Addressing Community Exposure to Hydrogen Sulfide in the Saskatchewan Oilpatch:

Interdisciplinary Investigations as a Lever to Expose Industrial Risk

by

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Abstract

How can communities from poorly regulated industrial regions assess their exposure to environmental contaminants? And what resources could their collaboration with interdisciplinary research groups provide to address the environmental health risks they are exposed to?

A corrosive neurotoxic gas, hydrogen sulfide (H_2S) is produced by the bacterial degradation of organic matter in the absence of oxygen. Characterized by a strong rotten-egg smell, it can be released through industrial processes like oil and gas extraction, sewage treatment, paper production, and hog farming. In the fall of 2017, several news articles published in *Global News*, the *National Observer*, and the *Toronto Star*, alerted readers to hazardous levels of H_2S emissions from oil and gas facilities in southeast Saskatchewan. Several incidents involving H_2S were also reported—including the death in 2014 of a worker from a local oil company.

If H_2S has been recognized as a major workplace hazard, it remains poorly monitored and regulated in residential areas affected by fugitive emissions. In fossil fuel producing regions, this concern has been growing with the development of oil and gas enhanced recovery techniques, such as hydraulic fracturing, that can contribute to H_2S proliferation. Why is community exposure to H_2S exposure so poorly prevented, while an increasing number of people live near oil and gas facilities? And why, despite being aware of significant exposure risks, has the Saskatchewan Government remained mostly silent on the issue and failed to take binding action?

This paper explores the interdisciplinary collaboration between an investigative media consortium, *The Price of Oil*, a team of social and data scientists, the Wylie Lab at Northeastern University in Boston, and a community group to assess residents' exposure to H_2S in southeast Saskatchewan. While *The Price of Oil* conducted extensive research, interviews, and Freedom of Information requests, the Wylie Lab developed with several families an experimental air monitoring study to detect H_2S around their living place. Conceived as a low-cost method to address the lack of accessible H_2S monitoring instruments and provide preliminary data on exposure to corrosive gases, the testing kit uses samples of photographic paper that darken when reacting with sulfur gases. The findings from the interdisciplinary investigation have been reported in two series of news articles, published by *The Price of Oil* in national media outlets in October 2017 and October 2018.

To analyze this collaboration and the environmental health risks it addresses, I first examine the conditions of production of H_2S, and the ways in which the economic and regulatory orientations of the Saskatchewan Government have contributed to the creation of exposure risk. I then evaluate

the resources that interdisciplinary investigations can offer to expose such environmental health risks, and to make them graspable through counter-narratives and what I call “operative data”. Finally, based on the preliminary outcomes of the investigation conducted in southeast Saskatchewan, I highlight the potential of such collaborations to consolidate community capacity, and to trigger greater public and corporate accountability mechanisms.

Foreword

> *"Shortly after the creation of the world and the birth of Nanabush, Nanabush took a trip around the world as a way of learning about the world. That's the first lesson. If you want to learn about something, you need to take your body onto the land and do it. Get a practice."*
>
> (Simpson, 2014, 17)

Writing this foreword, I was struck to rediscover the five words of the "area of concentration" that, as an incoming MES students, I had defined as a learning horizon for myself. Mine read "Chemical Bodies: Interdisciplinary Research in Environmental Health," and couldn't better prefigure the spectrum I would navigate over the two years during which I had the chance to readjust my professional trajectory.

The project that the present paper describes has been an engaging experience to learn, in practice, about the challenges inherent to addressing contested environmental contaminants, in areas where little resources exist to publicly question them. Concerned with community exposure to hydrogen sulfide (H_2S), a neurotoxic gas often associated with oil and gas production, this project has taken the form of an interdisciplinary collaboration that brought together residents from the southeast Saskatchewan oilpatch, an investigative media consortium (*The Price of Oil*), and a team of social scientists (The Wylie Lab). Their collaboration for nearly two years has made it possible to highlight—through in-depth news reporting, and an experimental participatory air monitoring study—a concerning lack of regulatory oversight, and significant health and safety risks for the local community.

Over the last year, the opportunity to contribute to the development of the community-based air monitoring study through my work with the Wylie, has been a fantastic way to explore and refine the different components of the area of concentration defined in my Plan of Study. Among others, it has been an inspiring framework to further reflect on, and experiment with, forms of visual evidence to meaningfully assess and expose environmental harm. It has also taught me about how the resources of academic research can be invested in developing open source tools that build on the needs of communities who face environmental injustices.

I am grateful to have had the chance to engage in a project so closely aligned with the questions I had entered the MES program with. Collaborating with the Wylie Lab during my studies has opened up a multiplicity of avenues for reflection, that have, in return, informed new interests and questions, as well as renewed desires for grounded engagements.

Acknowledgments

The work described in this research paper has been developed over two years of collaborative engagements. It has been composed, nurtured, and inspired by many. I would like to thank them all, and name those that I have particularly learned from.

Meeting and working with community members from southeast Saskatchewan has been a deeply marking experience. I admire the trust and courage they had in opening their doors and stories to our research team. Dr. Sara Wylie has been—in the field, and in the lab—an equally outstanding supervisor and mentor. I have been continuously inspired by her inventiveness, generosity, and communicative energy. Learning with her has been a joy as much as a tireless questioning process, and words are not enough to express how much this experience has informed my intellectual and personal trajectories. Collaborating with the Wylie Lab, and in particular with Lourdes Vera, Ph.D. student at Northeastern University, has also been an inspiring process—and I wished more than once to have the capacity to travel through my screen to share, in person, the learnings and joys of teamwork. My thanks and thoughts also go to Phil Brown, Director of the Social Science Environmental Health Research Institute; his work has profoundly inspired my research, and I would not be where I am today if he hadn't reintroduced me to Sara Wylie in the spring of 2018.

Kristina Hedlund, MES fellow and my first Saskatchewanian encounter, also holds a seminal place in this research; I would not have engaged on that path if we hadn't initially learned about and discussed together the issue of hydrogen sulfide exposure in her birth province. Patti Sonntag, Director of the Institute for Investigative Journalism at Concordia University, must also be thanked for her essential work and engagement with the issue. It has been a compelling experience to witness what can be achieved through collaborative investigations such as those deployed by *The Price of Oil*. Dr. Emily Eaton and Dr. Patricia Elliott at the University of Regina, have also been models of tenacity and engagement; I admire their courage for addressing the human and environmental impacts of the fossil fuel industry, within a province and university that sustain oil and gas developments.

I would like to warmly thank Dr. Ilan Kapoor for providing over our advising sessions a stimulating framework to define and mature my Plan of Study. I am also grateful to the Faculty of Environmental Studies for sustaining such a thrilling and interdisciplinary learning environment, and

for making it possible to work with a supervisor from across the border. The class in Environmental Law and Justice taught by Dr. Dayna Scott has also been an essential and inspiring framework for the inception of the work that this paper is concerned with, and I would like to specifically thank Dr. Scott for her guidance at several stages through the MES program.

I extend a special thought and *merci* to Ray Bennett for the time, care, and generosity he dedicated to assist me in the process of grappling with a foreign language, and in learning to articulate thoughts and words with more spontaneity. Nadine Ryan should also be thanked for the attention she gave to all and each of the following words, that she has fruitfully helped sharpen and refine.

Finally, I want to express my affection to the loved ones that have helped me bridge Europe and Canada, and start engaging on a path that moves and inspires me every single day. My thoughts and love particularly go to my three parents, Nicolas, Solange, and Michèle for their complementary affection and trust; to my sister Coline for our growing complicity and understanding; to Jamie with whom I have learned so much about navigating the world with an open mind and heart; to Sue with whom I have grown in confidence and experienced that everything is learned in relation; and, joyfully, to old and new friends from both continents.

Land Acknowledgments

The research presented in this paper has taken place across three territories marked by specific colonial legacies. As a French citizen recently re-settled in Canada, I attach a particular importance to acknowledging the processes of violence, and dispossession, that have affected these territories and the peoples who have cared for them long before European settlement.

York University is grounded on the traditional territory of Indigenous Nations that include the Anishinabek Nation, the Haudenosaunee Confederacy, the Huron-Wendat, and the Metis. The area known as Tkaronto is covered by Treaty 13 signed with the Mississaugas of the New Credit First Nation, as well as by the Williams Treaty signed with Mississaugas and Chippewa bands. The southeast Saskatchewan region in which the collaborative study addressed in this paper has unfolded, is covered by Treaty 2 and Treaty 4. It is the traditional territory of many Indigenous Nations including the Cree, Saulteaux, Nakota, Lakota and Dakota Nations, and is also home to the Metis people. The Wylie Lab at Northeastern University in Boston, is located in the homeland of the Mashpee Wampanoag, Aquinnah Wampanoag, Nipmuc, and Massachusett Nations.

These nations have stewarded Turtle Island for hundreds of generations. They inspire us to learn from one another, and to live on this land with the respect and love we owe to the seven generations to come.

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1. Introduction

1.1. Context of the Research

In October 2017, just one month after I moved to Canada to start the Master of Environmental Studies at York University in Toronto, I learnt through an article in the *Toronto Star* that high levels of hydrogen sulfide (H_2S), a neurotoxic gas associated with oil and gas production, threatened the health and safety of Saskatchewan communities (Cribb et al., 2017). My knowledge about H_2S, and about the western province was at the time minimal. The article stated that the Saskatchewan Government was aware of hazardous H_2S concentrations, yet did not issue any public warning. Kristina Hedlund, a friend from the MES program who had also just moved to Toronto from Regina, Saskatchewan, was shocked by the news. Both enrolled in a course on Environmental Law and Justice taught by Prof. Dayna Scott, we decided to focus on this issue for our final assignment, and began investigating the health effects of oil and gas development across the province.

We quickly realized that the dearth of accessible data on the topic would be a major obstacle in our research. We decided to reach out to area residents, and to produce a paper and short video from the interviews and materials we could collect. Despite Kristina's connection to the region, we encountered great difficulty finding local residents willing to share their experience, and even more so connecting with workers from the industry. Across the five interviews that we did manage to conduct on the phone, the social tensions surrounding the impacts of the oil and gas industry kept coming to the foreground.

Beside the environmental health issues at stake in Saskatchewan, our attention was also caught by the collaborative project behind the article that had highlighted the risks surrounding hydrogen sulfide emissions. The investigative series, titled *The Price of Oil*, was the product of several months of research that had gathered about fifty journalists, editors, students, and professors to examine "the impacts of the oil and gas industry on Canadian communities" (*National Observer*, 2019). Launched by Patti Sonntag, former managing editor at the *New York Times*, after winning an award from the Michener-Deacon Fellowship for Journalism Education, the project fostered a collaborative, cross-institutional form of investigative journalism in Canada.

The investigative series published in October 2017 by *The Price of Oil* noted that a team of researchers from Harvard and Northeastern Universities, had joined the investigation to collect air monitoring data in southeast Saskatchewan (McSheffrey et al., 2017). After reaching out to Carolyn Jarvis and Patti Sonntag, core members of *The Price of Oil*, Kristina and I were put in touch with Sara Wylie, Assistant Professor of Sociology/Anthropology and Health Sciences at Northeastern University in Boston.

Since 2014 the Wylie Lab, based within the Social Science Environmental Health Research Institute (SSEHRI) at Northeastern University, has been developing community-based research projects to address environmental injustices across the life cycle of oil and gas production. In particular, the Lab has contributed to the production of several open source tools to help communities visualize, assess, and address their exposure to pollutants from the fossil fuel industry. One of these tools is a low-cost testing kit that uses samples of photographic paper to detect corrosive gases such as H_2S. If exposed to H_2S, the silver halide in the photopaper reacts to form silver sulfide, which causes samples to discolor from white to dark brown depending on the concentration of gas. Each monitoring kit contains seven testing canisters, that participants set up for seven days at various sampling locations around their living place. Analyzed by the Wylie Lab, the results from testing provide residents living near H_2S-producing facilities with a preliminary, visual and quantitative assessment of corrosive gases on their property.

In September 2017, Lourdes Vera and Mia Renauld, Ph.D. students in the department of Sociology at Northeastern University, as well as Drew Michanowicz, a Postdoctoral Fellow at the Harvard T. H. Chan School of Public Health, joined the reporters from *The Price of Oil* in southeast Saskatchewan. During this first travel, the Wylie Lab conducted a pilot study with five families concerned about their exposure to the gas. Two months later, Kristina and I learned more about the testing kit through a Skype call with the Lab's team, that we were interviewing in the framework of our research at York University.

The following spring I contacted Phil Brown, director of SSEHRI in Boston, while I was looking for a summer work placement. Brown unexpectedly reconnected me with Wylie, who was looking for a research assistant to pursue the work her Lab had started in Saskatchewan. I jumped on board, and we were, a few months later, embarking for Regina to report-back on the results of the pilot study. After our field trip, I spent the summer of 2018 in Boston, where we further developed the method's experimental design and validation. Having had the chance to pursue this work with the Wylie Lab and Saskatchewan residents for over a year, I decided to make the community-based air monitoring study into the main focus of my Major Research Paper.

1.2. Methodologies

Concerned with an interdisciplinary collaboration, my paper draws upon a broad range of practices and theoretical frameworks. Three streams of research stand out among those that have nurtured my reflection. The first stream encompasses critical approach to environmental monitoring and regulations. It builds on Science and Technology Studies (STS), and in particular feminist STS, that question the power dynamics that have informed the development of scientific practices, representations, and instruments (see Haraway, 1988; Latour, 1999; Fortun, 2005 & 2012; Murphy, 2006; Harding, 2015; Daston & Galison, 2018; Wylie, 2018). It also includes critical analyses of the collusion between governmental and corporate actors, that have influenced the development, since the 1970s, of environmental regulations and epidemiological research (see Beck, 1992; Giddens, 1999; Michaels & Monforton, 2005; Hess, 2007; Frickel et al., 2010; Oreskes & Conway, 2010; Oreskes & Krige (Eds.), 2014; Boudia & Jas, 2014; Liboiron et al., 2018).

Another stream of research that has framed the following chapters relates to the participatory nature of the air monitoring study developed by the Wylie Lab. It includes the study of how practices such as community-based participatory research (CBPR) and popular epidemiology have made it possible to reevaluate the divide introduced, throughout the twentieth century, between experts and citizens in environmental health debates, research, and policy (see Brown, 1992; Kroll-Smith, Brown et al., 2000; Fischer, 2000; Wallerstein, 2006; Brown et al., 2011; Allen, 2018…). Furthermore, I connect these reflections with the ways in which feminist movements and the "material turn" operated by feminist theories in the 1990s, have contributed to rethinking the relationship between bodies and their material and chemical environments (see Haraway, 1991; Grosz, 1994; Braidotti, 1994; Harding, 1998; Alaimo, 2008; Alaimo, 2010; Scott, 2015).

Finally, a set of practices and studies that I have found inspiring to think with during my collaboration with the Wylie Lab, could be broadly referred to as "critical visuality." In relation to the visual nature of the data produced by the photopaper testing kit, it encompasses reflections on the role of visual evidence in the debate over contested environmental issues (see Jasanoff, 2001; Grevsmühl, 2016; Wylie, 2017; Weizman, 2017). In the context of a study concerned with the health risks associated with oil and gas production, I have also found generative to observe what is made visible, and invisible, in the process of extracting, refining, transporting, and consuming fossil fuels (see Mitchell, 2013; Murphy 2013, Gómez-Barris, 2017; Wilson, Carlson et al. (Eds.), 2017; Wylie, 2018).

Beyond the theoretical resources that have progressively enriched my research toolbox, an even greater number of experiences and discussions have enlarged my field of vision and sharpened, in practice, some of the aforementioned tools. The present paper particularly draws upon the field work experience and community engagement developed through my collaboration with the Wylie Lab since April 2018. In June 2018, Wylie and I spent five days in southeast Saskatchewan, to report-back on the preliminary results of the families who had enrolled in the air monitoring study, and conduct a second round of testing with residents who had expressed the wish to confirm their results. Our work also included ethnographic interviews on residents' experiences with H_2S exposure and the sociopolitical pressures that frames them, as well as on their engagement within the air monitoring study. The outcomes of this trip have informed two follow-up articles published, in October 2018, by *The Price of Oil* in *Global News* and the *Toronto Star*.

Following this field trip, I joined the Wylie Lab in Boston for the months of July and August 2018. Our work during this period included analyzing the results from follow-up monitoring in southeast Saskatchewan; and conducting a comparative round of testing as part of our method's validation process. Due to important evolutions in the analytical method used to interpret our study's results, we decided to postpone our next travel to the area, dedicated to report-back on the results from the second round of monitoring. This travel will take place at the beginning of August 2019, following the submission of the present paper.

In addition to the materials and experiences that have fed into this research, I have conducted five follow-up interviews to explore various aspects of the interdisciplinary collaboration between the Wylie Lab and *The Price of Oil*. These interviews were conducted with Lourdes Vera, Ph.D. student and member of the Wylie Lab since 2015; Patti Sonntag, current director of the Institute for Investigative Journalism at Concordia University and founder of *The Price of Oil*; Lori Erhardt, United Church minister and resident of the Glen Ewen area who has taken part in the air monitoring study as well as in the news investigation; Patricia Elliott, journalist and Assistant Professor in the School of Journalism at the University of Regina, who has been involved along with her students in *The Price of Oil* investigation; and Emily Eaton, Associate Professor in the Department of Geography and Environmental Studies at the University of Regina, who has contributed to *The Price of Oil*'s involvement in Saskatchewan. I am deeply grateful for the time and care that each of them has dedicated to share their insights about the collaborative work that brought us together.

1.3. Research Questions and Organization of the Paper

The project I reflect upon is marked by a series of "double binds," that have emerged both through the questions the Wylie Lab has been investigating, and through our own position as researchers. Building on the work of linguist and anthropologist Gregory Bateson, Kim Fortun defines double binds as "situations in which individuals are confronted with dual or multiple obligations that are related and equally valued, but incongruent" (Fortun, 2001, 13). Not reducible to difficult choices, "double binds" "create a persistent mismatch between explanation and everyday life" (Ibid.).

As the following chapters demonstrate, "double binds" abound in oil politics, in the management of industrial risks, but also in interdisciplinary engagements with these risks and the "uncertainty" they entail. How could the Saskatchewan Government be aware of high levels of H_2S emissions across the province, and yet deny and increase risks by omitting to alert the public? How could residents from the oilpatch live with H_2S exposure risk, and yet not be willing to publicly confront this risk and the perpetuation of environmental harm within their community? And how could we, as researchers, negotiate the tensions between the *analytical* uncertainties encountered in our work, and residents' *lived* uncertainties tied to their embodied experience of exposure?

Building on these questions, I have chosen to focus on the collaborative dimension of the research that has brought together *The Price of Oil*, the Wylie Lab, and community members from the southeast Saskatchewan oilpatch. In doing so, I aim to analyze how such interdisciplinary collaboration can make visible and thinkable the double binds that have crystallized around industrial hazards. What are the mechanisms behind H_2S exposure risk? Why has this risk been occulted and silenced by public authorities as well as within the community? And what resources can interdisciplinary, community-based investigations offer to *expose* such environmental health risks and make them speakable?

A byproduct of oil and gas production, H_2S emissions in southeast Saskatchewan need to be understood as the result of a broader technical, economic and political infrastructure. In the second chapter of this paper, I observe some of the technopolitical choices that have created the conditions for H_2S exposure risk. I argue that the management of H_2S in Saskatchewan manifests a common double bind, that weights economic benefits from fossil fuel production against the human health risks it entails. The resulting double talk and culture of silence have created a

specific “regime of imperceptibility” (Murphy, 2006, 10), that translates into paradoxical regulatory and monitoring practices.

In the third chapter, I demonstrate how the interdisciplinary investigation conducted by *The Price of Oil* and the Wylie Lab has made it possible to center residents’ experience of exposure, and thereby to reframe H_2S management as a public health matter. Through complementary strategies and forms of evidence, such collaboration allows for the production of counter-narratives and what I call “operative data.” By contrast with governmental and corporate approaches to environmental monitoring, “operative data” makes *visible* hazardous exposure and the mechanisms of risk production. By doing so, it lays the ground for meaningful community engagement.

Lastly, I show that the very process of community-based research and public outreach, has provided a space for residents to express and legitimate their environmental health concerns. A close examination of public and corporate responses to the investigation demonstrates the potential of interdisciplinary collaborations to shape what I propose to call—in reference to Michel Callon and colleagues—a “hybrid forum,” defined as a space that provides “visibility and audibility to emergent groups that lack official spokespersons” (2011, 35). Thinking forward, I suggest that consolidating this emerging “hybrid forum” could help further community advocacy capacity, and foster governmental and corporate accountability.

2. Double Binds in Canadian Oil Country: The Production and Occultation of Public Health Risks

2.1. Dilemmas in Canadian Extractive Economies

2.1.a. Fossil Entanglements, And The Contradictions of a Would-Be Climate Leader

Canada, when it comes to environmental governance, has "a tendency to 'talk' rather than to 'act'," a 2002 OECD report noted (2002, 44). Since the mid-nineties, several publications by the intergovernmental organization have been highly critical of the Canadian environmental record, pointing out the country's intensive exploitation of nonrenewable resources, unsustainable use of natural resources, subsidies to polluters, and lack of action to address climate change (Boyd, 2003, 8). Two decades later, the same observations and critiques can be addressed to the nation that both holds some of the largest natural resources on the planet, and a leading position among the countries with the highest global environmental impacts.[1]

Yet, as lawyer David Boyd remarked, Canadians' express passion for the natural environment—symbolically displayed through the emblems chosen to represent the country, and politically manifested through citizens' consensus to make environmental protection a national priority—is one of their rare subjects of societal convergence (Ibid., 4-5). Particularly since the election of Premier Justin Trudeau in November 2015, Canada has sought to position itself as a leader in international discussions on global environmental change. The nation stood out during the 21st United Nations (U.N.) Climate Change Conference in 2015, calling for a more stringent restriction of global warming to 1.5℃ instead of 2℃ above pre-industrial levels; Canada additionally committed to cut 30% of its own greenhouse gas (GHG) emissions by 2030—in comparison to measurements from 2005 (Prystupa, 2015). However, several recent reports have shown that the country is largely off track to meet its reduction targets. Its latest inventory report filled with the U.N. climate change secretariat demonstrates that Canada's 2017 GHG emissions were in fact 8M tonnes higher than those recorded in 2016—6M of which were coming from oil and gas production (Rabson, 2019). Furthermore, a report released in April 2019 by Environment

[1] See, for instance, the 2016 data from the Global Footprint Network in which Canada ranks 8th among countries with the highest ecological footprints per capita: http://data.footprintnetwork.org/#/

and Climate Change Canada, revealed that the country is warming twice as fast as the rest of the world (Bush & Lemmen, 2019).

A detailed analysis of the economic and political factors behind Canada's dichotomous approach to environmental issues is beyond the scope of this paper. Yet it matters to understand the double binds that have shaped federal and provincial governments' energetic choices and environmental policies; for these very choices have translated into the production of a known risk, for both global environmental health, and the health of local communities living near oil and gas production sites. A brief overview of some of the political choices made over the last fifteen years illustrate this dynamic.

