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Perspectives and Experiences of PFAS Contamination within the Agricultural Sector

An Ethnographic Investigation in the Veneto Region

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Abstract

This Master's thesis centres around an ethnographic investigation conducted within the agricultural sector in areas affected by per- and polyfluoroalkyl substances (PFAS) pollution in the Veneto region, Italy. In 2013, researchers were the first to identify the Rimar-Miteni Spa chemical plant, located in the Veneto region, as the source of extraordinary emission of PFAS. The latter are human-made chemicals, highly persistent and ubiquitous, showing multiple toxicological effects including the disruption of the endocrine system. In the absence of any control and regulation, these human-made substances have been discharged for decades, polluting the water cycle, the food chain, and the living organisms in an area spanning the provinces of Vicenza, Verona, and Padova. This dissertation comprises two main sections. The first part provides the historical description of the examined contamination and the background information about these chemicals. Within the context of the Veneto region, the historical and ecological dimensions of the contamination are presented, considering PFAS' ability to traverse the water cycle and their (eco)toxicity. In the second part, this research attempts to understand farmers' experiences and perspectives by asking: How did they experience the contamination? What do they think about what they have experienced? To accomplish this, I conducted semi-structured interviews and engaged in participant observations, visiting seven agricultural businesses from November 2022 to March 2023. The findings are discussed through the lens of what I term the three Ls (Latency, Toxic Layering, and Limit), while also examining the fractures among social movements, affected communities, and farmers. Additionally, using the work of Max Liboiron and Michelle Murphy, I aim to offer an alternative view of farmers, emphasising the potential and advantages of alternative viewpoints.

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Abbreviations

ARPAV: Agenzia Regionale per la Prevenzione e Protezione Ambientale del Veneto (Veneto Region Environmental Protection Agency);

BTF: Benzotrifluoride;

EDCs: Endocrine-disrupting chemicals;

EFSA: European Food Safety Authority;

EPA: Environmental Protection Agency;

ISS: Istituto Superiore di Sanità (Italian National Institute for Health);

NOE: Nucleo Operativo Ecologico dei Carabinieri (Ecological Operational Unit of the Carabinieri);

PCBs: Polychlorinated biphenyls

PFAS: per- and polyfluoroalkyl substances;

PFOA: Perfluorooctanoic acid;

PFOS: Perfluorooctane sulfonic acid;

TWI: Tolerable Weekly Intake;

ULSS: Unità Locali Socio-Sanitarie (Local Health Units).

1. Introduction

We beat each other with protein and groundwater.
The citizens of Parkersburg, West Virginia,
have been breathing
stain-repellent pants for years.
The French engineer,
who took his wife's suggestion
he try his coatings for fishing tackle
on her cooking pots,
has been editing the flesh
of ringed seals ever since.
Even in a boom year
there is washing to be done,
surfactants split the swimming pool
into garden-variety crudes.
Sealants stump for incendiary candidates
and slowly ripped versions of the coast.
Future generations will
consider detergents
shockingly feeble
instruments of thought.
Erogenous solutions have always
been attractive to midriff solvents.
Diffusing into each other,
we are adhesives,
hemoglobins bound to heart attacks
and heliotropes,
wanting to cleave,
to be clean,
so badly
we bead.

(Adam Dickinson, "Cleavage", The Polymers, 2013)

By emphasising the presence of per- and polyfluoroalkyl substances (PFAS), Adam Dickinson illustrates the primary characteristics of these chemical compounds. PFAS, also known as "forever chemicals,"[1] traverse everyday objects, diverse applications, and living organisms' tissues, ultimately infiltrating remote environments. They have managed to reach unexpected locations due to their adaptability, allowing them to navigate the Earth's water cycle and atmosphere. Due to their highly resistant carbon-fluorine chains, they are remarkably

[1] Over the years, per- and polyfluoroalkyl substances have been nicknamed "forever chemicals" due to their ability to bioaccumulate and their long half-life and persistence.

versatile and durable, which is why they are widespread and mixed with elements around the planet. Indeed, as they excel in repelling both fat and water while enduring high temperatures, such chemicals are employed across numerous industrial sectors.

These anthropochemicals were invented by DuPont in the US in the aftermath of the World War II, coinciding with the wake of the development of the fossil fuel sector. Riding the wave of the arms race and following technological advancements in the military sector, they played a significant role in what Jarrige and Le Roux (2020) refer to as the "plastification of the world." The extensive utilization of these substances had a significant impact on consumer culture within the capitalist economy. For instance, the significance of Teflon, the most renowned brand name associated with PFAS in the global market, recalls the words of Dimitris Papadopoulos who argues that «[e]lements and anthropogenic molecules shape human bodies and human action as much as human effects imaginaries» (2021, p. 42). This imaginative process was significantly influenced by their exceptionally small size. Thus, PFAS are impossible to see and taste by humans, and difficult to detect by chemical infrastructures. Their trans-corporeal and atemporal dimensions, which are described in Dickinson's verses, render them invisible to both human and non-human entities. Additionally, exposure to these substances is associated with various medical conditions. By acting as endocrine disruptors, per- and polyfluoroalkyl substances cause hormonal imbalances, fertility issues, birth defects, and various biochemical changes in humans. Therefore, high PFAS exposure is linked to hypertension, high cholesterol, thyroid disease, colitis, and pregnancy-induced hypertension and increases the risk of diabetes, stroke, heart attack, Alzheimer's, testicular, kidney, and breast cancer, just to mention a few.

Returning to Dickinson's poem, various geographical scales are interwoven throughout the verses. The poetry starts by referencing a particular location, Parkersburg, a city in West Virginia, USA. The contamination related to PFAS in this area - which is intersected by the Ohio River - provided an opportunity to bring attention to the repercussions of PFAS exposure, sparking conversations, research, and investigations into their global presence and (eco)toxicological effects. In 1998, a crucial turning point in per- and polyfluoroalkyl substances history occurred when a farmer, named Wilbur Tennant, utilizing a piece of land adjacent to a farm stable near the DuPont facilities in Parkersburg, where cattle had tragically suffered from the lethal effects of these contaminants in the 1990s, set off a chain reaction that gradually raised awareness about these substances. One year later, one of the most important litigations in US environmental justice history started. Since then, academic research, media attention, and general awareness of PFAS have experienced exponential growth.

In Italy, Rimar (Ricerche Marzotto) commenced PFAS production in the late Sixties when Giannino Marzotto, decided to open a laboratory to research anti-stain chemical products in Trissino, a small municipality located in the Vicenza province. This businessman was a member of one of the most prominent Italian entrepreneurial families that, between the nineteenth and twentieth centuries, not only shaped the textile and chemical sectors but also forever changed the ecologies of the Veneto region. Over the years, this factory has maintained an exchange of information with its US competitors. Nevertheless, the history of Rimar - which later became Miteni Spa - is intertwined not only with American corporations, such as Dupont and 3M, but also with worldwide chemical giants such as Mitsubishi Chemical, Enichem (Eni SPA), International Chemical Investors Group (ICIG), and the Solvay Group.

Fifteen years after Tennant's complaint, in 2013, research, carried out by Centro Nazionale Ricerca and Istituto Ricerca Sulle Acque (CNR-IRSA) (Polesello et al., 2013), detected high levels of PFAS in the drinking water and water bodies of various municipalities spanning the provinces of Vicenza, Verona, and Padova within the Veneto Region, Italy. The source of this contamination was identified as Trissino's chemical plant. This factory, in operation from its inception in 1965 until its closure in 2018, produced various "forever chemicals" - spanning from shorter and longer chain varieties - and disposed of them into the environment for decades. This occurred in an area situated above one of Europe's largest groundwater basins. Consequently, extensive public research and investigations were initiated, resulting in what is considered one of the most significant instances of water contamination in European environmental history affecting 350,000-400,000 human inhabitants and an undefined number of nonhuman beings within an area of over 590 km^2. Due to the characteristics of the pollutants' dispersion, in 2016, the regional government conducted a mapping exercise of the contaminated area, identifying 30 municipalities within the red zone. This designation marked an area characterised by the highest concentrations of PFAS in which residents were invited to take part in the health regional surveillance program.

As previously mentioned, it was indeed a farmer who first noticed that something was amiss near the Parkersburg chemical plant. It is from the viewpoint of farmers that this thesis aims to investigate the contamination that occurred in the Veneto region. In fact, what I intend to explore is the perspectives and experiences of the agricultural sector that has been forced to deal with these anthropochemicals. Initially, the question arises: How did farmers experience the contamination? What do they think about what they have experienced? Over the years, limited public and media attention has been devoted to understanding this unique chemical contamination from the perspective of farmers. Within academia, I could not find any

ethnographic or anthropological research specifically focused on PFAS and the agricultural sector. Similarly, no social sciences research covering the same sector has been conducted on "forever chemicals" contamination worldwide. However, an important biomonitoring study of per- and polyfluoroalkyl substances serum levels in farmers in the Veneto region (Ingelido et al., 2020) revealed that the highest median concentration in individuals from the most affected areas was 25 times higher than in individuals residing outside the impacted municipalities. In this scenario, agricultural producers in Veneto have been forced to face high costs in order to detect and lessen the amount of PFAS in their environment. Meanwhile, their products have been stigmatized as contaminated by local communities, adversely affecting their sales. Farmers found themselves subjected to a complex job blackmail, which has heavily affected part of the agricultural sector in these areas. Despite these outcomes, even from a media perspective, in the case of Rimar-Miteni, the focus was primarily on factory workers and citizens, while the isolation and challenges faced by farmers remained largely overlooked.

Undoubtedly, this is a challenging topic to be addressed, not only due to the difficulty of understanding and unravelling the complexities of PFAS pollution but also due to the multitude of actors and scales involved and the roles they have played. On the one hand, there is an ongoing trial that started in 2021 and which is in progress. On the other hand, there is a need to comprehend what has happened so far. By learning about the PFAS-Rimar-Miteni case, I realized how much farmers were one of the most impacted groups. In addition to suffering severe economic repercussions from the per- and polyfluoroalkyl substances contamination, the farming sector has been blamed and accused of spreading these contaminants through their products by local communities and social movements. In view of this, two primary reasons have driven my interest and fuelled my curiosity to the extent of writing a thesis about Veneto farmers and PFAS. The first is my desire to contribute to addressing a literature gap on these topics. Secondly, I was drawn to the characteristics of contamination, which entangle the chemical and physical attributes of these substances with the social, political, and historical dimensions in which these compounds have been dispersed into the environment over decades. Due to their infinite applications and ubiquity, and their chemical and physical characteristics, per- and polyfluoroalkyl substances have fascinated me from the outset. The efficiency of PFAS as a chemical substance applicable in various sectors is known to be directly proportional to their harmfulness. Indeed, by combining their long half-lives and their role as endocrine-disrupting chemicals (EDCs), a perfect and deadly combination takes shape. Furthermore, despite the surge in research following the West Virginia case, these synthetic compounds

remain enigmatic while continuing to evolve in industrial chemical laboratories. This represents another aspect I aim to explore.

1.1 Theoretical Framework

Beyond the curiosity to explore the agricultural sector within the delicate context of PFAS contamination, in this dissertation, my goal is to offer my personal and little contribution to the understanding of this case of environmental and social justice. By writing this thesis, I acknowledge that «understanding how a multiplicity of scales - both temporal and spatial - intersects is important when discussing both intergenerational and global environmental justice» (Müller & Nielsen, 2023, p. 6). Considering this complex terrain, anthropology stands apart from other social research disciplines due to its focus on concrete and local situations, experiential methods and its critical analysis of the cultural attributes of the individuals and communities involved. For this reason, I situate this exploration in mainly three fields: 1) critical medical anthropology - interpreted as ethnographic research primarily focusing on health-related topics; 2) science and technology studies (STS) - which emphasise health and the environment but prioritize inquiries into scientific expertise and knowledge production; 3) disaster anthropology - ethnographic works that focus on the destructive impact of circumstances and events.

I agree with Tim Ingold (2014) who views «anthropology as a practice of education» (p. 388): this research primarily serves as an educational exercise, and I consider it a privilege to have spent time with farmers. To structure this dissertation and comprehend potential narrative routes, I drew inspiration from *Writing the Implosion: Teaching the World One Thing at a Time* by Joseph Dumit (2014) and *Substance as Method: Bromine, for Example* (2021). Thus, this thesis incorporates an "Implosion Project," which is a teaching assignment developed by Dumit. Informed by the ideas of Deleuze and Haraway, this inspiring and educational tool was conceived on the understanding that «telling the stories of an object therefore begins unpacking our own clichés, our certainties, our affects» (Dumit, 2014, p. 349). It is accompanied by a set of questions aiming to investigate «the tissue of an object» (Dumit, 2014, p. 350) and it is grounded in the notion of situated knowledge put forth by Donna Haraway (1988). With this theoretical framework, I argue that the pervasive intergenerational and interspecies violence caused by Rimar-Miteni practices requires an unfixed view that necessitates an adaptable perspective that aligns with the methodological framework of situated knowledge.

Significantly, «[d]iscourses are not just 'words'; they are material-semiotic practices through which objects of attention and knowing subjects are both constituted» (Haraway, 1997, p. 218 in Dumit, 2014, p. 349).

Before delving into the structure of the dissertation, I would like to outline my perspective on PFAS in the current times of ecological disruptions, that grounds and came out from my ethnographic research. The analytical perspective underpinning these pages is that these synthetic compounds, due to their prevalence and enduring characteristics, much like other substances such as microplastics and uranium, may serve as indicators of human presence on the planet, signifying a «new ontological condition» (Masco, 2021, p. 133). It is worth noticing that they are indeed among the emerging chemical entities that have contributed to surpassing a "planetary boundary" (Cousins et al., 2022; Persson et al., 2022), thereby posing a threat to the stability of Earth's systems and becoming intertwined with the consequences of anthropogenic global warming. These include the loss of biodiversity and the ongoing social and ecological crisis, two different but connected crises.

Addressing the PFAS question in the Veneto region, I argue, requires a reconceptualization of our relationship with the world that recognises the extensive interconnectedness and mutual dependency of all entities, rather than viewing chemicals as discrete and isolated units (Murphy, 2022). In this sense, per- and polyfluoroalkyl substances represent puzzles that necessitate a deeper understanding of the interactions between different ecological and social systems.

To contextualize the presence of PFAS, in this thesis, I use as a baseline the critical reflections made by Boudia et al. (2018) on the notion of *residues*, namely intended or unintended outcomes of extractive and industrial technology, history, and organization. I contend that per- and polyfluoroalkyl substances, as residues, are also catalysts that inadvertently escaped from facilities such as laboratories, landfills, or mines «and urging into existence new biological, chemical, geological, and sociotechnical worlds» (p. 167). Indeed, «residues *are* the Anthropocene» and they «help us see the Anthropocene as combustion and synthesis of carbon-containing compounds» (p. 172). According to Boudia et al. (2018), being categorised as residues involves five properties that are interconnected in a political sense yet analytically distinct. These characteristics serve as guiding principles in this thesis to illuminate the networks of actors within which these contaminants are found. Therefore, residues are irreversible, stemming from the impossibility of returning to the prior state before their introduction; they possess materiality, even though chemical waste is often seen as the opposite, as residues «have substantive, empirical presence and political consequence» (p.

169). They are slippery and capable of eluding surveillance systems that often struggle to detect them. Indeed, while delving into the history of PFAS and their mismanagement for decades, it became apparent that if you don't actively search for PFAS, they are unlikely to become easily apparent to you.[2] Moreover, residues are also unruly due to their unpredictability and their capacity to interact with other substances and environments. And finally, they may change their value over time, initially being «primarily valued» for the output they generate, but their value may decrease as they are labelled as «waste» (Boudia et al., 2018, p. 170). In addition, I believe that these chemicals gain vitality when these substances come into contact with living matter. In this thesis, every PFAS «is not matter *itself* all by itself, but rather matter *in context*» (Abrahamsson et al., 2015, p. 5). Indeed, I identify "forever chemicals" as conduits through which the vitality and agency of others are articulated. By embracing this view and drawing on the actor-network theory (Latour, 1993), I identify PFAS as actants within the network of chemical entanglements driven by late-industrial ecological configurations.

1.2 Structure of the Thesis

The core of this research consists of two central chapters, representing the second and the third. In the second chapter, "How did PFAS end up in the Veneto region?", I aspire to amalgamate an investigation, or rather an overview, of how the contamination has unfolded, tracing the origin of per- and polyfluoroalkyl substances in the US and their productions and identification as contaminants in the Veneto region. At the beginning, I provide a concise overview of the scientific literature regarding PFAS as chemical compounds. In particular, I shortly expose their chemical and technical features, occurrences and usages, and their (eco)toxicological effects. Next, I take a step backwards to connect the stories of the protagonists of the Rimar-Miteni affair. Inspired by Hannah Landecker's famous article *Antibiotic Resistance and the Biology of History* (2016), this central part of the chapter is a journey through the chemical sector and the rising neoliberal economic system. It is dedicated to the history of Rimar-Miteni infrastructure and is based on the literature I consulted from local historical archives partially inspired by reconstructions published by activists and scholars (Lanzavecchia et al., 2022). By doing so, I also describe the history of PFAS, from their invention to their dissemination. I achieved this by using various journalistic sources and firsthand (Bilott, 2019) and secondary

[2] As a farmer told me: "Nobody has looked for them and did not even know where to look for them" (Diego,21 November 2022).

accounts (Lyons, 2007) from individuals who closely followed the contamination's development in the US context. To conclude, I summarise the PFAS presence in human and nonhuman bodies within the affected areas, taking farmers' bodies as a point of reference. Given the numerous events related to this contamination case, it is important to note that this chapter offers a partial overview of the PFAS saga.

The third chapter, titled "Cultivating in the PFAS Land: Farmers' Experiences and Perspectives," aims to delve into the impacts of these synthetic compounds on farmers' lives and the perspectives that have emerged within the agricultural sector in response to them. This chapter contains the outcomes and reflections of my ethnographic research within the agricultural sector in the red and orange zones. To commence this discussion, it is crucial to first comprehend the places that were also part of my investigation. Given the intricate geographical and social landscape, I will initially describe the PFAS Land while considering the insights of Eugenio Turri (2001), Francesco Vallerani (2013), and Vallerani and Varotto, 2005). Then, I examine farmers' experiences through the lens of what I refer to as the three *Ls*: Latency, toxic Layering, and Limit. To delve into these concepts, I drew upon the research of Donna M. Goldstein and Kira Hall (2015), Michelle Murphy (2015; 2017; 2021), Dimitris Papadopoulos (2022), and Max Liboiron (2018, 2021). Within this contamination, chemical exposure is underestimated, or reframed by farmers and institutions in response to the slippery dimension of these contaminants. PFAS' presence, temporalities, and blurring effects are discussed by taking as a point of reference the book *Reactivating Elements: Chemistry, Ecology, Practice* edited by Dimitris Papadopoulos, María Puig de la Bellacasa and Natasha Myers (2021). This text is exemplary in showing the need and possibility to treat chemicals anthropologically. Taking inspiration from this text, I integrate the discussion of PFAS chemical features, their history in the Veneto region with the feelings of farmers and their experiences that are characterised by a sense of isolation, stigmatisation, frustration, and helplessness. Adriano Zamperini and Marialuisa Menegatto's book, titled *Cattive Acque: Contaminazione Ambientale e Comunità Violate* (2021) and Menegatto et al. (2022) offer valuable background guidance in the writing of this thesis. Their contributions, primarily focused on the parental role within the affected communities from a social psychology perspective, were the sole social science research that addressed the issue of PFAS contamination in the Veneto region. By concluding the chapter, I seek to offer a new perspective for the impacted agricultural sector. Here, the aim is to provide an alternative direction that diverges from the neoliberal agrarian framework (Lapegna & Kunin, 2023). References used to further question the PFAS-farmers relations include Max Liboiron's

Pollution is Colonialism (2021), a useful journey through pollution and colonialism and a precious tool to frame the Rimar-Miteni deadly practices. Moreover, I made use of Murphy's contribution in *Reactivating Elements* (2021). To support my reflections related to PFAS, their history, the history of the infrastructures producing them, and the dissemination of uncertainty and ignorance linked to their manufacturing, I consulted the works of Renfrew and Pearson (2021), Pearson and Renfrew (2023), Cordner et al., (2019), Lanzavecchia et al., (2022), Richter et al., (2018) and Wickham and Shriver, (2015).

Before moving on to the methodology section, I would like to make some remarks about the terminology used in this thesis. First, when considering the human-contaminant dichotomy, I would have liked to extend this dualism to include nonhuman-contaminant as well. Although I initially intended to broaden my research without distinguishing between human and nonhuman aspects - except for certain brief occasions - there has not been an opportunity to do so. As a result, the conditions and outcomes of my fieldwork forced me to focus only on the PFAS-human interactions. Thus, this research is characterised by an anthropocentric focus. Despite this, I take Doreen Massey's critique on the identification of place with "community" as a point of reference in this essay. Following Liboiron (2021, p. 141), I do this to «extend this concept of community to include people who aren't human, materials, landscapes, events, obligations, and other types of relations». For Massey: «What gives a place its specificity is not some long-internalised history but the fact that it is constructed out of a particular constellation of social relations, meeting and weaving together at a particular locus» (Massey, 1991; in Liboiron, 2021, p. 141).

Furthermore, throughout this dissertation, I frequently refer to the name "Rimar-Miteni." I have chosen to do so because, despite differences in ownership and historical contexts, these factories shared a similar ecological approach, viewing the land as a "sink" (Liboiron, 2021), and employing similar strategies.

