of the herbicide glyphosate-Roundup in *Wistar rats*. *Toxicology Letters*, 142(1-2), 45–52. [http://dx.doi.org/10.1016/S0378-4274\(02\)00483-6](http://dx.doi.org/10.1016/S0378-4274(02)00483-6)
- Fischer, F. 2000. *Citizens, Experts, and the Environment: The Politics of Local Knowledge*. Duke University Press. <http://dx.doi.org/10.1215/9780822380283>
- Fitting, E. 2011. *The Struggle for Maize: Campesinos, Workers, and Transgenic Corn in the Mexican Countryside*. Durham: Duke University Press.
- Hardell, L., Eriksson, M., & Nordstrom, M. 2002. Exposure to pesticides as risk factor for non-Hodgkin's lymphoma and hairy cell leukemia: pooled analysis of two Swedish case-control studies. *Leukemia & Lymphoma*, 43(5), 1043–9. <http://dx.doi.org/10.1080/10428190290021560>
- Marc, J., Bellé, R., Morales, J., Cormier, P., & Mulner-Lorillon, O. 2004. Formulated glyphosate activates the DNA-response checkpoint of the cell cycle leading to the prevention of G2/M transition. *Toxicological Sciences*, 82(2), 436. <http://dx.doi.org/10.1093/toxsci/kfh281>
- Marc, J., Le Breton, M., Cormier, P., Morales, J., Bellé, R., & Mulner-Lorillon, O. 2005. A glyphosate-based pesticide impinges on transcription. *Toxicology and Applied Pharmacology*, 203(1), 1–8. <http://dx.doi.org/10.1016/j.taap.2004.07.014>
- Marc, J., Mulner-Lorillon, O., & Bellé, R. 2004. Glyphosate-based pesticides affect cell cycle regulation. *Biology of the Cell / under the Auspices of the European Cell Biology Organization*, 96(3), 245–9.
- McDuffie, H. H., Pahwa, P., McLaughlin, J. R., Spinelli, J. J., Fincham, S., Dosman, J. A., Choi, N. W. 2001. Non-Hodgkin's lymphoma and specific pesticide exposures in men: cross-Canada study of pesticides and health. *Cancer Epidemiology, Biomarkers & Prevention: A Publication of the American Association for Cancer Research*, Cosponsored by the American Society of Preventive Oncology, 10(11), 1155–63.

- Frickel, S. 2010. Shadow Mobilizations for Environmental Health and Justice. In J. C. Banaszak-Holl, S. R. Levitsky, & M. N. Zald, eds. *Social Movements and the Transformation of American Health Care*. Oxford University Press, p. 400. <http://dx.doi.org/10.1093/acprof:oso/9780195388299.003.0011>
- Frickel, S. 2011. Who are the Expert Activists of Environmental Health Justice? In B. Cohen & O. Gwen, eds. *Technoscience and Environmental Justice: Expert Cultures through Grassroots Engagement*. Cambridge, Mass.: MIT Press, pp. 21–39. <http://dx.doi.org/10.7551/mitpress/9780262015790.003.0002>
- Frickel, S., Torcasso, R. & Anderson, A. 2014. *The organization of expert activism: shadow mobilization in two social movements*, Alsace, Strasbourg, France.
- Grupo Madres de Córdova. Observatorio latinoamericano de salud. Quito. Ecuador: CEAS.
- Hess, D. 2004. Guest editorial: Health, the environment and social movements. *Science as Culture* 13 (4): 421. <http://dx.doi.org/10.1080/0950543042000311797>
- Hess, D.J. 2007. *Alternative pathways in science and industry: activism, innovation, and the environment in an era of globalization*. Cambridge, Mass.: MIT Press.
- Hess, David J. 2010. Social Movements, Publics, and Scientists. Invited lecture, Japanese Society for Science and Technology Studies, Tokyo.
- Hilgartner, S. 2000. *Science on stage: Expert advice as public drama*. Standford University Press ed. Standford, California, US.
- Irwin, A. 1995. *Citizen Science: A Study of People, Expertise and Sustainable Development*, Psychology Press.
- Kinchy, A. 2006. On the Borders of Post-War Ecology. Struggles of the Ecological Society of America's Preservation Committee, 1917-1946. *Science as Culture* 15: 23-44. <http://dx.doi.org/10.1080/09505430500529706>
- Klepek, J. 2012. Against the Grain; Knowledge Alliances and Resistance to Agricultural Biotechnology in Guatemala. *Canadian Journal of Development Studies* 33 (3): 310-25. <http://dx.doi.org/10.1080/02255189.2012.719824>
- Jasanoff, S. 1990. *The fifth branch: science advisers as policymakers*, Cambridge, Mass.: Harvard University Press.
- Kroll-Smith, S. & Floyd, H.H. 2000. *Bodies in Protest: Environmental Illness and the Struggle Over Medical Knowledge*, NYU Press.