Global oil consumption, political scientist Angela Carter reminds us, has doubled since 1971, triggering massive investments in enhanced recovery technologies. These have it made possible and affordable to exploit unconventional oil and gas deposits such as tar sands, shale oil and gas, and ultra-deep offshore deposits (2016, 293). In particular, the increasing exploitation of Alberta's oil sands since the 1990s, and the oil and gas production boom associated with the development of hydraulic fracturing and horizontal drilling since the early 2000s,[2] have propelled Canada to the rank of fourth global oil producer and exporter (NRCAN, 2018). With the third biggest oil reserves (98% of which are oil sands), the Canadian non renewable sector still has significant potential for development. Reflecting this reliance on fossil fuels, the energy sector overall accounts for 11% of Canada's gross domestic product (GDP), and oil and gas domestic exports totaled over $97 billion in 2017 (NRCAN, 2019).

A number of policy moves have further entrenched Canada's economic development in the exploitation of non renewable resources. Conservative Stephen Harper's mandate from 2006 to 2015 was notoriously marked by a severe rollback of environmental regulations, among which was the decision in 2011 to withdraw from the Kyoto Protocol—that had, since 2005, framed the international community's effort to reduce GHG emissions. Furthermore, the economic downturn

[2] Hydraulic fracturing (or fracking) is an oil and gas extraction technique in which fluids are injected at high pressures through deep wells to fracture underground rock formations. While hydraulic fracturing—just like "conventional" oil and gas production—was originally developed in vertical wells, technological innovations in the 1980s marked the beginning of horizontal drilling, with an increased expansion in the 2010s (Gandossi, 2013). The combination of directional drilling and fracturing techniques has made it possible to exploit more disparate hydrocarbon formations, such as shales, tight formations, and coalbed gas, which were previously inaccessible through vertical wells. The development of these unconventional techniques has led to increased energy production, but also increased risks for local communities (Willow and Wylie, 2014; Wylie, 2018). In addition to the large quantities of water used by the industry, and to the risk of anthropogenic earthquakes, over 1,084 chemicals were identified in fracking fluids, that can persist as long-term contaminants (EPA, 2016, 10 and 16). The fugitive gases associated with fracking, such as methane, or hydrogen sulfide, also represent an important risk for surrounding communities.

associated with the 2008 financial crisis resulted in a clear emphasis on resource extraction and export, supported by important fiscal incentives from the federal government. In 2010 alone, public subsidies to the oil sector amounted to $2.8 billion, in the form of tax breaks, government spending through low-cost loans and insurance, and research programs associated with the industry (Carter, 2016, 296).

Not limited to Harper's mandate, governmental support to the industry was continued by the Trudeau government despite public pledges to end "inefficient fossil fuel subsidies" (Rabson, 2018, b). In fact, a recent policy brief showed that between 2015 and 2016, Canada was the largest provider of fiscal support to oil and gas production per unit of GDP across the G7 countries (Whitley, 2018, 7). "Canada must improve transparency," the report highlighted, "as it does not publish specific reports on fiscal support to fossil fuels" (Ibid.). The decision, in May 2018, of the Trudeau government to buy the Trans Mountain pipeline from Kinder Morgan company, further illustrates the contradictory discourse of the federal government over fossil fuels and environmental change. Quite tellingly, the project, that would triple the pipeline capacity to up to 890,000 barrels a day, has been presented by Finance Minister Bill Morneau as "an investment in Canada's future" (Harris, 2018).

Beyond direct subsidies from the federal government, the fossil fuel sector has indirectly benefited from policy retrenchments and the obstruction of environmental research. Important budget cuts at environmental departments and research centers during Harper's mandate, have contributed to the weakening of scientific knowledge and regulatory capacity across the country (Carter, 2016, 298). Federal spending for environment-related departments and programs, for instance, was cut by more than $1.5 billion in 2015-2016, compared to that from 2010-2011. The Canadian Environmental Assessment Agency (CEAA) itself experienced a 41% budget cut, resulting in a drastic reduction of its full-time staff (*Ibid.*).

By prioritizing short-term economic benefits, the creation of jobs in a popular industry, and infrastructural investments in a well-established sector, these policy orientations have durably impacted Canada's approach to environmental protection—and its very definition of a "sustainable future". On the flip side, they have resulted in important knowledge gaps, particularly on environmental monitoring data and the cumulative impacts of the oil and gas industry, for instance in Alberta and Saskatchewan (Ibid.). Doing so, these choices have quite literally *occulted* the risks embedded in fossil fuels production.

2.1.b. Conflicting by Law: A Piecemeal Approach to Environmental Protections

Beyond the economic support the Canadian government provided to the extractive sector, it should be noted that the weakening of environmental protections across the country has also been enabled by a lack of statutory clarity over environmental regulations. A brief summary of this structural component is useful to understand the regulatory loopholes that characterize Saskatchewan's approach to natural resources.

"The uncertainty about constitutional responsibility for environmental protection," Boyd remarked, "is one of the most controversial aspects of Canadian environmental law and policy" (2003, 11). Canada's 1867 Constitution Act, and in particular sections 91 and 92 which address the distribution of legislative powers, indeed fails to name and explicitly allocate provincial or federal authority over the environment. As a result, researcher and lawyer Dayna N. Scott noted, the environment is "a matter of 'shared' jurisdiction in Canada, which is to say, it is always already contested—legally, socially, and politically—with ecological and environmental health consequences" (2017, 494-495).

In conjunction with the creation of public subsidies supporting the growing fossil fuel industry, legislative changes in the 1980s have progressively decentralized environmental policy to the provinces. A 1982 amendment (section 92A) gave provinces jurisdiction over the "exploration for non-renewable natural resources," and the development and management of those resources (*Ibid*., 499). However, the federal government retained jurisdiction over the environment on federally-owned property, as well as on bodies of water and Indigenous territories (*Ibid.*).

Such a piecemeal approach to environmental resources significantly contributes to the weakness of Canadian environmental protections. International observers have highlighted this structural flaw that impairs environmental enforcement. The OECD, among others, has criticized Canada's "unwarranted reliance on voluntary agreements in lieu of enforcing environmental laws" (Boyd, 2003, 80). This tacit "right to pollute" inscribed in law is in itself a determining factor in the production of environmental risk, and harm, for the communities affected by the development of extractive industries.

2.1.c. The Colonial Imprint—A History of Struggle over Resources Control in the Canadian West

"*Colonialism did not impress its will on a blank slate.*"
(Wolfe, 2016, 20)

I remember being struck, when first discovering Saskatchewan's landscape on Google Maps, and later on through the plane window before landing in Regina, by the orthogonal grid overlaid, through roads and fields, on the Great Plains. The grid that stretches across Saskatchewan reflects the process of rationalization that the land and its resources have, through cadastral mapping, been subjected to.[3] Yet it should be taken as a visible reminder that, far from having been imprinted on a "blank slate," this reorganization has also been conditioned by the dispossession and invisibilization of the Indigenous peoples who had for many generations been the stewards of the prairies. The understudied colonial history that has reshaped Saskatchewan would deserve more focused attention. Limited by the parameters of this paper, what follows is a brief overview of the colonial processes that have defined and redefined land ownership and the control of natural resources across the province.

The practice of intensive resource extraction as a mode of accumulation originated during the European colonial project 500 years ago; relying on the doctrine of *terra nullius*, the control of resources in the Americas, Africa, and India, required to render Indigenous peoples *invisible* (Acosta, 2013; Gómez-Barris, 2017). "Before the colonial project could prosper," Macarena Gómez-Barris writes, "it had to render territories and peoples extractible, and it did so through a matrix of symbolic, physical, and representational violence" (Ibid., 5). What Gómez-Barris calls the "extractive view," is the very process that has on the one hand made Native populations invisible, and on the other recasted territories as commodities (Ibid., x).

The history of "modern" Saskatchewan interestingly starts with a large scale privatization of the land—a quite radical form of commodification. In his book *Towards a Prairie Atonement* (2016) writer Trevor Herriot retraces how in 1670, the English Crown granted the Hudson's Bay Company a charter over "Rupert's Land", virtually placing it under a "corporate monopoly" (2016, 15). Covering up to 3.9 million km^2 in what is now northern and central Canada, Rupert's Land encompassed most of Saskatchewan. When the Royal Charter was granted, none of the First

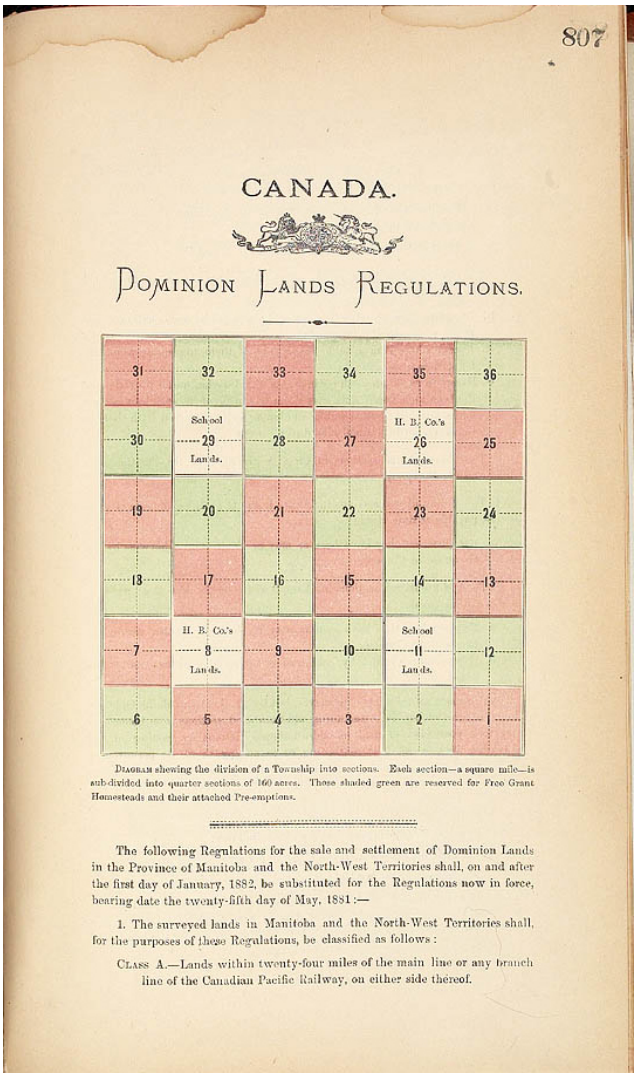
[3] See James Scott's analysis of the invention of cadastral mapping in *Seeing Like a State* (2008). Highlighting the ways *legibility* became a central concern in modern statecraft, the book retraces how the redesign of specific social and economic orders also came along with an administrative "ordering" of nature.

Nations and Métis Nations that had inhabited this land were consulted—the same logic of invisibilization prevailed when, two centuries later, Rupert's Land was sold by the Hudson's Bay Company to the Dominion of Canada for 300.000 British pounds (Ibid., xiii).

In 1872, the Dominion Lands Act further reshaped and privatized the newly acquired land, by dividing it into 1.25 million plots made available to encourage settlement in the West (Yarhi & Regehr, 2006). Modelled on homestead legislation in the U.S., the Act was "a unique checkerboard survey developed for the Prairies by the Canadian government," and in fact the world's largest survey grid laid down on a territory (Library and Archives Canada, 2019). Based on 160-acre units, these homesteads were handed over to settlers for three years for a $10 administrative fee (Yarhi & Regehr, 2006). Roughly 625,000 land patents were issued to Western settlers between 1872 and 1930. If this system has been seen by many as an experiment in democratizing land ownership, it has yet relied on the fundamental exclusion of First and Métis Nations from the new grid designed for the prairie (Herriot, 2016, 16). The 1872 Dominion Lands Act established First Nations reserves, and a "scrip" system was imposed on Métis families that removed their land titles (Yarhi & Regehr, *Ibid*.).

Figure 1: Map showing provinces, townships, ranges and meridians in Western Canada, Topographical Survey of Canada, Department of the Interior, 1929. Library and Archives Canada.

From corporate ownership to federal ownership and fragmentation into settlers homesteads, Saskatchewan's territory and its resources have been fundamentally disputed, divided, and appropriated. According to author Mary Janigan, this history, and Ottawa's control of natural resources in most of the Western territories since the Dominion Lands Act, is at the origin of the current tensions between western and eastern provinces in Canada. Janigan retraces these tensions in a book humorously titled *Let the Eastern Bastards Freeze in the Dark: The West Versus the Rest Since Confederation*—a reference to the bumper stickers that could be seen on western cars in the wake of Pierre Trudeau's infamous National Energy Program[4] (Janigan, 2013). Despite the protestations of the concerned provinces, the control of the federal government over western resources lasted until the repeal of the Dominion Land Act in 1930. The same year, the Natural Resources Transfer Acts ceded federal jurisdiction over crown lands and natural resources to the Prairie provinces.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CANADA.

DOMINION LANDS REGULATIONS.

31	32	33	34	35	36
30	School 29 Lands.	28	27	H. B. Co's 26 Lands.	25
19	20	21	22	23	24
18	17	16	15	14	13
7	H. B. Co's 8 Lands.	9	10	School 11 Lands.	12
6	5	4	3	2	1

DIAGRAM shewing the division of a Township into sections. Each section—a square mile—is sub-divided into quarter sections of 160 acres. Those shaded green are reserved for Free Grant Homesteads and their attached Pre-emptions.

The following Regulations for the sale and settlement of Dominion Lands in the Province of Manitoba and the North-West Territories shall, on and after the first day of January, 1882, be substituted for the Regulations now in force, bearing date the twenty-fifth day of May, 1881:—

1. The surveyed lands in Manitoba and the North-West Territories shall, for the purposes of these Regulations, be classified as follows:

CLASS A.—Lands within twenty-four miles of the main line or any branch line of the Canadian Pacific Railway, on either side thereof.

Figure 2: Diagram showing the division of a township into sections. "Land Grants of Western Canada, 1870 – 1930," Library and Archives Canada.

As Patrick Wolfe notes, settler colonialism is "a structure rather than an event" (2006, 390). As such, the current organization of Saskatchewan's territory around resource extraction can be seen as a legacy of colonial settlement, and of the cultural, economic, and administrative reappropriations it relied upon. Bridging this history to the contemporary oil rush, Herriot observes that we currently "live in an era when the prairie is veering back into corporate hands. Oil, gas, and potash corporations," Herriot writes, "are setting the agenda for provincial land-use policy" (2016, 17).

[4] The National Energy Program was a policy established in 1980 by Pierre Trudeau to increase the federal government control over the country's energy, and to redistribute Alberta's profits from oil production.

2.1.d. Beneath the Grid: Saskatchewan's Geological and Economic Landscape

Sitting atop four important oil and gas formations, Saskatchewan ranks the second-largest oil producer in Canada—after Alberta. Since the mid-2000s, the province has experienced a fast economic growth—also known as "Saskaboom"—largely triggered by the expansion of the oil and gas industry. As mentioned earlier, from the mid-2000s onward increased rates of production have essentially relied on technological innovations that have made non-conventional fossil fuel deposits accessible. The fast expansion of the industry in the southeast corner of the province came along with economic benefits and higher rates of employment—but also with a growing dependency on the oil sector and the emergence of a public health risk for oilpatch communities. It is this risk, and the very little data about it, that brought Wylie and I to the area in June 2018. Yet before addressing this risk in further detail, I will discuss the province's sources of economic wealth, above- and under-ground, as well as the relationship that the provincial government has maintained with the oil and gas industry.

Concentrating about 40% of Canada's cultivated farmland, Saskatchewan draws a considerable part of its income from industrial agriculture. Not only a major national grain producer, it is also the first global exporter of lentils, dried peas, oats, and canola (Government of Saskatchewan, 2018f). Yet altogether mineral extraction now constitutes an even larger share of the provincial economy, accounting for 17% of its GDP (*Ibid*.). In 2017, Saskatchewan counted about 37,000 active wells, producing 177.2 million barrels of oil. The combined value of oil and gas production for that year was over $9.2 billion, with yet important development potentials as the province holds an estimated 1.2 billion barrels of recoverable oil reserves, and 1.8 trillion cubic feet of recoverable natural gas (Government of Saskatchewan, 2018e, 1).

The southeast corner of the province, where the Wylie Lab and the reporters from *The Price of Oil* have been conducting research since the summer of 2017, stretches above the Bakken and the Mississippian formations—making it the main oil producing region in Saskatchewan. Both formations have been exploited since the 1950s, and major increases in production have been recorded since 2005, supported by the development of hydraulic fracturing and horizontal drilling that have opened access to previously unexploitable oil and gas deposits (Government of Saskatchewan, 2017b, 2). In the Bakken alone, most wells are horizontal with a multi-stage hydraulic fracturing completion; approximately 7,214 horizontal oil wells have now been completed, up from just 78 in 2004. Following a similar trend, 2,520 new wells have been

drilled in 2017 alone across the province—2,181 of which are horizontal (Government of Saskatchewan, 2018d, 1).

Rooted in a history longer than that of the fracking boom, the close ties between Saskatchewan and the fossil fuel sector originated in the 1940s. Since then, Carter notes, successive provincial governments have sought to replicate Alberta's oil boom by courting oil companies with "offers of generous land concessions and low taxes and royalties" (2018, 12). Until today, the competition between the two provinces can be felt through Saskatchewan's adoption of attractive taxation systems; a 2016 Conference Board of Canada report, for instance, showed that the province has the lowest net business tax burden in Canada (Government of Saskatchewan, 2018f, 5). Other direct subsidies to the industry include governmental funds such as the Petroleum Research Incentive and the Incentives for Enhanced Oil Recovery (Government of Saskatchewan, 2018a). Furthermore, aside from adopting economic incentives favorable to the fossil fuel sector, since the 1990s the industry has been invited to participate in policy-making through the Saskatchewan Petroleum Industry/Government Environment Committee—which supplemented environmental regulations and environmental assessment processes with specific guidelines (Carter, 2018, 12).

In turn, the energy sector has significantly contributed to the province's economic growth, reaching a high of 28% of Saskatchewan's GDP over the 2007-2014 period in which the fracking boom combined with elevated oil prices. In 2017, the revenues—directly provided by royalties and land sales to the industry respectively—amounted to $656 million and $64 million (data from the government's public accounts). A study from the Canadian Center for Policy Alternative has also shown that from 2008 to 2010, 28% of the main corporate contributions to the Saskatchewan Party, in government since 2007, was coming from the energy and energy service sector (CCAP, 2012). As a result, these economic ties with the fossil fuel industry have translated into the public image and shaped by government representatives—from deputy minister of energy and resources, Kent Campbell, promoting hydraulic fracturing in leading provincial newspapers (Carter & Eaton, 2016, 403), to former Premier Brad Wall defending the oil and gas sector in a speech at the Calgary Petroleum Club (Fletcher, 2016).

Bearing this in mind, the ongoing court challenge over the federal carbon tax undertaken by Saskatchewan Premier Scott Moe can be seen as symptomatic of the province's economic choices and its longstanding ties with the fossil fuel industry. Since the announcement, in 2018, of Ottawa's intention to impose a carbon tax on provinces and territories that are not equipped

with reduction mechanisms aligned with the Pan-Canadian Framework on Clean Growth and Climate Change (Government of Canada, 2018), Saskatchewan has indeed played a leading role in contesting the constitutionality of the federal plan. Arguing that the reduction plan would be ineffective across the province, would harm small businesses, and erode the sovereignty of provincial jurisdiction (Vomiero, 2019; Taylor, 2019), Premier Moe took the lead in challenging the federal carbon tax in court. Moreover, following the ruling of the Saskatchewan's Court of Appeal in May 2019 that stated the carbon tax fell within the legislative authority of the Canadian Parliament (Martell, 2019), Premier Moe announced that the decision would be appealed to the Supreme Court of Canada.

Despite the economic gains from the oil sector across the province, the predominance given to the fossil fuel industry yet goes hand in hand with certain economic and environmental risks. Indeed, the reliance on the income from the industry began rhyming with economic vulnerability, when oil prices started sliding in late 2014 and thus began waning provincial revenue and increasing unemployment and public debt (Carter, 2018, 4). Another side effect of the "Saskaboom," the province's carbon emissions increased by 65% from 1990 to 2014, predominantly due to the development of the oil and gas sector. Amounting to 17% of the province's total emissions in 2015, methane emissions can be expected to continue growing with the increased venting and flaring from the Bakken oil fracking boom (Carter, 2018, 4). With greenhouse gas effects thirty times higher than CO_2, methane is also concerning for the other gases, in particular H_2S, that it often comes along.

2.2. Hydrogen Sulfide, or How to Mitigate Risks From a Natural Byproduct of Oil and Gas

"*We are altering the environment, and the patterns of life we follow, almost constantly. Even many apparently benign habits or innovations could turn sour – just as, conversely, risk can often be overestimated*."
(Giddens, 1999, 4-5)

2.2.a. An Epidemiological Profile of H_2S

Naturally present in certain oil and gas deposits, hydrogen sulfide (H_2S) is one of the externalities of oil and gas production that industry and governments have sought to monitor and regulate since the 1970s. Yet H_2S has mostly been studied and regulated as a workplace hazard, leaving unaddressed the health risks faced by residents living in areas adjacent to H_2S-producing industries. Further, I argue that the regulatory system in place in Saskatchewan has contributed to producing, more than preventing, risks for citizens. The following overview of the health effects associated with H_2S exposure will usefully introduce the issue.

A potent neurotoxic and corrosive gas, hydrogen sulfide is produced by the bacterial degradation of organic matter, in the absence of oxygen. As such, it can be naturally found in swamps and sewers, as well as in the sediments from which natural gas and crude oil are extracted. H_2S, also referred to as "sewer gas" or "sour gas," needs to be separated and disposed of, a process that mainly occurs through the cost-effective method of flaring. The combustion of H_2S through flaring produces water and sulfur dioxide (SO_2), another corrosive gas that can cause significant respiratory issues.

From an epidemiological perspective, H_2S is toxic to human health even at relatively low doses. Yet it is important to note that the standards established by regulatory agencies in the U.S. and Canada are based on the expected effects of hydrogen sulfide on healthy adult males; as a result young or old individuals, as well as those with compromised immune systems, may be at risk at considerably lower concentrations (Skrtic, 2006, 29). The information provided by the Canadian Centre for Occupational Health and Safety (CCOHS) indicates that human exposure to H_2S, mostly through inhalation, can cause nausea and headaches starting from 1 to 5 parts per million (ppm). Severe nose, throat, and lung irritation can occur between 100 and 200 ppm, while

from 250 to 500 ppm the build-up of fluid in the lungs can have fatal outcomes. At 500 ppm unconsciousness and death can occur within 4 to 8 hours; and exposure to levels between 500 and 1000 ppm results in rapid respiratory paralysis and death (CCOHS, 2010).

Specific H_2S exposure statistics are not available in Canada, but the U.S. Occupational Safety and Health Administration recognizes it as "one of the leading causes of workplace gas inhalation deaths," that has been reported as the cause of death for 60 workers in the U.S. between 2001 and 2010 (OSHA, 2018). In addition to being colorless, H_2S can be difficult to detect as exposure to more than 100 ppm deadens the sense of smell; this threshold widely varies across individuals and can, for some, begin at 50 ppm (CCOHS, Ibid.). This particularity increases the risk of incidents, and justifies the need for preventive equipment in the workplace, such as portable monitors and, in some cases, atmosphere supplying respirators.