In these pages, the term "Capitalocene-Anthropocene" is frequently employed to characterise the current epoch marked by anthropogenic global warming and its diverse and far-reaching consequences. Avoiding any generalisation, this expression refers to the context of the capitalistic economic and social system of Western-oriented countries. By using this label as a reference point, I emphasise what Andreas Malm and Alf Hornborg have suggested in their memorable article *The geology of mankind? A critique of the Anthropocene narrative* (2014). By acknowledging the Latourian view and claiming the dissolution of the Nature-and-Society twins, their argument is based on the fact that the ongoing ecological crisis is rooted in intra-species inequalities that have made possible the fossil economy affirmation led by «a clique of

white British men» (Malm & Hornborg, 2014, p. 64) at the origin of the Industrial Revolution. Their intent is to dismantle the false myth of a supposed unitary and ahistorical human "civilization" by entering the debate regarding the political responsibilities within the Anthropocene. Lastly, I add to these reflections the theoretical framework offered by Jason W. Moore's *Anthropocene or Capitalocene?: Nature, History, and the Crisis of Capitalism* (2016).

1.3 Methodology

The PFAS contamination analysed in my research involved mainly the groundwater, an area of over 590 km^2 with around 350,000-400,000 human inhabitants (Orellana, 2022) and countless nonhuman bodies. In this context, between November 2022 and March 2023, I carried out ethnographic research on seven agricultural enterprises in the PFAS-contaminated area between the provinces of Vicenza and Verona. These farming activities were identified and selected by confronting the contamination map published by the Veneto Region (Regione Veneto, 2018a) with a satellite-originated map provided by Google Maps, where I was able to locate with precision the affected municipalities. I then proceeded to contact as many farmers as possible within the red and orange zones, reaching out to more than 50 agricultural businesses. Through a customer relationship management tool that I installed on my email provider; I was able to legally track when my emails were visualised by the farmers I contacted. Thanks to this tool I can offer a picture of their behaviour. I summarised the different responses I received in the table below.

Accepted to meet	Accepted to meet at first but eventually declined or ghosted	Visualized without answering	Refused to meet	Non-visualized emails
7	5	21	11	7

Table 1: Contacted farmers.

Every time I noticed that a farmer had visualized my email but avoided answering me, I would send two follow-up messages. In most cases, I did so also with those who did not visualize even my first email. In a few situations, the farmer promptly agreed to talk about my research

by phone call. Almost all the farmers who belong to this group are among the ones who eventually shared their time, experiences, and perspectives with me. Finally, seven agricultural businesses allowed me to visit their facilities, including their fields, shops, warehouses, and stables. They all spent at least one hour with me. Out of the seven farming activities located within the red and orange zones, I visited five of them one time, while I got the chance to spend time in the other two farms respectively two and three times for a total of ten visits. During these field trips, I recorded free and semi-structured interviews using a microphone. When I decided to not register the conversations, for example, while eating or helping them in the field, I took notes. During these times, I used participant observation as a key to detect their understanding and their experiences related to cultivating in contaminated land. Especially in one situation, details helped me to explore how agriculture is understood and applied.

In the preliminary phase of my fieldwork, I carried out interviews with around ten people, including researchers, activists, trade unionists, journalists, and other personalities who, most of the time, I contacted by phone call. This mixed group represents other support data for my research. In such cases, those chats helped me understand the perception, the atmosphere, and the multiple actors that in different ways are involved in the agricultural sector inside and beyond the contaminated area. I used these conversations to build my research questions and to organize a better strategy to contact farmers without scaring them.

To have a more comprehensive sense of the broader atmosphere of the so-called PFAS Land, I also joined a demonstration that was organized in February 2023 to request the immediate remediation of the Rimar-Miteni site. By exploring the research and the involvement of independent and academic scholars, I also joined two conferences. The first was hosted by the University of Padova in December 2022 and run by Adriano Zamperini and Marialuisa Menegatto, and the second was organized by a member of the European Parliament in Vicenza in the same period.

All informants have expressed verbal consent to be recorded or be part of this research. To protect the identity of the people that I encountered, all their personal information, including names, locations, and other relevant data has been anonymized with made-up names. Certain descriptions may appear scant and often lacking in detail. This is an intentional choice aimed at protecting the farmers' identities. Quotes from the interviews are translated from Italian and the Venetian dialect into English by the author. The original language is indicated in the footnotes.

In this thesis, I did not offer a comprehensive examination of the agricultural sector. This is because I primarily focused on farmers, without including the various other actors who

constitute the agricultural sector and significantly influence its dynamics. I am indeed aware of the incomplete picture and the absence of counternarratives in this dissertation. Nevertheless, I believe that these broader research pathways can be explored within academic discourse, and I am willing to further contribute to this issue.

2. How did PFAS end up in the Veneto region?

In this chapter, I aim to report on the PFAS hotspot contamination in the Veneto region. I will start by offering a brief overview of the scientific literature regarding these substances. In particular, I will shortly present their physical-chemical and technical properties, their occurrence and usage, and their (eco)toxicological effects. Secondly, I will take a step backwards to connect the stories of the protagonists of the Rimar-Miteni case. Among these actors, I decided to dedicate part of the dissertation to companies, chemical substances, and the ecological and social context which altogether play a role in this environmental justice case. By doing this, I use the Parkersburg case as a reference point and delve into the consequences of this contamination. Within these pages, I also provide a historical account of per- and polyfluoroalkyl substances, starting from the creation of PFOA and Teflon and extending to their gradual phase-out. To conclude this chapter, I will describe how PFAS entered the agricultural sector and the public initiatives related to this issue. I will summarise how public regulatory surveillance systems have mapped and studied PFAS presence in both human and nonhuman bodies. Additionally, I will briefly examine the agricultural sector, which is considered in this dissertation.

Considering that the events related to this contamination case are numerous, I believe it is important to outline that this chapter provides a partial overview of the PFAS-related contamination taken into consideration.

2.1 What are Per- and polyfluoroalkyl Substances (PFAS)?

Per- and polyfluoroalkyl substances (PFAS) are a group of thousands[3] of organofluorine compounds invented in the US in the 1940s. They became popular due to their chemical properties which have made them gain the nickname "forever chemicals." These human-made compounds have captured global attention in the last decades due to their persistence in the environment, bioaccumulation potential, and adverse health impacts (OECD, 2018; Lindstrom et al., 2011). Even though scientific attention on PFAS is growing every year, the available information concerning their occurrences and usages, together with their

[3] According to the PFAS definitions, estimates may change. The Organisation for Economic Co-operation and Development's (OECD's) chemical inventory classifies the presence of more than 4.000 substances that contain at least one perfluoroalkyl (–CnF2n–) moiety (OECD, 2018), while the US Environmental Protection Agency (EPA) has listed more than 8.000 PFAS (EPA, 2018).

(eco)toxicological effects, are scarce (Wang et al., 2017). Due to the well documented persistency and mobility through environmental monitoring carried out worldwide, they have been labelled as "emerging contaminants." In addition, they are commonly considered Persistent Organic Pollutants (POPs), a group of chemicals that represent «one of the great environmental challenges the world faces» (Wania & Mackay, 1996, p. 390A). POPs are long-lived organic compounds that have toxic effects on living beings and become concentrated while travelling through the food web (Wania & Mackay, 1996). PFAS are distributed ubiquitously in the aquatic environment (Ahrens & Bundschuh, 2014) and they have been found in natural waters (oceans, rivers, lakes, etc.) and worldwide (Lindstrom et al., 2011). Furthermore, these substances have been identified in the tissues and the blood of living beings in remote locations located thousands of kilometres far from the possible sources (Muir et al., 2019; Miner et al., 2021; Wang et al., 2014).

During the last few years, the per- and polyfluoroalkyl substances definition has been intensively discussed within the scientific community. According to Buck et al. (2011), whose contribution has been considered a "milestone" within this debate (Wang et al., 2021), PFAS are highly fluorinated aliphatic substances, a fluorinated substances subgroup,

> that contain 1 or more C atoms on which all the H substituents (present in the nonfluorinated analogues from which they are notionally derived) have been replaced by F atoms, in such a manner that they contain the perfluoroalkyl moiety CnF2n+1– (p. 513).

In 2021 the Organisation for Economic Co-operation and Development (OECD) revised the Buck et al. definition «to comprehensively reflect» (OECD, 2021, p. 13) on the PFAS universe. By outlining four major limitations that are characterised by «omissions,» «inconsistencies,» and ambiguity, especially regarding the use of the word «highly fluorinated,»[4] the OECD has offered the following new definition:

> PFASs are defined as fluorinated substances that contain at least one fully fluorinated methyl or methylene carbon atom (without any H/Cl/Br/I atom attached to it), i.e. with a few noted exceptions, any chemical with at least a perfluorinated methyl group (–CF3) or a perfluorinated methylene group (–CF2–) is a PFAS (OECD, 2021, p. 18).

[4] «The report details four major limitations with the previous definition in representing the PFAS universe: (1) omission of substances that have functional groups on both ends of the fully fluorinated carbon moiety (e.g., perfluoroalkyldicarboxylic acids); (2) inconsistencies in dealing with homologues that are fully fluorinated aliphatic cyclic compounds with or without a fully fluorinated alkyl side chain; (3) omission of substances with aromatic ring(s) in the nonfluorinated functional group(s) that can be cleaved in the environment and biota; and (4) use of the ambiguous term "highly fluorinated"» (Wang et al., 2021, p. 15576).

According to the length of the fluorinated carbon chain, per- and polyfluoroalkyl substances are distinguished into two categories: “short-chain” and “long-chain”. As reported by Buck et al. (2011), the Organisation for Economic Co-operation and Development (2011) defines “long-chain”[5] as perfluoroalkyl carboxylic acids with eight carbons or more (i.e., with 7 or more perfluorinated carbons) and perfluoroalkane sulfonates with six carbons or more (i.e., with 6 or more perfluorinated carbons). Since the 1990s, due to the increased concerns regarding their (eco)toxicological effect on living beings and the environment, the long-chain PFAS Perfluorooctanoic acid (PFOA, C7F15COOH), Perfluorooctane sulfonic acid (PFOS, C8F17SO3H) and their precursors have gained attention becoming the most studied and discussed perfluoroalkyl acids (PFAA) and PFAS in the scientific literature (OECD, 2018; Blum et al., 2015). Following the definition of long-chain PFAS, the short-chain homologs are defined by shorter fluorinated carbon chain lengths. In addition, Ateia et al., 2019 have proposed “ultrashort-chain” as a label for the PFAS characterized by 2-3 CF2 moieties.

It is worth noticing that the number of C-F chains may influence their physicochemical characteristics, their bioaccumulation, and (eco)toxicity that characterize their behaviour in the environment and in living beings (OECD, 2018). Since the 2000s, long-chain PFAS and their precursors have been gradually and commercially replaced by short-chain PFAS (OECD, 2021; Wang et al., 2017). However, according to estimates, most of these alternatives are similarly persistent and mobile in the environment as long-chain PFAS (Gomis et al. 2015) and pose similar threats to the environment and living beings’ health (Pelch et al., 2019; Kotthoff et al., 2015).

Because of the scientific evidence and the following debate in the 1990s and 2000s, PFOS and PFOA were included in the Persistent Organic Pollutants Stockholm Convention list in 2009 and 2019, respectively. Additionally, the short-chain perfluoroalkyl substance perfluorohexanesulfonic acid (PFHxS, C6HF13O3S) was added to the same list in 2022 (Secretariat of the Stockholm Convention, 2022).

2.1.1 Usage and Exposure

Given that PFAS are not regulated as a class, no data on total PFAS production is available (Kwiatkowski et al., 2020). As previously reported, they are broadly considered

[5] Long-chain PFAS definitions may differ by jurisdictions (OECD, 2021).

ubiquitous in environmental media because of their widespread use in diverse commercial sectors, their persistence, bioaccumulation capacities, and their potential to travel through the water cycle or sediments (Jian et al. 2018; Sunderland et al. 2019; Abunada et al. 2020). For instance, the estimated number of sites in Europe that could potentially release PFAS is approximately 100,000 (Goldenman, 2019), while concerns are growing over possible sources of contamination in countries that have not developed regulation policies. Due to their oil and water repellency, together with their temperature and chemical resistance, they have been largely produced and used in almost all industrial sectors and manufactured goods (Glüge et al. 2020). However, in the last decades, PFAS have become a matter of concern for regulators and scientists (Abunada et al. 2020). Within the entire PFAS group, each substance may exhibit different properties. For example, many are mobile, while others are immobile, and some bioaccumulate while others do not (Cousins et al., 2019). These differences depend on the chemical structure of these compounds which is characterised by the C-F moieties, which are extremely resistant to environmental and metabolic degradation (Cousins et al., 2019).

Even though some PFAS partially degrade in the environment, these compounds may eventually transform into highly stable end products that will last in the environment for hundreds or thousands of years (Wang et al., 2017). PFAS are water-soluble substances that can occur in water, soil, and air, and they do resist breakdown by various environmental processes (Abunada et al. 2020). In addition, these anthropogenic chemicals found in marine environments can present a risk to the process of ocean carbon sequestration (Mahmoudnia, 2023). As a consequence of their capacity to travel and to resist within the water cycle, per- and polyfluoroalkyl substances have been found in remote locations even several kilometres away from the closest possible source. For example, they have been detected in the waters and wildlife within the Arctic environment (Muir et al. 2019) and in the Tibetan plateau (Miner et al., 2021; Wang et al., 2014).

Different studies have been carried out to calculate the number of PFAS in the market and to estimate their usage (OECD, 2018; EPA, 2018). Glüge et al. (2020) have identified more than 200 use categories within over than 1400 different PFAS. Just to mention a few, these substances are employed in plastic and rubber manufacturing, in the building and construction sectors, in the chemical industry (for example in the production of other PFAS), within the energy sector (to produce solar collectors, photovoltaic cells, windmill blades, lithium batteries) but also to manufacture aqueous film forming foam (AFFF), food packaging, textiles, photographic paper, and films, and within the automotive and pharmaceutical industries (Glüge et al. 2020). As an illustrative instance of their usage, PFOA has been used for decades in the

manufacture of the most famous commercial fluoropolymer, polytetrafluoroethylene (PTFE)[6], better known by the trademarked brand name Teflon (Goldenman et al. 2019). However, these anthropogenic chemicals can be found in everyday objects, including toilet paper, which is considered to be one of the potentially significant sources of PFAS entering wastewater treatment systems (Thompson et al., 2023).

In addition to drinking water,[7] which is the primary source of exposure, other pathways of contamination are indoor dust and air, and food - including contamination from food packaging (Sunderland et al., 2019). While typical PFAS concentrations in water are usually very low, higher concentrations have been reported near fluorochemical manufacturing facilities and in locations where firefighting activities occurred (Abunada et al. 2020). As reported by Yan et al. (2015), PFOA and other PFAS were found in landfill leachate in China, which was eventually identified as the source of groundwater contamination. Moreover, the process of incinerating PFAS-containing waste can release hazardous air pollutants, including fluorinated greenhouse gases and by-products of incomplete combustion, and certain PFAS may persist in the resulting incinerator ash (Stoiber et al., 2020). Consequently, per- and polyfluoroalkyl substances can disperse through the atmosphere (Cousins et al., 2022), being discharged into the air from landfills and wastewater treatment plants. Therefore, these chemicals may also travel through biosolids-contaminated agriculture, which represents a source of dietary exposure for farm animals (Sunderland et al. 2018). PFAS sewage sludge can be applied on agricultural land and contaminate crops (Stoiber et al., 2020). Another important pathway of contamination is the human body. Indeed, human milk, together with trans-placental transfers, is an important exposure source for newborns (Blake & Fenton, 2020; Jian et al., 2018; Johnson et al., 2014).

2.1.2 (Eco)toxicological Effects

For decades, PFAS were believed to be safe. As shown by many (Bilott, 2019; Richter et al., 2018; Pearson & Renfrew, 2023), chemical businesses have asserted that PFAS are not harmful to human beings. Only during the 1990s, did health concerns regarding PFAS grow

[6] In the next chapter, I will explore the invention and the manufacture of PTFE.

[7] For instance, in the US PFAS have been found in orange juice (Rosane, 2023). per- and polyfluoroalkyl substances.

due to different locations in which drinking water was identified as the main source of exposure in the US population (Goldenman et al. 2019).

Despite the scientific evidence regarding the negative impacts of these substances on living beings' health, research has still to evaluate the effective scale of the risk related to PFAS exposure (Abunada et al. 2020, Wang et al., 2017). For instance, an epidemiological study on the linkage between per- and polyfluoroalkyl substances and cancer can be influenced by the methodology of the exposure assessment, the exposure time, and the possible interference with other chemicals (Steenland & Winquist, 2021). Therefore, PFOS, PFOA, and PFHxS which are all listed in the Stockholm Convention, are characterised by long half-lives in the human body (PFOS 5.4 years, PFOA 3.8 years, PFHxS 8.5 years) (Lindstrom et al., 2011).

Following the circumstances of the exposure (magnitude, duration, route of exposures, etc.) and factors associated with the individuals exposed (e.g., age, sex, health status, etc.), these substances are potentially capable of producing a wide range of adverse health effects by accumulating in protein-rich body parts, such liver, kidney, and blood (Verreault et al., 2005). Research has also reported adverse effects on the immune, endocrine, brain, metabolic, and reproductive systems related to PFAS exposure. These compounds act indeed as endocrine-disrupting chemicals (EDCs) interfering or mimicking the body's hormones. In this case, PFAS in human bodies were reported to cause hormonal unbalances, decreased fertility rates, birth defects, and many other biochemical alterations (Bonato et al. 2020). Changes in sperm quality have been linked to PFAS exposure, which may contribute to damage in the testicles and epididymis, as well as disrupt testosterone synthesis (Sun et al., 2023). Furthermore, epidemiological studies have shown that hypertension, higher cholesterol levels, thyroid disease, ulcerative colitis, and pregnancy-induced hypertension are also associated with high PFAS exposure (Sunderland et al., 2019). Within children, generally, consistent scientific evidence has shown PFAS' influence on the immune system, including vaccine response and asthma, renal function, and on age at menarche (Rappazzo et al., 2017). Moreover, research associated being highly exposed to per- and polyfluoroalkyl substances with a higher risk of diabetes, cerebrovascular diseases, myocardial infarction, Alzheimer's disease, testicular cancer, kidney cancer, breast cancer, and Parkinson's disease in females (Steenland & Winquist, 2021; Mastrantonio et al., 2018). Young adults may suffer from elevated blood pressure and hypertension (Pitter et al., 2021) and it was observed that highly exposed populations may experience higher mortality risk for Covid-19 due to PFAS immunosuppression, bioaccumulation in lung tissue, or pre-existing diseases related to per- and polyfluoroalkyl substances (Catelan et al., 2021).

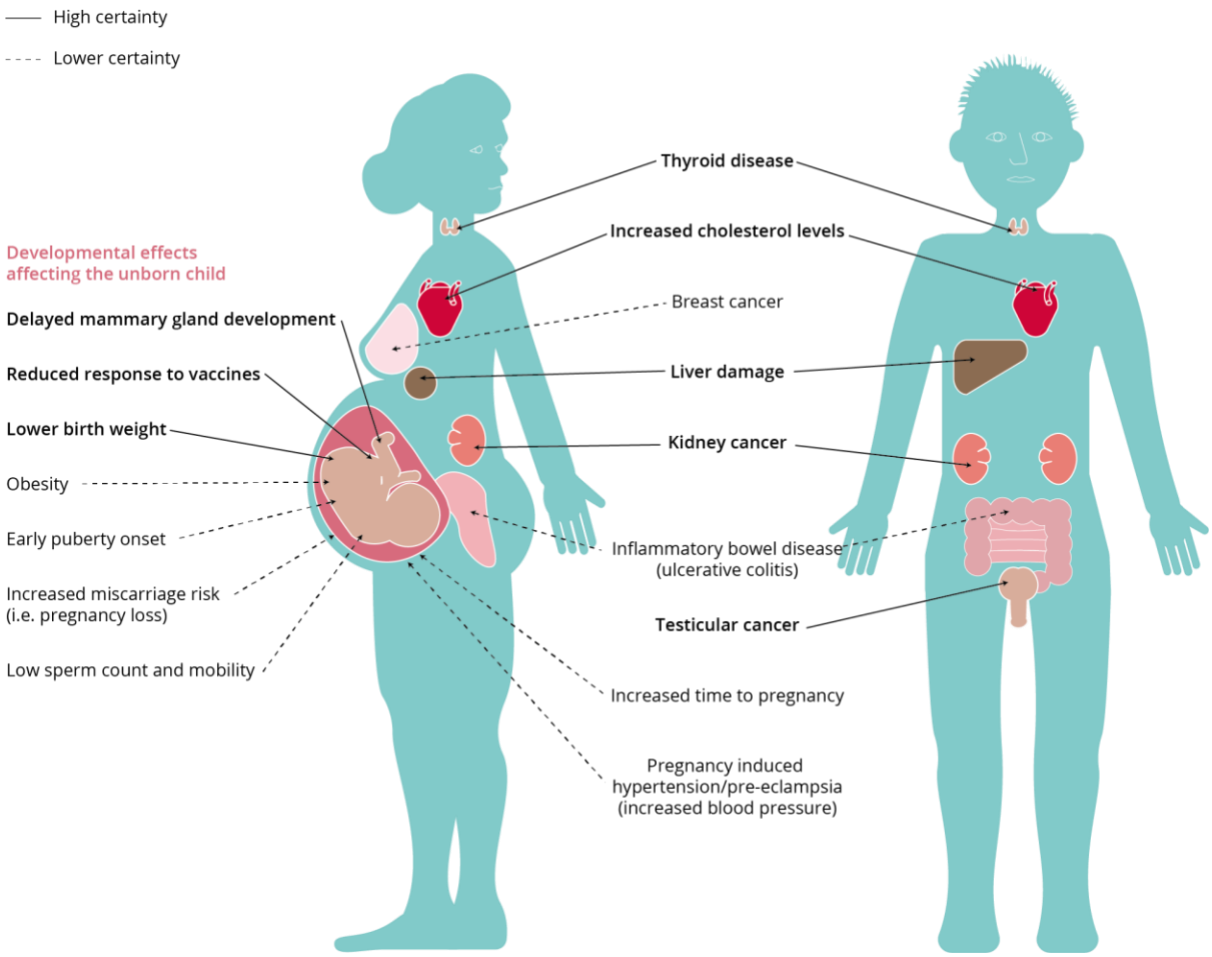

Figure 1: Effects of per- and polyfluoroalkyl substances on human health (European Environment Agency, 2019). Sources: US National Toxicology Program, (2016); C8 Health Project Reports, (2012); WHO IARC, (2017); Barry et al., (2013); Fenton et al., (2009); and White et al., (2011).