- Lapegna, P. 2014. Global Ethnography and Genetically Modified Crops in Argentina: On Adoptions, Resistances, and Adaptations. *Journal of Contemporary Ethnography* 43(2):202–27. <http://dx.doi.org/10.1177/0891241613516629>
- Martin, B. 1999. Suppression of Dissent in Science. *Research in Social Problems and Public Policy*, 7, 105–135.
- Moore, K. 2008. *Disrupting Science: Social Movements, American Scientists, and the Politics of the Military, 1945-1975*, Princeton, New Jersey: Princeton University Press.
- Moore, K. 1996. Organizing Integrity: American Science and the Creation of Public Interest Organizations, 1955-1975. *American Journal of Sociology*, 101(6), pp.1592–1627. <http://dx.doi.org/10.1086/230868>
- Moore, K. et al. 2011. Science and neoliberal globalization: a political sociological approach. *Theory and Society*, 40(5), pp.505–532. <http://dx.doi.org/10.1007/s11186-011-9147-3>
- Newell, P. 2008. Trade and Biotechnology in Latin America: Democratization, Contestation and the Politics of Mobilization. *Journal of Agrarian Change* 8 (2-3): 345-76. <http://dx.doi.org/10.1111/j.1471-0366.2008.00173.x>
- O'Rourke, D. & Macey, G.P., 2003. Community environmental policing: Assessing new strategies of public participation in environmental regulation. *Journal of Policy Analysis and Management*, 22(3), pp.383–414. <http://dx.doi.org/10.1002/pam.10138>
- Otero, G. 2008. *Food for the Few: Neoliberal Globalism and Biotechnology in Latin America*. Austin: University of Texas Press.
- Ottinger, G. & Coehn, B.R. 2011. *Technoscience and Environmental Justice: Expert Cultures in a Grassroots Movement*, MIT Press. <http://dx.doi.org/10.7551/mitpress/9780262015790.001.0001>
- Paganelli, A., V. Gnazzo, H. Acosta, S. L. López, and A. E. Carrasco. 2010. Glyphosate- based herbicides produce teratogenic effects on vertebrates by impairing retinoic acid signalling. *Chemical Research in Toxicology* 23: 1586. <http://dx.doi.org/10.1021/tx1001749>
- Pearson, T. 2009. On the Trail of Living Modified Organisms Environmentalism within and against Neoliberal Order. *Cultural Anthropology* 2 (4): 712-745. <http://dx.doi.org/10.1111/j.1548-1360.2009.01045.x>
- REDUAS - Médicos de Pueblos Fumigados. 2010. *1º Encuentro Nacional de Médicos de Pueblos Fumigados* (pp. 1–40).

- Richard, S., Moslemi, S., Sipahutar, H., Benachour, N., & Séralini, G.-E. 2005. Differential Effects of Glyphosate and Roundup on Human Placental Cells and Aromatase. *Environmental Health Perspectives*, 113(6), 716–720. <http://dx.doi.org/10.1289/ehp.7728>
- Seralini, G., Clair, E., Mesnage, R., Gress, S., Defarge, N., Malatesta, M., De Vendomois, J. 2012. Long term toxicity of a Roundup herbicide and a Roundup-tolerant genetically modified maize. *Food Science & Technology Toxicology*, 50(11), 4221–4231. <http://dx.doi.org/10.1016/j.fct.2012.08.005>
- Tilly, Charles. 2008. *Contentious Performances*. Cambridge Studies in Contentious Politics. <http://dx.doi.org/10.1017/CBO9780511804366>
- Vara, A. M. 2005. *Argentina, GM nation, chances and choices in uncertain times project on international GMO regulatory conflicts*. NYU.
- Vara, A. M., Piazz, A. & Arancibia, F. 2012. Biotecnología agrícola y “sojización” en la Argentina: controversia pública, construcción de consenso y ampliación del marco regulatorio. *Política & Sociedade*, 11(20), 135–170. <http://dx.doi.org/10.5007/2175-7984.2012v11n20p135>
- Woodhouse, E., Hess, D. & Breyman, S., 2002. Science Studies and Activism: Possibilities and Problems for Reconstructivist Agendas, *Social Studies of Science*, 32(2), pp.297–319. <http://dx.doi.org/10.1177/0306312702032002004>

END-NOTES

¹ This toxicological classification might be useful for those involved in direct handling (distinguishing those chemical substances that are instantly lethal from those that are not); but irrelevant to exposure in the agricultural context. At the same time, WHO's toxicological classification was mainly based on studies conducted by the very same industry that sells pesticides.

² Being a federal country, Argentina has four jurisdictional levels: Nation, Province, Municipality and the Autonomous City of Buenos Aires; having each of them different competences and duties. The regulation of environmental issues is done at the four levels. The Nation establishes minimum requirements, while each Province defines the norms to complement them. The approval, registration and commercialization (which includes manufacture, traffic, and selling) of phytosanitary products are jurisdiction of the National government, through SENASA. However, the use of phytosanitary products is regulated by Provincial and Municipal governments. This means that only the Nation –through SENASA- can ban the commercialization of a phytosanitary product (based on technical justification); while only the Province and Municipality can define “wrong use” or “wrong place to use it” (for example, through the definition of environmental protection areas, or “pesticide-free” areas). At the same time, the control of the environmental norms (included national norms) depends on each Province within their territory, as the police power is a provincial faculty, not delegated to the Nation.

³ The writ of “amparo” serves to guarantee fundamental rights found unregulated. It is a limited, summary, emergency procedure, and merely supplementary, requiring previous exhaustion of administrative remedies before rendition of judgment of mandamus or injunction.