Several studies have shown that non-fatal exposure to H_2S can result in impaired brain functions manifested through persistent symptoms such as impaired balance, delayed recall memory, elevated depression, and confusion scores (Kilburn, 2004, 81). Some studies have also linked H_2S exposure with higher rates of spontaneous abortion, in the case of accidental exposure to relatively high concentrations (Xu et al., 1998).

Yet it is important to note, as most papers on the subject do, that the large majority of existing studies are concerned with acute, workplace exposure to the gas; epidemiological research on the health effects of chronic, low-dose exposure to H_2S remains a relatively limited field, and requires further development. Among the existing studies on the topic, several have found that chronic exposure to low concentrations of H_2S can be associated with increased headaches, fatigue, dizziness, memory loss, loss of concentration, and depression (McGavran, 2001; Lewis & Copley, 2015).

Interestingly, the management of H_2S as a hazard has in itself a contested genealogy. Until today, the U.S. Environmental Protection Agency (EPA) does not regulate H_2S as one of its criteria pollutants, nor as one of the Hazardous Air Pollutants listed under the 1990 Clean Air Act. Quite to the contrary, H_2S was initially appearing among the hazardous substances to be regulated under the Act, but was removed from this list "as a result of successful efforts by the oil and gas, chemical, and paper industries" (Skrtic, 2006, 30). The American Petroleum Institute notably argued that H_2S emissions are an "accidental-release issue" more than a routine one. As a result, H_2S—referred to as "the least regulated common poison" in a 1997 news article reporting in EPA's failure to regulate it—is listed among the Extremely Hazardous Substances that does

not require regular emission controls of the substance (Ibid., 30-31). Canadian environmental regulations of toxic substances have, to a large extent, been shaped on the model of its american neighbor. As a result, H_2S is similarly absent from Canada's Toxic Substances List, and only classified among the list of workplace hazardous materials (CCOHS, 2012). At the federal level, the levels of allowable exposure to unprotected workers were set in accordance with the American Conference of Governmental Industrial Hygienists (ACGIH). The recommended workplace "threshold limit value" (or TLV, set for an exposure of 8 hours per day) was originally set at 10 ppm by the ACGIH, before being lowered to 1 ppm in 2010 (ACGIH, 2010). Interestingly, contrary to some other Canadian provinces, Saskatchewan's Health & Safety Regulations contain no clause to automatically incorporate any new ACGIH TLV. As a result the current contamination limit set for H_2S workplace exposure in the province is still 10 ppm for 8 hours, and 15 ppm for 15 minutes (Government of Saskatchewan, 1996, 278).

Quite tellingly, a recent Draft Screening Assessment conducted by Environment and Climate Change Canada, together with Health Canada, has further affirmed that H_2S does not meet the criteria in section 64 of the Canadian Environmental Protection Act which defines "toxic substances". The report concludes: "It is proposed […] that hydrogen sulfide is not entering the environment in a quantity or concentration or under conditions that constitute or may constitute a danger in Canada to human life or health" (Environment and Climate Change Canada & Health Canada, 2017, 62). Concerningly, the data used in the report to assess ambient H_2S concentrations in Canada dates from 2000—well before the fracking and tar sands booms exponentially increased production in Western Canada. Despite the ACGIH's lowered recommendation for prolonged H_2S exposure, the report also does not account for the potential effects of low-dose exposure to the corrosive gas—virtually ignoring this risk.

Conversely, the low-cost monitoring kit developed by the Wylie Lab and tested in collaboration with families in Saskatchewan's southeast oilpatch aims to highlight this gap and reopen the debate around chronic exposure to corrosive gases in communities living close to oil and gas production facilities. Raising this question highlights the extent to which H_2S has been studied—and regulated, as I will elaborate, based on workplace criteria, leaving unaddressed concerns of residents who live across the roads, ditches, or fences that delimit their homes from extraction, storage, or processing sites.

2.2.b. Saskatchewan's Regulatory Landscape

Reflective of the province's hands-off approach to environmental regulations, Saskatchewan was ranked second, among the world's small reserve holder jurisdictions, in the Fraser Institute's "Policy Perception Index;" this index is a measure of attractiveness for companies' investments, based on a jurisdiction's regulatory climate, political risk, production taxes, and quality of infrastructure (Stedman & Green, 2017, 10 and 15). And indeed, beyond the economic and research incentives previously outlined, another way in which Saskatchewan offers favorable conditions to the industry is through a relatively permissive regulatory system and the lack of environmental oversight and enforcement.

Until February 2018, oil and gas sector regulations across the province were handled by the Ministry of the Economy, which was guided by the mandate to "attract investment and remove barriers to growth" (Government of Saskatchewan, 2017c, 3). The Ministry was subsequently restructured into three distinct government bodies. Among these, the Ministry of Energy and Resources now "operates as the primary regulatory authority for the oil and gas industry and ensures competitive royalty systems, regulations and policies for all natural resource sectors" (Government of Saskatchewan, 2018f). The province does not have an independent regulatory agency, unlike Alberta which created the Alberta Energy Regulator in 2013, to manage energy resources across the province (Carter et al., 2017).

Moreover, Carter and Eaton highlight, the province has gradually shifted toward industry self-regulation, which has been referred to as "regulation by declaration" (2016, 408). Companies are required to self-declare that they meet provincial regulatory requirements through the Integrated Resource Information System (IRIS), which has been available online since 2015. Well license applications are also submitted through IRIS, and "routine" licenses (defined as a "low risk licence location based on licensee declaration") are automatically and immediately approved upon online submission (Government of Saskatchewan, 2017a, 2).

With regards to H_2S-specific regulations, several measures—or lack thereof—have also contributed to the production of risks for Saskatchewan's oilpatch communities. Provincial regulations state that gas and vapor from a well, facility, or pipeline must be under 10,000 ppm measured at the source, or 10 ppm measured at the perimeter fence or edge of the lease (Directive S-20, Saskatchewan Upstream Flaring and Incineration Requirements, 2015). It is also recommended, but not required, that extended flaring events or venting contain below 10 ppm of

H_2S (2015, 5.3). Yet, Saskatchewan's regulations do not require specific setback distances between sour wells and public infrastructures or residential areas, unlike Alberta that has adopted setback distances that increase proportionally to the concentration of H_2S associated with the oil or gas being extracted (Pembina Institute, 2016). In a 2015 interview with the journal *Pipeline News*, Ed Dancsok, then an assistant deputy minister in the Ministry of the Economy, pointed out another policy gap, in the absence of regulations to monitor or restrict H_2S emissions from trucks transporting oil. At times improperly sealed, these trucks can represent important sources of emissions along public roads. The loading and unloading of trucks also produces important amounts of fugitive emissions, and the Ministry has no jurisdiction over that, Dancsok noted (Zinchuk, 2015).

A close examination of the province's regulatory system thus reveals that, if H_2S is a "natural" byproduct of oil and gas production, the ways in which it is regulated and managed can significantly increase exposure risks, for workers and civil communities alike.

2.2.c. Policy Drifts, and the (Mis)Management of a Souring Situation

The "competitive" regulatory environment crafted by the Saskatchewan government has, to a large extent, contributed to what researchers Carter and Eaton have described as a "Wild West" approach to oil and gas development (2016). Beyond the mechanisms in place to encourage corporate "self-regulation" and minimize the number of environmental assessments, Saskatchewan's governmental policies have also indirectly benefited to the industry by failing to update its legislation while oil production grew.

In their study on the evolution of environmental policies in Canada's oil producing provinces, Carter et al. (2017) build on the notion of *policy drift*, defined by political scientist Jacob S. Hacker as the situation "when institutions or policies are deliberately held in place while their context shifts, changing their effects" (Hacker et al., 2013, 1). This concept highlights how policy inaction and the omission to adapt existing rules to a shifting reality weakens governmental responses to risk (Carter et al., 2017, 71). In Saskatchewan, systematic budget cuts, since the election of Premier Brad Wall in 2007, and the resulting increase in workload for regulatory staff, have resulted in a lack of enforcement capacity and a relatively permissive approach to industry compliance (Ibid., 67). A worker interviewed by Carter and Eaton reported that the number of staff in field offices responsible for enforcing regulations, has remained roughly unchanged since the 1980s, while the number of wells has been increasing exponentially (2016, 408). In addition, Carter and Eaton underline that very minimal revisions have been made, to existing oil and gas

regulations, to address the new types of challenges and risks associated with hydraulic fracturing (Ibid., 394).

Meanwhile, as the number of wells proliferated throughout the last decade in the southeast oilpatch, an increasing number of incidents involving H_2S have also been signaled. The first news article to cover the issue was published in April 2015 by *CBC News*; it reported the detection by the Saskatchewan Ministry of the Economy, then in charge of oil and gas regulations, of 43 facilities in southeast Saskatchewan leaking sour gas with average concentrations of 30,000 ppm—30 times the level of 1000 ppm which is instantly lethal to humans (Leo, 2015). One well was additionally found to be leaking 150,000 ppm. The article also reported on the death of six calves on a farm in 2013, likely due to H_2S exposure; and the accidental death in 2014 of a worker, Michael Bunz, after a valve had failed while he was collecting samples at a facility (Leo, 2015; Zinchuk, 2018). Over the same period of time, 60 complaints about odor and nose and eye irritations had been addressed to the Ministry of the Economy (Leo, Ibid.).

Despite these incidents, the provincial government tends to minimize the issue and to consider H_2S exposure as rare and isolated cases. In fact, the response of government and corporate officials, as well as the coverage of some media outlets, further "naturalize" the occurrence of sour gas and the risks that come along with it. A few months after the release of the *CBC* article, Dancsok was interviewed by *Pipeline News* on the H_2S issue. Dancsok stated that "natural gas, or associated gas with oil, is a fact of life. It comes up with the oil. With that, at times, in Saskatchewan's past, and in other jurisdictions as well [...] some of that gas can be sour" (Zinchuk, 2015). Also testifying in Leo's *CBC* article, Dancsok had highlighted that most Saskatchewan oil fields in the past were considered "sweet" and did not emit sour gas; as they age, he went on, "they're becoming sour and producing hydrogen sulfide at an increasing rate" (Leo, 2015).

This insistence on the fact that H_2S is a "natural" byproduct of oil and gas has largely influenced a discourse and a state of *ir*-responsibility surrounding H_2S exposure. As the opening quote to this chapter suggests, it is as easy in contemporary societies to produce risks as it is to deny them. In Saskatchewan, the autonomy given to the oil and gas industry, the weakness of environmental regulations, and the undermining of public health risks by government officials, have created the conditions for what Ulrich Beck has called in his landmark analysis of risk management in postindustrial societies, a state of "organized irresponsibility" (Beck, 1995, 64). Invoking the causal complexity of industrial risks, organized irresponsibility upholds the "non-

attributability of systemic hazards" that are, instead, "legally and scientifically normalized into improbable 'residual risks'" (*Ibid*.). While translating into a state of public and corporate unaccountability, it also feeds into a climate of uncertainty that makes chemical hazards ever more difficult to address.

2.3. Building Regimes of Imperceptibility

2.3.a. Silencing Dissent, Polarizing Communities

Saskatchewan's political, economic, and regulatory landscape has informed a tacit tradeoff between the public health risks generated by the oil and gas industry, and the economic growth and employment supported by the sector. I argue that through this choice, the provincial government has generated a specific *regime of imperceptibility*, that relies on two forms of invisibilization: the silencing of local communities' concerns about harmful exposure, and the production of inoperative air monitoring data.

On the first point, beyond the way in which the public declarations of government agents might have influenced public opinion and downplayed the risks associated to H_2S exposure, structural disincentives for communities to engage in the environmental debate have also played out at both federal and provincial levels. Analyzing the "criminalization of dissent" that has been particularly active during Harper's mandate, Carter underlines that this constriction of dissenting opinion has been expressed not only in rhetorical terms, through the public funding of advertising campaigns promoting the oil and gas sector, but also through the complexification of public access to policy-making processes (Carter, 2016, 297). One notable example was the adoption in 2012 of an amendment to the National Energy Board Act that required citizens to fill a nine-page application form and to provide supporting documents to participate in National Energy Board (NEB) hearings on energy developments (Ibid., 300).

In Saskatchewan, one of the most complex and difficult aspects of the collaborative project developed by *The Price of Oil* and the Wylie Lab was residents' hesitation, or reluctance, to share and voice their concerns about the environmental and health effects of the industry around their living places. The recruitment of participants was in itself no easy task, and the residents who had consented to share their testimonies with the journalists, and/or to take part in the air monitoring study with the Wylie Lab, had for the most part done so on the condition of anonymity. Quite

tellingly, even though the southeast Saskatchewan community is a “tight-knit” community, most participants in the study didn’t know each other’s identity—in some cases even when they were neighbors or relatives.

One of the factors for this reluctance to speak up has been the political marginalization of dissenting voices, specifically during the mandates of Saskatchewan Premier Brad Wall from 2007 to 2018. In a speech at the Calgary Petroleum Club in June 2016, Wall had for instance both sowed the seeds of the province’s firm opposition to any added price on carbon pollution, and defined an “existential threat” that the oil and gas sector has to defend itself from (Fletcher, 2016). Incriminating an "ever-growing matrix of activists," composed both of Hollywood environmentalists, universities, and faith-based organizations, Wall denounced their attempt at directing investment away from fossil fuels, based on “not entirely factual evidence" (Ibid.). This demonization has also operated at more local and interpersonal scales, we would discover in the course of our research and travel, hearing about the backlash that some community members had faced after deciding to voice their concerns about the risks associated with the industry.

In an article that compares oil and gas developments in Saskatchewan and in Pennsylvania, researchers Emily Eaton and Abby Kinchy further analyze the silence and “nonmobilization” that prevail in both jurisdiction around the negative impacts of the industry (2016). The culture of silence that reigns in these regions has been the result of socio-political stigmatization, but also of communities’ dependency on income from the sector, and, relatedly, of the absence of a critical narrative to confront the dominant discourse shaped by the government and the industry (2016, 23). In southeast Saskatchewan, a lot of residents indeed have economic ties with the industry—either through direct employment in the oilpatch, or through the revenues provided by surface leases and from selling access to surface water. In the province, surface lease can represent $1,500 to $3,000 per well each year, and the decline of income from agricultural activities has made off-farm revenue an important resource for many residents (Carter & Eaton, 2016, 413). Several participants in our study expressed an unwillingness to speak publicly, either because they were themselves working from near or far in the oil and gas sector, or because some of their family members were. “One thing that's saving the oil industry about here, is that I still work in the oil industry,” a participant told us in June 2018. “If I was not working in the oil industry, I would be way more louder.”

What is more, researchers Andrea Olive and Katie Valentine noted, the absence in Saskatchewan of environmental NGOs or community groups mobilized around these issues has

made it even more difficult and isolating to question the negative impacts of the industry (2018). NGOs that the authors have been able to interview showed a concerning lack of awareness about the effects of the oil and gas sector in the area; this disengagement, they found, owed to the fact that these organizations depended both on the sponsorship of the fossil fuel sector, and on the support of individual members that also had personal connections to the sector (2018, 195). Far from only being an economic actor, the oil and gas industry is at the heart of the community's social life as it contributes to fund associations, community events, sport arenas, if not public infrastructures and services. When asked about the impact the industry had on her community's livelihood, Lori Erhardt, one of the participants in our investigation, fittingly replied that it depended on how one was *defining* livelihood. Beyond its economic benefits, the influence of the fossil fuel sector in the area is also socio-cultural in nature—and powerfully outweighs residents' willingness to address the public health risks associated with the chemical exposures they can be affected by.

2.3.a. Politics of Corporate Monitoring

If it is important to recognize and *see* the political dynamics between corporate actors, governments, and civil society—my collaboration with the Wylie Lab has also taught me to observe the political dynamics at play in environmental monitoring. In the opening essay of an issue of the journal *Engaging Science, Technology, and Society*, focused on community-based research projects tackling contaminants from the petrochemical industry, Wylie, Nicholas Shapiro and Max Liboiron highlight "how power dynamics are structured in the architectures of present environmental monitoring tools" (2017, 404). Beyond the presupposition that environmental monitoring is produces "objective" and relevant data, it can in fact produce invisibility.

"'You can't manage what you can't measure' and its inverse, 'you can only manage what you do measure'" (2015, 3), wrote Kathleen Pine and Max Liboiron in an article analyzing the political dimension of measurement practices (2015, 3). H_2S in southeast Saskatchewan is not entirely left unmeasured, yet the monitoring practices in place only distantly echo the Latin root of the term—"*monere*," warning, or reminding. The Southeast Saskatchewan Airshed Association (SESAA) counts a network of 8 air monitoring stations, in an area of approximately 36,800 square kilometers. Since 2005, the association has sought to "collect credible, scientifically defensible air quality data" and to make it "freely available to all stakeholders" (SESAA, 2018). The association's board counts 5 industry representatives out of 10 members, and a list of 129 member companies

involved in the extractive sector. As a private actor, SESAA collects “continuous” data on nitrogen dioxide (NO_2), sulfur dioxide (SO_2), hydrogen sulfide (H_2S), ground level ozone (O) and fine particulate matter (PM 2.5)—yet has no enforcement capacity. Despite, in July 2018, an effort to redesign its interface and make its data more accessible, SESAA leaves a number of questions unanswered: Why do some of the stations monitor H_2S, ozone, or particulate matter, and not others? How has the location of each of these stations been determined, and how can residents make sense of their data in relation to the topography and infrastructural landscape specific to their own surroundings? What happens if the monitored gases exceed the provincial air quality thresholds?

In an article addressing the policies and practices of air monitoring in European cities, Nerea Calvillo highlights, building on the example of Madrid, that “data are not a direct translation of air into numbers, but an assemblage of practices, objects, spaces and actors” (2018, 384). In 2009, Madrid’s City Council had virtually “improved” the city’s air pollution average by changing the location of some of its monitoring stations, without informing the public nor any relevant organizations. This scandal illustrates not only how toxicity is often merely “defined as a quantitative relation to human health” (Ibid.), but also how monitoring practices are always techno*political*, in the sense that their design is informed by specific institutional frameworks and actors that, willingly or not, make certain things visible and others invisible. In line with Beck’s seminal analysis of risk production in postindustrial societies, Michelle Murphy has termed “regime of perceptibility” the ways in which a discipline perceives and does not perceive the world. “Over the course of the twentieth century,” Murphy writes, “imperceptibility itself became a quality that could be produced through the design of experiments or monitoring equipment in order to render claims of chemical exposures uncertain” (2006, 10). In Saskatchewan, I learned *in practice* how a specific, corporate “regime of perceptibility” had redefined and framed air monitoring practices.

Beyond the partial oversight provided by the SESAA monitors, another intriguing moment was learning that two passive “AGAT” monitors had been installed on the property of a family participating in our study. Carrying filters to measure H_2S, SO_2, and NO_2, the monitors had been commissioned by Steel Reef, the midstream company which operates pipelines and processing plants in the area. Interestingly, they had been installed on that property a few months after one of its residents had been knocked down by a cloud of H_2S. Sometime later, it is only because this family had inquired about the findings of these two monitors that were silently standing in their

yard, that they eventually received a report from Steel Reef. Finding difficult to make sense of the figures inscribed in the report, the family solicited our help to get a sense of how these should be understood. The report was accompanied with a note mentioning that their results were well below the maximum levels recommended across the province. A closer look at the figures would show that the document could not reveal much. Communicated as averages for periods ranging from two to four months, the low levels reported for H_2S and SO_2 were erasing any variations and peaks that might have occurred in the testing window. Not only did this design reveal a rather paradoxical approach to air monitoring, in which a company was keeping private exposure data collected on an individual property; but it also dismissed the ways in which communities living in oil and gas producing areas are actually experiencing H_2S exposure—that is, living with unpredictable clouds of gas, released through leaking infrastructures or from incomplete flaring. Though important to monitor, background emissions levels, calculated as monthly averages, are more likely to demonstrate the industry's compliance to a jurisdiction's regulatory thresholds, than they are to effectively inform residents and protect them from accidental exposures.

Figure 3: AGAT passive monitor, southeast Saskatchewan. Picture Garance Malivel, June 2018.

3. Reframing Community Exposure to Hydrogen Sulfide through Counter-Narratives and Data

3.1 Addressing Silence and Knowledge Gaps

3.1.a. Exposing the Human Price of Oil through Investigative Journalism

How can communities' environmental health concerns be made visible and heard, in places that do not have any social structure to do so? And what resources are needed to breach the culture of silence that has been fueled by the collusion between governments, regulators, and fossil fuel industries? In this chapter I examine the potential for interdisciplinary collaborations to address controversial industrial hazards. I argue that the diversity of resources, tools, perspectives, and forms of visibility they provide, can play out as a trigger to make these hazards more speakable, and to bring them into public sight and discussion. I first outline in more detail the nature of the work developed by *The Price of Oil* on the one hand—and the Wylie Lab on the other, before moving on to examine their collaboration with community members in southeast Saskatchewan.

Founded in 2016 by Patti Sonntag, current Director of the Institute for Investigative Journalism at Concordia University, the media consortium *The Price of Oil* was created in response to the lack of in-depth investigative capacity in Canada, in particular around the influence and impacts of the fossil fuel industry. Quite strikingly, there has conversely been an emergence of media outlets expressly mandated to promote the action of provincial governments or defend key lobbies. In April 2019, the creation of *Ontario News Now* by Premier Doug Ford's government has raised concerns about risks of collusion between partisan messaging and journalism (Stone, 2019). Paid for by taxpayers for an unknown cost, the communications service has the appearance of a mainstream media, but has the mission to advertise on the activities of the Ontario Progressive Conservative Caucus. In Alberta, Premier Jason Kenney unveiled at the beginning of June 2019 his "war room," intended to "expand public support for Canada's vital energy industry" (Heydari, 2019). With a budget of $30 million, partly levied on Alberta's major industrial emitters, the "war room" is promoted as one of Kenney's strategies to combat the "foreign-funded radicals" that are presumed to hamper the development of the province's oil and gas industry (*Ibid.*).

Fostering, instead, an independent, collaborative, and cross-institutional form of investigative journalism, *The Price of Oil* has sought to examine "the impacts of the oil and gas industry on Canadian communities" (National Observer, 2019). Also an educational project, the consortium has brought together journalists from *The National Observer*, the *Toronto Star* and *Global News*, as well as students from the Ryerson, Concordia and the University of British Columbia's (UBC) schools of journalism. After its initial coverage on H_2S exposure in southeast Saskatchewan, the collaborative has also published extensive reports on fossil-fuel related issues in Ontario and Alberta.

The investigation developed in southeast Saskatchewan originated in a 2016 meeting with the Corporate Mapping Project, a SSHRC-funded academic initiative investigating the corporate power of the fossil fuel industry in Western Canada. Dr. Emily Eaton who has been studying at the University of Regina the impacts of the industry in Saskatchewan, highlighted the lack of media coverage on H_2S risks across the province. The only existing report covering the issue is the previously mentioned article published by Geoff Leo in 2015 in *CBC News*.