2.2 The Origin of Contamination

2.2.1 The Marzotto Family and the Ricerche Marzotto (Rimar)

Gaetano Marzotto Senior (1820-1919) and his nephew Gaetano Junior (1894-1972) can be considered the most relevant figures in the history of the Marzotto family. Within the industrial sector, this family name is associated with the development of the Italian textile district and the so-called "industrial paternalism"[8] (Bairati, 1986; Dal Lago et al., 2012). Over its long history, this family brand has depicted an example of social entrepreneurship, and it is

[8] Industrial paternalism is a managerial strategy aimed at establishing accepted hierarchical relationships and is one of the central tools for building and negotiating consensus within workplaces (Bertucelli, 1999). In the Marzotto case, this family aimed to provide a system of services, assistance, and benefits that, in the debates of the post-World War II period, would be termed "paternalism" (Bairati, 1986).

still linked today with something more than a textile manufacturing business. In this light, their venture and ambition have shaped the landscape of the Agno Valley, in Veneto, since the early nineteenth century.

Gaetano Marzotto Senior did not only contribute to the first expansion of his textile business, but he also influenced the social history of the population of the valley. He was responsible for launching the tradition of social entrepreneurship that became synonymous with his family name (Bairati, 1986). In the period after the Unification of Italy,[9] he enlarged his political influence by becoming the first mayor of Valdagno and later a member of the national parliament. Through generations, Gaetano Senior, his son Vittorio Emanuele, and his nephew Gaetano Junior contributed to model numerous municipalities through infrastructural interventions aiming to establish a strong connection between the factories, their workers, and their communities. Valdagno, a little town in the province of Vicenza where the textile group took its first industrial steps, was the heart of their project. In this location, the Marzotto family carried out many social initiatives, also contributing to the development of welfare facilities for both the population and his workforce. Especially under the management of Gaetano Junior, in this small town at the foothills of the Piccole Dolomiti, the family presence grew by building entire neighbourhoods,[10] schools, care homes, holiday resorts, worker's clubs, sports, welfare facilities, and houses for their industry members. By creating strong ties with the workforce and with the local communities, the Marzotto family imbued itself with a philanthropist's status and created a rooted imaginary transforming not only the urban texture and the cultural heritage of the valley, but also the social dimension of this corner of the so-called *Pianura Padana*, the Po Valley. For these reasons, Marzotto's social activities not only have been labelled as "paternalistic" but have also been perceived as "compensation" for the business' biosocial intrusiveness within the local communities (Bairati, 1986; Dal Lago, 2012). Today, while walking in Valdagno, my hometown, the enduring legacy of this family is still evident. For generations, the local community has depended on the company's presence, and reciprocally, the textile plant has relied on the local workforce for more than two centuries.

Meanwhile in the US, during the first decades of the twentieth century, cellophane, neoprene, freon, lucite, nylon, and finally Teflon were invented and developed by DuPont scientists. Decades later, all those synthetic materials gradually became global markers of the

[9] The unification of Italy took place in 1861, while the annexation of Veneto occurred in 1866.

[10] Today, Valdagno is still structured on what was named the "Harmony's city" (also known as "New Valdagno" or "Social's city") a label given by the architect Bonfanti who designed, between 1927 and 1937, most of the facilities that are still located today in town (Bairati, 1986).

"plastification" of the planet (Jarrige & Le Roux, 2020; McNeill & Engelke, 2016). By inventing Teflon (PTFE), DuPont will play an important role in the industrial success of Rimar-Miteni company while also contributing to the progress in various industrial sectors and in the worldwide history of chemistry and pollution. Its saga started at the dawn of the nineteenth century when a French chemist, Éleuthère Irénée du Pont de Nemours, moved to the US and founded the E. I. du Pont de Nemours and Company with the aim of manufacturing gunpowder (Lyons, 2007). A few decades later, in the 1860s, this chemical corporation was the primary manufacturer of gunpowder within the US, providing almost half of the powder employed by the Northern forces during the Civil War. Subsequently, in the 1880s, the corporation broadened its activities to encompass the production of smokeless powder and dynamite (Lyons, 2007).

In 1922, Gaetano Marzotto Junior succeeded his father Vittorio Emanuele as the head of the family enterprise (Bairati, 1986). Over his initial ten years, the wool mill workforce in Valdagno grew from 1,200 to 3,500 employees, with textile and yarn production experiencing a two-fold and five-fold increase, respectively (Dal Lago et al., 2012). As already reported, Gaetano Junior's social initiatives encompassed a wide range of non-work-related aspects of his employees' daily lives, such as healthcare, entertainment, holidays, education, sports, culture, social security, food, housing, and public services. During his leadership, the Marzotto Group expanded its industrial facilities outside its hometown, carrying his peculiar presence around the country. At that time, the social and industrial Marzotto project was, at a different level, a reality in many municipalities in centre-north Italy, such as the town of Chiampo, located in the nearby valley, Mortara, Manerbio, Brugherio, Brebbia, all in the Lombardy region, and even in Tuscany, Pisa (Bairati, 1986).

To understand the presence of this business within the local communities, it is worth mentioning that in 1937 Valdagno municipality counted 20,000 inhabitants while the local Marzotto plants employed 7,500 workers and that, in the thirties, due to its expansion and industrial renovation, the Marzotto group was responsible for 40 to 50% of the national wool production export (Dal Lago et al., 2012). In recognition of his merits in the industrial sector, his social-entrepreneur initiatives, and his agricultural and livestock activities in Italy, and in the Cyrenaica, Tripolitania, and East Africa Italian colonies, Gaetano Marzotto Junior, was awarded the noble title of count of "Valdagno e Castelvecchio" by the King, upon the initiative of Benito Mussolini in 1939 (Bairati, 1986). In fact, in those years, despite the eventual failure of the project, Gaetano Junior devoted a considerable number of financial resources to the colonization of Africa (Bairati, 1986). More precisely, he selected several families from his

workforce to lead the colonization of Libya, with the dual objective of broadening his business activities overseas and enhancing his public reputation (Dal Lago et al., 2012).

Meanwhile, in the US DuPont facilities, in 1938 the discovery of Teflon was fortuitously stumbled upon in a laboratory accident marking the beginning of the per- and polyfluoroalkyl substances (PFAS) planetary presence and subsequently impacting worldwide textile production. Specifically, during the cleaning of a cylinder employed in a refrigerant experiment that did not succeed, Dr. Roy Plunkett inadvertently discovered PTFE, a white and waxy substance (Science History Institute, n.d.). Upon conducting further investigations on this substance, he realized that it exhibited remarkable resistance to water, grease, and stains. Perfluorooctanoic acid (PFOA), also known as C8 and one of the most manufactured and efficient PFAS, resulted to be a by-product of Teflon (Lyons, 2007) boosting the production of fluorochemicals in the US.

Following the entering of World War II, the United States' chemical factories across the country redirected their resources towards supporting the war effort. The US federal government recruited the scientific knowledge and skills of DuPont's experts for the highly confidential Manhattan Project, which sought to develop the first atomic bomb in the world (Bilott, 2019). Thus, this trademarked product was initially utilized for military purposes, such as in the production of nuclear materials and artillery shell fuses (Lyons, 2007). To respond to the government's request, DuPont agreed to construct a full-scale plutonium plant in Hanford, Washington, and to manage such production Teflon was considered the right chemical compound. Its manufacturing was entirely reserved for government use, with the majority being allocated to the Manhattan Project. During the same period, it is noteworthy that DuPont commenced its inaugural public relations effort to rebrand itself from a gunpowder enterprise to a manufacturer of chemicals for peaceful purposes (Lyons, 2007). It is the start of the age of plastic (Jarrige & Le Roux, 2020), in which this chemical company had already begun making plans for its post-war operations, including constructing a new chemical plant. In 1948, this facility, the Washington Works, was built in Parkersburg, West Virginia, a place that will be crucial to the history of per- and polyfluoroalkyl substances (Bilott, 2019; Lyons, 2007).

In 1944, the Teflon trademark was officially registered, ten years after extensive research on the substance had begun. Those years were very intense in terms of chemical discoveries, as J. Donald LaZerte, a 3M chemist, reported: «[a]lmost every day we turned out a new molecule which had never been on the face of the earth before» (LaZerte, 1989, p. 25 in Pearson & Renfrew, 2023). In the meantime, PTFE was finally made available to consumers by the American company in 1949 while this plastic gained widespread recognition in the 1960s with

the introduction of its application in cookware, ultimately cementing its status as a household name (Lyons, 2007). Despite already in 1961 the scientists employed by DuPont identified that PFOA exhibited hepatomegaly in rats and rabbits, leading to a significant increase in liver size (Rich, 2016), Teflon will enter the popular imagination with many other brand names such as Gore-tex and Scotchgard. Since 1951, the production of PFOA has been carried out by the Minnesota Mining and Manufacturing Company, known as 3M, in its facility located in Cottage Grove,[11] Minnesota (Bilott, 2019). The company was originally launched in 1902 and quickly became a chemical giant that will have a key role in the PFAS saga by directly contributing to the know-how of Rimar-Miteni (Fontana & Bressan, 2009).

In Europe, the start of the manufacturing of PFOA began twenty years later the discovery of Teflon. In 1965 when "the Count" Giannino Marzotto (1928-2012), as he was called during his life, established Ricerche Marzotto S.p.A ("Marzotto Research"), known as Rimar. Giannino Marzotto, Gaetano Junior's nephew, belonged to the fifth generation of Valdagno's entrepreneurs and he was the first to be directly involved in the chemical sector. After leaving most of the business' ownership to the Marzotto Group, he decided to settle his own company close to his residency, a villa located in the Trissino hills (Fontana & Bressan, 2009). By doing so, the first venue of his business was a stable that today appears empty and abandoned, sited just next to the main road that climbs the hill from the centre of Trissino. Today, this town is known for its jewellery manufacturing and is characterised by a certain acknowledged economic wealth.

[11] In this area, between the 1950s and the 1970s, 3M disposed of its factory waste in four regional landfill sites, which resulted in the contamination of drinking water for nearby communities. Subsequently, in 2010, the state of Minnesota took legal action against 3M, seeking $5 billion in compensation for the corporation's actions, which caused the permanent contamination of groundwater over an area of approximately 150 square miles. However, shortly before the trial in 2018, 3M chose to settle for $850 million instead. Despite the settlement, efforts to find solutions for the affected drinking water supply are still ongoing (Pearson & Renfrew, 2023).

Figure 2: The entrance to the building where Giannino Marzotto initiated the production of the Rimar company (February 2023; photo by the author).

Among the reasons to expand the family business, there was the intention to avoid the discharge of tinctures and chemical compounds in the Agno River due to the textile production in Valdagno. According to Giannino Marzotto:

> While going to the factory [the Marzotto plant in Valdagno] early in the morning and looking at the Agno stream turning blue when Carabinieri clothing was produced with indigo tincture, and on other days turning red due to the manufacturing of legwear, a lot of water was dumped into the rivers. I thought (at that time there was no depuration culture) it would have been appropriate to study a cleaning system that used solvents apart from water. All these reflections brought to the conclusion that it was necessary to have a research centre inside the Marzotto factory.[12]

[12] «Un'altra considerazione che facevo andando presto in fabbrica al mattino e vedendo l'Agno diventare talora blu quando si facevano i panni per i carabinieri con la tintura all'indaco, altre volte rosso quando si producevano le calzetterie, era che si riversava troppa acqua nei fiumi. Sarebbe stato giusto, pensavo (non c'era ancora la cultura della depurazione), studiare un sistema di lavaggio che utilizzasse solventi prescindendo dall'acqua. Tutto ciò

In contrast to PFAS which are invisible to the human eye, the tinctures released by the Marzotto plant were an evident sign of the activity of the factory for most of the valley.[13] As one of the farmers from the red zone told me,[14] the change in the tone of the water streams was visible in other municipalities of the province even 25 kilometres from the Marzotto textile plant.

Following the intention to preserve the transparent water of the valley stream, by opening Rimar, the Count decided to develop a research centre. Environmental concerns were, however, not the unique driver of the research enterprise: the Count also aspired to create a stain-resistant product that was able to release textile fibres coated by a waterproof and oil-resistant film (Fontana & Bressan, 2009). This material prevented oily and water liquids to dirty the fabric. Vittorio Sandri, the chemical engineer who designed the Rimar-Miteni plant in 1967, was aware of the existence of per- and polyfluoroalkyl substances. Indeed, Zepel, manufactured by DuPont, and Scotchgard, produced by 3M, were the stain-resistant products taken as points of reference by Rimar. These similar products were manufactured and used in the US to make the American army uniforms water-resistant to the jungles during the Vietnam War (Fontana & Bressan, 2009). Again, the military-chemical complex resurfaces. At Rimar, the fabric treated with difficult synthesis and expensive perfluorinated intermediates resulted in being «stiffened and, as textile workers used to say, they had a 'bad hand'.»[15] Sandri claimed that at that time: «it must have been obvious that the indiscriminate application of a stain-resistant product was not possible.»[16] For these reasons, he prospected the application of such substances only on request for particular items, but the company decided to start a production campaign aiming to beat the competition from the US. By doing so, Marzotto and Rimar technicians' opinion was not taken into consideration (Fontana & Bressan, 2009). The temptation to undermine the American market monopoly was too strong. From that moment the development of the forthcoming Miteni Spa as the main PFAS producer in Europe began. In the first months of 1966, Rimar started to manufacture the base product for the synthesis of

portava alla conclusione che occorreva dotarsi di un polo di ricerca interno alla Marzotto» (Fontana & Bressan, 2009, p. 213).

[13] The change in the colour of the river was among my older relatives' memories, including my parents. A testimony of this is also present in *Works* by Vitaliano Trevisan (2022). A character from the book remembers how the colour of the water streams near Vicenza changed due to the waste waters from the tannery district of Chiampo and Arzignano. Such municipalities are settled in the Chiampo Valley which is located next to the Agno Valley and known worldwide for its large tannery sector.

[14] During this interview, this farmer was the only one who shared her memory regarding the early history of Miteni and the only person who indirectly met the Rimar factory.

[15] «irrigiditi e, come dicevano i tessili, aveva una cattiva "mano"» (Fontana & Bressan, 2009, p. 215).

[16] «Doveva perciò essere evidente che non si poteva prospettare l'applicazione indiscriminata di un prodotto antimacchia a ogni prodotto tessile» (Fontana & Bressan, 2009, p. 215).

its stain-resistant compound, PFOA, known at that time by the Italian acronym APO (Fontana & Bressan, 2009).

Simply put, the inception of Rimar-Miteni was motivated by two factors that had significant implications for the market and overall production. The primary objective of Rimar-Miteni was to research alternatives to using water as a solvent, while simultaneously seeking chemical products to enhance fabric production for their family textile enterprise and reducing costs (Fontana & Bressan, 2009). These goals were achieved but mismanagement and lack of regulations were part of the process.

2.2.2 The First Incidents and the Relocation

On an August evening in 1966, a chemical leak occurred from the Rimar facility, resulting in no immediate harm to individuals. However, a cloud of hydrofluoric acid was released, causing vegetation around the property to wither. Following pressure from the local parish priest, the mayor of Trissino temporarily suspended plant operations four days after the event (Fontana & Bressan, 2009). The temporary closure of the factory ended with the commitment to moving the chemical plant to «a more adequate location.»[17] Due to this unpredicted episode, the local water network was connected to another aqueduct and communities were assisted by the local institutions and supplied with drinking water. In September of that year, Giannino Marzotto decided to construct a new facility in Colombara, situated on a plot of land he owned in the Trissino plain, close to the passing of the Poscola stream. This location was chosen as a temporary solution, despite being above the second-largest groundwater basin in Europe. The position of the venue will be a decisive factor in the spread of the chemical substances, making this water contamination case the largest in European history. Vittorio Sandri was commissioned to design the chemical plant and was asked: «to proceed in "forces stages" avoiding any pollution-related problems.»[18] Nonetheless, this location was temporary, and the final site chosen for the company was San Giorgio di Nogaro, situated along the Corno River in the Friuli-Venezia Giulia region. Despite these developments, the company's activity resumed in January 1967, with the Colombara site becoming a permanent location (Fontana & Bressan, 2009).

[17] «una sede più adeguata» (Fontana & Bressan, 2009, p. 217).

[18] «di procedere "a tappe forzate" evitando ogni problema di inquinamento» (Fontana & Bressan, 2009, p. 217).

Until certain events related to the 1968 revolts in Valdagno disrupted the Marzotto Group, Rimar conducted part of its operations within the Marzotto facility in Maglio di Sopra, located in the municipality of Valdagno, where the family originally commenced its textile business.[19] Following Giannino's words, he took a «big risk - I am not a chemist - and I looked for societal partners, developing a company that had a huge potential.»[20] In those years, to introduce both the know-how of anti-stain products and the PFAS on the market, he engaged in extensive correspondence with foreign industry experts and travelled to the United States, Germany, and England. It was during these trips that he secured contracts with various companies, including DuPont (Fontana & Bressan, 2009) and 3M, where he even met with the president to negotiate the purchase of a patent (Marzotto, 2006).

> It may seem easy, but it was not: in a short amount of time, the company gained tremendous momentum, generated profits and cash, and became a leading figure in its industry.[21]

This marks the beginning of a commercial relationship that transcends the mere acquisition and transfer of patents. Throughout its history, Rimar-Miteni will engage in recurring interactions with DuPont and 3M, involving the exchange of data associated with the production of PFAS (Pietrobelli, 2023b).

Finally, a Rimar stain-resistant product was developed. In the same period, Rimar technicians had access to the development of «the production of PFOA (Perfluorooctanoic acid) to sell this compound to the Teflon (polytetrafluoroethylene) [PTFE] producers, in whose synthesis it performs an essential function, and to the producers of fluorocarbons that were important by-products of the PFOA synthesis.»[22] According to Sandri, since 1969 Rimar succeeded in

[19] On 19 April 1968, the statue of Gaetano Marzotto Senior was toppled by a heterogeneous group of protesters in the centre of Valdagno, marking this day as a key date within the Italian 1968 movement. According to Donato Tagliapietra (2019), on that day, a strike was declared by the labour unions in response to the escalating work pace and the recent reduction in salaries. Marzotto workers, other local workers, approximately 300 students, and bystanders assembled outside the factory gates. After the police arrested two protestors, the properties belonging to the Marzotto family were damaged by the demonstrators, including the wool warehouse and the villas of certain executives, as well as that of Gaetano Junior's brother, Paolo. However, the most significant event of that day, which also propelled the '68 season forward, was the toppling of the statue of Gaetano Marzotto Senior. This monument was erected in 1955, located not far from the factory's entrance, and it still represents a tribute to the legacy of Gaetano Senior.

[20] «Allora ne assunsi l'intera proprietà prendendomi un grosso rischio - io non sono un chimico - e ricercai altri partner societari, dando sviluppo ad un'impresa che aveva grandi potenzialità di sviluppo» (Fontana & Bressan, 2009, p. 219)

[21] «Sembra facile, ma non lo fu: in breve tempo l'Impresa prese uno slancio enorme, produsse profitti e cassa, divenne, nel suo settore, una leader d'immagine» (Marzotto, 2006, p. 48).

[22] «[...] sviluppare la messa a punto dell'Apo (acido perfluoroottanoico) (PFOA) per la vendita ai produttori di Teflon (politetrafluoroetilene), nella cui sintesi esso svolge una funzione essenziale, e dei fluorocarburi che erano un importante sottoprodotto della sintesi dell'Apo (PFOA)» (Fontana & Bressan, 2009, p. 219-220).

starting to erode the 3M worldwide market monopolization of the production and selling of PFOA while the fluorocarbons markets took more time to deliver satisfactory results for the company. This happened because the Trissino company was not considered reliable and large enough by the potential clients, primarily multinational electronic companies. In that period, Rimar, as a new entrant into the market, was selling PFOA «almost six times less expensive than the American monopolist offer»[23] and this was a *shock* for 3M (Fontana & Bressan, 2009). In 1970, these companies were the leaders of the sector while Rimar was able to manufacture alone 12 tonnes of PFOA per year. However, as outlined by Fontana and Bressan (2009),

> the intensive development did not come without traumas: in the late Seventies, the beginning of a new important production, without the essential de-pollution plants, carried out a serious environmental crisis that could have brought to the closure of the factory which was avoided by the timely and punctual public administration intervention.[24]

During the first Seventies, the factory started to produce Benzotrifluoride (BFT) derivatives and, later, fluoroaromatic substances. Meanwhile, in the US, the usage of Aqueous Film Forming Foam (AFFF) increased remarkably due to the death of 134 American sailors in Vietnam in 1967. This event was considered «one of the worst disasters in U.S. naval history» (Lerner, 2018) and triggered the interest of the US Navy scientists in the study and application of PFAS. Since the early 1960s, such researchers have worked together with 3M to develop the material. Until the 1990s, the company was their only supplier of the "fluorinated surfactant" required to manufacture AFFF. It was the perfluorooctane sulfonate (PFOS) that began to be adopted in the whole American defence industry to produce foam fire extinguishers (Lerner, 2018). This substance has been utilized on military bases throughout the United States, both to extinguish unforeseen fires and, more frequently, to quell fires deliberately ignited as a training exercise for firefighters in anticipation of such emergencies. By doing so, it has been discharged into the environment contaminating the drinking water of hundreds of communities around the US (Lerner, 2018). Together with PFOA, PFOS has been considered the most efficient PFAS and it has been the most manufactured since the discovery of Teflon (OECD, 2018; Blum et al., 2015).

[23] «[…] ad un prezzo quasi sei volte inferiore a quello praticato dalla monopolista americana» (Fontana & Bressan, 2009, p. 220).

[24] «L'intenso sviluppo non fu senza traumi: nella seconda metà degli anni Settanta l'avvio di una nuova importante produzione, senza i relativi necessari impianti di disinquinamento produsse una grave crisi ambientale, che poteva portare alla chiusura dello stabilimento, evitata con la tempestiva e puntuale messa in atto degli interventi prescritti dalla pubblica amministrazione» (Fontana & Bressan, 2009, p. 220).

Moreover, by 1976, only 25 years after PFOA commercial introduction, both 3M and DuPont had come to realize that most of the American population detected traces of PFOA in their bloodstream. It wasn't until about three decades after its initial synthesis that the two companies responsible for PFOA production established "acceptable" baseline levels of the compound in the blood (Bond, 2021). Additionally, they discovered that 3M workers at Cottage Grove Minnesota exhibited levels of PFOA in their blood that were «1,000 times normal» (Lerner 2018a, also in Bond, 2021, p. 383).

Turning back to the history of Rimar-Miteni, in 1977 benzotrifluoride (BTF) and its derivates were found in the drinking water near the chemical plant area. BTF is utilized as a synthetic intermediate in various industrial processes and is extensively employed as a non-reactive solvent, dielectric fluid, and industrial additive (Budavari et al., 2013 in Lava et al., 2021). That was the second incident caused by the factory. Local communities lamented the presence of weak yellow well waters and an aromatic-like smell in the air (Lava, 2010). After having identified the source of the contamination, authorities promptly banned the utilization of groundwater for potable purposes. In addition, alternative water sources were established for the aqueducts. The water systems of Sovizzo and Creazzo municipalities, today both located within the current PFAS orange zone, were closed (Lanzavecchia et al., 2022). Part of the municipality of Montecchio Maggiore was also affected, a fraction located on the other side of the hills in the Valle dell'Onte, which carries water to the springs of the Retrone, a river that flows near the city centre of Vicenza (Fontana & Bressan, 2009). As reported by Lava (2007), no limitations were imposed on the usage of polluted water for activities such as irrigation, industrial applications, and consumption by livestock.

In the aftermath of the incident, some wells had been found polluted by halogenated aromatics compounds, subsequently identified as 4-chlorobenzotrifluoride, 4-chloro-3-nitro-benzotrifluoride, 4-chloro-3,5-dinitrobenzotrifluoride, trichloroethylene and tetrachloroethylene (Lava, 2010). It has been estimated that the production of such intermediates by Rimar skyrocketed from 200 t/year in 1973 to 2500 t/year in 1980 (Lava, 2010). At that time, Rimar's production was expanding to «around 86 products in the catalogue and 200 employers,»[25] reaching its maximum workforce composition. However, Giannino Marzotto's management was approaching the end. While describing his last period at Rimar, he wrote these words in his autobiography:

[25] «[…] circa 86 prodotti in catalogo e 200 dipendenti» (Fontana & Bressan, 2009, p. 221).

> We were specialists in the sophisticated "chemistry of fluorine." In the experiments, I saw mice navigating calmly submerged, or rather drowned, in a jug of fluorocarbons, which provide oxygen to the lungs. I witnessed the same products being tested in the search for liquids capable of preserving human organs for transplantation. And many other fantastic things. There were also intellectually extraordinary prospects, but they required time, capital, and safety.[26]

The BTF episode was the second incident with relevant consequences with environmental implications in eleven years of the history of the chemical company. It was also the first to occur in the new location and it can be considered a wake-up call that remained unheard by the authorities. A few days after the incident, the chemical plant closed for 14 months. Between 1978 and 1980, the requisite enhancements were implemented at the Rimar plant. To capture any potential spills and their associated washing water, an impermeable perimeter with raised edges was installed around all the equipment and adjacent areas (Lava, 2010). In conclusion, this environmental disaster was a severe blow to the company budget with no legal consequences for both the owner and the company itself (Marzotto, 2006). Rimar continued to operate under Giannino Marzotto for around a decade, when the decision to sell the business was taken (Fontana & Bressan, 2009).

2.3 The Miteni S.p.A.

As shown in the previous section, DuPont has been producing PFAS since the late 1940s. The U.S. Environmental Protection Agency (EPA) was established on the initiative of Richard Nixon in 1970, in the aftermath of the publication of the milestone environmental science book *Silent Spring* (1962). On this occasion, Rachel Carson was harshly attacked by DuPont, the main worldwide manufacturer of dichlorodiphenyltrichloroethane (DDT) (Jarrige & Le Roux, 2020). In its first years, EPA was working to increase its authority to scrutinize and oversee chemicals such as DDT and polychlorinated biphenyls (PCBs). According to Lyons (2007), in the same period, PFAS did not represent a significant concern for EPA, but a DuPont memo written in 1984 shows that uncertainty regarding per- and polyfluoroalkyl

[26] «Eravamo specialisti della sofisticata "chimica del fluoro". Vidi, negli esperimenti, topi navigare tranquillamente sommersi o meglio affogati, in una caraffa di fluoro-carburi, apportatori di ossigeno ai polmoni. Vidi sperimentare gli stessi prodotti nella ricerca di liquidi capaci di conservare gli organi umani destinati al trapianto. E molte altre cose fantastiche. Prospettive anche intellettualmente straordinarie, ma cui necessitavano tempo, capitali e sicurezza» (Marzotto, 2006, p. 55-56).

substances exposure effects was growing. This document reported that, in 1978, 3M notified DuPont of the presence of elevated levels of PFOA in its employees' bloodstream, which prompted DuPont to initiate an internal review and monitoring program. Additionally, in 1981, 3M released a study demonstrating PFOA's teratogenicity in rats, leading to the relocation of potentially affected female workers. In the same year, according to the memo, DuPont developed a PFOA-specific blood test in April 1981 and research, which concluded in 1982, determined that this substance had no harmful health effects and established a definitive exposure limit for its employees (Lyons, 2007).

However, there exists an unreported fact in the 1981 document. DuPont, through medical monitoring studies, became aware that two out of seven workers in the Teflon division at Washington Works who were exposed to PFOA had infants with eye and facial birth defects,[27] and detectable levels of PFOA were present in the new-borns' blood (Kelly, 2016). Subsequent scientific analyses established a similarity between the observed birth defects and those previously documented in laboratory animal studies conducted by 3M (Lyons, 2007). Through the decades, as the consequences of PFAS exposure became increasingly evident, DuPont acknowledged the necessity of eliminating 'off-plant' and consumer PFOA exposures. According to Lyons (2007), the author of a memo expresses concerns about the feasibility of eliminating exposure, citing the significant costs associated with such a measure.

> Currently, none of the options developed are, from a fine powdered business standpoint, economically attractive and would essentially put the long-term viability of this business segment on the line. From a broader corporate viewpoint the costs are small (DuPont, 1984, in Lyons, 2007, p. 31).

Therefore, as Richter et al. (2018) state, «the costs of eliminating exposure would be too great» (p. 701) for the company. As I will explore later in this thesis, Rimar-Miteni has also been found to adopt this approach. Indeed, over the decades, various strategies have been employed to conceal and control information related to chemical formulations, usage, and the associated health and environmental impacts (Lanzavecchia et al., 2022; Richter et al., 2018; Wickham & Shriver, 2021). In this sense, it is worth noticing that public institutions often rely on the industrial apparatus to monitor chemical substances in the US (Renfrew & Pearson, 2021).

[27] This event is documented in *The Devil We Know* (2018), a documentary about PFAS-related water contamination that occurred in Parkersburg, West Virginia.

Meanwhile, in Italy, environmental awareness related to industrial plant safety was growing. In 1976, the government established the so-called Merli's law[28] that disciplines and regulates urban and industrial discharges imposing new parameters and conditions. Less than two months later, a cloud of toxic chemicals containing dioxin leaked from the ICMESA chemical plant in Meda. It will be labelled as the "Seveso disaster," following the name of the main municipality in the Milan mainland which was impacted. This event will be a turning point in the history of Italian environmentalism increasing awareness regarding environmental protection in industrial areas. The legacy of the event brought to the forefront significant issues that extended beyond the discourse on occupational safety and health in the industrial sector. Addressing the harm inflicted by the incident gave rise to concerns that challenged the intersection of different disciplines such as medical and environmental science, politics, and law (Centemeri, 2006). Following the aftermath of this environmental disaster, in 1982, European Union Member States established a common environmental policy on the prevention of major industrial risks. It is the European Directive 82/501/EEC, commonly referred to as the "Seveso Directive," that mandates member states to identify their respective high-risk sites (MASE, n.d.). This policy has been revised thrice (in 1996, 2003, and 2012), and Miteni S.p.A. was included in the list in 1994. (Lanzavecchia et al., 2022).

In 1985 Giannino Marzotto and the other shareholders decided to sell the company to EniChem Synthesis, today Eni Rewind S.p.A. This Italian corporation has been the name of the chemistry side of the well-known fossil fuel multinational group Ente Nazionale Idrocarburi (Eni). It took over part of the Rimar due to its interest in the engineering section responsible for research and development (Fontana & Bressan, 2009).

To shed light on the wasting trajectories originating from Rimar-Miteni, as reported by Lanzavecchia et al. (2022), it is relevant to highlight that the company name "Rimar" was included in the list of enterprises whose industrial waste was found in the cargo of the Lynx and Zanoobia ships, two of the so-called "Navi dei Veleni" ("toxic ships"). Although the name of the Trissino company is mentioned, the involvement of Rimar in this criminal network has never been fully substantiated. However, I believe it is relevant to understand the modus operandi of the "Navi dei Veleni" to describe the wasting trajectories of certain chemical companies. Among these enterprises, it is noteworthy to mention the presence of various European chemical and pharmaceutical corporations. Additionally, the Defense Logistics Agency (DLA), a US government agency responsible for managing waste generated by US

[28] Law of 10 May 1976, n. 319.

military installations in Italy, including the Aviano military base, had its waste discovered on these ships (Braga, 2018). In 1987, the Lynx ship carrying two thousand barrels containing pesticides, paints, solvents, and sludge left the Marina di Carrara harbour in Italy, heading to Djibouti. It is the beginning of a one-year-and-a-half journey in which industrial toxic waste produced by Rimar and more than fifty companies travelled on four different continents passing through different hands and boats. However, the French navy prevented the ship from docking in Africa and the Lynx headed to Puerto Cabello, Venezuela where again the authorities refused the load (Greenpeace, 2010). Makiri ship took the shipment and sailed to Syria. In this country, the barrels changed destination again and were moved to the Zaanobia ship. In June 1988, this Syrian vessel arrived in Italy where, after months of uncertainty, it was finally directed and unloaded in the Genova harbour (Santucci, 2017).

The "Navi dei Veleni" used the discharge of toxic substances into the open sea and the environment in various countries, with the ultimate destinations of toxic waste being countries outside of the Western industrialized world. Criminal organizations and individual brokers were involved in these practices. The individuals and organizations proposing these schemes often consisted of Swiss lawyers and trustees, as well as Swiss and UK-based companies that were later found to be shell companies (Greenpeace, 2010). These waste disposal trajectories exploited the absence of regulations addressing waste transportation outside the European Union and waste management globally. Similarly, as in the case of the "Navi dei Veleni," in the gap between the emergence of new human-made chemicals and their regulations, Rimar-Miteni, DuPont, and 3M have built their fortune in the chemical industry over the decades.

In the same year of the Zaanobia ship's final docking, Mitsubishi Italia S.p.A., a subsidiary of Mitsubishi Corporation interested in fluorocarbons, set up a joint venture with Eni. On this occasion, Gianni Marzotto and the other owner, a corporation from Brescia, finally left the board of the company (Fontana & Bressan, 2009). Because of the change of ownership, the factory switched its name to Mit-Eni S.p.A, which a few years later will become Miteni S.p.A. In 1996, Mitsubishi became the Miteni primary owner. This new phase of the business assured financial capital and power to invest and enlarge its presence in the global market, «particularly on those in great expansion as China and India» (Fontana & Bressan, 2009, p. 221). But in the late nineties, the concerns and debate regarding PFAS exploded.

In the US, one of the most important litigations in American environmental justice history started in 1999. It is the turning point in the history of per- and polyfluoroalkyl substances. Before this case, little independent or academic research had been conducted concerning the health or environmental effects of PFOA or other PFAS. From this moment onward, by starting

from the absence of any threshold limits, mainly in European and North American public regulatory surveillance systems are embarking on a regulatory process that will result in a reduction by approximately two orders of magnitude in the threshold limits for drinking water and food. Nevertheless, it will take years for these regulations to be effectively enforced. As reported by Richter et al. (2018), the scarcity of research was a consequence of multiple factors aligning together, including corporate proprietary trade secrets regarding chemicals, the absence of legal regulations for PFOA, and the absence of institutional mandates for impact-oriented scientific investigations.

What started in Parkersburg, West Virginia, may be considered the anticipation of what will happen in the Veneto Region in fifteen years. Robert Bilott,[29] an environmental attorney based in Cincinnati, Ohio, undertook the legal representation of Wilbur Earl Tennant, a farmer from Parkersburg.[30] Through the years, Tennant had experienced the loss of his herd of 280 cattle due to unusual symptoms, which he attributed to the activities of DuPont's Washington Works facilities that were producing Teflon using PFOA from 3M (Bilott, 2019; Lyons, 2007). In the 1980s, the company acquired a plot of land from Tennant's brother who worked for the company, indicating that the land would be used as a landfill that posed no threat to the environment. The propriety encompassed a stream that flowed directly into the Ohio River (Bilott, 2019; Lyons, 2007).

After being alerted to the health problems of cattle, the company's in-house lawyer responded by informing the affected party that the chemical company and the EPA would jointly fund a study of the property. The study was conducted by three veterinarians selected by DuPont and three selected by the EPA (Bilott, 2019). The resulting report, however, concluded that the facility was not responsible for the cattle's health problems. This marks the beginning of the end of years of denial and deception, a reality that Bilott will ultimately debunk. In the same period, the phased-out of long-chain PFAS started. In 2000, 3M halted production of both PFOS and PFOA (Lyons, 2007), while the year after an investigation funded by the same company, twelve food samples sourced from various regions of the United States, such as ground beef, bread, apples, and green beans, were found to contain either PFOA or PFOS (Lerner, 2019). This wave will enhance awareness of the presence and detrimental effects of per- and polyfluoroalkyl substances in Europe. Nevertheless, in 2002 DuPont became the

[29] The American attorney visited the contaminated communities in the Veneto Region in October 2017 and discussed PFAS and the connections between DuPont and Rimar-Miteni at the Public Prosecutor's Office of Vicenza and the Regional Commission (Lanzavecchia et al., 2022). He will return to Italy in 2023 for the Rimar-Miteni trial.

[30] Robert Bilott's story is the object of the movie *Dark Waters* (2019) and the book *Exposure* (Bilott, 2019).

exclusive US open-market manufacturer of PFOA (Lyons, 2007). For this reason, according to Bilott, Dupont's management asked the Italian factory to continue producing PFOA even though they were aware of the risks: «Miteni responded with a yes, adding that they would actually increase production to meet the growing demands of the European market» (Fazzini, 2023).

In 2004, after having discovered that the PFOA contamination was not limited to the Tennant property but had spread over a vast area of the Mid-Ohio River Valley infiltrating the water supply of six public water systems in West Virginia and Ohio, Bilott initiated a class action lawsuit against DuPont representing approximately 70,000 people from the six water districts (Bilott, 2019). In 1984, the company conducted tap water testing in communities located near the Washington Works facility in West Virginia, but this information only came to light when a class-action lawsuit was initiated. Furthermore, the Parkersburg case played a significant role in launching the most extensive chemical investigation by the EPA to date (Lyons, 2007).

Following the class action lawsuit against DuPont, a Settlement Agreement was reached in the court. As a result of this settlement, an autonomous entity named Brookmar Inc. was established, and it carried out an extensive epidemiological study known as the C8 Health Project, spanning from 2005 to 2013 (C8 Science Panel, n.d.). The C8 Health Project involved conducting interviews, distributing questionnaires, and collecting blood samples from approximately 69,000 individuals who drank PFOA-contaminated water residing near the Washington Works plant in West Virginia. The study «concluded that there was a probable link to C8 [PFOA] exposure: diagnosed high cholesterol, ulcerative colitis, thyroid disease, testicular cancer, kidney cancer, and pregnancy-induced hypertension» (C8 Science Panel, n.d.). In July 2015, Chemours, which was formerly a division of DuPont specializing in "performance chemicals," separated from its parent company as a response to the increasing legal actions faced by DuPont (Wickham & Shriver, 2015).

2.4 The Discovery of the Veneto Contamination

In 2002, following the increasing attention on per- and polyfluoroalkyl substances due to what was happening in the US, the PERFORCE project was launched with the support of the European Union, and 3M (McLachlan et al., 2007). This investigation concluded in 2006 and it was the first assessment in Europe aiming to detect the presence of perfluorinated organic compounds (PFC) in different aquatic environmental media. As mentioned in 2.1 section,

perfluorinated compounds are a subset of PFAS that contain only carbon-fluorine bonds, while PFAS include a broader range of compounds that also contain other elements, such as oxygen, nitrogen, or sulphur.[31] Among 14 water streams taken into consideration in the continent, the Po River showed the highest concentrations of perfluorohexanoic acid (PFHxA), Perfluoroheptanoic acid (PFHpA), PFOA, and Perfluorononanoic acid (PFNA). In the case of PFOA, the concentration detected in the Po River was over nine times higher than that found in the Thames, which ranked second among the 14 water streams taken into consideration. While levels of 200 ng/litre of PFOA have been detected in the Italian river, the same research revealed a European average of 30 ng/litre (McLachlan et al., 2007).

In 2003, the GIADA project was launched within the Chiampo and Agno Valleys under the coordination of the Environment Office of the Province of Vicenza. It was founded by the European Union and administered by the Vicenza Province and 16 municipalities involved in the Chiampo Valley tannery district. The initiative aimed to contribute to the reduction of pollution by implementing technological advancements within the local businesses and enhancing environmental protection in the region. It also intended to increase citizen participation in defining environmental policies and promoting economic growth while improving the quality of life (progettogiada.org, n.d.). Until 2010, research carried out under this project reported an increase in the concentrations of BTF and BTF derivates produced by Rimar during the seventies (Lava et al., 2021; Lanzavecchia, 2022). However, the study was not published (Ciculli, 2021), and in 2017, the Nucleo Operativo Ecologico dei Carabinieri (NOE),[32] following the access to the results, documented the presence of illegal industrial waste containing PFAS buried along the Poscola stream. The NOE investigations carried out have revealed that Miteni commissioned leading consulting firms in the field to conduct surveys aimed at assessing the pollution status of the site and providing possible solutions for the containment of the contamination detected in 1990, 1996, 2004, 2008, and 2009. Despite being obligated by law[33] to report the findings to the competent authorities (Region, Province, and Municipality), the company has failed to transmit the aforementioned investigations (NOE, 2017). According to the NOE, a «widespread and serious scenario emerges» (2017, p. 8)

[31] The definition of PFAS is elaborated upon in section 2.1.

[32] The Ecological Operational Unit of the Carabinieri (NOE) was established on December 1st, 1986, by a decree of the Ministers of Environment and Defense. It is functionally subordinate to the Minister of Environment and is responsible for the surveillance, prevention, and repression of environmental violations (Carabinieri, n.d.)

[33] See. artt. 17 del D.Lgs. 22/1997; 7, 9 del D.M. 471/1999; 242 del D.Lgs. 152/2006.

because the company did not prevent the expansion of BTF, BTF derivates, and PFAS contamination while being aware of it.

In June 2007, the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), the Regulation (EC) 1907/2006, one of the most important chemical regulations within the history of the European Union, entered into force. It regulates the registration, evaluation, authorisation and restriction of chemical substances, including the main PFAS. According to its text, this regulation aims to protect both human health and the environment and to support the internal market, with its rules grounded in the precautionary principle. REACH requires that all businesses engaged in the production or importation of chemical substances into the European Union, with quantities exceeding one tonne or more annually, must complete registrations through the European Chemicals Agency (ECHA).

In 2008, a report issued by the European Food Safe Authority (EFSA, 2008) brought attention to the potential of new-generation PFAS, specifically C4 and C6, which have shorter C-F chains than PFOS and PFOA, to leach from contaminated soil and contaminate vegetables. The following year, another change of ownership occurred: Mitsubishi sold Miteni for only €1 to the International Chemical Investors GmbH, ICIG's German subsidiary (Kiezebrink, 2017), a group of mid-sized chemicals and pharmaceutical business investors that has its head office in Luxemburg. According to a report released by Greenpeace (Kiezebrink, 2017), the reasons why Mitsubishi sold the company for only €1 are not clear. No explanations have been given regarding the difference between the book value given of the Italian chemical company, €33,9 million, and the amount paid for it. In the same year, PFOS was added to the Persistent Organic Pollutants Stockholm Convention list. PFOA will be included in 2019 while perfluorohexane sulfonic acid (PFHxS), a short-chain perfluoroalkyl substance will only be inserted in 2022 (Secretariat of the Stockholm Convention, 2022). The concern regarding PFAS harmful effects was growing in Europe. Indeed, the EU included PFOS in Regulation 790/2009, requiring labelling as «Carcinogen Type 2, Reprotoxic 1B, Acute Toxicity, Toxicity to Breastfeeding Infants, Chronic Toxicity to Aquatic Organisms (P182)» (p. ii in Lanzavecchia et al., 2022 p. 407-408).