Picking up where Leo had left off, Sonntag launched an investigation to confirm if H_2S levels in the southeast oilfield indeed posed a threat to public health. On Eaton's advice, Sonntag reached out to Prof. Elliott, at the University of Regina's School of Journalism. From October 2016 to the summer of 2017, thirty-four students conducted their own investigation, building on the relationship established with certain residents through Eaton's research. The students' research, fed into the articles published by the collaborative in October 2017, and informed a four-part documentary, *Crude Power*, on the influence of the oil and gas industry in Saskatchewan.

The investigation essentially relied on documents obtained through Freedom of Information requests, as well as on a number of interviews conducted with government and industry stakeholders, as well as with community members. In doing so, it revealed some of the contradictions of the regulator, and contributed to making residents' voices audible and accounted for.

Journalism, Dr. Robert A. Hackett wrote, is "one of modernity's most important forms of storytelling" (2017, 2). With the capacity to conduct thorough, evidence-based investigations, and through effective public outreach, journalism can have important impacts by "certifying issues and events as publicly relevant"—if not "setting agendas for publics and policymakers" (*Ibid.*). By bringing public attention to issues and personal stories that had been occulted, *The Price of Oil* in Saskatchewan has taken a crucial step in representing and reframing the problem of community exposure to H_2S.

3.1.b. Civic Technoscience: Exposing Gaps in Monitoring Tools and Science

Bringing the resources and capacities of academic research into the field, the Wylie Lab has taken part in a broader movement of grassroots research that has sought to rethink, in action, the design, uses, and power dynamics behind institutional tools for environmental monitoring (Wylie et al., 2017). Designed for community use, and inviting critical questioning of the existing regulatory frameworks and ecosystem of tools to monitor H_2S, the photopaper corrosive gas testing kit builds on what Sara Wylie, Kirk Jalbert, Shannon Dosemagen and Matt Ratto have characterized as tools for "civic technoscience" (2014). Borrowing from Kim and Mike Fortun's notion of "civic science"—a science "that questions the state of things, rather than a science that simply serves the state" (2005, 50)—"civic technoscience" refers to the collaborative creation of low-cost, open source tools with and for non-experts, that makes possible the production of a critical knowledge that is not being accounted for by institutional science (2014).

Echoing the lack of media coverage that provoked the formation of *The Price of Oil* consortium, the DIY corrosive gas testing kit was essentially motivated by the lack of H_2S monitoring tools accessible to communities. Indeed, as the first part of this paper has shown us, H_2S has mostly been studied and monitored in occupational settings. Yet with the exponential quantity of oil and gas wells as an effect of the boom of unconventional recovery techniques, an increasing number of citizens live near producing facilities that might be leaking H_2S. In the U.S., it is now estimated that about 15 million people live within one mile of an oil or gas well (Gold and McGinty, 2013), 15 to 25% of which are predicted to be sour (Skrtic, 2006, 50). Despite this risk, most existing instruments to monitor H_2S are expensive and require the intervention of an expert to be handled and interpreted (Vera et al., forthcoming). The Jerome Meter, one of Arizona Instruments' monitoring technologies, is the standard tool to measure H_2S concentrations. It uses a gold sensor to detect the gas, and thus costs about $15,000 U.S., making it only affordable to industry, government, and research institutions (Ibid.). The portable monitors designed for workers from H_2S-producing industries, are comparatively more affordable, but still cost above $3000 U.S. when they have a capacity to log data.

This gap in affordable and reliable instruments to monitor H_2S, and the resulting lack of consistent monitoring across residential areas, has left communities living in oil and gas producing areas with no data to assess and prevent their exposure to the gas. It was in response to this technological gap that the Wylie Lab developed, in collaboration with residents in Wyoming, Texas, and more recently Saskatchewan, a low-cost kit that could be made and used by

communities to detect corrosive gases. Inspired by previous peer-reviewed studies by Claire Horwell and colleagues to develop an affordable tool to monitor H_2S from volcanic activity (Horwell et al., 2004; Horwell et al., 2005), the DIY testing kit uses samples of photopaper placed into small light-proof canisters. By contrast with the previously mentioned tools, each canister costs about $1.00 U.S. to produce. During the monitoring period, which generally lasts seven days, the bottom cap of each testing canister is opened to let the air in, but not light. Reacting with sulfur gases, the silver halide contained in the photopaper turns into silver sulfide, causing samples to discolor from white to dark brown. As such, data interpretation can rely on a visual assessment of the samples' discoloration, without any added cost. The quantitative assessment of silver and sulfur quantities using X-Ray Fluorescence (XRF), that the Wylie Lab has more recently developed to further estimate corrosion levels, raises the cost of processing to about $35.00 U.S. per sample (Vera et al., forthcoming). Economically, and socially accessible, the photopaper testing kit provides residents with preliminary data that *visually* evidence, quantify, and localize corrosive gases emissions around their living place.

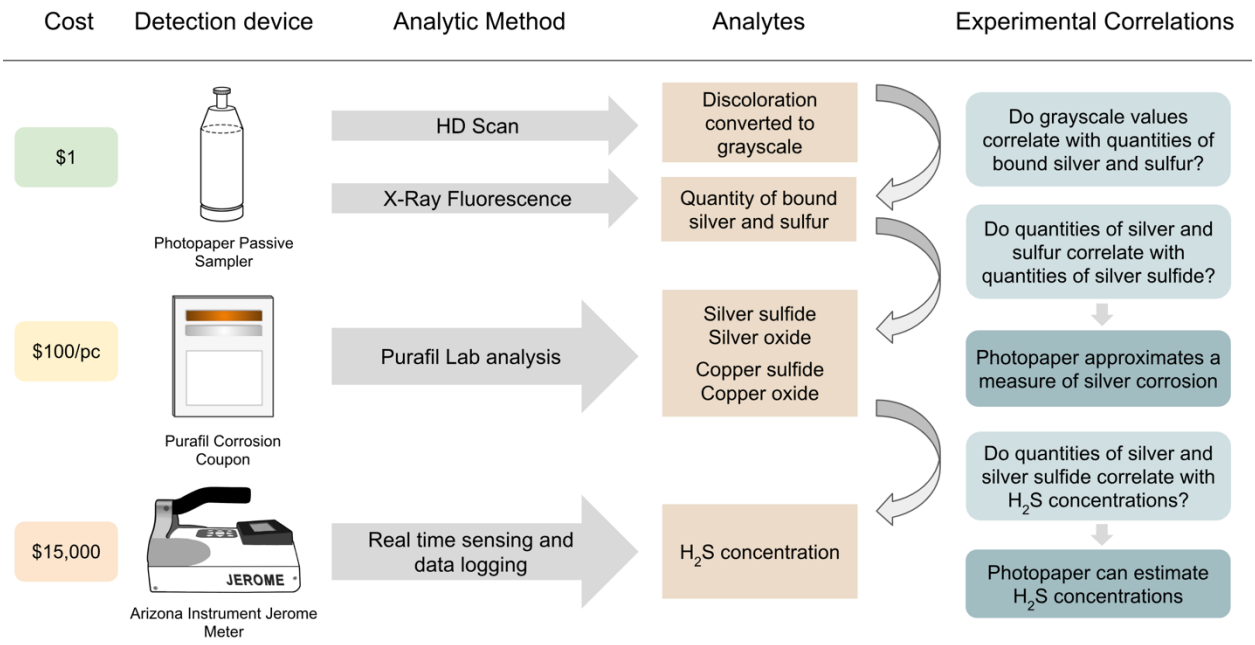


Figure 4: Validation plan for the photopaper passive samplers. Wylie Lab, 2019.

3.2. Building on Community Knowledge and Experience

3.2.a. Amplifying People's Voices and Stories

"You could tell he was under a lot of stress, because he basically said: 'Look, I've been told to make this problem go away'. Those were his words." (Erhardt, L., personal communication, June 27, 2019). This is how Lori Erhardt described her interaction with the field officer who was, a few years ago, in charge of inspecting industrial compliance with environmental regulations. Suffering from acute respiratory symptoms since she had moved to southeast Saskatchewan, Lori had been hospitalized several times and diagnosed with atypical pneumonia. Her repeated complaints to the government about the gas were left unrecorded and unaddressed.

This example encapsulates both the psychosocial pressures, and the structural form of silence that residents from southeast Saskatchewan are confronted with when it comes to their exposure to industrial hazards. In response to the absence of public discussion of H_2S exposure, *The Price of Oil* and the Wylie Lab have sought to center residents' personal experience and intimate knowledge of the issue. I will first explore how each of the collaborating teams has done so, before briefly highlighting some of the differences and similarities that have marked their collaboration in the field.

After several months of investigation, *The Price of Oil* published in October 2017 a first series of articles in the *National Observer*, the *Toronto Star*, and *Global News*, covering the risks and secrecy that surrounded the problem of H_2S emissions in southeast Saskatchewan. The journalists had gathered evidence that sour gas had been an issue for years across the area, and that no consistent effort had been taken to mitigate it. The main article, published in *The Star*, features an internal map produced in 2014 by the Saskatchewan Ministry of the Economy. The map shows the levels of concentration of H_2S in production fluids in the southeastern corner of the province—some of them concerningly reaching up to 200,000 ppm. Made from data reported by the industry, the map had not been publicly released (Cribb et al., 2017b). We can learn in the article that the fines proposed by the government, for emission breaches at some of the facilities audited that same year, were rejected by two lobby groups and eventually dropped.

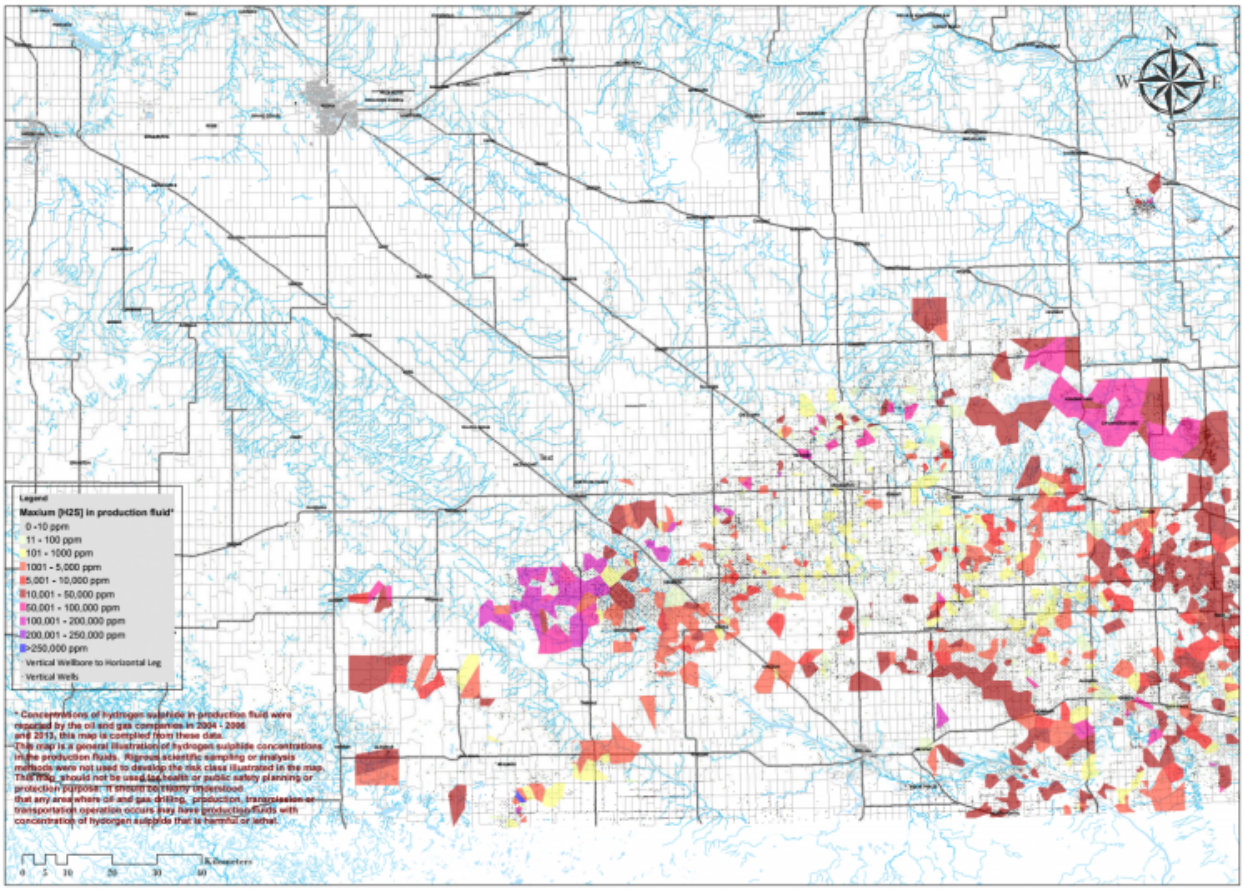
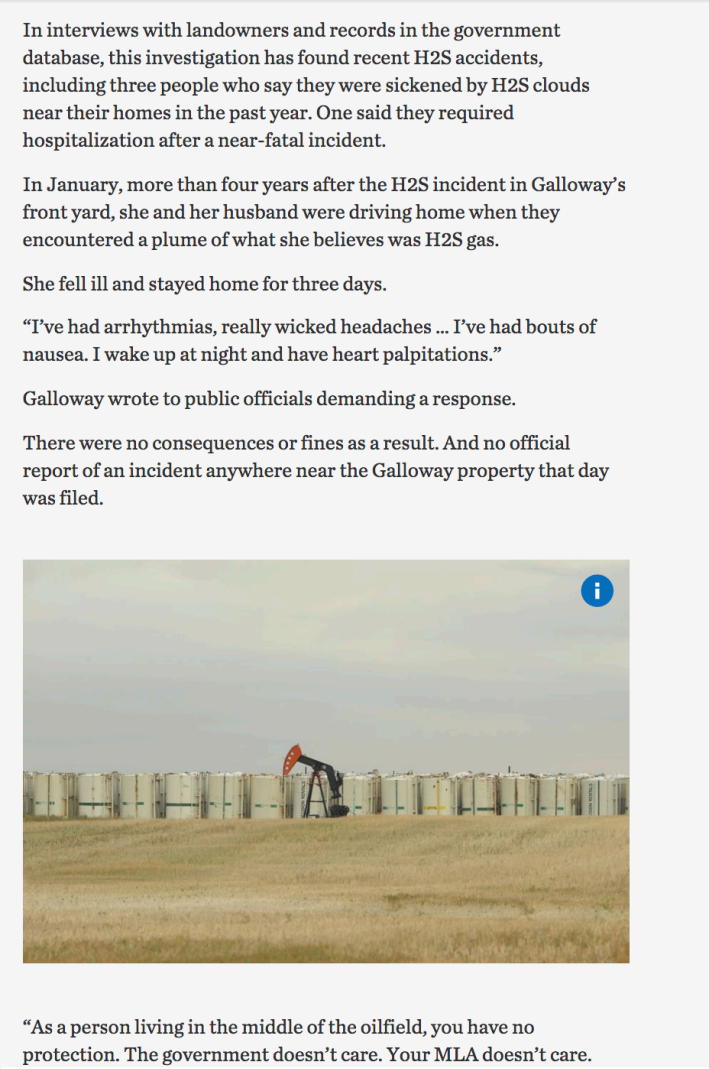


Figure 5: Ministry of the Economy's internal map showing H2S concentrations from oil and gas production. McSheffrey et al., “Inside Saskatchewan’s Failure to Stop a Silent Killer,” *National Observer*, October 1, 2017

Drawing attention to the collusion between the provincial government and the industry, the 2017 articles also gave voice to a number of residents who had been personally affected by H_2S exposure. Shirley Galloway, a nurse who has lived in the Oxbow area for more than 20 years, became one of the rare vocal residents while witnessing the rapid transformation of the region and the increasing number of incidents involving H_2S. In 2012, one of her family members was knocked down by a cloud of H_2S in her yard, causing her to suffocate and vomit. After rescuing the victim, Galloway, who owns an occupational safety firm and has trained many workers in the “H_2S Alive” course, pointed an air monitor toward the yard, which showed a level of 100 ppm of H_2S several meters away from where the incident had happened (Cribb et al., 2017b). No public warning was released after the accident, in spite of Galloway’s report to the government. A few years later, Galloway and her husband were themselves caught in a cloud of H_2S while driving home. Sick with headaches, nausea, and arrhythmias for several days, she demanded a response from public officials. The incident, once again, remained unaddressed. Further, she was

intimidated by workers from a local drilling company who repeatedly drove down her road at night to shine lights onto her house (McSheffrey et al., 2017b).


In interviews with landowners and records in the government database, this investigation has found recent H2S accidents, including three people who say they were sickened by H2S clouds near their homes in the past year. One said they required hospitalization after a near-fatal incident.

In January, more than four years after the H2S incident in Galloway's front yard, she and her husband were driving home when they encountered a plume of what she believes was H2S gas.

She fell ill and stayed home for three days.

"I've had arrhythmias, really wicked headaches ... I've had bouts of nausea. I wake up at night and have heart palpitations."

Galloway wrote to public officials demanding a response.

There were no consequences or fines as a result. And no official report of an incident anywhere near the Galloway property that day was filed.

"As a person living in the middle of the oilfield, you have no protection. The government doesn't care. Your MLA doesn't care.

Figure 6: Screenshot from the article "That rotten stench in the air? It's the smell of deadly gas and secrecy," Cribb et al., *The Toronto Star*, October 1, 2017.

Besides Lori Erhardt and Shirley Galloway's stories, the articles published in 2017 built on the testimonies of several other residents, including Trina Hansen, an oil worker who was hit by a cloud of H_2S while clearing gas and fluids from a pipeline (McSheffrey et al., 2017a); and from the parents of Michael Bunz, who was killed in 2014 by high H_2S exposure levels while collecting samples at a facility (Cribb et al., 2017). Allan Bunz, the father of the victim, who worked for the industry for twenty years, told journalists he actually learned more about H_2S protection when he worked on a pig farm than from his work in the oil industry; Bunz explained, "To me, they were protecting us [...] more at this simple small hog operation in Saskatchewan than the oil industry ever did the entire time I was working out there" (*Ibid.*).

Stories of H_2S exposure abound in southeast Saskatchewan, and the difficulty for journalists rather resides in finding people ready to tell them. A dozen residents did take the risk of public exposure by sharing their stories with *The Price of Oil*. Their testimonies have informed an extensive and compelling coverage, that clearly depicts how fear, economic interests, and the industry's impunity "breed silence" in Saskatchewan (McSheffrey et al., 2017b). "The project started with the people," Sonntag stressed (Cribb et al., 2017); and doing so, it has reframed the issue of H_2S exposure from a different angle—one that takes into account the voices that government and corporate actors had mostly dismissed.

3.2.b. Community-Based Science and the Revaluation of Residents' Embodied Experience of Exposure

"When we smell the stinky smell we go inside and stay till wind changes." This note, handwritten on the "odor and health log" of one of the families Wylie and I met and collaborated with in June 2018, is emblematic of the relationship between oilpatch communities and H_2S exposure. Residents' familiarity with the gas, infamously characterized by a strong rotten-egg smell, and their makeshift strategies to avoid any hazardous encounter, signals the lived reality of exposure risk in southeast Saskatchewan. In this section, I will outline how, similarly to the work conducted by *The Price of Oil*, the air monitoring study developed by the Wylie Lab has also built on the first-hand knowledge of residents, thereby fostering more grounded research practices that can align with the experience and needs of communities.

More often than not, people's personal experience and knowledge of toxics has been dismissed in modern epidemiology and environmental policy making, leading to a lasting divide between experts and non-experts (Brown et al., 2011). The scientific mediation, needed to establish causal links between the production of toxicants and their health effects, has contributed to make environmental health into an essentially technical debate, and to transfer the political dimension of policy making to experts (Fischer, 2000). The distancing of citizens from scientific and regulatory discussions has in some cases been echoed by the silencing of lay people's voices and experiences, under social and corporate pressures—such as those that operate in Saskatchewan. In reaction, and particularly since the 1990s in the U.S., community-based movements have sought to democratize knowledge production and policy advocacy in public health matters, nurtured by a growing awareness of the limited ability of medical science to solve persistent health problems that are *socially* and *economically* mediated (Brown et al., 2011, 5). "Citizen or lay science," Brown and colleagues write, "is at once a claim to know something rational and valid about the world and a potent form of protest against state- and corporate-sponsored research" (Kroll-Smith et al., 2000, 19).

Building on this critical turn, and in contrast to the positivist tendency to discount citizens' "subjective" embodied experience, the studies currently developed by the Wylie Lab in Texas and Saskatchewan are grounded in community work and on the experiential knowledge of residents living in oil- and gas-producing regions. Having witnessed the impact of the industry on the infrastructural, social, and economic landscapes around them, these residents have also seen and sensed the effects of these changes on their own lands and bodies. "There are no better

sensors or indicators for our lived world than our bodies," Wylie writes in her book, *Fractivism*, that retraces several years of fieldwork and engagement with communities that have seen their lives radically altered by shale gas development in Colorado (2018, 283). The low-cost corrosive gases testing kit is in itself an heir to this work—having been inspired by the testimonies of landowners in Colorado, New Mexico, and Ohio, collected by Wylie during her doctoral research.

In turn, learning from the field, I remember having been struck during our meetings in June 2018 by residents' knowledge and familiarity with H_2S gas and the industrial infrastructure behind it. "The body doesn't lie," I was told by Lori Erhardt a few months later. Observing the color of the flares and thickness of their plumes, the smells in the air, and the wind directions, the residents we met had all developed what Donna Haraway might call "situated knowledges" and strategies to avoid exposure to the toxic gas (1988, 581).

On the second day of our trip, sitting at a kitchen table with one of the families participating in the monitoring study, we were shown a map recently sent to them by the oil company that operates in their area. "We're in that bad zone! We have sour gas all through the ditches there, that's what it is," our interlocutor explained. "If you follow the elevation, we're at the end of a ridge. So we get anything from here to the highway, which is 14 kilometers. Just because of air currents, it ends up here. And H_2S can go along in a cloud, and then pshhhhhh—do its thing." The map delineated in red the "evacuation zone" that the family lives in. Along with the map, they had been sent a magnet with a phone number to call in case of emergency. Yet they had not received any monitoring instrument nor any training, such as the "H_2S Alive" course that worker must have taken before working in the oilpatch.

The DIY corrosive gases testing kit aims at incorporating, rather than dismissing, residents' experience of exposure, and can thereby contribute to the gaps left by institutional and corporate monitoring. The very process of sampling and producing data relies on this experience, as the location of each of the canisters contained in a kit is chosen based on people's embodied awareness of where the gas can be smelled, where it might be coming from, and traveling through. The instruction sheet provided with the kit recommends placing one canister downwind of where participants think a source of corrosive gases could be, and another one upwind of this same place to serve as a control. A canister is generally placed close to where family members spend considerable time on their property, and another one indoors to see if corrosive gases are penetrating the house. At the end of the testing window, participants are invited to mail their canisters to the Wylie Lab in Boston. At Northeastern University, the samples are fixed in a dark room. Once dry, samples are scanned and analyzed, based on their level of discoloration and

through X-Ray Fluorescence which indicates the quantities of silver and sulfur that have formed on the samples. The results are provided to participants in an individual report, that includes a map of residents' property overlaid with the images of each sample, a detailed interpretation for each sample point, and the health effects of the gases that might have caused samples' corrosion.

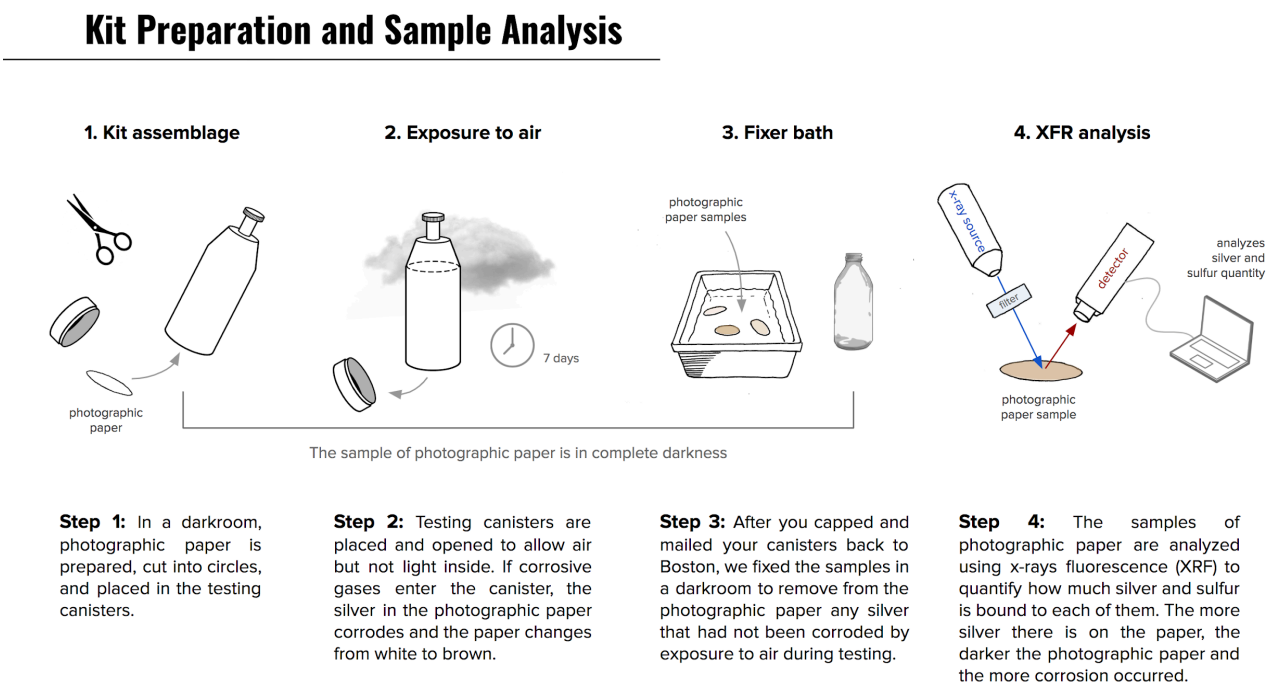


Figure 7: Air monitoring kit preparation and sample analysis, as described in the results reports provided to residents participating in the corrosive gases study. Wylie Lab, 2019.

In a paper covering earlier stages of the testing kit's development, the Wylie Lab and community members highlighted how critical monitoring tools can render residents' "embodied exposure experiences more perceptible" (Wylie et al., 2017, 429). In contrast to the corporate approach to monitoring and risk assessment discussed earlier, through the examples of the SESAA and AGAT monitors, the community-based testing kit invites residents to take part in the processes of air monitoring, data production, and interpretation. It builds on an ethics of transparency; that is, "rather than the emissions being the known but invisible threat, the monitoring itself becomes the visible activity where the results are invisible to the polluting industry" (Wylie et al., 2017, 439). Inverting the institutionalized power dynamic in which industry controls the data that is produced and reported—if required—to governmental agencies, the DIY testing kit foregrounds communities' concerns and experience of exposure.

3.2.c. The Convergence of Different Work Practices in the Field

Having joined the Wylie Lab relatively shortly before our field trip to Saskatchewan in June 2018, it was an engaging learning experience to take part in this aspect of the project, and to observe the work practices of *The Price of Oil* and our Lab. If a number of porosities exist between journalism and ethnographic work, a few divergences have also emerged in the field, that I consider worthy of reflection for the developments of similar interdisciplinary collaborations.

It should first be noted that, quite unusually, the participants in the air monitoring study have been recruited through the news reporters, who had gotten in touch with a dozen residents through researchers at the University of Regina, as well as through door-to-door contacts in the area. In many ways this facilitated the initial steps for the Wylie Lab, which was working with an extremely limited budget (less than $10.000 U.S. in total) and research capacity, having joined the project just a few months before traveling to southeast Saskatchewan in September 2017.

Our first meeting in the area in June 2018 highlighted one of the most sensitive questions encountered throughout our collaboration. The person we were meeting was visibly torn between the will to address the risks and health effects of H_2S exposure, and a clear resentment about the personal and professional backlash that the news articles had provoked for several people in the area. She expressed that she would not testify again, or at least not before she had retired or moved to another region. The risk of being exposed to critique, retaliation, or even to lose one's job after contributing to a journalistic investigation, dramatically feeds into the double binds that residents concerned about H_2S exposure are confronted with. What is the cost of denouncing the threats posed to public health by the oil and gas industry? How can these threats be addressed, and are they actually "offset" by the benefits of bringing these concerns into public view and discussions?

Interestingly, it became apparent in several of our discussions with residents, that the somewhat sensationalist headlines of the articles had raised critiques in the community and might have fueled the polarization and backlash experienced by some of the interviewees. "That rotten stench in the air? It's the smell of deadly gas and secrecy" (Cribb. et al., 2017); "Inside Saskatchewan's failure to stop a silent killer" (McSheffrey et al., 2017a)... To some residents, these headlines did not accurately represent the reality of the situation, nor their community—making some think that the articles were addressed to an Eastern readership rather than a local audience. Quite strikingly, we learned during our trip that these headlines had been chosen by the articles' copy editors and not the reporters—a common practice in journalism in

which copy editors have the final word on articles' phrasing and layout. "I don't package my articles," Elliott humorously confirmed during our follow-up conversation in July 2019. Elliott highlighted the frustration that this practice can generate for authors themselves, when eye-catching titles are effective at attracting the public's attention, without reflecting the content of the articles (Elliott, P., personal communication, July 22, 2019).

Other residents, however, noted the profound change that it was to see the H_2S issue represented in the news. Lori Erhardt for instance highlighted: "What I felt the articles did was to broaden the criteria for what is quality of life—which really annoys the groups who don't want that criteria to be broadened, because when you broaden that criteria, you're going to have to be accountable for more than just how many jobs you create" (Erhardt, L., personal communication, June 27, 2019).

In terms of research practices, the biggest difference between the work practices of *The Price of Oil* and the Wylie Lab, resided in the ethical protocols that framed each of our productions. Where the Wylie Lab's relationship with participants was developed in the framework of an IRB (Institutional Review Board) approved study, their interactions with the journalists mainly relied on interpersonal agreements and consent processes. Indeed, both at the academic level and in the practice of professional journalists, media investigations were not (and are not) subjected to comparable ethics protocols for the recruitment and consent of participants, nor for the production and dissemination of data.

Additionally, while journalists seeking for their interlocutors to go on record because it strengthens their knowledge claims, and therefore accountability, academic researcher norms around consent require that consent be entirely voluntary without any enticement to participate or to be identifiable in a study. Many of these differences were not recognized until we were working in the field together and required discussions to clarify each parties tacit expectations.

In an article on the pervasiveness of ethics protocols in social sciences, Kevin Haggerty noted that if IRB-framed research importantly seeks to prevent unethical academic practices, and to protect human participants' rights, privacy, integrity, and control of data—it can yet also "stifle" research (2004). Comparing the process of knowledge production in journalism and social sciences, the author underlines that academic research is comparatively "less robust and critical than investigative journalism that can and does 'name names'" (2004, 413). Based on our practical experience in the field, and on the difficulties that can be generated by having two different consent processes to frame the collaboration with a single participant, I suggest that

establishing a common ethical framework for interdisciplinary and cross-institutional collaborations might help ensure people's integrity, all the while facilitating the ethical and administrative questions that surround it.

3.3. Producing Operative Data and Counter-Narratives

3.3.a. Triggering Public Accountability through "Freedom" of Information

Both working closely with community members, the Wylie Lab and *The Price of Oil* have given a greater visibility to the lived experience of residents from the southeast Saskatchewan oilpatch, and attested to the reality of the H_2S issue on the ground. Each with their own specific strategies, both teams have worked toward the production of critical data and stories that reframe H_2S exposure as a public health matter. I will now examine the type of evidence that *The Price of Oil*, on the one hand, and the Wylie Lab, on the other, have uncovered and mobilized.

"Information is always situated in a political context," Kevin Walby and Mike Larsen stress in their introduction to *Brokering Access: Power, Politics, and Freedom of Information Process in Canada* (2012, 5); further, Walby and Larsen suggest, "the ability to access information and the power to control access to it depends in many ways on one's position in organizational hierarchies" (*Ibid.*). Freedom of Information (FOI) requests have been increasingly used by journalists and activist organizations to work around these hierarchies and access governmental data. By illustrating how power operates in democratic societies, and exposing the ties between governments and corporate elites, FOI indeed "makes it possible to tell a different story" (Brownlee & Walby, 2015, 10). Yet the process of conducting a FOI request, and the data it might lead up to, is not as straightforward as it might sound. "An increase in information requests is not an indicator of transparency," Brownlee and Walby warn us; it is also citizens' last resort when the information they need can't be accessed otherwise, a "sign that government is exercising tight, centralized control over information" (2015, 12). Illustrating this paradox, while the number of FOIs grew across the country, the amount of information effectively made accessible considerably declined. Between 2007 and 2011, instances where requesters received no information at all increased by nearly 50% (McKie, 2012). Brownlee and Walby suggest such "creative avoidance" highlights the strategies through which governments circumvent FOIs and prevent information from being disclosed.

In the context of their investigation in Saskatchewan, the journalists and students behind *The Price of Oil* have not only conducted a number of interviews with residents, government officials, and corporate representatives, but have also initiated no less than 118 FOIs (Elliott, 2018, 235). Besides the previously mentioned map showing H_2S concentration in production fluids across the southeast corner of the province, the investigation obtained a number of documents and correspondence that revealed the existence of concerning data and the lack of effective action from the government. The main finding, Elliott told me during our conversation in July 2019, was the discovery that there were higher levels of concern within the government than its public comments were suggesting. Among some of the documents obtained by the journalists, a confidential ministry report listed 161 facilities suspected to be in violation of sour gas emission control. According to the report, “Time and resources required to investigate and verify violations would take all available field officers over a year” (Crib et al., 2017). Other documents reported a high number of wells and facilities leaking or venting H_2S in quantities far exceeding those authorized by provincial standards (*Ibid.*). “You could see the frustration of government workers in some cases,” Sonntag noted about the documents; “ They are not allowed to issue fines, so it was merely paperwork going back and forth. They didn't shut down any of the facilities" (Sonntag, P., personal communication, June 11, 2019).

Beyond what has been obtained by the investigation, it is also important to note what has *not* been obtained, and the resistances that reporters have instead faced through the process of conducting FOIs. “Our work with FOIs shows quite clearly that records are being destroyed, routinely,” Sonntag attested; “Where it would be very natural that there would be correspondence records about a subject like H_2S, no records are produced. That is impossible” (Sonntag, P., personal communication, June 11, 2019). Among the many FOIs that have received a “no record” response, are the documents associated with the 60 sour gas complaints sent by residents to the government, as well as the industry’s dataset that had served to produce the map indicating H_2S concentrations in production fluids (McSheffrey et al., 2017a).

“Freedom of information is particularly weak in Saskatchewan,” Sonntag summarized (Sonntag, P., personal communication, June 11, 2019). And in fact, two more recent developments indeed highlight the loopholes of the provincial access to information legislation. Both Eaton and Elliott are currently involved in court cases after initiating FOIs: Eaton, due to her efforts to obtain documents from the University of Regina about the funding of research at the university and the possible influence of fossil fuel industries on public education; and Elliott because she requested, from the province, documents related to the clean-up of the Husky

Energy oil spill that occurred in 2016 in the North Saskatchewan River. Both requests have been denied. Eaton and Elliott appealed to the provincial Information and Privacy Commissioner, who after an examination of each case recommended that the documents be released (MacPherson, 2019; Braat, 2019). However, contrary to most Canadian provinces (including Alberta, Ontario, and Quebec), Saskatchewan's Information and Privacy Commissioner has no order-making power, and in 2017-2017 only 50% of the cases in which the Commissioner's office recommended the release of documents have been followed by full compliance (MacPherson, 2019).

3.3.b. Opening Up the "Black Box", Producing Operative Data

Mobilizing evidence of another kind, the study developed by the Wylie Lab included background research materials, interviews with participants on their experience of exposure, and the production of preliminary data on this exposure. It is important to note that given the limited budget and resources available to the Lab for the investigation in southeast Saskatchewan, our team has only been working with the low-cost photopaper testing kit to conduct monitoring on residents' living places. I would like to take a moment to examine further the type of evidence and data that this kit provides, which I call "operative images," and to consider contrasts with "blackboxed" monitoring instruments that make invisible the processes of data production and analysis.

A physical and epistemic factor that has contributed to making communities' exposure to toxics so often discredited or controversial, lies in the very invisibility of the chemicals they are exposed to. In a book that retraces the history and role of scientific expertise in the definition and management of toxic issues, Soraya Boudia and Nathalie Jas highlight the paradoxical role that science has played in making toxicants and their health effects "visible," all the while often contributing to their "invisibilizations" through the pervasive influence of corporate interests (2014, 23). Echoing this observation, Michelle Murphy shows how toxicants have been mediated through "regimes of imperceptibility" (2006), and how this imperceptibility has been historically informed by Western cultural and scientific representations (Murphy, 2013). Pointing at the technoscientific habit of "portraying chemicals as discrete entities" or "isolated molecules" (Ibid., 495), Murphy highlights the need to shift these representations toward other ways of seeing and knowing that better account for the *infrastructural* nature of chemicals (Ibid., 496). In a lecture delivered in Toronto in June 2018, Murphy elaborated on the dangers of picturing toxicants as small, "chemicals in white space," and instead called for the production of alternate ways of visualizing

chemicals, that encapsulate the technopolitical systems that produce them (Critical Theory for the Future, Toronto*f* ministry , June 2018).

Since the early 1980s, increasing scholarly interest has been given to the role of visual representations and processes in science and technology (see Foucault, 1975; Latour, 1986; Lynch & Woolgar (eds.), 1990; Daston & Galison, 2018; Burri & Dumit, 2008; Tufte, 1997; Coopmans et al. eds., 2014; Treichler et al. (eds), 1998, to name but a few). More recently, this interest for image-making in science and scientific communication has also turned towards the framing of environmental changes, and the impact of visualizations on public perception and policy-making (Jasanoff, 2001 & 2004; McInerny et al., 2014; Sheppard, 2005; Edwards, 2010; O'Neill & Smith, 2014; Schneider & Nocke (eds.), 2014; Walsh, 2015, Grevsmühl, 2017). Far from being mere *illustrations* of a previously existing meaning, scientific visualizations are in themselves *meaning-making* processes and vectors; they are "epistemic things" (Rheinberger, 1997), with a capacity to "transgress disciplinary boundaries" (Burri & Dummit, 2008, 308).

Critical forms of visuality can be triggers to move beyond the invisibility of chemicals and the regimes of imperceptibility that occult them, but also beyond the "blackboxing" effects that have often prevailed in the design of technological instruments. Originally defined by Bruno Latour and Steve Woolgar, the "black box" became a popular concept in STS to describe the way in which scientific and technological instruments can produce opacity and mask their own internal complexity by functioning efficiently (Latour & Woolgar, 1986; Latour, 1999). Instead, what has been described at the beginning of this chapter as tools for "civic technoscience" (Wylie et al., 2014) seek to spark generative questions for their users, to make technical processes visible, and to foster an ethics of transparency between researchers and communities.

The data produced by the corrosive gas testing kit critically engages with visuality, and reverses the "black boxing" logic that we have seen at play in the case of the SESAA and AGAT monitors. Not only does it open up the processes of monitoring and data production to participants, but by relying on the chemical and physical alteration of photopaper samples it also brings to the foreground the reactive sensing component of the monitoring device (Wylie et al, 2017, 427).

As such, the experimental monitoring tool produces what I call "operative images": images that are not representations, but the product of an operation; images that manifest a compound that was not visible to the human eye, as well as the infrastructure that produces it. I discovered, after I started thinking with these words, that the notion of operative image had previously been elaborated in a quite different context, and by someone I happen to deeply admire. In 2004,

German filmmaker Harun Farocki wrote an essay titled *Phantom Images* in which he elaborated on the idea of “operative images” to describe warfare images that are produced without the intervention of the human hand. Beyond the differences between the context of Farocki’s “operative images”, and the one I am writing about, the term has commonality in its reference to images “that were taken in order to monitor a process that, as a rule, cannot be observed by the human eye” (2004, 17-18).

In particular, the gradient of corrosion and discoloration made visible across samples of photopaper around a testing site, both literally and figuratively, “materializes” exposure, and can help localize sources of corrosive emissions (Wylie et al., 2017, 430). Unlike stationary air monitors that can only detect chemical compounds in a limited perimeter, the samples of photopaper are located at multiple points around participants’ properties. Scanned and overlaid on a plan of residents’ living places, they produce “data-rich maps” of participants’ exposure landscape (Ibid., 427). Doing so, the testing kit provides a longitudinal view of exposure to corrosive compounds, that spreads from privately owned industrial infrastructures into public and residential spaces (Ibid., 430). As a recording surface, the photopaper attests to exposure as a body would experience it while moving through space (Ibid., 443).

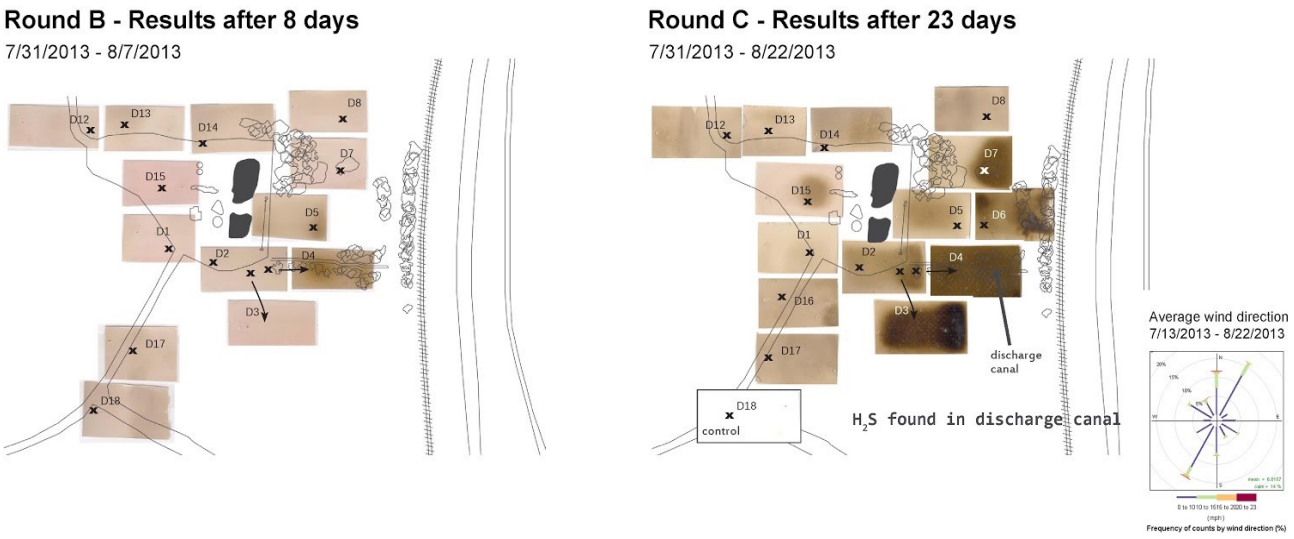


Figure 8: Photopaper results from early developments of the testing kit in Deaver, Wyoming, 2013. Results after 8 days (left) and 23 days (right) of exposure. The strongest discoloration was seen along a discharge canal that contained high H_2S concentrations.
Image Credit: Megan McLaughlin. Wylie Lab, 2013.

Beyond the ways in which photopaper samples produce an "operative image" of exposure, that can meaningfully resonate with residents' embodied experience, the data they provide is also *operative* in the sense that it is not abstract metrics, but the very product of the reaction between corrosive gases and the silver halide on their surface. As such, the photopaper acts as a translational surface that makes visible toxic gases through their corrosive *effect*. This performative quality—maybe reinforced by the evidentiary value culturally attached to the photographic medium (Mnookin, 1998)—makes the data produced over the monitoring process into material witnesses, both of communities' experiences of exposure, and of the chemical and technical infrastructures that have produced exposure risks.

3.3.c. Monitoring Corrosion, Exposing Infrastructures

Building on the above, I would like to highlight the implications of monitoring corrosion, and not only quantitative concentrations of a chemical in the air. If corrosion is a "fact of life" and a natural consequence of the gaseous environment we live in, it is also, and increasingly, a by-product of industrial societies and the pollutants they emit. The development of corrosion science at several universities is a telling sign—and the Division of Surface and Corrosion Science at the Royal Institute of Technology (KTH), consulted by the Wylie Lab, is but an example. An increasing number of national and international organizations focusing on corrosion have also developed, exemplified by the World Corrosion Organization that launched an annual Corrosion Awareness Day. In addition, the National Association of Corrosion Engineers (NACE), founded in 1943, describes itself as the "Worldwide Corrosion Authority," with a mission to equip "society to protect people, assets and the environment from the adverse effects of corrosion" (NACE, About, 2019). In 2016, NACE published an international study that estimated the global cost of corrosion at $2.5 trillion U.S.—the equivalent of 3.4% of the global GDP (Koch et al., 2016, iii).

Corrosion is a particular concern in the oil and gas sector, as it can affect widespread networks of underground and surface infrastructures. Interestingly, NACE itself was born from a Texas-based association dedicated to corrosion mitigation on underground pipelines—sponsored by the petroleum industry (NACE, *Ibid.*). Not incidentally, corrosion is now recognized as a major cause of pipeline failure worldwide. In Canada, a report published in 2016 by the Canadian Energy Pipeline Association (CEPA) revealed that corrosion was the leading cause of pipeline leaks, responsible for close to 36% of the total number of spills (Bakx, 2016).

The choice of monitoring corrosion, as the photopaper testing kit does, thus consists in more than an "end-of-pipe" approach to air contaminants. Quite the contrary, it makes visible and graspable the feedback loop through which H_2S can corrode the very infrastructure meant to contain it, and result in fugitive emissions with the potential risks of further corrosion and hazardous exposures.