In 2010, in the wake of the new limitations on long-chain PFAS, Miteni started the production of a new perfluorinated compound the Perfluoro{acetic acid, 2-[(5-methoxy-1,3-dioxolan-4-yl)oxy]} ammonium salt, known as C6O4, characterised not only by chemical and physical properties similar to PFOA and other perfluorinated compounds but also formed by a shorter number of carbon-fluorine chains (Ciculli, 2021; Lanzavecchia et al., 2022). Solvay Specialty Polymers shipped the bases to the Rimar-Miteni plant to produce the C6O4 resin, which was

then sent back to the Solvay facilities in Spinetta Marengo. The Trissino company managed the waste generated from this process, providing the customer with a product ready for use as a polymer in the production of Solvay's Teflon, registered under the Algoflon brand.[34] C6O4 production, which started at 132 kg in 2010, reached 54 tonnes in 2015. In total, approximately 189 tonnes of products attributable to this compound have been produced by the Trissino company (Girardi et al., 2018).

In the period 2011-2013, to explore the results discovered by the PERFORCE project, Centro Nazionale Ricerca and Istituto Ricerca Sulle Acque (CNR-IRSA) carried out a PFAS pollution evaluation in major Italian river basins (Polesello et al. 2013). The aims of the research were to investigate the dispersion of PFAS within bodies of water, recognise their origins, conduct an evaluation of potential hazards to consumers, and approximate the toxicological and ecological aftermaths. The study traced back the PFAS producers along the Po River, identifying the Solvay Specialty Polymers plant of Spinetta Marengo, locality of Alessandria in Northwestern Italy, the main manufacturer of per- and polyfluoroalkyl substances found in the rivers.

Solvay has been one of the protagonists in the growth of chemicals during the last century. At the inception of World War I, it was the largest chemical business on the planet (Jarrige & Le Roux, 2020). Its history is firstly associated with the production of soda and many other compounds together with the diffusion of pollution. In the first decades of the twentieth century, the Spinetta Marengo facility was born as a local copper sulfate and chemical fertilizer manufacturer (Solvay Spinetta Marengo, n.d.). After being owned by Montedison, it later became Ausimont. Since 2002, Solvay Solexis acquired the majority of the business, which specializes in the development and production of fluorinated materials, created following the acquisition of Ausimont's fluoropolymer activities (Solvay Spinetta Marengo, n.d.). Even today, the main industrial activity is the production of fluorinated polymer-based materials, for which significant investments have been made in recent years to meet the growing demand for fluoropolymers. As outlined by CNR-IRSA (Polesello et al., 2013), PTFE with different brand names has been produced at Spinetta Marengo since the early 1950s, but numerous other industrial processes have also taken place, leading to a gradual degradation of the soil and the

[34] Since 1954, Teflon has been distributed and manufactured in Spinetta Marengo, initially by Montecatini, which began production under the commercial name Algoflon. After acquiring the chemical plant in 2002, Solvay continued production until June 2023 when the company decided to cease manufacturing PFTE, in line with the Solvay's One Planet sustainability roadmap that set "the direction for the fluoropolymers industry to support a more sustainable economy" (Solvay Solexis, 2022).

groundwater beneath the chemical complex (chlorinated solvents, chromium, but also DDT and phenols).

By being both a PFAS customer and supplier of the Trissino company, Solvay Solexis had exchanged PFAS with Rimar-Miteni for years. CNR-IRSA has conducted four monitoring campaigns (May 2011, October 2012, February 2013, and April 2013) in the Veneto basin of the Brenta and Adige rivers, focusing on superficial water bodies and industrial effluents of the industrial district of Chiampo and Agno Valleys (Polesello et al. 2013). The chemical facility in Veneto was found to be the main source of the discharge of PFAS in the region. For an indefinite period, the company reportedly released industrial processing waste containing PFAS into the environment without adequate precautions. The Agno-Guà watercourse, also known as the Poscola stream, already impacted by discharges from numerous tanneries in the region employing PFAS in specific operations, is identified as the most heavily contaminated. Furthermore, the existence of industrial sludge used as agricultural fertilizers requires attention. In 2016, the Veneto Region requested the Italian National Institute of Health (ISS) to conduct a risk assessment related to the utilization of these sludges (Regione Veneto, 2016). CNR-IRSA (Polesello et al., 2013) eventually discovered the same list of toxic substances which scientists found in the Po River (PFBS, PFOA, PFPeA, and PFHxA were found at higher concentrations) in the Miteni plan wastewaters. In 2011, in correspondence with the business, 4,834 µg/l (4.834 million ng/l) of perfluorobutane sulfonate (PFBS) was one of the highest concentrations ever recorded (Polesello et al., 2013). Among drinking water samples collected from public and private supply points in the Agno-Fratta Gorzone basin, the values of PFOA were greater than 1000 ng/L while the total PFAS concentration was greater than 2,000 ng/L. In the absence of Italian or EU drinking water quality standards, comparing these concentrations with proposed limits from the US-EPA (400 ng/L for PFOA) or Germany (100 ng/L for the sum of perfluorinated compounds for a ten-year exposure) the research suggested a potential risk for the affected communities (Polesello et al., 2013).

In May 2013, in the aftermath of the contamination discovery, to supply PFAS-free water, activated carbon filters started to be installed by the water-service companies within the red zone public drinking-water distribution system (Regione Veneto, n.d.). However, a portion of the costs associated with implementing these filters was passed on to the affected communities, resulting in an additional expense on their bills (Regione Veneto, n.d.).

In 2014, following these results, the Veneto Region Environmental Protection Agency (ARPAV)[35] conducted an extensive environmental investigation that led to the identification of the source and the plume of contamination. The monitoring network was consequently established to map the space-time evolution of the pollution related to the presence of 12 PFAS[36] within a 590 km^2 covered area and 52 groundwater monitoring network points. In this context, the maximum PFAS concentrations detected in drinking water were 1,214 ng/L that were found in the municipalities of Brendola, Lonigo, and Sarego (WHO, 2017). It resulted that there were two primary means by which the pollution was disseminated. First, the discharge of wastewater from the Miteni plant into the Poscola stream, where it infiltrated into the groundwater system. Secondly, the deposition of wastewater from a wastewater treatment plant connected to the factory into a canal that emptied into a river, whose rapid flow rates facilitated the transportation of PFAS over significant distances (WHO, 2017).

In the same year as the ARPAV investigation, regional authorities allowed Miteni to start to treat new short-chain PFAS (Nicolussi Moro, 2018). Among them was the ammonium salt of hexafluoropropylene oxide dimer acid (HFPO-DA), known by the brand name GenX (Greenpeace, 2018) – originally produced by DuPont (Wickham & Shriver, 2021) – together with the short-chain C6O4. Due to the lower number of carbon-fluorine bonds, these substances were firstly supposed to be less harmful to living beings maintaining the efficiency of longer C-F PFAS. Later studies revealed the opposite by showing their harmful effects on nonhuman beings[37] and suggesting harmful effects on humans (Bernardini et al., 2021). Indeed, following the phasing-out of long-chain per- and polyfluoroalkyl substances, GenX was invented by DuPont as a substitute for PFOA in 2009 (EPA, 2019). According to Greenpeace (2018), Miteni recovered GenX from the DuPont chemical plant located in Dordrecht, Netherlands, where it was used as a substitute for PFOA in Teflon production. Without any limits related to the dumping of this chemical into the environment,[38] the Italian company received around 100

[35] Agenzia Regionale per la Prevenzione e Protezione Ambientale del Veneto (ARPAV).

[36] PerfluoroButyric Acid (PFBA), PerfluoroPentanoic Acid (PFPeA), PerfluoroButane Sulfonate (PFBS), PerfluoroHexanoic Acid (PFHxA), PerfluoroHeptanoic Acid (PFHpA), PerfluoroHexane Sulfonate (PFHxS), PerfluoroOctanoic Acid (PFOA), PerfluoroNonanoic Acid (PFNA), PerfluoroDecanoic Acid (PFDeA), PerfluoroOctane Sulfonat (PFOS), PerfluoroUndecanoic Acid (PFUnA), PerfluoroDodecanoic Acid (PFDoA) (ARPAV, 2017).

[37] Research evaluated for the first time the effects of C6O4 and PFOA to the clam Ruditapes philippinarum and «during exposure at least five clams treated with 0.1 µg/L of C6O4 showed foot cut-off, clams being unable to withdraw it before shell closure» (Fabrello et al., 2021, p. 3).

[38] «Authorizing the treatment of waste for the recovery of a hazardous chemical without defining any limit, even in a potential and risk-based manner, for the discharge of the substance contained in the waste, represents a serious negligence on the part of the regional authorities and renders the Environmental Integrated Authorization (AIA) granted to Miteni in 2014 effectively ineffective in preventing such contamination. Therefore, if Miteni had not

tonnes of industrial waste and treated it to manufacture GenX which was then sent back to DuPont in the Netherlands (Greenpeace, 2018). Despite the company lacking the necessary authorizations from the Veneto Region - granted in 2014 - Miteni has been processing C6O4 since 2011 and GenX since 2014 (Ciculli, 2021; Lanzavecchia et al., 2022). In those years before the regional permission was granted, Miteni exchanged such substances with Solvay Solexis in Spinetta Marengo. Thus, as in the case of the 2013 discovery (Polesello et al., 2013), C6O4 was detected in the Po River by the ARPAV in 2019 while GenX was found in the environment nearby the Trissino's chemical plant (Arpav, 2019). While mainly producing PFOA and PFOS between 1966 and 2011, Miteni officially ceased the production of PFOA as a raw material and ammonium salt in 2012. However, it continued to manufacture the compound through waste recovery, producing 29.8 tonnes in 2012 and 8.25 tonnes in 2013 (Girardi et al., 2018). The average amount of PFOA annually produced was 250 tons in the period 2001–2014 (Girardi & Merler, 2019). Additionally, Miteni continued to synthesise PFOS until 2011, despite its phase-out in 2004 (Girardi et al., 2018).[39]

In 2017, DuPont and Chemours reached a settlement agreement with the parties involved for a sum of 671 million dollars, pertaining to 3,550 personal injury claims related to PFOA used in the production of Teflon in Parkersburg, West Virginia (Nair, 2017). Six years later, on March 14, 2023, the EPA unveiled its proposed National Primary Drinking Water Regulation (NPDWR) pertaining to six PFAS compounds. These include the threshold for groundwater, surface water, and drinking water related to the PFOA, PFOS, PFNA, HFPO-DA, also known as GenX, PFHxS, and PFBS presence (US EPA, 2023).

Meanwhile, in Italy, the continuous change of ownership at Miteni came to a conclusion on 26 October 2018 when the board of directors terminated the history of the chemical company, declaring bankruptcy (Il Giornale di Vicenza, 2018). One year later, Viva Life Sciences Private Limited, an Indian company, won the Miteni licenses, equipment, and machinery in a public auction by adding just one euro to the starting bid. It is believed that the Asian company will move the production of per- and polyfluoroalkyl substances to India (Alba, 2019). In April 2021, «the largest trial for environmental crimes in contemporary European history» commenced in the Assize Court of Vicenza (Lanzavecchia et al., 2022, p. 414). Nonetheless,

requested to dispose of GenX, and if the relevant authorities did not consider regulating it, it is evident that this substance should not be present in any quantity, regardless of whether there are legally defined threshold values for it or not» (Greenpeace, 2018, p. 2).

[39] As reported by Girardi et al. (2018), available information on Miteni PFAS production only covered the period after 2001. This study monitored the PFAS concentration in the blood serum of Rimar-Miteni present and former employees and outlines that «there seems to be a correlation between serum PFOA concentration and the quantities produced» (p. 39).

the dismantling of the chemical plant was only finalised on December 31, 2022, with a two-year delay attributed to various technical challenges related to the Covid-19 pandemic and the Russian invasion of Ukraine (Zordan, 2022). Despite the contamination being discovered a decade ago, as of September 2023, no remediation has commenced at the site where Rimar-Miteni S.p.A. operated for more than fifty years.

2.5 Mapping the Contamination

Following the discovery of the contamination, the Regional Environmental Protection Agency conducted an extensive environmental investigation that led to the identification of the source and the plume of contamination (ARPAV, 2017). A monitoring network was consequently established to map the space-time evolution of the pollution within a 590 km^2 covered area and 52 groundwater monitoring network points. In this context, the maximum PFAS concentrations detected in drinking water were 1,214 ng/L found in Brendola, Lonigo, and Sarego (WHO, 2017). As a result, in 2016, municipalities within the provinces of Vicenza, Verona, Padova, Rovigo, and Venezia were divided into different colour zones according to the estimated health impact (Regione Veneto, 2018):

- Red area: "maximum health exposure", later divided into:
  Red A area: characterised by the highest concentration of PFAS in surface water, drinking water and groundwater;
  Red B area: characterised by high levels of PFAS in surface waters and groundwater;
- Orange area: for autonomous drinking water intakes which refer to municipal areas where PFAS exceedances have been detected in the autonomous surveyed intakes; it is characterised by private wells at risk of contamination;
- Yellow area: under observation, characterised by networks of environmental control systems for surface water and groundwater, including agricultural irrigation and watering;
- Green area: required further monitoring in which the PFAS were detected only in environmental matrices, requiring additional monitoring and studies.

Among the criteria related to the zones' division, there is the presence of a groundwater extraction well characterised by PFAS[40] exceedance, along with the requirement that the area must be «in hydrogeological consistency with the propagation of the contaminant plume originating from the industrial site of Trissino (VI)» (Regione Veneto, 2018). In 2018, the map was updated, and 9 municipalities were added to the red zone reaching a total of 30 municipalities.

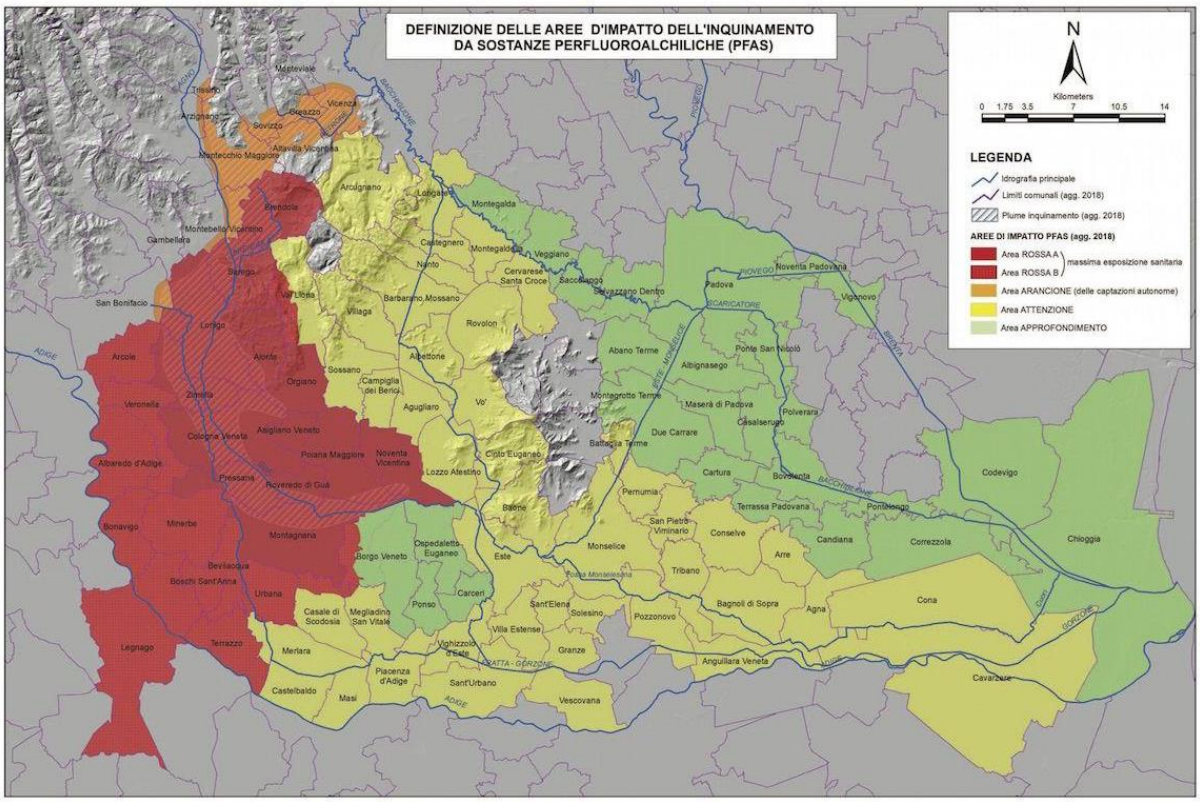

Figure 3: Definition of the areas impacted by Perfluoroalkyl Substances (PFAS) pollutions (Regione Veneto, 2018a).

2.5.1 The Regional Health Surveillance Program

Four years after the officialization of the contamination, the regional government initiated a free-of-charge health surveillance program to monitor the presence of PFAS in the population born between 1951 and 2002 within the red zone (Pitter et al., 2020). Starting in

[40] «superamento di uno dei limiti di performance (PFOS > 30 ng/l; PFOA > 500 ng/l; altri PFAS > 500 ng/l), definiti dal Ministero della Salute di cui alla nota prot. n. 2565 del 29/01/2014 e recepiti con la D.G.R. n. 1874 del 14/10/2014» (Regione Veneto, 2018). In English: "Exceedance of one of the performance limits (PFOS > 30 ng/l; PFOA > 500 ng/l; other PFAS > 500 ng/l), defined by the Ministry of Health in the note prot. n. 2565 of 29/01/2014 and incorporated with the Regional Government Resolution (D.G.R.) n. 1874 of 14/10/2014".

February 2017, residents from 21 municipalities were invited to participate and, in December 2018, the recruitment was extended to the paediatric population and then prolonged following the expansion of the red zone. Former Rimar-Miteni employees and those who were still working for the Trissino factory at the time were also invited to take part in the monitoring. The residents of the 9 municipalities that were added to the red zone in 2018 were invited to join the program in 2019. All the participants underwent a structured interview,[41] blood pressure measurements, and blood and urine sampling.

Due to multiple activity suspensions linked to the Covid-19 pandemic's health crisis, the health program has slowed. However, as of April 18, 2023, the Veneto Region reported that the initial phase of population surveillance for eligible individuals is mostly finished, encompassing over 106,000 residents from the red zone who have been invited, and a total of 63,000 visits have been conducted resulting in an adherence rate around 60% (Azienda Zero, 2023). For over 61,000 individuals, the first-level process is concluded while the second round starting in September 2020 at ULSS 8 Berica and in April 2023 at ULSS 9 Scaligera is currently underway (Azienda Zero, 2023).

In May 2023, the expansion of the regional health monitoring initiative to the orange zone occurred. Nevertheless, even though residents in the red zone had free access to the previous health monitoring program, those in the orange zone were presently obligated to pay a fee of €90. Furthermore, as of May 2023, data collected by the region indicated that only 42 individuals expressed a desire to partake in the initiative (Regione Veneto, 2023), even though the total population contacted amounted to 171,201 individuals (Pietrobelli, 2023a).

2.6 The Agricultural Sector

In relation to the presence of agricultural businesses in PFAS-contaminated areas, I could not locate any census data related to the number of affected agricultural enterprises. Moreover, I have not found assessments of the impact in terms of reduced production or quality of agricultural products within the provinces involved. As a result, there are no officially direct or quantifiable economic consequences within the agricultural sector. According to the region sampling plan for food which was carried out in 2016-2017, all varieties of vegetables and

[41] «The structured interview investigates residential history, education, occupation, dietary habits (including consumption of self-produced food), drinking water intake and sources (public distribution system, private well, bottled water), smoking habits, alcohol consumption, physical activity, family and personal history of disease, medications, reproductive history, and self-reported height and weight [...]» (Pitter et al, 2020, p. 2).

fruits are free from risks related to PFAS dietary exposure. For this reason, within the impacted areas, no limiting actions have been taken. The only exception has been made for the fish farming industry. According to a regional ordinance, there is a temporary ban, until December 31, 2023, on the consumption of fish caught in the red zone municipalities (Regione Veneto, 2022).

Concerning the economic repercussions, individuals I met during this research have consistently indicated a significant impact on the agricultural sector. However, estimating the precise economic consequences remains challenging. This complexity arises from the extension of PFAS contamination beyond the primary zone identified by public authorities. In the upcoming chapter, I will delve into this aspect explaining how fear, uncertainty, and scepticism shape consumer behaviour when it comes to purchasing products from agricultural activities situated in contaminated areas. Particularly for smaller enterprises that may be less equipped to handle market fluctuations, this dynamic may result in significant economic distress for the sector. Despite the absence of data related to the farming sector in the contaminated areas, it is important to outline that in 2020, Veneto was the fourth region in Italy in terms of number of agricultural enterprises (83.017), after Puglia (191.430), Sicily (142.416), and Calabria (95.538) (ISTAT, 2022). This number points out how agriculture is a relevant presence in the region.

For centuries, the agricultural vocation of the Veneto region has been a defining element of its identity. As I will mention in the next chapter, the farming sector of the region has been subject to numerous social and economic changes that have profoundly altered its landscape and culture. While talking with farmers, at first glance, I noticed that the agricultural sector is perceived as divided into two parts: conventional agricultural and alternative agriculture enterprises. This division is one of the most crucial distinctions made by my informants, which I believe is essential for comprehending the reflections presented in the third chapter. Before delving into the experiences and perspectives of farmers, it is crucial to explain this dichotomy. Broadly, conventional agriculture is known to often involve synthetic fertilisers and pesticides and is also frequently associated with monoculture farming. However, there is an ongoing discussion about the precise definition of conventional agriculture (Sumberg & Giller, 2022). As a point of reference for this thesis, I rely on the interpretation presented by de Ponti et al. (2012). According to them, this term

> […] generally refers to any agricultural system in which chemical inputs are used. Conventional agriculture may at present have high external inputs in industrialised

> countries and low external inputs in developing countries, but it does not rule out any external inputs that may be beneficial for its productivity (de Ponti et al., 2012, p. 2).

Certainly, as emphasised by Sumberg & Giller (2022), the distinction between conventional and alternative agriculture fails to capture the complexity of the sector adequately. Making such a clear-cut division within the farming industry is superficial and overlooks the diverse landscape of the agricultural world.