3.3.d. Rethinking Standards for Environmental Harm

As the reflections above have shown, the photopaper testing kit relies on the rethinking of air monitoring process itself, of the sensing element reacting to pollutants, and of the very nature of the data it provides participants with. Furthermore, it also relies on a rethinking of the benchmarks used to interpret this data. As the following section will demonstrate, instead of analyzing residents' results against abstract concentration curves, it adopts a comparative tactic to make sense of field results based on real-world monitoring and safety standards.

Tested for the first time in the field in Saskatchewan, the experimental design developed by the Wylie Lab proposes to interpret residents' results against a "corrosion scale" that displays a gradient of corrosion with both visual and numerical entry points. Quite uniquely, this experimental design builds on two preexisting industrial benchmarks. Indeed, the colorimetric scale is composed of photopaper samples that have been exposed in the "grit room" of a large sewage treatment plant, containing relatively high concentrations of H_2S that averaged between 200 and 500 ppb (Vera et al., forthcoming). The Wylie Lab has conducted several rounds of testing in this sewage treatment plant to validate the method, the latest one occurring over the summer of 2018. Workers who enter the "grit room" are trained in H_2S safety, and have to be equipped with H_2S portable monitors. The air from the room is also scrubbed clean before atmospheric release.

During testing in the "grit room" in August 2018, H_2S concentrations were hourly measured using the Lab's Jerome Meter, which provided an average H_2S concentration for each photopaper sample. Exposed for different periods of time ranging from 24 hours to 7 days, the samples from the sewage treatment plant displayed varying levels of discoloration. Following exposure in the "grit room", samples were fixed, and analyzed using X-Ray Fluorescence (XRF)—an elemental technique used in this case to detect the quantities of silver and sulfur bound to each sample of photopaper. Added during the latest developments of the kit's experimental design, XRF made it possible, in addition to the visual estimation of samples' corrosion, to more accurately assess the

level of corrosion of each sample based on the quantity of silver and sulfur formed through the reaction with corrosive compounds. If samples have been exposed to H_2S, the silver halide in the paper indeed reacts with the sulfur element of the gas to produce silver sulfide.

Beside H_2S concentrations from the "grit room", the second benchmark used in the study was the standard established by the International Society of Automation (ISA) to measure rates of corrosion (from mild, moderate, and harsh, to severe) in order to protect electric and electronic equipment, in factories or data centers for instance. In the "grit room" of the sewage treatment plant, photopaper samples were collocated with Corrosion Coupons, developed by the company Purafil, that use strips of silver and copper to estimate rates of corrosion based on the ISA standard. Our analyses have shown that any photopaper sample that displays discoloration, is already above the "severe" ISA threshold, which predicts that corrosive attack might occur within six month and critically affect electrical and metal equipment.

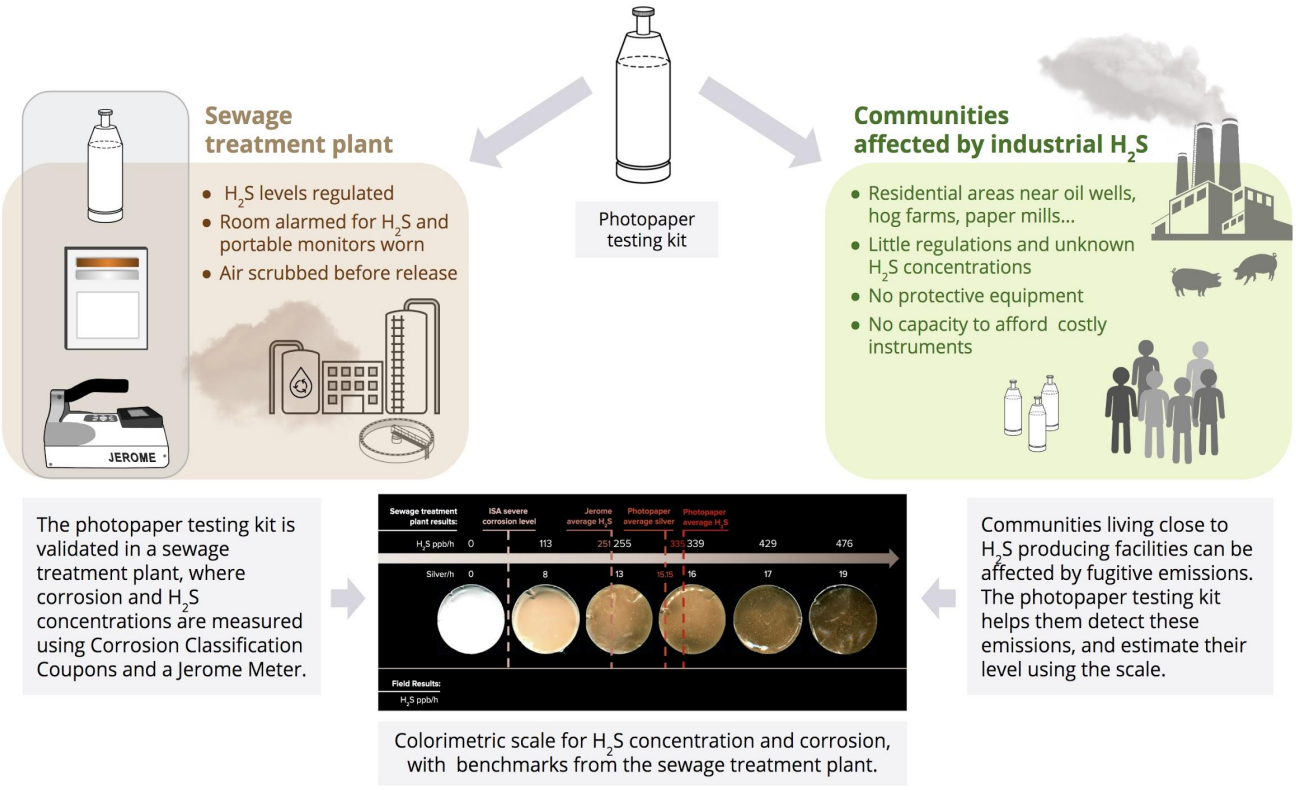


Figure 9: Figure 8: Study design of the community-based corrosive monitoring study. Wylie Lab, 2019.

Both represented on the Lab's corrosion scale, the ISA standard and the "grit room" H_2S benchmarks make it possible to meaningfully interpret participants' results. Field samples that display similar or higher levels of corrosion than those recorded in the "grit room", indeed make it

possible to formulate an environmental justice argument: Where workers are protected with training and monitoring equipment, civil communities exposed to comparable amounts of corrosive gases are not equipped with any monitoring device nor effective regulatory protection.

Bringing real-world occupational benchmarks into the field to interpret communities' air monitoring results, the study adopts a critical stance on institutionalized exposure science that has mainly relied on numerical assessments of risk and harm. Standards such as the "Permissible Exposure Limits" set by the Occupational Safety and Health Administration (OSHA) in the U.S., explicitly illustrate the dynamic that has prevailed with the development of environmental regulatory frameworks in the second half of the twentieth century: the "thresholds" that govern human exposure to chemicals function as an *allowance* mechanism, rather than a precautionary rule. Yet, as Bhavna Shamasunder and Rachel Morello-Frosch have stressed, for most measurable chemicals "the quantification of exposures in biological samples precedes scientific understanding of their potential health effects"—consequently leading to a statistical, "risk-based" approach to peoples' exposure to hazardous substances (2015, 6). How long does research need to engage in an "endless cycle [...] to 'prove' readily apparent harms and quantify risks" (Wylie, Shapiro, Liboiron, 2017, 401)?

Breaking away from strictly quantitative approaches to environmental harm, the corrosive gases monitoring study suggests new benchmarks be devised, that better acknowledge communities' experience and needs, and to build on preventive measures already applied in industrial or public infrastructures. These experiential benchmarks are part and parcel of the ways in which the participatory monitoring kit produces "operative images" and data, that can be actioned as effective arguments by communities facing exposure risk.

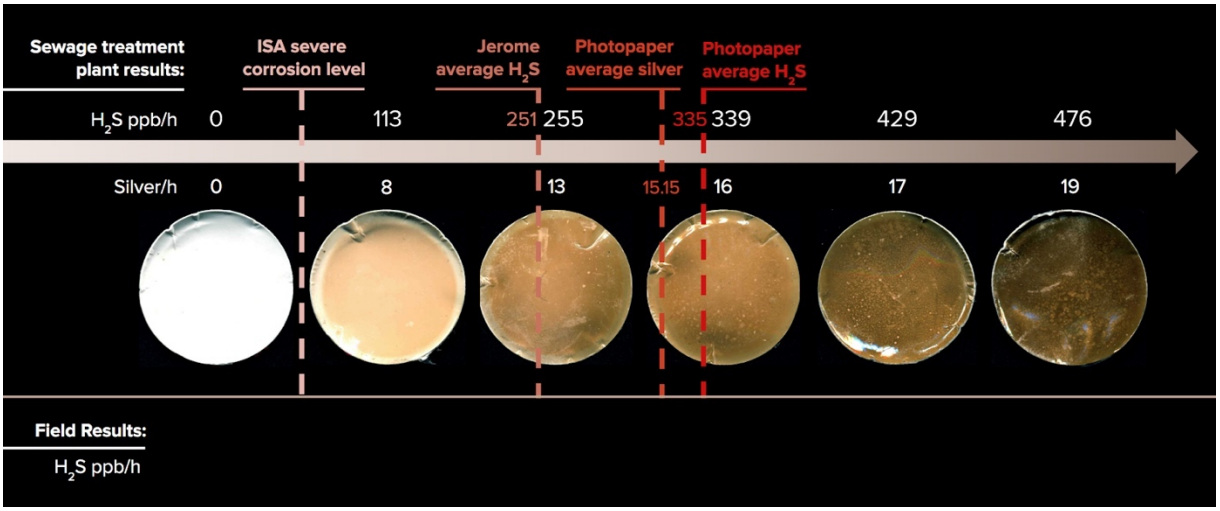


Figure 10: Colorimetric scale from August 2018 sewage treatment plant testing. Wylie Lab, 2019.

4. Opening Up Interdisciplinary Hybrid Forums: Working Toward Community Capacity and Public Accountability

4.1. The Double Binds of Science in the Making—Or Learning from Uncertainty

"Experimental systems are not testing devices, designed to confirm what is already known. They are designed to allow for the emergence of questions that could not be asked before."
(Fortun, 2012, 451).

4.1.a. Representing Scientific Research

As we approach the conclusion of this paper, I would like to examine some of the questions and findings that have emerged during the collaboration of community members, *The Price of Oil*, and the Wylie Lab, as well as some of the local impacts of this investigation. I will first turn to the second series of articles published by *The Price of Oil* in *Global News* and the *Toronto Star* in October 2018., This series not only followed-up on the question of H_2S emissions and exposure risk in southeast Saskatchewan, but also covered the participatory monitoring study conducted by the Wylie Lab with a few families in the area. This experience was marked by a series of double binds that gave rise to interesting discussions. How can we accurately represent the complexity of scientific research, while simultaneously addressing the broad audience of mainstream media outlets? And how can we represent science as a *process*, rather than a protocol providing definitive answers?

"No Fines. No Public Warning. And an 'Off the Chart' Air Quality Indicator in Saskatchewan's Oil & Gas Country" (Cribb et al., 2018). This article published in *Global News,* one year after The Price of Oil's first report came out, highlighted the continued lack of public response to H_2S exposure risk in southeast Saskatchewan. The article built on two specific findings put forth by the reporting team: 1. the record of several H_2S exceedances, over the previous months, at the SESAA air pointer located in Wauchope, along with the absence of an alert system to warn residents about such exceedances; and 2. the discovery of two H_2S incidents that had occurred in 2015 at the tank battery that sits at the entrance of Louis and Lucille Gervais' property. The Gervais, one of the families enrolled in the air monitoring study, were never warned

about the incidents uncovered by the reporters. During one of the incidents, a worker was knocked down by H_2S emissions that came from a leaking valve.

In addition to these incidents, the article covered the participatory air monitoring study conducted by the Wylie Lab in the area, and in particular results from two participants, the Gervais family, and Lori Erhardt, who had agreed to publicly share their data. The fact that the work of the Wylie Lab was, in turn, becoming part of the story articulated by *The Price of Oil*, raised interesting discussions between and within our teams. How could the articles represent the data provided to residents as preliminary data resulting from an experimental study, and not from a "gold standard" monitoring instrument? How would reporters summarize the complex experimental design behind the study, and the way in which participants' results are interpreted in comparison to those of a public infrastructure where H_2S is monitored and regulated?

Figure 11: Screenshot from the article "'Off the chart' air quality readings in Saskatchewan's southeast raise new concerns — but little public warning," Cribb et al., *The Toronto Star*, October 16, 2018.

Partly owing to the "black boxing" mechanisms outlined earlier (Latour & Woolgar, 1986), it is often believed that science and its instruments have the steadfast capacity to accurately and

"objectively" record and interpret physical phenomena. Yet the data provided by an instrument is always the product of a singular design, of the intrinsic setup of the instrument, and of external conditions within which the instrument is used.

Considerable literature in STS and science epistemology, has since the 1970s highlighted the constructed nature of scientific facts, and their inevitable reliance on specific social and technical circumstances (see Knorr-Cetina, 1981; Haraway, 1988; Latour, 1999; Daston & Galison, 2018, to name but a few). In her book *The Manufacture of Knowledge: An Essay on the Constructivist and Contextual Nature of Science*, Karin D. Knorr-Cetina reminds her readers that the word "fact" draws its meaning from the Latin *facere*—to *make*—and should thus be understood as "that which has been *made*" (1981, 3). Yet, she writes, "we tend to think of scientific 'facts' as given entities, and not as fabrications" (Ibid.). There is a world of difference between coming to the theoretical understanding of the mediated "nature" of scientific data, and accepting, in practice, their *unnaturalness*.

An enlightening moment that contributed to my own understanding of the labile nature of air monitoring data took place in the hospitable sewage treatment plant in which Wylie and I spent our mornings during one week in August 2018, while conducting the latest round of comparative testing to validate our method. In order to precisely measure the H_2S concentrations that photopaper samples were exposed to, we had designed a sophisticated setup to enable hourly H_2S sampling using our Lab's Jerome Meter—the industrial standard to measure the gas. In the "grit room," which was not equipped with any electrical outlet due to a risk of explosion, we complemented the instrument with an external battery, and were regularly changing its internal battery to maximize the number of days during which it could continue operating. Five days after the beginning of our monitoring campaign, the Jerome Meter was off when we entered the "grit room," and its last readings displayed a long list of "zeros". Thinking that its sensor might have been saturated, we launched a "regeneration" and went out for lunch. Back at the sewage treatment plant, we verified whether the instrument was operating "normally," by collocating it with a second Jerome Meter belonging to the sewage treatment plant. We placed both instruments in a spot where we had noticed high levels of H_2S, their captor pointing at the same direction. The two instruments displayed significantly different readings. Unsettled by this difference, the lab analyst who was accompanying us brought two additional, portable, H_2S monitors. The 4 instruments placed on the floor, their sensors pointing at the same spot, again displayed four considerably different values. Illustrating what I am tempted to call the extreme situatedness, or *myopia* of monitoring data, this moment shows the extent to which sensing instruments ever only deliver a *partial vision* of what they are able to sense through their own focus and calibration.

Interestingly, because the Wyllie Lab's study became a subject of representation for the journalists, an additional degree of reflexivity was added to our work. How would Wylie herself, who was to be interviewed on the last day of our trip with the journalists, summarize the complexity and processual nature of the research? How would the reports we had handed to the participants be presented and discussed in the articles? Had we made it clear enough that the data was preliminary, and that the only possible assertion was that unusually high corrosion levels had been recorded, that needed to be confirmed through further monitoring?

A few weeks after our report-back trip to Saskatchewan, *Global News* sent cameraman and editor Ben Jonah to Boston to document the analytical aspect of our work at Northeastern University and the Harvard School of Public Health. This second degree of representation gave us more room to further describe and *show* the experimental design of the study, as well as the way in which samples are prepared, processed, and analyzed. In October 2018, the new article in *Global News* was accompanied by a video from the TV broadcast which, in four minutes, managed to remarkably clearly retrace residents' experience of H_2S exposure the incidents uncovered by the reporting team, the method developed by the Wylie Lab, and the reactions of Lori Erhardt and Louis Gervais concerning their results and the journalists' findings. As a result of numerous discussions around the risk of oversimplifying the conclusions of the study, the articles and video report eventually represented the monitoring results as part of an ongoing process, put in perspective with the lack, so far, of reliable data and information accessible to residents.

Interviewing Lori Erhardt in June 2019, I questioned her about the moment when both the reporters, and Wylie and I were entering her living room, setting the stage for the moment when she would receive her air monitoring results in front of the camera. "We are all part of the story," Lori Erhardt said; "We need to remember that." Her words resonate as I am writing these lines, and I hear them today, highlighting not only the role that everyone needs to play to bring to light contentious environmental health issues, but also the shared responsibility of journalists, scientists, residents, and readers, in crafting and interpreting the stories through which these issues are brought to public awareness.

4.1.b. Analytical Peregrinations

In the months following the release of the new articles by *The Price of Oil*, the Wylie Lab, all the while interpreting the results from the second round of air monitoring in southeast Saskatchewan, was also at work to scientifically validate its experimental method. As a new analytical process

was emerging to interpret corrosion results, we discovered unexpected data in the Saskatchewan study. What follows here is a brief summary of several months of analytical wanderings and uncertainties.

The cautiousness that the Wylie Lab has put into reporting results from the first round of monitoring in Saskatchewan, came from the fact that the study's experimental design, outlined above, was being pilot tested for the first time in the field. During the previous steps of the method's development, field samples were analyzed based on their discoloration, without being compared to the benchmarks from the sewage treatment plant. It was a novelty, in June 2018, to be able to use XRF data to assess corrosion levels more accurately, as much as it was to align participants' samples with the scale displaying benchmarks from the sewage treatment plant.

About a month after our trip to Saskatchewan, Wylie and I took samples from the second round of testing in Saskatchewan to the Harvard School of Public Health (HSPH). We were seeing for the first time the XRF instrument used in our study, and we had many questions for our interlocutor, Choong-Min Kang, Research Associate at the HSPH Department of Environmental Health. As we were inquiring about the calibration of the XRF instrument, Kang, who generally conducts the element analysis for the Lab's samples, opened a transparent cabinet that contained the "standards" used to calibrate the machine for each of the elements it is able to detect. Looking at the silver standard, Wylie explained to Kang that it was after several scientists advised her against the reliability of the sulfur element, that she had conceptualized an experimental design based on silver corrosion. Surprised, Kang replied that sulfur was, from his experience, a stable element that could reliably be detected using XRF.

Over the following days, we pulled out previous XRF spreadsheets to look at their sulfur results. Sometime later, Lourdes Vera who was in Texas working with community members from Karnes county, prepared a regression analysis, that indeed showed a strong correlation between sulfur and silver values on our samples from the sewage treatment plant. The consistency observed between the levels of silver corrosion, and the sulfur quantities detected through XRF, meant that we would be able to estimate the concentrations of H_2S that each sample had been exposed to. A few consultations, calculations, and weeks later, we were indeed calculating estimated H_2S concentrations based on sulfur quantities detected on the samples, the molecular weight of H_2S, and the uptake rate of H_2S by photopaper—previously measured by researcher Claire Horwell and colleagues (2004). The predicted H_2S concentrations we found in samples from the sewage treatment plant matched those we had measured in the "grit room" using our Jerome Meter. This success was later corroborated by similarly strong correlations between silver

and sulfur quantities detected on samples from Deaver, Wyoming, where an earlier model of the testing kit had been developed in 2013.

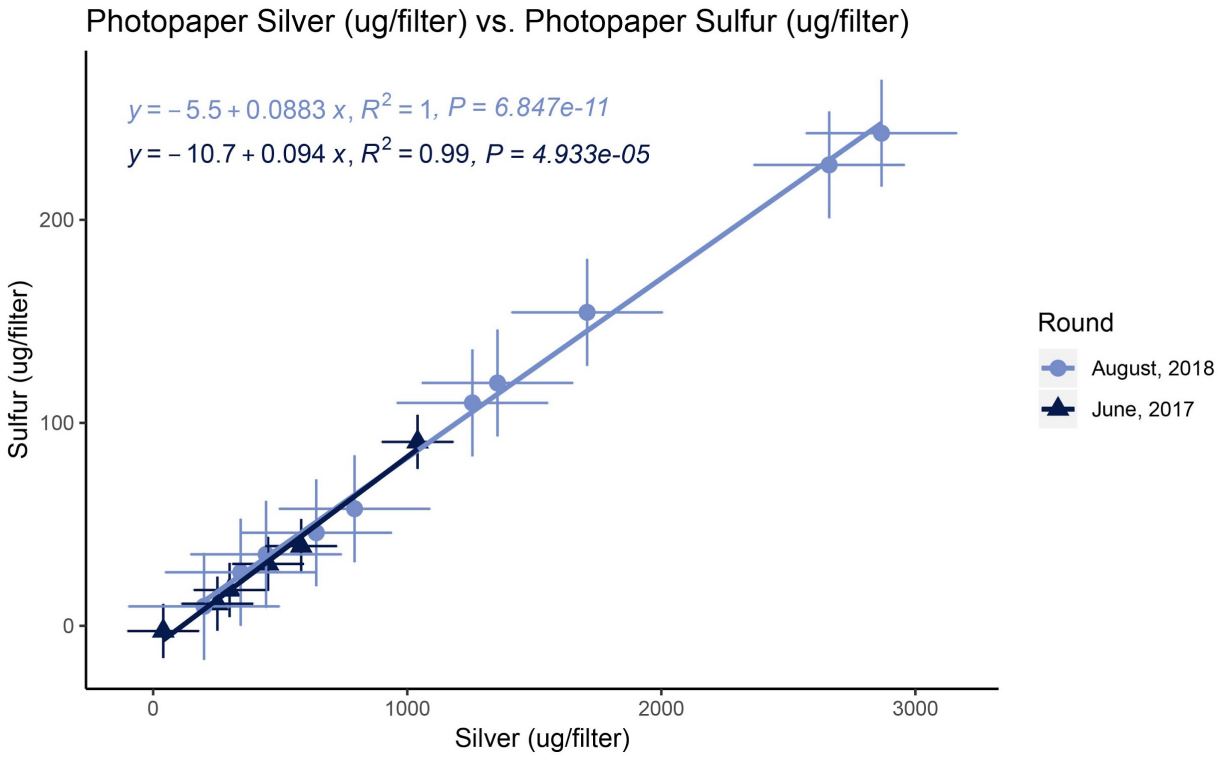


Figure 12: Sewage treatment plant photopaper testing results from June, 2017, and August, 2018. Silver and sulfur values per area detected by XRF. Wylie Lab, 2019.

This novelty considerably changed our experimental design, and the data we would be able to deliver to residents. We redesigned our corrosion scale accordingly, and rearticulated around this finding the methods paper that we had been writing to validate our scientific protocol. Yet, at the very same time that we were adjusting our method—and becoming more confident about the possibility of reporting on predicted H_2S concentrations—some new uncertainties were emerging while we were analyzing results from the second round of testing in Saskatchewan. Indeed, several samples analyzed with XRF were showing unusually high silver values, suggesting important corrosion levels, yet had low sulfur values. This suggested, we hypothesized, that field samples in Saskatchewan might have been exposed to other corrosive compounds than H_2S or SO_2 (sulfur dioxide)—both sulfur gases. The news was somewhat unsettling; but we also realized it might open up interesting perspectives if the photopaper could function as an indicator for other air contaminants. A quite broad literature review, and a number

online exchanges with experts in silver corrosion, showed that other corrosive compounds susceptible to affect silver indeed included nitrogen oxides, ozone, and to some extent benzene and particulate matters.

We decided to put the report-back process on hold, and to try to find an alternative analytical technique that could make it possible to determine what other gases the samples from Saskatchewan had been exposed to. XRF was limited in scope, as it only informs on the elemental composition of samples but not on their chemical bonds. It also cannot detect lighter elements such as nitrogen and oxygen, and was thus inappropriate to help us determine if samples had been exposed to ozone or nitrogen oxides. Several techniques that might provide more exhaustive information on the chemical state of the samples from Saskatchewan are currently being examined. Identifying the "right" instrument is in itself no easy task, as no standard exists to analyze, not *silver* corrosion, but the corrosive reaction of *silver halide* in photopaper.

These analytical uncertainties—and the difficulties coming from the fact to be validating our method in the field and in a sewage treatment plant—show the complexity of doing science in real-world conditions. I saw this experience as an interesting lesson on the phantasmatic nature of "pure" data, standards, or environment—outside of the "test chambers" manufactured since the mid-twentieth century to artificially reproduce and isolate physical phenomena.

4.1.c. Negotiating Safe and Unsafe Uncertainties

The uncertainty encountered in the development of our research has been the most difficult aspect of my work with the Wylie Lab, and, until now, the most challenging to write about. After much hesitation about including it in the present paper, I came to think that excluding this aspect of our work, would be attempting to excluding one of the core reasons why this work exists at all. Yet, while trying to understand the uneasiness I felt about the analytical meanders outlined above, I started understanding that it might in fact hide another double bind.

From the uncertainties inherent to any work on toxicants (Boudia & Jas, 2014; Callon, 2011, Cordner & Brown, 2013), to the uncertainties at times raised by our interdisciplinary collaboration, and the analytical uncertainties uncovered through the latest developments of our method, we did not lack opportunities to question ourselves and our work. Rather, these questions and methodological fumbling are part of the very process of science and knowledge production, and the trouble I felt was coming from something else that I had difficulty naming and articulating.

Sitting on my couch and unable to write, I realized that I was staring at an issue of *Psychologies Magazine* left there by my roommate, titled “DEAL WITH UNCERTAINTY.” Parting ways with academic literature for a bit, I opened the glossy journal expecting to find well-meaning words and self-indulgent pieces of advice. This is partly what I found, but to my surprise I also came across an insight that has helped me understand and articulate my worry. The monthly report mentioned an article of Barry Mason, Family and Systemic Psychotherapist, that details four ways of addressing risk factors: unsafe uncertainty, unsafe certainty, safe uncertainty and safe certainty (Mason, 1993). What the words I found in *Psychologies Magazine* have helped me discern is the discrepancy between our, *safe* uncertainty as researchers, and the *unsafe* uncertainty experienced by the families we have been working with. If uncomfortable, safe uncertainty can be adaptive and creative. The words of Lourdes Vera come back to mind; while questioning Vera about how she had personally been handling uncertainty over the course of our research, she expressed how “thankful” she was for it. For uncertainty, Vera eloquently said, “does open the door for new questions, and for new investigations that take us further into the chain of inquiry" (Vera, L., personal communication, June 7, 2019). This form of uncertainty is undoubtedly generative, and can be catalyzed into words, thoughts, tools, and trials. My emotional response came from the difficulty to articulate *this* form of uncertainty, with the awareness that residents in the areas we are engaging with, live with a form of uncertainty that *is* a threat to their health and livelihood.

Double binds “proliferate,” Fortun beautifully writes (2001, 3). And the emerging bind I was uncovering could be outlined as such: How can we possibly conciliate the safe uncertainties of experimental research, with the unsafe uncertainties experienced by community members living with exposure risk? How can we respond to the expectation and hope to produce *certain* data, where *no* data existed?

These double binds have specifically been felt in the decisions we had to make about how and when to report back on the results from monitoring. After the first round of testing in September 2017, the timeline of the report-back process was defined with the journalists from *The Price of Oil*. The main ethical question we came across while preparing participants’ reports was whether or not we should deliver these results before the experimental method was fully validated through a peer-reviewed article. Interestingly, researchers Alissa Cordner and Phil Brown have specifically addressed the ethical concerns related to the study of understudied environmental contaminants (Cordner & Brown, 2013). Highlighting the lack of studies on how scientists can make ethical decisions in the face of uncertainty, the authors explain this gap with

the fact that “formal ethical guidelines and codes of conduct develop more slowly than do scientific advances, and because scientific research on modern sources of risk is often unavoidably uncertain” (Ibid., 470). Moreover, they note, research on emerging contaminants that is policy-relevant, interests a broader set of actors (legislators, nonscientific publics, activists, and in the case of the Wylie Lab, journalists), which binds scientists to an accountability to multiple audiences (Ibid., 471). Echoing what the authors have termed a process of “reflexive research ethics” (Cordner & Brown, 2012), the Wylie Lab determined that it was more ethical to report on the preliminary results of the air monitoring study in June 2018, rather than to risk perpetuating harm by waiting for the end of a peer-review process that could take up to a year.

More recently, we have similarly decided to report on the results from the second round of monitoring, as well as on the analytical questions we are currently still working through. This second report-back trip to Saskatchewan will take place in early August 2019, and should help identify participants’ needs and intentions for the next steps of this study.

Working on the development of the corrosive gases monitoring kit over a year—witnessing, contributing to, and grappling with its progress and readjustments—has been a learning experience on the non-linearity of science, and on the art of “staying with the trouble” of uncertainty. Owing its existence to the scarcity of exposure studies, monitoring data, and regulatory measures to prevent harm from H_2S exposure, the community-based testing kit in itself *informed* by uncertainty. As such, uncertainty can be viewed as an essential part of, and impetus for, our work, rather than a pitfall to be overcome.

In fact, owing to their lived experience of risk, oilpatch communities might be better equipped than many researchers—or at least than I was so far—to negotiate the fact of not knowing exactly what is in the air. In an article addressing the significance of reporting-back environmental exposure data, Crystal Adams et al. highlight that despite risks of emotional discomfort associated with enduring uncertainties surrounding toxicants, reporting-back on study findings, and linking results to individual and collective action, can help participants “mitigate negative emotions,” and “make plans to act upon new knowledge regarding contaminated communities and homes” (2011, 16). Thus, the authors conclude, “instead of underestimating lay capacity to grapple with uncertainty, researchers interested in public engagement should be aware that lay empowerment can emerge from an awareness of the limits of science” (Ibid.).

4.2. Toward Just Designs and Relations: Thinking through the Performativity of the Research Process

4.2.a. Design Justice and Relational Accountability

The process of self-reflexively thinking about our work practices within the Wylie Lab has triggered my interest in design practices and in the ways in which they influence the technical and epistemic developments of a project. I would thus like to propose a few reflections that consider design as a *process* that is not only geared toward the production of an object or output, but also toward the development of meaningful practices and relations.

In February of this year, I joined a workshop organized in Toronto by the Design Justice Network (DJN)—a collective formed during the 2015 Allied Media Conference in Detroit. Design Justice is concerned with "how the design of objects and systems influences the distribution of risks, harms, and benefits among various groups of people," and seeks to develop "principles that might help practitioners avoid the (often unwitting) reproduction of existing inequalities" (Costanza-Chock, 2018, 1). Focused on the highly debated project proposed by Sidewalk Lab (Google's sister company) to develop a "smart city" on Toronto's eastern waterfront, the DJN workshop had us split into four groups and collectively reflect on Sidewalk Lab's project from a Design Justice perspective. Who is included in the planning process, and who is not? Who will the project benefit to, and who might it marginalize or harm? What kind of data infrastructure and governance will rule the collection, storage, and use of citizens' data? Inspired by this encounter and collective discussion, several participants in the workshop expressed the interest to keep gathering and addressing local issues using a Design Justice lens. Since then, eight of us have created a Toronto chapter which, though still in its infancy, is actively defining itself as a platform that mobilizes Design Justice principles to engage primarily with housing, environmental, and health inequities.

Contributing to this project, in parallel with my work with the Wylie Lab and more recently with the Environmental Data Governance Initiative (EDGI) in the U.S., has helped me put into perspective my work with each of these two organizations. Both of them working toward social and environmental justice goals, they appropriately share a number of the principles spelled out by the DJN. Building on our earlier discussion of the participatory dimension of the air monitoring study, and its revaluation of residents' embodied experience of exposure, one of the important

principles that the Wylie Lab and the DJN have in common is to “center the voices of those who are directly impacted by the outcomes of the design process” (Design Justice Network Principles #2, 2018). Following the same logic, they also share the belief “that everyone is an expert based on their own lived experience, and that we all have unique and brilliant contributions to bring to a design process” (Ibid. #6). Who gets to contribute to the design of environmental monitoring instruments? And who defines what will be measured, where, how, and with what outcomes and intentions? Elaborating on the participatory dimension of Design Justice processes, Sasha Costanza-Chock, one of the co-founders of the DJN, highlights that involving concerned communities makes it possible to produce ideas and approaches that an individual, external to the community, might have been unlikely to have; but also that an inclusive design process can “create formal community accountability mechanisms” (2018, 10).

Building on this notion, I argue that a Design Justice framework also helps create accountability mechanisms between researchers and community members. As such, I see the previously discussed decision to report on uncertainty, as emerging from a just process of accountability and reciprocity. When I questioned Lori Erhardt her about her experience during the participatory monitoring study, she expressed having particularly valued that our team reached out and explained her results in person, as well as transparently engaged with the unknowns of the data. “What I appreciated about having academic researchers there, was that strong desire to be very consciously reflective about this, and not jump on any results that hadn't quite been established,” Lori said, referring to the moment in June 2018 when Wylie, the journalists, and I came to her place to deliver her results (Erhardt, L., personal communication, June 27, 2019).

As a generative framework to lay the ground of a project, the Design Justice Principles can also support the critical assessment of existing or ongoing projects. As such, I would like to suggest that it might provide interesting perspectives and questions for the Wylie Lab to assess and think about the next steps of the air monitoring study. The principles might indeed help define or redefine the objectives of the project and some strategies to achieve them: “We prioritize design’s impact on the community over the intentions of the designer” (Principle #3); “We share design knowledge and tools with [...] communities” (Principle #7); “We work towards sustainable, community-led and -controlled outcomes” (Principle #8).

Discussed collectively, these principles might offer a generative framework for self-assessment, and to work through some of the double binds that have been outlined in this research: How do we ensure that design tools and research capacity are effectively shared with

communities? How do we negotiate the differences between community-based and community-led research? And how do we address the discrepancies between the urgency and unpredictability of risk for involved communities, and the timeframe and latencies inherent to academic research and to scientific validation processes?

Reflecting with Design Justice perspectives makes it possible to evaluate if, and ensure that, a community-oriented project remains aligned with communities' needs, priorities, and questions. This process suggests a constant and collective assessment of the project and its achievements, and, when needed, a reevaluation of its objectives. Thinking with the Design Justice principles was a way for me to recall and reckon with the fact that the monitoring tool developed with the Wylie Lab has fundamentally been provoked by a techno-political gap, and the resulting risks and uncertainty surrounding oilpatch communities' exposure to risk. As such, its primary purpose is not, and should not be to replace standard H_2S specific technologies, but to produce meaningful preliminary data and discussions that have the potential to highlight this gap, and center communities' experience of exposure. Beside the outputs and uses it aims at generating, a *just* design process is one that cares and accounts for the *relations* it relies on and enables; one that intentionally considers the epistemic function of the designed object or interface, beyond their use values. What do participants—might we ask—need the data to perform on the ground?

4.2.c. Science and Design as a "What If" Question

Departing from more traditional definitions, a *just* design process can be used to work toward reciprocal relations, accountability mechanisms, and community stewardship. As such, it is not only an expert-led activity concerned about specific outputs, but also a collective, and potentially speculative and performative reflection process, which is of focus in the following section. This approach echoes Fortun's own definition of experimental systems, as not being designed to confirm what is already known, but to "allow for the emergence of questions that could not be asked before" (2012, 451).

In a book evocatively titled *Speculative Everything: Design, Fiction, and Social Dreaming* (2013), Anthony Dunne and Fiona Raby reflect on the potential of design to create not only things, but ideas, and on its capacity to imagine how things *could be*. "We are interested," Dunne and Raby state, "in the idea of possible futures and using them as tools to better understand the

present and to discuss the kind of future people want, and, of course, ones people do not want" (2013, 2). Suggesting that this kind of design can take the form of *scenarios*, often starting with a "what-if" question, Dunne and Raby highlight the capacity of such an approach to "open up spaces of debate and discussion" (Ibid., 3).

To some extent, the participatory air monitoring study has started to perform this function and might further do so if we were pursuing this line of inquiry. Several conversations with residents from Saskatchewan come to my mind, and bring me back to my very first impression from the situation back in October 2017; the impression of a silent status quo, that no one was truly satisfied with, but that was perpetuated through the absence of an attainable alternative, and even through the absence of a discussion about the *possibility* of an alternative. Numerous analysts have highlighted the problematic lack of a capacity to envision alternatives to established systems that produce harm and inequalities, and even more so to envision resources for action in particular in situations that are so complex, pervasive, and alarming as the climate crisis. In our last conversation in July 2019, Eaton, who has been one of the rare researchers involved in studying the impact of the oil and gas industry in Saskatchewan, expressed the need for an economic alternative to be thinkable, but also for a "positive vision" of what "*transition* looks like" (Eaton, E., personal communication, July 23, 2019)—particularly when so many people depend on an industry that has, for decades, been framed as a major job creator. It was enlightening for me to hear Eaton talk about her own research framings, and how, after initially focusing on grievances around the local, human, and environmental impact of oil and gas, she came to realize that excluding climate change as a global, urgent question was not a solution—but rather led to "makeshift," local approaches to finding solutions.

This discussion has led me to think about our own avoidances and exclusions as researchers, when it comes to the root causes of the issues we are engaging with. I would also hear in July 2019 from Elliott about the "self-doubt" that certain witnesses in *The Price of Oil* investigation had demonstrated, after facing the denial and criticism that had followed the publication of the first articles in October 2017 (Elliott, P., personal communication, July 22, 2019). And yet, I would also hear about how certain workers spontaneously reached out to the investigators to testify about their own experience of exposure, and about how a discussion that had never happened was finally enabled (*Ibid.*).

These conversations have strengthened my belief that speculative, reflexive frameworks can be generative, and provide space and capacity to start envisioning other realities by simply asking questions that were deemed unthinkable; questioning the lived reality. By comparison, it is interesting to note that corporations, particularly from the extractive sector, have excelled

throughout the twentieth century in using scenario writing and speculative thinking not only to model development strategies, but also to inform research agendas and collective imaginaries. The “Shell Scenarios” developed by the oil giant since the 1970s are telling examples—and this topic might deserve greater attention. In contrast with the idea of a corporate-written future scenario, it is important to highlight, thinking with Dunne and Raby, “design’s role in facilitating alternative visions rather than defining them,” its capacity to be “a catalyst rather than a source of visions” (Ibid., 9). Envisioning futures, too, should emerge from a collective, community-based process.

The conversations we were able to have with participants while reporting-back on their results, have already given shape to a new set of questions. Moving away from the initial question that had gathered us in the field—“is there any risk of community exposure to H_2S in southeast Saskatchewan?”—the participating families have started formulating their own questions and concerns during our discussions. “How can I know if there is a risk for my children when they play outside?” “When does H_2S start to be harmful for human health?” “Are we all similarly susceptible to its health effects?” “What are the effects of chronic, low-dose exposure to H_2S?” Erhardt, during our last interview this year, also pointed at new research questions even before we formally reported on the results of the second round of monitoring, and of our analytical fumbling: "Pointing up the possibility of H_2S has the potential to just keep people recognizing that H_2S is an issue, and that there are other things in there as well... [...] in terms of the conversations expanding, that's what I see. This could really help engage this conversation" (Erhardt, L., personal communication, June 27, 2019).

Engaging with the air monitoring study in Saskatchewan has nurtured my interest not only for the speculative and prospective dimension of design, but also for its *performative* dimension. In addition to the “operative images” and data that have been produced with participants, the surrounding discussions have made it possible to question the very situation and infrastructure behind them. Providing an updated definition of what they have called “critical design”, Dunne and Raby write: “All good critical design offers an alternative to how things are. It is the gap between reality as we know it and the different idea of reality referred to in the critical design proposal that creates the space for discussion” (2013, 35). Building on this definition, I would like to suggest that the participatory monitoring kit has indeed acted as a “critical design” tool to rethink the conditions of toxic exposure in oilpatch communities (Dunne and Raby, 2013, 35). Beyond, it

has also acquired a performative dimension by opening up a critical space for discussion that has, in turn, triggered what could be called “micropolitical shifts”.

4.3. The “Micropolitics” of Change and Public Accountability

4.3.a. Reconsidering H_2S Production—Or the Technical Production of a Natural Contaminant

Beyond the very data produced by the experimental air monitoring kit, and its inherent limitations, we have seen that what is at stake are also the processes and relations that have been opened up through the participatory study. I suggest that this process has already been *operative*, as, in conjunction with the news investigation, it has contributed to making community H_2S exposure into a public health matter, and triggering local mechanisms of accountability. The following sections highlight some of the findings and responses that have been enabled by this collective research and outreach process.

One of the interesting outcomes of the interdisciplinary collaboration between *The Price of Oil* and the Wylie Lab was the surfacing of a technical element that considerably affects the production of H_2S. As I have highlighted in the second chapter of this thesis, the fact that H_2S is a “natural” by-product of oil and gas production has largely contributed to the lack of effective regulations and enforcement mechanisms, and to the state of impunity described throughout this paper. To some extent, the “naturalness” and “unavoidability” of H_2S has been showcased in public discourses and used as an argument to justify the government’s inaction.

In the 2015 *CBC News* article that had revealed high levels of H_2S emissions across the province, Dancsok, at the time responsible for the Petroleum and Natural Gas Division in the Ministry of the Economy, told journalist Geoff Leo that most Saskatchewan oil fields in the past were considered "sweet," and didn't emit sour gas; as they age, he went on, “they're becoming sour and producing hydrogen sulfide at an increasing rate” (Leo, 2015). A few months later, in the previously mentioned interview with *Pipeline News’* editor Brian Zinchuk, Dancsok further asserted that “natural gas, or associated gas with oil, is a fact of life. It comes up with the oil. With that, at times, in Saskatchewan’s past, and in other jurisdictions as well (...) some of that gas can be sour” (Zinchuk, 2015). These statements suggest that ”souring” deposits and wells are the result of an unavoidable geological process. Echoing this discourse, an article in *The Western Producer* addressing sour gas concerns, similarly affirmed that although the province’s oil wells

have typically been sweet, in southeastern Saskatchewan “the geology is such that the oil reservoirs become sour as they age” (Briere, 2015). Yet exactly how and why are wells “becoming” sour?

Interestingly enough, in June 2018 a source contacted by the investigative team pointed out that the formation of sour gas can partially be the result of contamination through fracking fluids. A preliminary literature review indeed shows that the bacteria that produce H_2S in oil and gas deposits, can, when a well is fracked, contaminate the fluids used for the fracturing process, and, through the reuse of these fluids, contaminate other wells (Kahrilas et al., 2015; Marriott et al., 2016; Environment and Climate Change Canada & Health Canada, 2017). Yet still poorly studied, H_2S contamination of wells or storage tanks through fracking fluids is an increasing source of concern in unconventional oil and gas production regions. Marriott highlighted that “the technologies employed in oil and gas production, especially from unconventional resources, also can contribute to generation or delay of appearance of H_2S” (2016, 2). Steam assisted gravity drainage (SAGD), Marriott explains, “and hydraulic fracturing used in production of oil sands and shale oil/gas [...] can potentially convert the sulfur content of the petroleum into H_2S or contribute excess amounts of H_2S during production” (2016, 2).

This anthropogenic factor has been occulted in the public discussions concerning H_2S exposure in Southeast Saskatchewan. It however raises important concerns, since provincial regulations are extremely evasive, or incomplete, on the question of how many times fracking fluids injected into wells can be reused, and how they are treated and disposed of. Very little information is also available on governmental websites regarding the assessment and control of bacterial proliferation in wells and storage tanks. This question requires much further research and attention, and could be made into a relevant policy question in southeast Saskatchewan.

4.3.b. Triggering Public Responses

Published in major media outlets such as *Global News*, *The National Observer*, and the *Toronto Star*, the investigation by *The Price of Oil* received wide public attention. In 2017, the articles, television broadcasts, and the student documentary *Crude Oil* garnered a combined audience of three million viewers within the first month (Elliott, 2018). In one of the essays published in Brownlee and Walby’s book *Access to Information and Social Justice*, Leslie Young, Senior journalist at *Global News*, stresses the potential to hold governments accountable with their own data (2015). Young advocates: “Use data to get answers, and if the answers are insufficient, say

so. Write about it. Get enough people's attention and the government will respond" (2015, 51). The Saskatchewan government did respond, and an FOI conducted by the journalists about their own coverage after the release of the articles revealed that government officials had taken note of what they called a "thorough and impressive" investigation (Elliott, P., personal communication, July 22, 2019).

In a letter responding to the 2017 articles, Energy and Resources Minister Nancy Heppner insists that "protecting the health and safety of Saskatchewan citizens is the number one priority for the Government of Saskatchewan" (Heppner, 2017). Listing the measures taken by the government since 2014 to strengthen its oversight of sour gas management, Heppner mentioned, among others, a budget increase for regulatory programs thanks to a new levy tied to oil and gas wells, as well as the improvement of incident reporting through IRIS, an online tool that has been set up in 2015 to manage inspection and incident data. The letter concludes that "the inspection activities by the ministry confirm the sour gas management practices of industry operators have improved," and that, as a result, air quality has also improved in southeast Saskatchewan. In her reply to Heppner's letter, Elizabeth McSheffrey from *The Price of Oil* quoted some of the rare internal records pertaining to the issue, from the Ministry of the Economy (then in charge of environmental regulations), that state that the ministry "prefers to see operators deal with public complaint without having to be involved" (McSheffrey, 2017c).

Recent testimonies have indeed shown that direct and indirect support is still provided by the government to the industry, specifically by withdrawing from its role as regulator. The articles published in October 2018 for instance quote a former ministry staff member, talking on condition of anonymity: "If you're an inspector who issues a fine, you don't keep working there [...] And there simply aren't the resources to issue fines… There are so few inspectors left" (Cribb et al., 2018). Thus, as the journalists had noted in 2017, if a few dedicated government staff, and even a few industry leaders, are seeking to introduce greater accountability, their efforts are overcome by "larger forces" (Cribb et al., 2017).