In the context of this research, all the companies I interviewed, except for one, identified themselves as practitioners of non-conventional or alternative agricultural methods. Some explicitly adhere to organic practices and hold organic certification, while others, lacking any official certification, explained how they distinguish themselves from what is commonly referred to as conventional agriculture. According to my informants, the latter involves intensive farming practices that entail the use of pesticides and chemicals. In Italy, agricultural businesses seeking organic certification must adhere to EU Regulation 2018/848, which outlines the system for the production, transformation, labelling, inspection, and certification of organic products within the European Union. Additionally, they must comply with Commission Implementing Regulation (EU) 1165/2021, which authorizes the use of specific products and substances.

Among the agricultural practices and habits employed by most of the farmers I met, there is the absence of machinery, pesticides, and synthetic fertiliser, the use of microorganisms, agroecological and biodynamic practices, just to mention a few. Furthermore, the farmers I spoke with are all employed in or manage small-scale operations, often run as family enterprises. These small-size activities, with land holdings ranging from 1 to 15 hectares and their workforce compositions varying from two to fifteen employees, are the only ones that accepted my presence.

2.6.1 Biomonitoring Program

From 2015 to 2016, a study was conducted to evaluate PFAS exposure in two groups: one group lived in the affected areas (red zone) where drinking water contamination was confirmed, while the other group resided in nearby areas of the Veneto Region that were unaffected by PFAS water contamination. The study analyzed blood samples from 507 individuals aged 20-49 years and 122 farmers, and it was conducted by ISS, ARPAV, and local health care trusts (Ingelido et al., 2018). A total of 629 participants were included in this human

biomonitoring study, comprising 257 individuals living in municipalities affected by the contamination, 250 individuals residing in municipalities with presumed background exposure, and 122 farmers[42] residing in contaminated rural areas who engaged in livestock and vegetable production, as well as frequent use of well water for consumption. Blood samples were analyzed between July 2015 and April 2016, by Italian National Institute for Health (Istituto Superiore di Sanità, ISS) in collaboration with the Region and the Local Health Units (Unità Locali Socio-Sanitarie, ULSS) (Ingelido et al., 2018). The results showed how the PFAS blood concentration within the exposed populations was higher than in the unexposed populations. Indeed, the median PFOA and PFOS levels detected in the background exposure group were 1.64 ng/g and 5.84 ng/g while for red zone participants was 13.8 ng/g and 8.69 ng/g (Ingelido et al., 2018; WHO, 2017).

The exposed farmers' subgroup comprised individuals residing in 17 municipalities located within the red and orange zones who were considered to be at a higher risk of overexposure to PFAS due to their involvement in producing and consuming their own livestock and vegetables (Ingelido et al., 2020). The analyses were conducted at ISS, where several PFAS, namely nine perfluorocarboxylic acids (PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUdA, and PFDoA) and three perfluorosulfonates (PFBS, PFHxS, and PFOS), were measured in serum samples. Most of the farmers taken into consideration by the study watered fruits, vegetables, and animals using well water. A «significant percentage of subjects» (Ingelido et al., 2020, p.4) reported consuming bottled water, indicating their growing concerns about PFAS contamination in the local water supply through the years. However, according to the study, it cannot be ruled out that tap or well water was also used for drinking, and it is reasonable to assume that this might have been the case in the past. The research outlined how PFOA showed

> [...] the highest median concentration: it was almost three times higher than in E [Non-farmer exposed] group (14 ng/g) and 25 times higher than in NE [Not-Exposed] group (1.6 ng/g). On the whole, PFAS serum levels in EF [Exposed Farmers] subjects were significantly higher (Ingelido et al., 2020, p. 5).

It is highly probable that additional exposure to PFAS can be attributed to the widespread consumption and use of non-public drinking water sources, particularly well water. This includes the use of well water and groundwater for irrigation of vegetables and livestock raised

[42] «Participants were selected in each area and stratified by gender and age (age classes: 20–29, 30–39, and 40–51 years). Each subject had resided in an area for at least 10 years. The additional selection criteria for EF were to produce fruits or vegetables and/or to raise farm animals» (Ingelido et al., 2020, p. 3).

for personal consumption, especially during the 10-year period of residing in rural environments, which was one of the inclusion criteria for the study. This observation is supported by the findings described in the Not-Exposed group, where higher concentrations of PFAS in serum were associated with the duration of residence in the affected areas and the practice of cultivating vegetables and raising livestock for personal use (Ingelido et al., 2018). Furthermore, the findings of Ingelido et al. (2020) indicated a potential spread of contamination to other environmental media, including neighbouring geographic areas that are not directly impacted by drinking water contamination. It is important to note that these areas were not incorporated into the map created by regional authorities.

Overall, the research carried out by ISS provided support for the hypothesis that the practice of irrigating vegetables and animals with contaminated well water and groundwater has contributed to increased exposure among farmers through food consumption. Following the fact that the quantification of the food eaten was based on self-reported data, the study had a limitation in adequately characterising the contribution of local food consumption to serum concentrations of PFAS (Ingelido et al., 2020) but it offers a relevant overview on the agricultural sector exposed to the contamination. Indeed, Ingelido et al. (2020) outlined how:

> The highest PFOA concentration (720 ng/g) was observed in a 44 years old man, which was the only subject with serum concentrations of 5 PFASs (PFHpA, PFOA, PFDA, PFHxS, PFOS) above their respective P95 values. This subject has all the main determinants of exposure detected in the study: he is a male, born and resident in ULSS 5, he drank tap water and consumed own fruits, vegetables and animals grown and raised with local water.

Therefore, «PFOA serum concentrations in farmers residing in the areas of the Veneto Region impacted by PFAS contamination are among the highest found worldwide» (Ingelido et al. 2020, p. 7).

2.6.2 The Sampling Plan for Food Testing for Perfluoroalkyl Substances

In the years 2016-2017, the ISS, ARPAV, and the Experimental Zooprophylactic Institute of Veneto carried out a monitoring program for PFAS food contamination promoted by the Veneto Region. Titled “Piano di monitoraggio degli alimenti in relazione alla

contaminazione da sostanze perfluoroalchiliche (PFAS)" ("Sampling Plan for Food Testing for Perfluoroalkyl Substances"), it was conducted in the municipalities of the red zone by sampling 27 types of food, with a total of 1,248 samples (614 of plant origin, and 634 of animal origin). As outlined by Mothers NoPFAS & Greenpeace Italia report (2021), most of the samples come from farms that use well water. However, it is worth noting that the food analyses performed as part of the regional monitoring program rely on data from the European Food Safety Authority (EFSA) dating back to 2017 and have not been updated to incorporate the new 2018 and 2020 thresholds. Indeed, after a few months of the sampling monitoring program, in March 2018, EFSA issued new tolerance limits for PFAS intake through the food chain. It transitioned from a daily dose (TDI) to a weekly one (Tolerable Weekly Intake, TWI),[43] setting the limit for PFOS at 13 ng/kg of body weight. For PFOA, the new limit is 8 ng/kg of body weight, which is 1,750 times lower than the one used in the monitoring assessment (Greenpeace, 2023). With these new reference values, most of the samples from the Veneto region exceed the new European threshold. Two years later, in 2020, EFSA introduced a new safety threshold for the primary PFAS compounds (PFOA, PFOS, PFNA, and PFHxS). This threshold is established at 4.4 ng/kg of body weight per week as a TWI (EFSA, 2020). In 2019, the region initially opposed the publication of the findings, and the results were not disclosed to the public. It was only thanks to the efforts of Mothers with Greenpeace, who appealed to the court, that the results were eventually published two years later in April 2021. Despite having considered only PFOA and PFOS, the ISS study detected additional PFAS molecules which were not considered. Moreover, Mothers NoPFAS & Greenpeace Italia report (2021) emphasised how the monitoring process did not analyse certain important food items commonly produced in the region, such as spinach and radicchio (with only one sample each), as well as kiwi, melons, watermelons, wheat (with only one spelt sample analysed), soy, apples, and various leafy vegetables. According to them,

> This assessment reduces the previous limit set by the same European authority in 2018 for just two compounds (the sum of PFOA and PFOS) by more than four times (19 ng/kg of body weight). Despite this significant downward revision of safety parameters having occurred for over a year, it is incomprehensible, and even less acceptable, that no new

[43] The Group Tolerable Weekly Intake (TWI) is a concept used in food safety and toxicology to quantify the acceptable amount of a particular substance that can be ingested by an individual over a given period of time, a week, without appreciable health risks (EFSA, n.d.)

> assessment has been carried out, let alone concrete actions to protect the population and the agri-food and livestock sectors by the Veneto Region.[44]

According to Commission Recommendation (EU) 2022/1431, issued in August 2022, all member states were urged to evaluate the presence of 27 PFAS in all food matrices, including organic production. In addition, those responsible for monitoring, such as health authorities and environmental regional agencies (ARPAs), are required to adhere to EFSA protocols. Feedstuffs are also subject to EU scrutiny, as they are considered a means of transmission to livestock animals. Additionally, with Regulation 2023/915, on April 25, 2023, the European Commission established maximum levels for certain PFAS in specific food products. In this context of constant regulation updates, according to the ISS:

> The monitoring study provided an initial characterization of PFAS contamination levels in the main agri-food productions of the red zone, highlighting presence levels higher than background levels in some food matrices, particularly for PFOA and PFOS, in matrices of animal origin (eggs, pork muscle, pork liver, cattle, and poultry). This initial data indicated the need for specific attention to the potential exposure to PFAS in the livestock sectors.[45]

2.7 "Better things for better living... through chemistry"

DuPont's 1935 slogan, "Better things for better living... through chemistry," emphasised how the expansion of the chemical industry was intended to preserve the environment by reducing the need for biomass and providing alternatives to scarce or costly natural materials (Jarrige & Le Roux, 2020). As previously mentioned, Giannino Marzotto was driven by a similar intent to protect the environment. He wanted to avoid the discharge of tinctures and chemical compounds in the Agno River. Due to this reason, he started the production of PFAS to support the textile manufacture of the Marzotto Group. As in the case

[44] «Tale valutazione riduce di più di quattro volte il limite precedentemente fissato dalla stessa autorità europea nel 2018 per soli due composti (somma PFOA e PFOS 19 ng/Kg di peso corporeo). Nonostante la forte revisione al ribasso dei parametri di sicurezza sia avvenuta da più di un anno non è comprensibile, e tantomeno accettabile, che non sia seguita alcuna nuova valutazione né tantomeno un'azione concreta di tutela della popolazione e delle filiere agroalimentari e zootecniche da parte della Regione Veneto» (Mamme NoPFAS & Greenpeace Italia, 2021).

[45] «Lo studio di monitoraggio ha offerto una prima caratterizzazione del livello di contaminazione da PFAS delle principali produzioni agro-zootecniche dell'area rossa, evidenziando livelli di presenza superiori a quelli di fondo in alcune matrici alimentari, in particolare, per PFOA e PFOS, in matrici di origine animale (uova, muscolo suino, fegato suino, bovino e avicolo). Questo primo dato ha indicato la necessità di una specifica attenzione verso la potenziale esposizione ai PFAS delle filiere zootecniche» (Regione Veneto, 2022a, p. 1).

of other human-made chemicals, the story of per- and polyfluoroalkyl substances raises questions about the responsibility of science in safeguarding human and environmental well-being and the consequences when this responsibility is compromised. However, by observing the history of PFAS, it is important to highlight how the military sector contributed to the petrochemical industry development. It is essential to recognise that numerous technological advancements have their origins in warfare research. Particularly during and after the World Wars, innovations - ranging from chemical substances to new logistical systems - stemming from conflicts, were accompanied by unprecedented increases in pollution and the exploitation of natural environments. Furthermore, as pointed out by Jarrige & Le Roux (2020), the absence of wartime research would have likely resulted in slower progress or even the unavailability of the inventions that have defined the past century. Without wars, for instance, chemical giants such as Monsanto and DuPont would not have produced the compounds that today are ubiquitously present in the environment and in human and nonhuman bodies (Jarrige & Le Roux, 2020). Within this scenario, conflicts have not only frequently prompted a redefinition of humans' relationship with nature, including the nature-society dichotomy, but they have also fostered the development of ecological knowledge within human communities (Jarrige & Le Roux, 2020). Considering this, regions marked by warfare and military installations often manifest distinct characteristics as *toxic timescapes* (Biggs, 2023). Being today legacies of past practices within the petrochemical-military industrial society, PFAS pollution stemming from the utilisation of Aqueous Film Forming Foam (AFFF) in firefighting have been intentionally ignored or simply faded from memory over time. Today, especially in the United States, military bases are the most common locations where per- and polyfluoroalkyl substances have been detected at high rates[46] (Environmental Working Group; n.d.). This has been a continuous issue for numerous years across the states during training exercises, routine testing, or emergency responses, and in many instances, records of such use are non-existent (Renfrew & Pearson, 2021).

Beyond the local context of Veneto contamination, what I explored in the previous pages shows the global dimensions of these chemicals. These toxic compounds are emblematic of a political-economic system driven by US-led globalisation. Following the industrialisation of Italy in the aftermath of World War II, the production of Teflon was established at the chemical plants of Spinetta Marengo and Trissino, importing the first PFAS patents to Italy. In the early decades

[46] According to the Environmental Working Group, there are 710 military sites affected by known or suspected discharges of PFAS (EWG, n.d.).

following the foundation of Rimar-Miteni, DuPont and 3M held a monopoly in the US market, while in the Veneto region, Giannino Marzotto and his successors aimed to gain ground in the European market. This is part of the process that led to the globalisation of per- and polyfluoroalkyl substances. Similarly, during the history of Rimar-Miteni, the commercial success of these anthropochemicals and their growing presence went hand in hand with the remarkable transformations that have taken place within the industrial Veneto landscape. The transition from early attempts at a welfare-oriented industry - exemplified by the Marzotto family's initiatives - to the transnational nature of PFAS production and distribution, led by petrochemical giants, complicates accountability and externalises the damage to fragmented, imprecisely temporal, and localised spaces. By providing services and a substantial number of job opportunities, some companies have managed to establish their roots in the territory as Marzotto Group did. The case of Rimar-Miteni is emblematic of this trend but also illustrates how its presence has faded over the years. Indeed, it has transitioned from a company linked to the most prominent entrepreneurial family in the area, namely the Marzotto family. This transition involved a series of ownership changes that have propelled it into the international market, making it even more challenging to identify those responsible for its polluting practices. In this sense, the time in which the "industrial paternalism" of the Marzotto family aimed to build public infrastructure and welfare systems for the communities cooperating with public institutions is a distant memory.

Over the past two decades, there has been a heightened focus on per- and polyfluoroalkyl substances, involving regulatory bodies, companies, and research institutions. This has led to a significant reduction, by approximately two orders of magnitude, in the amount of PFAS present in drinking water under international regulations.

PFAS can be analysed from diverse critical perspectives. I already outlined the PFAS' characteristics as residues (Boudia et al., 2018). What I have not emphasised so far is that residues can transition from serving as valuable assets for the petrochemical sector, such as by-products for other chemicals, to becoming waste to be disposed of specifically industrial leftovers. Once dumped as wastewater, PFAS are allowable pollution that is supported by institutional threshold levels (Liboiron, 2021). As chemical residues, they «shouldn't appear, alter environments, and enter communities and bodies without permissions» (Boudia et al., 2018, p. 167). However, this is exactly what per- and polyfluoroalkyl substances did for decades in the Veneto Region. At the time of discovering the contamination, no threshold was applied, and their presence was deemed imperceptible. While the attention on the importance of regulating PFAS is increasing, it is essential to highlight that profit-driven dynamics and

unregulated environmental exploitation are still part of the problem. As briefly indicated, licences, equipment, and machinery have been acquired by Viva Life Sciences Private Limited, an Indian company that will relocate the production of per- and polyfluoroalkyl substances to India.

3. Cultivating in the PFAS Land: Farmers' Experiences and Perspectives

The aim of the chapter is to discuss the outcomes of my ethnographic research within the agricultural sector in the orange and red zones. In this chapter, by reflecting on the time spent with farmers, I will attempt to answer to these questions: How did they experience the contamination? What do they think about what they have experienced? To do so, I will render the presence of per- and polyfluoroalkyl substances in the agricultural sector visible and perceptible. While the first section will serve a further introduction by providing a description of the PFAS Land, farmers' perspectives and experiences are analysed in the following three sections by taking as a point of references the three *Ls* (Latency, toxic Layering, and Limit). In the last two sections, I reflect on the role and actions of different actors involved in this contamination. I continue the exploration through the challenges farmers face in dealing with community mistrust and fear related to PFAS contamination. Michelle Murphy and Max Liboiron's ideas offered potential solutions. Such alternative models could help address petrochemical violence and redefine relationships between people, land, and industry in contaminated areas like the Veneto region.

3.1 The PFAS Land

"The idea is that this is a calamity that has occurred and has removed the lid on a series of things, but the cauldron is infinite."[47] According to Eric, the farmer who uttered this sentence, the discovery of PFAS contamination has opened a can of worms. Through my research, I have come to understand that the PFAS Land represents a collection of locations where chemical exposure is pervasive and established as a routinized practice. Different *chemosocial*[48] pathways compose the layers of this geographical and social context. The whole PFAS-contaminated area is a sub-class of the larger landscape of the Po Valley, the so-called *Pianura Padana*, that represents almost one-fourth of the entire country's surface. Such flat

[47] "L'idea è che questa è una calamità che è successa e che ha aperto, tolto il coperchio a una serie di cose, ma il pentolone è infinito" (Eric, 2 March 2023).

[48] Following Shapiro and Kirksey (2017), I believe the meetings I have had with farmers are forms of chemosociality that «involves novel, altered, attenuated, or augmented relationships that emerge from shared and shifting chemical ecologies» (p. 484). In this sense, PFAS have constantly shaped the relationships I established during my fieldwork with farmers. These contaminants have been somehow part of the conversations.

land is a geographical area in which pollution is normalised.[49] Moreover, it has been linked to specific historical and political narratives and it is composed of shared macroregional features (Rumiz, 2013). By outlining its urban and social peculiarities, Eugenio Turri (2001) has renamed this macroregion *Megalopoli Padana* ("Po Megalopolis"). This label encompasses a geographic continuum that, like a single urban unit, stretches from Turin to Milan and extends to the Veneto-Friuli cities on one side, and from Turin to Bologna and Rimini on the other.

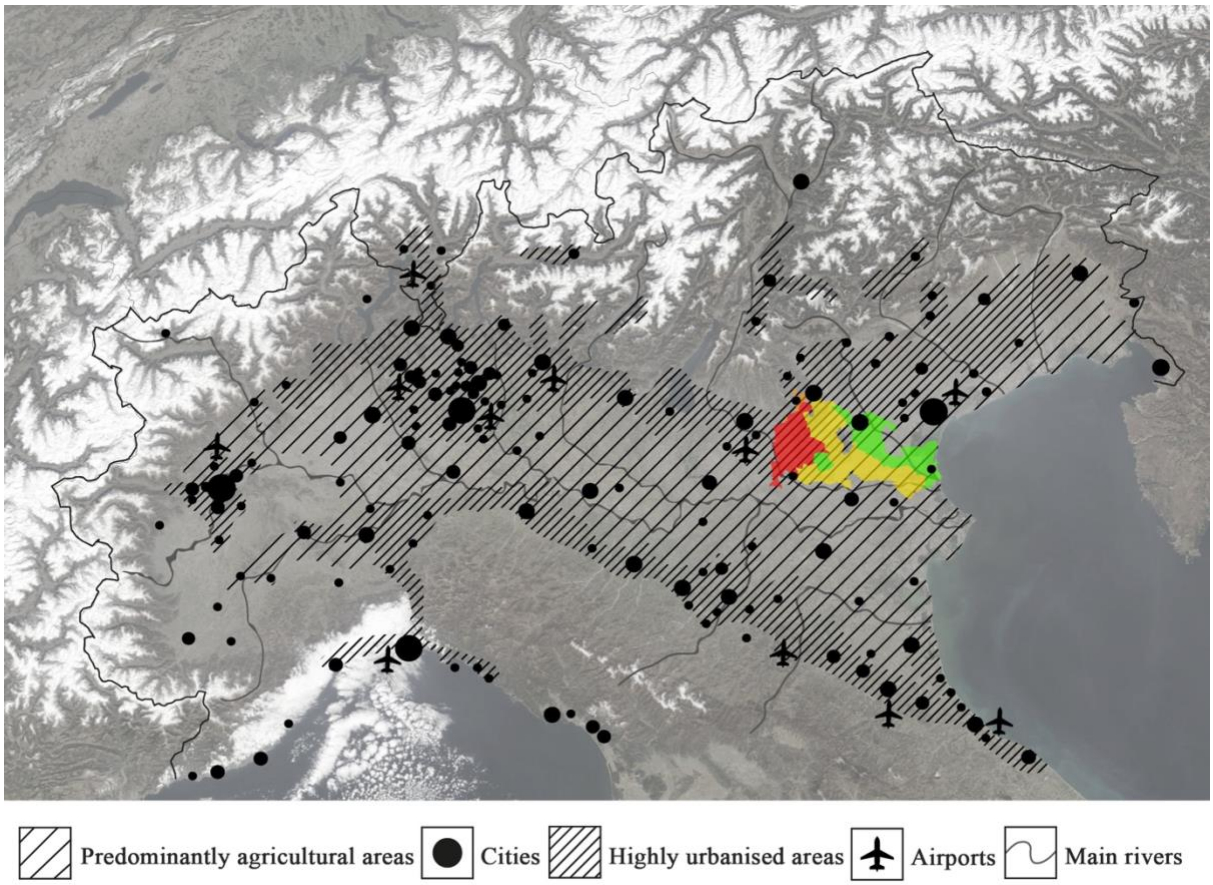

Figure 4: Northern Italy by NASA overlapped with the Megalopoli Padana map and the PFAS contamination regional map (Designed by the author; Sources: NASA, 2023; Regione Veneto, 2018a; Turri, 2001, p. 18-19).

According to Turri (2001), the Po Valley has become a dispersed single city, thus forming a "megalopolis" that, however, does not reflect the particularities of a megacity. Instead of having eye-catching infrastructures and skyscrapers, this landscape is still marked by elements of its rural past. In this macroregion, most of the waters of channels, rivers, and other streams enter the principal Italian waterway, the Po River. By crossing one of the most extensive

[49] When I use the word 'pollution' I follow Liboiron's definition: «[p]ollution was (and still is) about naming a deviation from the good and true path of things—good relations manifested in the material» (p. 19).

industrial zones of the European continent, this river brings a large part of the industrial wastewater to the Adriatic Sea. Indeed, the Megalopoli has emerged as a confluence of industrial waste, both legal and illegal, and a construction sector that has contributed to its morphological impoverishment, resulting in both aesthetic and ecological detriment (Quagliato & Rinaldi, 2021). As outlined by Roberta Raffaetà (2013), these changes have influenced how communities perceive the socio-material environment of the *nordest*, contributing to the emergence of a sense of nostalgia. This feeling of longing, rooted in their peasant heritage, is expressed through notions of naturalness that stand in contrast to the growing pollution levels and industrialisation. Raffaetà argues that in Italy the concept of naturalness is pervasive, connecting notions of health to morality, politics, and aesthetics.

In this intricate terrain, when scientists traced PFAS watery trajectories in the Po River,[50] thereby discovering the polluted practices carried out by the Rimar-Miteni facility, they opened a can of worms. First, they discovered that the main Italian river is the one with the highest presence of PFAS in Europe. Then, they gradually uncovered the largest PFAS contamination in the continent, initiating a long process of revelation and acknowledgment that is still ongoing. During my research, I observed that PFAS has raised unresolved questions that are connected with even tougher inquiries, such as how surveillance regulatory systems are structured; the ethical implications of long-term environmental contamination; the complex interplay between corporate interests and public health; and the role of victims and communities in shaping and challenging petrochemical powers and violence. These issues arise from multiple factors that intersect in the highly anthropized background of Italy together with the social and political apparatus in the late industrial society.

Within the PFAS Land scenery, the everyday low-dose consumer culture[51] that characterised the Global North economy is combined with a persistently polluted background, a routinized and normalised chemosphere. The cultural and economic spheres mutually reinforce each other, driven by the fact that the Megalopoli Padana stands as one of the most industrialised areas in the European continent. Indeed, research underscores that this densely urbanized area is marked by elevated emissions from both vehicular traffic and industrial sources, combined with frequently stagnant meteorological conditions. This convergence of factors makes this macroregion one of the most polluted regions in Europe (Khomenko et al., 2021). Here, by

[50] I refer to the PERFORCE project (McLachlan et al., 2007) and to Polesello et al., (2013), already mentioned in chapter 2.

[51] With "low-dose consumer culture" I refer to the Western consumerist habits that are based on exposure to low levels of chemical substances (such as heavy metals, human-made contaminants as POPs etc.) that enter our bodies daily (Renfrew & Pearson, 2021).

interacting in this human-made complex environment, local human-driven incidents, the effects of anthropogenic global warming, and the Covid-19 pandemic are compounded by the presence of harmful chemicals. However, these intersections involve multiple social and public actors that merge following a network of interconnected relationships between the human and the nonhuman realm. These interconnections can be ascribed to the label of "ecology of infrastructure." Such a term, coined by Susan Leigh Star (1999), has been taken as a point of reference by Michelle Murphy (2017) in her analysis of the Polychlorinated biphenyls (PCBs) pollution along the St Clair River – a river flowing between the US and Canada border – and it will offer a guideline to explore the synthetic harmful trajectories that farmers have experienced.

Since the beginning of PFAS production in Veneto, the slippery features of these substances were exacerbated by the *laissez-faire* strategy of public and private institutions. This is a fundamental aspect of the "cauldron" that Eric mentioned. On this basis, in this section, I will provide a brief description of PFAS Land, starting from my initial visit to the red zone. Subsequently, I will introduce some of its distinctive features that I will further describe in the next sections. I conceived this part as introducing the investigation of the experiences and viewpoints of the agricultural sector.

On the first day of my field research, I spent most of the time with Diego. Claudia, his partner, arrived later and brought us lunch, and we had it all together. It was a cold and sunny November morning; they were the first farmers who agreed to share their time with me. As I travelled to meet them, I experienced a sense of apprehension. Previous research in the Veneto region conducted by Bettoni (2018) and Zamperini & Menegatto (2021) emphasised the scepticism and exhaustion expressed by communities affected by PFAS contamination when discussing their experiences. Consequently, I anticipated encountering similar challenges. In fact, as explained in the methodology section, during the initial phase of the research, I faced difficulties finding farmers willing to share their personal experiences regarding the contamination. While preliminarily contacting farmers, I received many refusals and many conflicting answers. I approached 51 agricultural businesses but only 7 accepted to talk. The remaining 44 farmers eventually declined or ghosted me. Those who replied often denied any connections with the PFAS contamination. For instance, by approaching by email an agricultural business located within the red zone, a person answered me that «PFAS have not caused any issues»[52] to their company, thus also denying any direct or collateral damage caused

[52] «mi spiace tanto ma per la nostra azienda i PFAS non hanno creato nessun problema» (E-mail answer, 2022).

by PFAS exposure. However, other enterprises situated in the red zone were eager to meet with me and share their painful experiences. I believe that these responses, along with others, were influenced by fear, scepticism, and panic. All these elements are found in the PFAS' "cauldron."

I consider the silences I encountered precious information. The concepts of silence, speech, and (in)visibility may be explored by taking into consideration the irregularity in which silence «takes the most multifaceted and ambiguous forms» (Samuels, 2021, p. 500). Indeed, it is difficult to assert what silence meant in this investigation. According to Stefan Hirschauer (2006), those who embrace the ethnographic method encounter limits related to what can be articulated, encompassing areas of the «voiceless, the ineffable, the speechless, the indescribable, the pre-linguistic, the mute, and that which reveals itself wordlessly» (p. 424). The key practical dilemma in ethnographic writing resides in the process of transposing intensely private aspects, such as one's personal sensory perceptions, into the public domain of academia (Hirschauer, 2006). Within the PFAS Land, at first glance, silence can be perceived as indescribable. From my point of view, in the threatening and distressing context of the contaminated zones, the unspoken entails many different feelings for farmers. Silence, like PFAS exposure, is also influenced by the personal stories of individuals and their socio-cultural and political interactions. As I will show later, the majority of the farmers' decisions were driven by the necessity to safeguard their agricultural productivity and income. Due to these reasons, many of them provided me with conflicting statements. Therefore, in my interactions, silence is also associated with the fact that my research partners were often tired and not inclined to discuss the topic. This is compounded by the frequent lack of understanding and general scepticism that I perceived during my interviews.

However, silence was not a part of the time I spent with Claudia and Diego. Especially Diego was eager to talk and answer my questions. They cultivate a small plot of land. It is the smallest enterprise in terms of field size that I visited. At first glance, their farmland catches the eye due to the variety of species planted in such a limited space. Around their crops, the surroundings were covered with agricultural fields and small settlements. As I will observe again during my visits in the contaminated zones, most of the area nearby the places I visited is devoted to monoculture conventional farming that is interspersed with small-scale agricultural businesses like Diego and Claudia's. Along with the industrial districts, this combination of fields and concrete represents the typical scenery of the PFAS land. Within agricultural areas in Europe, the effects of neoliberal capitalism have led to what Harvey (2004) calls "accumulation by

dispossession," namely the consolidation of land and assets by major agribusiness corporations to the detriment of small-scale farmers (Mamonova & Franquesa, 2020).

A few hundred meters away from the couple's crop, the noise of trucks and cars made me notice the presence of one of the main highways of the region. In these areas, roads are made only for motorized transport, with no sidewalks. As I will see in other parts of the impacted zones, the colours and the texture of the land transmit how the pursuit of productivity has shaped the landscape. By approaching their crops, I observed not only concrete and industrial warehouses, both emblematic of the industrial character of the Veneto region, but I also came across small urban conglomerates where the architectural legacy of Andrea Palladio[53] is still perceptible yet simultaneously hidden, surrounded by hedges. In this sense, in 2001, Turri wrote:

> The industrial warehouse is the type of building that repeats itself the most, the leitmotif of this endless, indescribable parade that seems to be more about display than functionality. Nevertheless, it obscures the view of the countryside's background, the pre-Alpine mountains, hills, castles, the remnants of memory and art, and the monuments of the past.[54]

Such background represents one manifestation of the *geografie smarrite*, or "lost geographies," a phrase that has been used by Francesco Vallerani & Mauro Varotto (2005) to portray the human detachment from their surrounding ecologies typical of the *nordest*, the Northeast of Italy. In my opinion, this separation is also the result of a long-term process that, starting from the tumultuous decades of pellagra in the Nineteenth century and passing through the massive outbound migration that occurred in the Veneto region, paved the way for the economic, urban, and social changes that involved the regional landscape, today transformed by PFAS and other anthropochemical trajectories.

According to Vallerani (2013), these geographical and social detachments went through the transition from small agricultural business to artisanal entrepreneurship. Indeed, after the so-called economic Italian boom (1953-1963),[55] several factors such as institutional clientelism, geographical texture, demographic growth, and polycentrism - typical of the Pianura/Megalopoli Padana - have fostered the rise of many small businesses linked with

[53] Andrea Palladio (1508-1580) was an Italian Renaissance architect active during the Venetian Republic within the province of Vicenza, Padova, and Treviso.

[54] «Il capannone è il tipo di edificio che più si ripete, il leitmotiv di questa interminabile, inenarrabile sfilata che non si sa se più esibitoria che funzionale, ma che in ogni caso toglie alla vista i retroscena campestri, le montagne prealpine, i colli, i castelli, i dati della memoria, dell'arte, i monumenti del passato» (Turri, 2001, 58-59).

[55] «decennio febbrile (1953-1963) del boom economico» (Vallerani, 2013, p.137).

traditional artisan knowledge (Vallerani, 2013). It is also the rise of voted individualism, which will reflect the emerging neoliberal economic system and the spread of illegal constructions.

> This ability to "make do" in construction can be attributed to deeply ingrained attitudes, a sort of endemic predisposition to self-exploitation just to erect four walls, which can have significant effects on the rural landscape, often not accounted for by existing regulations. The practice of building abuse, and the subsequent enthusiasm for amnesty, should still be considered as a symbol of individual affirmation, as the long-awaited redemption after centuries of mixed existences, as an opportunity to establish oneself independently, freed from the control of "siori"[56] (lords), be they old landowners or first-generation factory employers.[57]

In the post-war period, the agricultural field and the farm shed made way for the industrial warehouse. The Venetian peasants transitioned into factory workers, establishing their businesses on their property. During these social changes, the phrase "better dying of cancer than of pellagra" (in Venetian dialect: "Xe mejo morir de tumore che de pelagra") has become widely known in the Veneto region. In my view, this sentence encapsulates what the Veneto communities and those affected by the Rimar-Miteni disaster have internalized over generations: the prioritization of economic prosperity above all, even at the expense of their health.[58] Such give-and-take is an integral part of the neoliberal economic system that characterizes life in the Capitalocene-Anthropocene. To explain this compromise, which I consider one of the theoretical pillars of this dissertation, I take the concept of double bind from Thomas Hylland Eriksen's *Overheating: An Anthropology of Accelerated Change* (2016) which resumes a series of reflections from Gregory Bateson's *Steps to an Ecology of Mind* (2000) to offer a new perspective on issues including energy consumption, mobility, cities, and waste in the current time. While Bateson initially developed the notion of double bind in the context of schizophrenia studies, focusing on pathological family relations and communication, Eriksen adopted the same term within the Anthropocene zeitgeist. According to him:

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[56] "Siori" is a Venetian dialect word.

[57] «Questo saper "arrangiarsi" nell'edilizia è riconducibile ad attitudini assai radicate, una sorta di endemica predisposizione all'autosfruttamento pur di tirar su quattro muri, in grado di produrre rilevanti effetti sul paesaggio rurale, quasi sempre non contemplati dalle normative vigenti. La pratica dell'abuso edilizio, e il conseguente entusiasmo per la pratica del condono, va comunque valutata come simbolo dell'affermazione individuale, come l'agognato riscatto dopo secoli di esistenze promiscue, come l'occasione di mettersi in proprio, svincolati dai siori, siano essi il vecchio proprietario terriero che il datore di lavoro nelle fabbriche di prima generazione» (Vallerani, 2013, p. 150).

[58] On the topic, an interesting podcast is Chiara D'Ambros' (2020) *A Tutti i Costi* (RadioRai3) which precisely deals with the contamination caused by Rimar-Miteni.

> In the contemporary world, the world of the Anthropocene and neoliberal runaway growth, the double bind of growth and sustainability is a fundamental contradiction. It seems impossible to have it both ways (Eriksen, 2016, p. 23-24).

Eriksen locates the conflict between economic development and sustainability from many different angles. By addressing the nexus between energy and environmental degradation, he quotes Trawick & Hornborg (2015) who outlined how economic growth is a «physically destructive process» which lies in the exploitation of «limited stocks of natural resources» (p. 16). This double bind, namely the dedication to perpetual economic growth in a context of overuse of limited natural resources, has faced criticism from some of the farmers I met. In opposition, the phrase "better dying of cancer than of pellagra" symbolizes the pursuit of prosperity among Venetian peasants, who were weary of being forced to eat only polenta[59] at every meal, due to the imposed maize monoculture, and were eager to improve their social status. In light of this complex terrain, dynamics of ecological disruption have been tolerated by many: land mismanagement has been carried out, waste has been buried, water has been contaminated, and the air has become polluted.

> But the urbanized countryside is also an agronomic transformation resulting from the rapid and noticeable loss of workers in the agricultural sector, the spread of new production processes, new distribution rules, and crop management. From a landscape perspective, this translates to a simplification of traditional physiognomic structures and ecological degradation due to the prevalence of monocultures, which have led to the removal of tree hedges, the burial of a large portion of ditches and drainage channels, the abandonment of rural settlements, and, in summary, a general disregard for non-productive aspects of the landscape.[60]

In 2021, Veneto region ranked second in land consumption, following Lombardia, and it maintained the same position in terms of the annual increase in land consumption during the

[59] Between the Nineteenth and Twentieth centuries, the introduction of salaried work and the transformation of *mezzadri* into the modern proletariat played a pivotal role in the Pellagra outbreak. Alberto De Bernardi, in his book *Il Male della Rosa: Denutrizione e Pellagra nelle Campagne Italiane fra '800 e '900* (1984), well illustrates how specific economic trends went hand in hand with structural and cultural changes in the agricultural sector which, in turn, triggered poor sanitation and dietary deficiencies exacerbating the expansion of pellagra within peasants.

[60] «Ma la campagna urbanizzata è anche trasformazione agronomica a seguito della rapida e vistosa perdita di addetti nel settore agricolo, della diffusione di nuovi processi produttivi, di nuove regole distributive e di gestione delle colture e ciò in termini paesaggistici significa una semplificazione dei tradizionali assetti fisionomici, nonché un degrado ecologico dovuto al prevalere delle monocolture che hanno imposto la rimozione delle siepi arboree, l'interramento di gran parte dei fossati e delle scoline, il disuso delle sedi rurali e, in sintesi, una generale disaffezione nei confronti degli aspetti non direttamente produttivi del paesaggio» (Vallerani, 2013, p. 151)

same year (DeAndreis, 2022). In recent decades, the region has exhibited a tendency to invest in costly and environmentally impactful infrastructure development. Indeed, Veneto is also home to the most expensive infrastructural project ever constructed in Italy, the MOSE, an electromechanical barrier designed to protect the Venice lagoon. In addition, in 1963 the region faced the consequences of a landslide that shook the Vajont dam which caused a megatsunami that resulted in the death of almost 2,000 people. The dam, one of the highest dams ever built, was constructed without sufficient geological examinations, and the acquisition of building permits was facilitated through connections with political and financial authorities. Additionally, the regional government is completing the construction of the Pedemontana, a highway that divides the region from east to west for 94 kilometres, and plans are underway for the extension of the High-Speed Train (Treno ad Alta Velocità, TAV) between the provinces of Vicenza and Verona, above the PFAS-contaminated groundwater basin. The construction of the aforementioned infrastructures has been accompanied by intense public debates in which environmental concerns have been overshadowed (cfr Vianello, 2020), driven by productivity-focused and technocratic policies that disregard environmental and social disruption.

Figure 5: Vineyard in the red zone (March 2023, photo by the author).

Pollution and contamination are typical features of the economic development of the region. Cities like Vicenza, Verona, and Padua are characterised by concerning levels of air pollutants (PM 2.5, PM 10, and NO_2) (Minutolo et al., 2023; Pivato et al., 2023). On the edge of the Po Valley, Porto Marghera is the industrial district of Venice and one of the largest in Italy. Due to the decades-long discharge of hazardous substances from petrochemical plants, this site and its neighboring areas were affected by air, soil, and groundwater pollution. Consequently, Porto Marghera was included in the list of Siti d'Interesse Nazionale (SIN) ("National Interest Sites"), made by the Italian government to track and monitor the largest contaminated sites that require land reclamation. While moving towards the Venetian mountains, the contrast between being a UNESCO heritage site and a region characterised by the intensive use of pesticides and monoculture in vineyards becomes evident in the hills of Treviso and Belluno. Therefore, the industrial district of Vicenza, in which also Rimar-Miteni has operated, offers locations that condense the concept of "sacrifice zone" (Juskus, 2023). Just to mention a couple of examples, the hexavalent chromium contamination in corrispondence of ex Galvanica PM factory in

Tezze sul Brenta and the tannery sector in Arzignano-Chiampo each recount distinct tales of pollution and environmental injustice in the Veneto region, which have often gone unnoticed by media and academia.

In the heart of the Veneto region chemosphere, within the PFAS-impacted areas, the agricultural land is often cultivated «to the last possible centimetre»[61] and for the most part occupied by monoculture crops. One of these exceptions is Diego and Claudia's farm. It was during my first meeting with them, while I was assisting Diego in planting onions, that he shared the reason behind the decision to start an agricultural project with Claudia. Motivated by the principles of permaculture, biodynamic agriculture, and agroecology, they launched their farm-to-table business in 2016, when the fear and uncertainty related to contamination were reaching their first peak. Like the other farmers I will meet - Cristina, Eric, Francesco, Paolo, Adriana, Monica, Laura, and Carolina - they sell products directly to customers while claiming to establish a mutual trust-based relationship. For these reasons, they considered themselves an "anomaly"[62] within the agricultural sector of the area. In the context of the PFAS pollution, maintaining a vision of ethics and care in agriculture presents greater challenges. For many farmers I have encountered, per- and polyfluoroalkyl substances have posed and continue to pose obstacles, but they have also served as a stimulus for their desire to cultivate in accordance with specific principles. These principles aim to provide their customers with pesticide-free and chemical-free products. Indeed, for Diego, understanding how they work and consequently comprehending the presence of PFAS is "inevitable,"

> [B]ecause we also have children, so we are the first consumers of ourselves; what others eat, we eat first. [...] And then, the attention to the customer: if you work well and know that you are providing something good to people, you work much better. If you know that you are giving a product that is not good and you have to mask it as a good product, I could never work well. It's clear that you would work poorly because our direct sales rely heavily on how you feel about your product, and when you express it well, we see that we can sell a product that others would never have tried because you explain how it was made and its properties, right? So, we couldn't have worked knowing that we were working with contaminated water; it was our necessity. And yes, we had expenses, of course. There are

[61] "fino all'ultimo centimetro possibile" (Eric, 2 March 2023).

[62] "è un po' anomalo perché non siamo una semplice azienda che produce, porta mercato e non vede nessuno. Qua la gente può vedere cosa vendiamo nel punto vendita, può capire chi siamo e quindi è una cosa... un rapporto aperto col cliente di fiducia reciproca ecco…». English: «is a bit anomalous because we are not a simple company that produces, brings to the market and does not see anyone. Here people can see what we sell in the [our] store, they can understand who we are and so it's a thing... an open relationship with the customer of mutual trust is…" (Diego, 21 November 2022).

> always additional expenses that you wouldn't want to have. The analyses cost, of course, it's not the end of the world if you do them once a year, but they are always your expenses.[63]

We ate couscous with black cabbage and broccoli from Diego and Claudia's crops. While eating outside and sitting on a wooden table together, the couple started to wonder about the substances. How many PFAS exist? For Diego, there are 20, which comprised the 17 poly- and perfluorinated substances checked by the public surveillance program in his blood. Nevertheless, in the midst of the industrial lobbies and the continuous discoveries of new substances, they are an indefinite number[64] and characterised by different chemical and physical features. Due to the scarcity of information and the incapacity to understand alone the complexity of substance, PFAS are a source of anxiety and uncertainty for farmers. While job blackmail in the case of chemical labour can be ascribed to the typical terrain of industrial pollution cases (Barca & Leonardi, 2018), the situation appears even more complicated for farmers. As in the case of other persistent chemical substances, the ubiquity of PFAS indiscriminately affects different social groups and nonhuman entities. Indeed, there is a massive disproportion in terms of how specific social groups and communities deal with the effects and consequences of this contamination. In the case of small-size agricultural businesses, particularly individuals who consume and sell what they cultivate, often relying on contaminated water and soil, their elevated chemical exposure is a consequence of an unequal condition.