Building on these testimonies, and on further documents obtained through FOIs, the 2018 news articles clearly demonstrated the continued contradictions of the government's declarations—and lack of action—about H_2S exposure. These contradictions echo double binds in the federal government's management of the climate crisis—which I mentioned at the opening of this paper. They also bring to light the tendency of Saskatchewan's regulators to "privately" address risk and safety, and avoid the public debate that the reporters have sought to activate. Tellingly, in their 2018 articles, *The Price of Oil* mentioned a note from 2014 in which the

Emergency Management and Fire Safety branch, along with the Ministry of Environment, alerted the government about "a significant risk and potential threat to the public" from H_2S exposure in the southeast corner of the province (Cribb et al., 2018). The authors of this note recommended the organization of a town hall meeting with experts from the Ministries to inform the public and answer any question. However, such a meeting was never held—the government argued that "the risk was managed through increased enforcement action against non-compliant operators" (Ibid.).

If anything, the sustained investigation conducted by students and journalists informing *The Price of Oil* publications has shed light on the political and administrative conundrum that has blurred responsibilities and accountabilities with respect to H_2S exposure risk across the province. Such a conundrum recalls what Beck refers to as "cycles of damage"—systems that produce risks but with no moral or political author for it (1992, 33). Yet, if further efforts and engagement are needed to generate greater *public* accountability, it should nevertheless be noted that a discreet but significant change has occurred within government, when, in February 2018, the Ministry of the Economy was reshuffled and split into three government bodies. This reshuffling, that several observers see as a consequence of the release of the first set of articles by *The Price of Oil* a few months earlier, has seen the creation of an independent Ministry of Energy and Resources, now in charge of regulations and policies for natural resources sectors.

4.3.c. Corporate Oversight and Local Accountability

As the governmental responses to *The Price of Oil* coverage has shown, community exposure to H_2S is in Saskatchewan is managed through a regime of *corporate*, rather than governmental, accountability. In contrast with the efforts of the reporters to bring the problem into public sight, the government has sought to re-privatize the issue, and to treat it as a local phenomenon on a one-to-one basis. Residents who notice or experience incidents involving oil and gas infrastructures, are encouraged to directly contact and fix the issue with energy companies rather than notifying the regulator (Cribb et al., 2017). This practice, beyond "individualizing" the issue, has also made it difficult to trace records of residents' complaints. I would like to highlight a specific case in our work that both testifies to the effective, local changes that have been brought about by the interdisciplinary collaboration between community members, reporters, and the Wylie Lab, and illustrate the "corporate" logic of accountability at play in Saskatchewan.

The Gervais, mentioned earlier in this chapter, have been living for decades on a family farm near Alida. At the entrance to the farm, 200m away from their house, five tanks collect the oil extracted in the surrounding wells of the company Vermillion. A few meters behind the tanks, two flare stacks are burning the residual gases extracted along with the oil. Facing the public road that goes by their farm, a large rusted wheel surmounted by metallic letters announces “Gervais Family Farm”. In front of the wheel, two warning signs read: “Do not enter if flashing red-light or horn alarm is activated. Poisonous H_2S Gas.” Willing to take part in the air monitoring study, the Gervais had set up seven testing canisters around the property in the fall of 2017, with the help of Lourdes Vera and Mia Renauld. Wylie and I would meet them for the first time in June 2018, to report on the results from this first round of testing.

“We’re moving out!” are the words with which Louis half-jokingly started the conversation. Sitting around what Lucille and Louis like to call their “negotiation table,” we reviewed the results report that we had sent to them by mail a few weeks earlier. Their results were the highest across the properties tested in September 2017, corroborating the concerns caused by the nearby flares and tank battery. As the conversation unfolded, the couple gradually began describing the pungent gas they could smell around their house, and their need to close their windows at night when it becomes too strong. “That's why we got AC, because sometimes it was terrible," Lucille explained. "It is worse in the house, it comes here and it stays." Maybe as a result of the ventilation and of their habit to close their windows, the low level of corrosion displayed by their indoor sample was reassuring. The two duplicate samples placed on their front porch however showed the highest corrosion levels across this round of monitoring, falling beyond the values represented on the corrosion scale. When the wind blows from the tank battery to their house, they tell us, their dog Finesse always lies down behind their house. Later in our discussion, the Gervais discreetly evoked their headaches, and their grandson’s nosebleeds that start up when he is over at their place. “If it gets higher, we would not like the kids to live here.”

Joined later by the reporters, our conversation turned toward the history of the Gervais family in the area, the progressive change in the infrastructure around their place, and the H_2S exceedances recorded at the Wauchope air monitoring station, a few kilometers north of their property. In addition, the reporters had brought the copy of a spill report filled in August 2017 on the Gervais’ property, as well as two worker’s incidents involving H_2S at the tank battery near the family’s house. The Gervais had never been notified about any of these incidents (Cribb et al., 2018).

About an hour after the beginning of our conversation, Louis Gervais, much to everyone's surprise, agreed to be interviewed by the journalists and to publicly share his results. "I think they should do more testing," Louis told us, adding that the public should be warned when there is a risk. As a well-known figure in the community, Louis knew, as did we, that him speaking up might make a difference. Two weeks after the release of the articles in October 2018, I called the Gervais to organize the second round of testing that the family had expressed the wish to conduct on their property. Louis, while driving, told me he had not read the news reports yet, but that he had received a lot of phone calls since their publication. Vermilion, the company that operates on the Gervais property, had also sent him two engineers with whom Louis inspected all the wells on his property. They were at work to fix the ones that were "in bad shape".

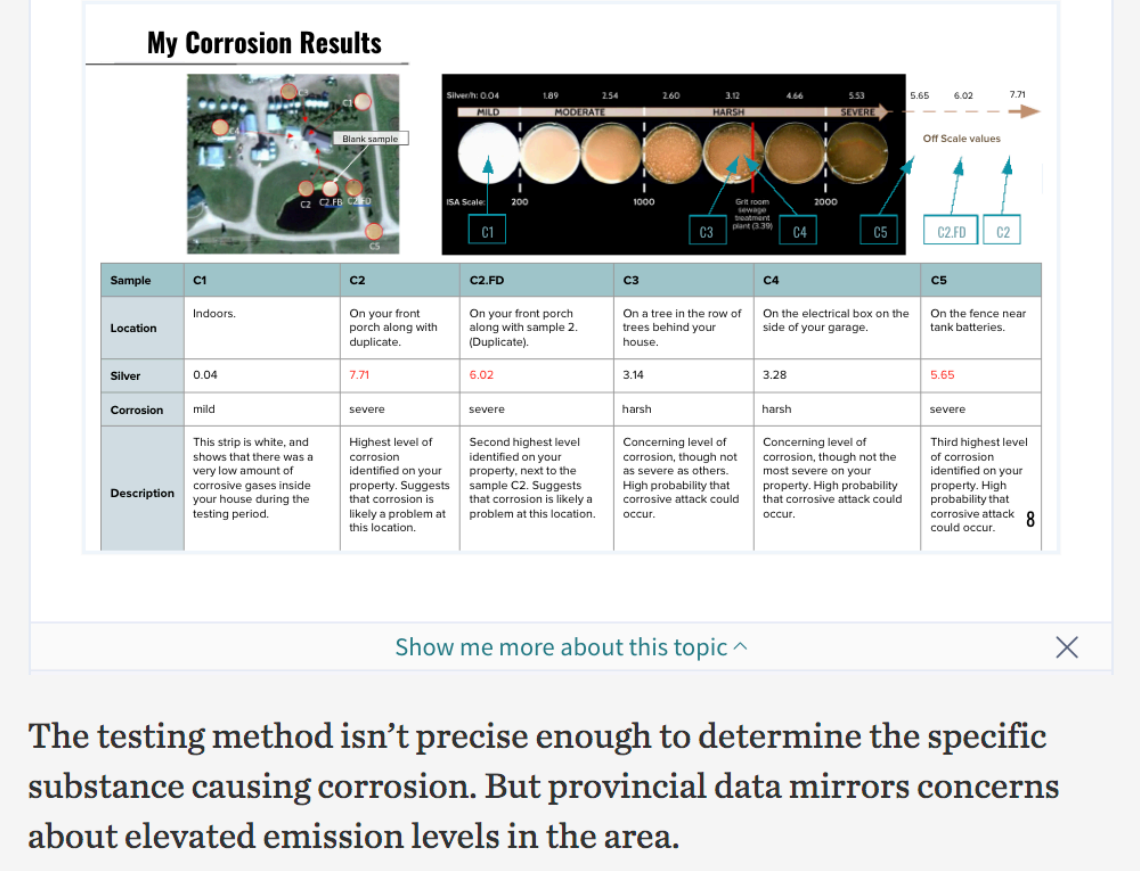


Figure 13: Louis Gervais' air monitoring results as featured in the article "'Off the chart' air quality readings in Saskatchewan's southeast raise new concerns — but little public warning," Cribb et al., *The Toronto Star*, October 16, 2018. Courtesy Wylie Lab, 2018.

The fact that companies are "pulling up their socks," as Louis told us in June 2018, is an important achievement in a place where H_2S exposure could simply not be addressed until

recently. It reflects the role that the combination of evidence-based research and public outreach can play in stimulating greater vigilance and accountability. Yet these shifts are what I would call "micropolitical"—with a Foucauldian understanding of the power dynamics that are exerted not from the center of a political infrastructure, but between secondary institutions and individuals (1977, 26). From the corporate response received by the Gervais family, and the testimony of other participants, to the corporate approach of monitoring illustrated by the SESAA and AGAT monitors, the "micropolitical" shifts I am pointing at reflect the substitution of corporate authorities for the role that public authorities would traditionally play.

4.4 Opening Up "Hybrid Forums"

> "We view change as emergent from an accountable, accessible, and collaborative process, rather than as a point at the end of a process."
> (Design Justice Network, Principle #4, 2016)

4.4.a. Building Community Capacity

The "micropolitical" shifts we have seen occur in southeast Saskatchewan following the release of the investigation, did not only manifest the government's response and related corporate, local accountability, but also in terms of personal and interpersonal experiences within the community. Louis Gervais' change of position within the investigation, and vis-à-vis the industry, is an example. I suggest that the collaborative experience of thinking about one's own experience of chemical exposure, learning about the conditions of risk production, and of producing "operative data", has opened up what Michel Callon and colleagues have termed "hybrid forums" (2001, 9), and a capacity for the community to start addressing the H_2S issue. Let's briefly examine what this entails.

"There is power in conversations," Lori Erhardt eloquently noted during our last discussion (Erhardt, L., personal communication, June 27, 2019). And indeed, it might be owing to the transformative capacity of conversations, that the government has carefully avoided holding any public discussion around sour gas-related risks. The investigation conducted by *The Price of Oil* and the Wylie Lab, was the first attempt to open a public debate about community exposure to these risks. By creating a critical space to testify, assess, and reflect on community exposure, this

collaboration has contributed to reframe the question of H_2S risk to make it into a public health matter.

The sustained engagement of several community members in the study has been essential in this effort. Their testimonies, and consent to media exposure, made it possible to move "beyond the data and numbers" and thereby "humanize the problem" of chemical exposure (Wallerstein, 2006, 1620). They have also, through such public outreach, contributed to making chronic exposure into a question that can be taken seriously, shifting from a "personal problem" to what Kroll-Smith defines as an "issue;" that is to say, "a socially recognized occasion for communal response" (Kroll-Smith & Couch, 1991, 63).

This collective work, ultimately, has initiated a redefinition of who gets to conduct monitoring, produce data, address environmental health risk, ask questions—and gather responses about it. Building from Michel Callon, Pierre Lascoumes, and Yannick Barthe's work on socio-technical controversies, I suggest that this interdisciplinary collaboration has become a foundation of an "hybrid forum"—defined as a space for collective experimentation and learning, in which "uncertainties predominate, and everyone contributes information and knowledge that enrich the discussion" (2001, 9). In their book *Acting in an Uncertain World: An Essay on Technical Democracy*, Callon et al. highlight how socio-technical controversies—and particularly environmental controversies—are marked by a fluctuating border between what is considered to be technical, and what is considered to be social. "To declare that an issue is technical," they write, "is effectively to remove it from the influence of public debate;" and "on the other hand, to recognize its social dimension restores its chance of being discussed in political arenas" (Ibid., 25).

In Saskatchewan, it is precisely in reaction to the government's attempt to relegate H_2S exposure to the technical realm, that the effort initiated by *The Price of Oil*, community members, and researchers has sought to make it *visible* and *addressable* in the public sphere. "Hybrid forums", Callon and colleagues write, give "visibility and audibility to emergent groups that lack official spokespersons," and make it possible for laypersons to dare intervening in technical questions (Ibid., 35-36). Doing so, "hybrid forums" challenge two divides typical of Western societies: "The division that separates specialists and laypersons and the division that distances ordinary citizens from their institutional representatives" (Ibid.). Far more than technical questions, these discussions reveal, environmental controversies are also and ultimately concerned with how we envision democratic representation.

Beyond the secrecy and social pressures that had prevailed so far, several people, including oil workers, have, since the publication of the investigation, come forward to express their own concern about H_2S exposure. Moving passed silence and status quo, interdisciplinary collaborations can thus be a generative framework for community members to acquire the capacity to engage more deeply with a controversial issue. Besides their impact at individual scales, the “hybrid forums” interdisciplinary collaborations shape can create a sense of community in areas polarized by socio-political divides. Two moments in June 2018 were particularly striking in this regard:

Meeting with a new family who was interested in learning more about the corrosive gases testing kit, Wylie and I presented an anonymized example of an air monitoring results report, and explained what the study consisted in. While discussing the difficulties we had encountered in addressing environmental exposure in the area, the person we were talking with, thinking out loud, wondered if local residents might in fact be *reproducing* silence, through their own assumption that their neighbors will not be willing to address these questions. In fact, the community-based investigation has demonstrated that more people than it is generally assumed, share these concerns and would like to see risks effectively assessed and addressed.

Figure 14: Sara Wylie reporting on Lori Erhardt's air monitoring results. Screenshot from *Global News* video coverage "'Off the chart' air indicator in southeastern SK leaves residents concerned," by reporter Carolyn Jarvis. October 16, 2018.

The second notable moment was Lori Erhardt's reaction when receiving her report, in front of the journalists' camera. Her outdoor samples on average showed a moderate level of corrosion—a reassuring result compared to the other properties that fell in the harsh and harsh-to-severe ranges. Reviewing these results with Wylie, Erhardt expressed how important it was to feel, for the first time, that some of her neighbors, even though she did not know their identity, shared the same concerns. Talking about this experience during our more recent conversation, Lori elaborated on what this collaboration had entailed for her: "Even just knowing that people are out there, and that there is something in place, I think has brought me [...] a little bit more peace." "It is still pretty powerless," she added, "but you're not lonely in it, and you're not completely powerless either, because something has been brought forward, and it becomes part of a [...] larger conversation" (Erhardt, L., personal communication, June 27, 2019).

4.4.b. Thinking Forward

The interdisciplinary investigation on H_2S exposure risk has been an engaging learning experience. Beyond some of the specific outcomes for the families involved in the study, several community members have expressed that they learned much about the ins and outs of exposure, air monitoring, and regulatory work. Reflecting on her experience within the study, Sonntag pointed out the nuances of health and monitoring data that she had learned from conversations with Wylie, and explained that it had made her better prepared for some of her subsequent reporting (Sonntag, P., personal communication, June 11, 2019). Finally, this collaboration has also been a fantastic learning opportunity for the Wylie Lab, and for myself. While discussing this aspect, Lourdes Vera in particular highlighted how learning to work with the media was an important skill for her to have to make an impact as a scholar(Vera, L., personal communication, June 7, 2019).

In my view, the most crucial question that remains centers on how to build on these experiences, and how to sustain and possibly upscale this collective effort to create a springboard from which the "hybrid forum" can expand. What follows are three avenues for reflection.

<u>Bridging the "Hope Gap"</u>

In an article on the role of visualization in drawing public attention to often imperceptible environmental hazards, Olga Kuchinskaya rightly notes that "the question is how to facilitate not just spikes in public visibility of hazards, but more sustained public engagement with environmental data" (2017, 10). And indeed, our own work in Saskatchewan raises the question

of how to support the local community's ability to make claims for change, especially after the attention sparked by the press articles fell through?

The possibility for community engagement fundamentally relies on the definition of common goals or values to work towards; an article by Robert Hackett provides a useful notion to think with in this regard. Addressing the importance of tackling altogether the reform of media and citizens' engagement in the climate debate, Hackett notes that the main obstacle in taking action is often not a lack of information, but a "hope gap," which he describes as "a discrepancy between the scale of the challenge and the sense of efficacy that ordinary people need as a basis for real engagement" (2017, 3). "Simply shoveling more data at people will not inspire them to act," Hackett adds (*Ibid.*).

The recognition, and transformation of "hope gaps" in generative perspectives, could, and should, be a horizon for journalists and researchers to work towards. Evidencing injustice is one thing; unlocking perspectives and prompts for action is another. I remember taking note, during some of our conversations with community members, that what they might be lacking was precisely a perspective; to see and think change. Interestingly, the second round of the investigation conducted by the reporters in June 2018, was very much oriented toward the policy proposal of an alert system that would warn residents of nearby areas of exceedances at the SESAA air-pointers. Although not resolving the limitations inherent to this approach to monitoring (explored in chapter one), this idea already represents a lever and the possibility for greater transparency and accountability.

Enlarging the "Hybrid Forum"

Also crucial to enabling more sustained engagement and mobilization is the creation of a more permanent technical and human infrastructure to pursue the critical discussions initiated in Saskatchewan. The absence of such community structure in the area, to some extent, explains the lack of continued engagement on environmental health issues—in contrast, for instance, with the presence of the environmental NGO Earthworks in Texas, with which local residents and Wylie Lab member Lourdes Vera are collaborating for a similar air monitoring study. If the research process is to be "community-led and -controlled" (Design Justice Principle #8, 2016), the resources must be mobilized to entrench, and enlarge, the "hybrid forum" that has been opened. Such resources could include holding a community meeting about the outcomes of the collaborative investigation of H_2S risks; publicly calling for the town hall meeting that the government has carefully avoided; and connecting the local community with other communities in Canada and/or the U.S. that are actively engaging similar challenges. Building literacy and a

pool of shared resources can be an important step toward more sustained action.

Policy-Oriented Interventions

Last, but not least, I suggest that collectively working toward relevant policy arguments, can constitute a foundational endeavor to further consolidate communities and the "hybrid forum" they could engage within. There is no shortage of opportunities to highlight regulatory loopholes, and working at limiting toxic emissions still is a priority regardless of longer-term objectives and discussions. Framing this initiative as a form of public outreach, for example through an open letter or petition addressed to the government, might help catalyze further community engagement.

The present paper has highlighted some of the policy issues, or gaps, that could be included in such a claim: the absence of an alert system to warn residents in the event of air pollutants exceeding regulatory thresholds; the absence of setback distances between wells or facilities that emit high levels of sour gas, and public infrastructures or houses; the absence of regulations to control the concentration of H_2S in the fluids transported by truck, that can be the source of important leaks; the need for more stringent regulations *and* enforcement around the volume of H_2S that can be legally vented or flared; and the need for clearer, binding regulations on the reuse, treatment, and disposal of fracking fluids, which, as I have discussed, is a concerning factor in the proliferation of sour gas in wells and storing facilities.

Lori Erhardt recently informed me that, after discovering residents' "duty" to report on any flare burning gas for longer than the legally permitted amount of time across the province[5], she started documenting and reporting on a flare that was systematically emitting black plumes close to her living place. After facing institutional latencies and avoidance, the flare stack was eventually turned off. The capacity to conduct such processes, Lori said, was to a large extent the result of the "traction" she had acquired during our collaborative research (Erhardt, L., personal communication, June 27, 2019).

Such policy-oriented interventions show the importance of community research on, and awareness of what can already be *done*. It is a framework in which researchers could usefully engage, to support communities in articulating their claims, and in doing so, carving a stepping stone to bridge the "hope gap".

[5] "Routine gas combustion must not result in continuous or repeated black smoke emissions over a consecutive period of six minutes. Any smoke emissions that may result in public concern must immediately be reported to the appropriate ER Field Office" (Saskatchewan Government, Directive S-20 on Flaring and Incineration Requirements, 2015).

5. Conclusion

Although conducted with limited resources and a small number of participants, the collaboration between southeast Saskatchewan residents, *The Price of Oil*, and the Wylie Lab, has shown the potential of interdisciplinary collaborations to make visible, and addressable, environmental health issues that had been occulted by a lack of accessible data and public oversight. Benefiting from the research and outreach capacity of investigative media on the one hand, and from the evidentiary and relational dimensions of community-based participatory research on the other hand, such collaborations offer the resources to expose the environmental injustices experienced by communities living under the plume of unruly and unregulated toxicants. Specifically, the study of community exposure to hydrogen sulfide in southeast Saskatchewan, has demonstrated how the very process of interdisciplinary research and the production of "operative data" can open a discursive space to productively address residents' concerns about industrial contaminants. Not only shedding light on the sociotechnical infrastructure that generate environmental risks, such collaborations can offer a framework to prefiguratively build the relations of trust, reciprocity, and accountability that are needed to address the production of environmental harm.

If the investigative series published by *The Price of Oil*, and the results from the participatory air monitoring study have already triggered local changes and greater accountability mechanisms, this work needs to be sustained to achieve broader and longer-term community safety. It is indeed concerning to see the provincial government respond by encouraging a corporate, techno-fix approach to toxicity, more than regulatory enforcement and policy interventions. These responses perpetuate the government's attempts to undermine public health risks, and further blur the roles of public and private actors in the administration of questions vital to communities' livelihood. Yet, they represent an important first step in a context that was until then essentially marked by sociopolitical polarizations and status quo.

Although conclusions are generally thought of as a place of resolution, I would like to open this reflection with further questions to think with.

> What if, through sustained collaborative research and public interventions, individual residents could translate their environmental health concerns into community claims and causes?

What if beyond local corporate accountability, community-led interdisciplinary investigations could prompt governmental accountability and policy change?

And what if, starting with critical discussions on specific toxicants, communities and researchers engaging in “hybrid forums” could come to address the structural and political factors behind these toxicants?

Given the collaborative nature of my work with the Wylie Lab, and given the multiple voices, perspectives, and insights that have informed this paper, I would like to give the final word to Lori Erhardt, whose sustained engagement has contributed to make this collaboration possible:

"I would like to see some impetus and some accountability from the government. If we're going to begin a private-public partnership, what would that look like with all the players and the environment taken into account? I'm dreaming, I'm dreaming—but I would love that the people who are working in the oil batteries, the farmers, and people who have had health troubles, could talk about how we create the best community for this generation, and the following generations; and how we budget for that in terms of money, and time, and energy, and community, and all of that. People talk about the weather, they don't talk about this kind of thing, they don't see this as a conversation that could be had, without anybody dying. The truth is... We're up against comfort zones... There just isn't the practices... We are talking about creating a different practice of relating, with different people. And so... I think that would be my dream, for what it's worth."

(Erhardt, L., personal communication, June 27, 2019)

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