The conversation shifted to the personal experience with the analysis of Diego and Claudia's water well. Claudia recounts the days when they received the results. She was anxious. After having opened the company with much effort, she admitted that it would have been terrible to deal with a high level of PFAS in their irrigation water. Their business is probably one of the rare exceptions in which the locations and the depth of the wells have not condemned them to consider the possibility of relocating or even closing their business. Like the other farmers I

[63] "[è] inevitabile intanto per noi, per sapere come stavamo lavorando. [...] [P]erché noi abbiamo anche noi dei bambini e quindi siamo noi i primi acquirenti di noi stessi, quindi quello che mangiano gli altri prima lo mangiamo noi. [...] E poi appunto, la l'attenzione per il cliente: se tu lavori bene, e sai cosa stai dando bene alla gente lavori molto meglio. Se tu sai che stai dando un prodotto che non va bene e lo devi mascherare come un prodotto buono. Non potrei mai lavorare bene, chiaro e lavori male, perché la nostra vendita diretta si basa tanto su quello che tu senti del tuo prodotto e quando lo esprimi bene noi vediamo che riusciamo a vendere il prodotto che ha altri non avrebbero mai assaggiato, perché gli spieghi come hai fatto e le proprietà, no? Quindi non avremmo potuto lavorare sapendo di... Lavorare con l'acqua inquinata e quindi è stata una necessità nostra. E quindi sì, le spese le abbiamo avuto, è ovvio, son sempre spese in più che non vorresti avere. Le analisi costano per carità, non è la fine del mondo se lo fai una volta all'anno, però sono sempre spese tue" (Diego, 21 November 2022).

[64] As I explained in the introduction, the total number is indeed difficult to calculate.

encountered, Diego looked in vain for state and regional subsidies to sustain the costs of the analysis or purchase filters:

> [...] we asked around but there was nothing, there was so much confusion, so much. So much silence, because obviously, no one wanted to risk blocking a huge agricultural system in this area. So everything was allowed to continue as usual.[65]

Colours may tell many aspects of this landscape. During my second meeting with Diego in early spring, we observed that the shades of colour of the cultivated soil were not significantly distinct from the concrete roads that ran nearby. This observation varies depending on the time of year and the chemical treatments employed by agricultural businesses. However, for Diego this colour similarity serves as an indicator of the nutrient deficiency within the soil, resulting from the practice of intensive monoculture farming. In this sense, all the farmers that opened the doors of their businesses to me, namely who let me enter their crops and facilities, embraced a specific vision of agriculture. Far from belonging to the conventional agriculture world, some distanced themselves from the majority by claiming to be "organic" and refusing any form of certification, while others obtained organic certification while embracing an ethical view of farming.[66] As Cristina, one of the members of an old family business in the red zone, told me,

> [...] the first lovers and custodians of the environment are the farmers themselves, because it is the land on which they live, with which they coexist and which they follow and love with compassion. Because if there was no passion, if you look at how we are taken into consideration or how we are protected, who would make it?[67]

In Claudia and Diego's field that morning, I saw different rows of seasonal vegetables, including different varieties of kale, cabbage, and broccoli. As is often the case in organic farms, short trees marked the borders of the property to divide the crops from the external land. Beyond these frontiers is the uncertainty of conventional and intensive agriculture. For Eric, whose farm is situated 20 kilometres away from Diego and Claudia's farm but still within the red zone,

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[65] "[..] abbiamo chiesto in giro ma non c'era niente, c'era tanta confusione, tanta. Tanta omertà, perché ovviamente non si rischiava di bloccare tutto un sistema agricolo grandissimo in questa zona. Quindi si è fatto andare avanti tutto lo stesso" (Diego, 21 November 2022).

[66] I will return to the organic certification ("certificazione bio") later.

[67] "[...] i primi amanti e custodi dell'ambiente siano proprio i contadini, perché è la terra su cui vivono con la quale vivono e che seguono e che amano compassione, perché se non ci fosse la passione, se tu guardi come siamo calcolati o come siamo tutelati, ma chi te lo fa fare?" (Cristina, 13 February 2023).

> [...] the hedge is precisely what allows us, well… we needed it, especially for the organic regulations, to protect our crops. Okay? But also to create and maintain biodiversity, even in terms of animal life, compared to what exterminates my crop on the other side, beyond this border: *Vietnam*, with flamethrowers…[68]

The demarcation between *us* and *them* will be one of the leitmotivs of the following pages. By mapping the impacted areas, it is indeed a fact that the regional government has set specific limits: internal (the red, orange, yellow, and green zones), and external boundaries (the PFAS Land and the presumed[69] PFAS-free Land). However, the impacted areas lack external boundaries. As previously noted, these chemicals are impossible to contain within a delimited geographical area due to their physical and chemical characteristics. The movement of per- and polyfluoroalkyl substances through these gaps creates social divisions within the communities. In these geographical and social contexts, the enigmatic nature of PFAS is unravelled through contradictions, a term that represents another pivotal keyword of this dissertation. Indeed, the PFAS Land is where various interconnected routinized toxicities are present in different temporal dimensions (Renfrew & Pearson, 2021; Müller & Nielsen, 2023). These multidimensional features give rise to dissonances among the impacted communities, leading to stigma and isolation. These consequences may stem from a collective "trauma." To use Vallerani's words (2013):

> When places undergo damage, it is the community of inhabitants that experiences a disrupted relationship with the landscape, thus transforming "geographic trauma" into "psychological trauma."[70]

During the chaotic years after the discovery of the contamination and even today, the stakes are high, and I believe not all the farmers within the contaminated zone can reflect on and express their memories and feelings like the farmers I met. The multifaced consequences of the Rimar-Miteni contamination created a complex form of job blackmail. For the around 600 people (Girardi et al., 2018) who have worked in the Rimar-Miteni plant, PFAS represented at

[68] "La siepe è proprio ciò che ci permette, beh, ne avevamo bisogno soprattutto per i regolamenti biologici, per proteggere le nostre colture. Ok? Ma anche per creare e mantenere la biodiversità, anche in termini di vita animale, rispetto a ciò che mi stermina dall'altra parte, oltre: il Vietnam, con lanciafiamme…" (Eric, 2 March 2023).

[69] I use the term "presumed" because I believe that PFAS are ubiquitous, especially in nearby areas heavily affected by massive PFAS contamination, such as the unmapped region of Veneto.

[70] «Quando i luoghi subiscono lesioni, è la comunità degli abitanti che vede alterato il suo rapporto identitario con il paesaggio e così il "trauma geografico" si trasforma in "trauma psicologico"» (Vallerani, 2013, p. 10).

the same time «hazards, harms, and hopes»[71] (Papadopoulos et al., 2021, p. 7), while for the silently affected small-sized agricultural businesses in the Veneto Region, PFAS primarily consist of an unknown and lethal threat.

Although considered essential by some of the actors involved in the contamination, the agricultural sector has often been mentioned in passing without being actively involved in concrete actions, except for some initiatives promoted by small citizen groups (activists or other grassroots organizations). As explained in the second chapter some agricultural companies, prompted by the Veneto region, have been contacted and involved in monitoring plans to trace the presence of PFAS in food products. However, there has been no initiative to support the expenses incurred by agricultural businesses to cope with the pollution they have experienced. Public institutions have not supported farmers with funds to cover or mitigate the costs of the analyses that their companies had to bear. Not even trade associations have provided financial support for the analyses and costs related to the contamination caused by Rimar-Miteni. By consistently conducting tests on their water well in the last few years, Diego and Claudia independently decided to allocate money to monitor the presence of PFAS in their irrigation water and in some vegetables. In my research, the lack of funds for PFAS-related analysis is a sign of little willingness on the part of institutions to shed light on the issue. For Eric, the discomfort related to the absence of any financial support is part of what has been found in the cauldron.

> [...] The problem is not about burdening the agricultural company with an additional expense that nobody forces them to undertake. No, let me give you another example. When I practice organic farming, the situation is that if I have Rossi next to me, who cultivates every last centimetre here and supplies beef for McDonald's. Because cultivating every last centimetre here allows them to receive subsidies from the European Union *for every last centimetre*. However, I remove 10 meters of surface area, so I cultivate up to here to plant a hedge. And when I submit my annual report, this is considered a drawback, a DEDUCTION. And people fail to realize that this surface area actually holds value for the environment, the territory, the community, and those who live here... fundamentally, the issue is the cultural perspective through which we view our territory, the lens we use. If the territory is seen as something to be exploited up to a certain point, then you yourself must consider paying for the analyses. However, if the culture begins to shift towards the idea that, oh well, you've removed 10 meters of land because it makes sense for the

[71] As happened in the American case of Parkersburg, the company's management concealed the risks associated with PFAS exposure from the workers employed at the Trissino plant (Fazzini, 2023).

environment, the local flora, fauna, and preservation. Then, I mean, it's a different matter altogether. [72]

The detachment of the landscape that occurred in these areas went hand in hand with the exploitation of the land made by agroindustry and conventional farming. According to Eric and the other farmers, their colleagues from intensive and conventional agriculture are devoted to the maximization of the quantity of products. They rely on quantity over quality, and they are economically well-connected with large agri-food enterprises. Small-sized businesses have thus found themselves alone in dealing with the fear of managing something threatening and unknown. Thus, in the PFAS Land, individuals were unable to fully grasp the situation they had to deal with. In this sense, the lack of familiarity with bodies of water reveals the fact that water itself is beyond human control even more so if it is contaminated (Zamperini et al., 2021). However, before the Italian Unification, rivers, water streams, springs, seeps, and channels have been part of the artificial waterscape that frames the Veneto region. What has also been called the «engineers' landscape»[73] (Vallerani, 2004) is indeed an artificial landscape shaped by centuries of work aimed at harnessing the water flow.

[72] "Ma non è il problema che lascia all'azienda agricola il fatto di accollarsi una spesa in più che nessuno la obbliga ad assumersi. No, perché ti faccio l'altro esempio: nel momento in cui io faccio biologico e la ratio è che se vicino a me ho Rossi che mi fa i Manzi per McDonald's e coltiva fino all'ultimo centimetro qua. Perché coltivare fino all'ultimo centimetro qua gli permette di avere un contributo fino all'ultimo centimetro dall'Unione europea. Ok? e invece io mi tolgo 10 metri di superficie; quindi, io coltivo fino a qua per mettere una siepe qua. E quando vado a fare la mia denuncia annuale, questa è una tara, è una TARA. E non si prende coscienza che questa qui invece è una superficie che ha una sua valenza per l'ambiente, per il territorio, per la comunità, per chi ci vive è quello lì.... cioè di fondo, il problema è quello, la cultura che abbiamo nel vedere, cioè con che occhi, con che paio di occhiali vediamo il nostro territorio. Se il territorio è una cosa da sfruttare fino a qua, allora, ma ti poni tu il problema di pagarti le analisi. Se invece la cultura comincia a diventare che, ah dai, ti sei tolto 10 metri di terra, perché questa cosa ha senso per l'ambiente, la flora, la fauna locale, il mantenimento. Allora voglio dire è un'altra cosa" (Eric, 2 March 2023).

[73] «paesaggio degli ingegneri».

Figure 6: A drainage canal that discharges into the Poscola stream behind the Rimar-Miteni plant in Trissino, Vicenza (photo by the author, January 2020).

Behind the Rimar-Miteni plant flows a small torrent called Poscola. Its waters enter the Agno River that becomes Fratta Gorzone. The latter is a river that flows between the province of Verona and that of Padua, passing through several municipalities located in the red zone. It goes then into the Brenta River, whose stream ends in the proximity of Chioggia, in the Adriatic Sea, below the Venice Lagoon. While few farmers I met knew Rimar-Miteni before the discovery of the contamination, for others the Rimar-Miteni facility and the Poscola waters were and still are blurred entities. Located between the hills of Trissino and industrial shields, the chemical plant was somehow hidden from the local communities. The narrative about PFAS as slippery substances. «Our standard surveillance systems miss residues when we don't look in the right place or we don't look for the right thing» write Boudia et al., (2018). Indeed, from a human perspective, the invisibility and tastelessness of PFAS were exacerbated by the factory's subtle material presence, which was further concealed by its hidden location (Zamperini et al., 2021).[74] In this light, the only farmer who was directly in contact with the Rimar-Miteni's presence was Francesco, whose hometown is close to it:

[74] In Menegatto et al. (2022) as well, Rimar-Miteni is perceived as a concealed entity, «completely surrounded by large trees» (p. 9).

> I used to live in Ghisa [a fraction of Trissino], which is roughly 2 kilometres as the crow flies from Miteni, just to give you an idea. As soon as the tanneries ended, my family's lands would begin. So, it was exactly along the Poscola stream. I have always eaten *bruscandoli* (wild asparagus) collected along Poscola, throughout my life.[75]

Instead, Carolina, another farmer whose crop is in the red zone, came in contact with the chemical plant in the late Sixties due to an incident that occurred in the Rimar plant in Trissino.

> [...] I was a little girl of 9 or 10 years old, and Tavernelle used to get its water supply from the aqueduct that came from Chiampo... from Arzignano... and at a certain point, the contaminated water arrived. [...] I remember that at the time, I was in charge of my family. It was me and my cousin, and we were given containers. The municipality used to come every morning to supply the [drinkable] water needs according to the people and the families. However, the municipality immediately implemented strategies, and things changed... We spent the whole summer like that [...]. And I experienced this water situation firsthand, it was dangerous to drink the water, and it was very, very polluted. My husband tells me that there was a small river [...] that passed right through the village, you could see it clearly, there were houses right by the river. And at the time when I experienced this, we didn't know each other yet because we met later, they had a river that was blue one day, red the next day, green another day [...].[76]

As shown in the previous chapter, Marzotto Group and Rimar-Miteni were bound together by more than just a business relationship. By influencing the landscape and the social texture of this part of the Veneto region, they have played a fundamental role in irreversibly partaking in the biogeochemical cycles within the communities. While these corporations were integrated into the global market, the businesses that welcomed me were small-scale or even family-run. Farmers that opened the doors of their businesses to me were individuals for whom agriculture was not merely a means of sustenance, but a way of life. In this context, being threatened by

[75] "Io abitavo alla Ghisa, abitavo in linea d'aria a 2 km dalla Miteni, per capirci. Appena finite le concerie, poi iniziavano i terreni miei, dei miei familiari. Quindi esattamente lungo Poscola. Io ho sempre mangiato i bruscansoli (bruscandoli) raccolti lungo la Poscola, tutta la vita" (Francesco, 5 December 2022).

[76] "io ero una bambinetta di 10 anni, 9, 10 anni e Tavernelle si riforniva con l'acquedotto che veniva giù da Chiampo... da Arzignano... e a un certo punto arriva l'acqua inquinata. [...] Mi ricordo che all'epoca, io ero la proposta della mia famiglia, eravamo io e mia cugina e ci davano delle taniche. Il comune passava tutte le mattine a portarci il fabbisogno dell'acqua, secondo le persone, le famiglie, da bere, però subito il comune ha messo in atto delle strategie poi è cambiato proprio... tutta quell'estate lì l'abbiamo fatta così [...]. E io ho vissuto proprio questa cosa dell'acqua, guai bere l'acqua ed era molto, molto inquinata. E mio marito mi racconta che [c'era] un fiumicello [...] che passa proprio nel paese lo vedi proprio, ci sono proprio delle case sul fiume. E nel momento in cui io vivevo questa cosa che non ci conoscevamo noi, perché siamo conosciuti più tardi, loro avevano il fiume che un giorno era blu, un giorno era rosso, un giorno era verde, un giorno era […]" (Carolina, 3 March 2023).

the presence of something invisible and unknown is frustrating and mentally detrimental to those experiencing this situation (Zamperini & Menegatto, 2021). What farmers experience is a mix of stigmatisation, helplessness, and vulnerability. These sentiments, along with their perspectives, the infrastructural violence perpetuated by Rimar-Miteni, and the peculiarities of the PFAS' "toxic continuum" (Renfrew & Pearson, 2021), constitute what I am about to describe in the following pages. Before questioning the farmers-victims dichotomy, in the next section I will focus on the health effects related to PFAS exposure and how farmers have dealt with them. In the following part of this chapter, I will render the presence of per- and polyfluoroalkyl substances in the agricultural sector visible and perceptible.

3.2 Latency and Reproductive Justice

As already reported, in the DuPont 1981 memo, two out of seven women in the Teflon division at Washington Works had infants with eye and facial birth defects, comparable to the ones discovered in the rat experiments (Lerner, 2015). This fact is explored in *The Devil We Know* (2018), a documentary about the PFAS-related contamination in Parkersburg. In the film, one of the affected children, named Bucky, discusses growing up near the DuPont facility while experiencing various medical conditions. Notably, his mother was exposed to PFOA while working at the Teflon manufacturing plant in Parkersburg alongside other women. This was part of the company's strategy to downplay the risks, as they had claimed for decades that PFAS were not harmful substances.

In this documentary, Bucky is depicted as a victim of DuPont's deadly practices. He represents one of the multifaceted examples of "environmental victims." In this thesis, many farmers I met referred to themselves as victims. In this sense, Christopher Williams (1996) raises questions regarding the applicability of victim conceptualisations in cases where victims do not self-identify, and in complex situations involving unborn children or instances resulting in severe intellectual disabilities due to environmental pollution. He argues that, as environmental justice heavily depends «on *subjective (often self-) definitions of victimization*» (p.17), it often presents difficulties in its application within legal and social frameworks. Williams defines "environmental victims" as «those of past, present, or future generations who are injured as a consequence of change to the chemical, physical, microbiological, or psychosocial environment, brought about by deliberate or reckless, individual or collective, human act or act of omission» (1996, p. 35). He outlines how the etymology of "victim" embodies "sacrifice,"

highlighting how environmental victims are frequently sacrificed to serve the interests of more "powerful" actors. As explained by Lanzavecchia et al. (2022), both DuPont and Rimar-Miteni might have made a rational choice to engage in pollution, fully aware that the expected profit value would likely surpass the estimated costs resulting from the damages caused. Pursuing these profits requires a short-term increase in production, which brings to higher profits, and the utilisation of various tactics to postpone the payment of associated and subsequent costs to a later time. The power of these corporations lies precisely in the possibility of making this choice, which has been reinforced by a general laissez-faire attitude on the part of local and national public and private actors. In contrast to the Parkersburg DuPont facility, over almost fifty years of operation, the vast majority of Rimar-Miteni employees have been males. According to Girardi et al. (2018), most of the women workforce was employed in administrative offices far from direct contact with chemicals. In the second chapter of this thesis, I briefly reviewed the (eco)toxicological effects derived from PFAS exposure. As mentioned, per- and polyfluoroalkyl substances are linked with many medical conditions related to reproduction such as hormonal unbalances, decreased fertility rates, birth defects, and many other biochemical alterations and they are associated with hypertension, higher cholesterol levels, thyroid disease, ulcerative colitis, and pregnancy-induced hypertension. These synthetic substances are considered endocrine disruptors, namely chemical substances, either occurring naturally or created by humans, which can imitate or interfere with the hormones present in the endocrine system.

It is documented that women eliminate certain types of PFAS more rapidly than men through menstruation or breastfeeding (Upson et al., 2022). Six out of ten farmers I met identified as female. None of them informed me that they were suffering from medical conditions related to per- and polyfluoroalkyl substances exposure. As shown in the second chapter, Ingelido et al. (2020) reported that among farmers located in the red and orange zones, PFOA serum concentrations were «among the highest found worldwide» (p. 7). Moreover, the same research outlined those male individuals «showed serum [PFAS] concentrations significantly higher than females» (p.5). PFOA and PFHxS median concentrations respectively were about 5 times higher than in females and PFOS concentrations were about 3 times higher than in males (Ingelido et al., 2020). During chats with farmers, medical conditions were one of the common topics, although nobody explicitly mentioned experiencing any health issues associated with them. It was Diego who first spoke with me about these chemicals in his blood,

> My PFAS level was quite high, so like... higher end… 140 [ng/ml] of PFOA when the limit is 8 [ng/ml]… Something like that. So I said, well, we're all going to die anyway.[77]

PFOA concentration that characterised the blood of 95% of the general Italian population is estimated to be 8 ng/g (Ingelido et al., 2010), while Diego claimed to have a concentration almost 19 times higher. Even though the production of these chemicals began in the 1960s, no threshold existed at the time of the discovery of the contamination. PFAS-linked medical conditions and their capacity to «cascade intergenerationally across bodies» (Murphy, 2017, p. 499) fall within the category of *invisible harm*, a term employed to denote the «broad effects of increasing environmental toxicity and contamination in specific late capitalist contexts» (Goldstein, 2017, p. 321). Moreover, the uncertainty that arises in Diego's words leads to the concept of *latency* proposed by Michelle Murphy (2015). Such a notion represents the first of the three *Ls* that I use as a reference point to depict the relationships between farmers and these chemicals. Within the PFAS Land, it assists in emphasising the difficulty of drawing a distinct line between the past, the present, and the future. Indeed, latency signifies a delay that represents the temporal interval between a stimulus and response.

> In medicine, latency time is similar to an incubation period. Latency time is the leg between infection and infectiousness. Or it is the wait between chemical exposure and symptom. To be latent is to be dormant, a potential not yet manifest. In temporal terms, latency is the wait for the effects of the past to arrive in the present. As such, latency is movement from past to present, or even to future. It is the inverse temporal orientation of anticipation - in which the not yet future reorients the present (Murphy, 2015, p. 106).

In ecological terms, latency is the lag of time that affects a submerged fragment of the past by disrupting its presence in the present. Thus, «through latency, the future is already altered» (Murphy, 2015, p. 106). These body alterations are triggered by the presence of persistent pollutants that bioaccumulate in tissues. The per- and polyfluoroalkyl substances in Diego's body were due to the fact that he was born in a municipality located on the edge of the red zone, just a few kilometres away from the fields where his crops are located. He has been living there for the first thirty years of his life, drinking and using tap water containing PFAS. Later, he relocated and spent the last 10-15 years outside the impacted municipalities. Despite no

[77] "io avevo gli PFAS abbastanza alti, quindi tipo... altini… 140 di PFOA, quando il limite è 8. Una roba del genere... Quindi ho detto vabbè, moriremo tutti" (Diego, 21 November 2022). These words echo what a resident of a PFAS-contaminated community in New South Wales, Australia: "Since I moved here I have had this thyroid condition, which is one of the conditions that you get if you have too much PFAS in your blood… I just think about these things all the time" (Legg et al., 2022, p. 4).

longer residing in the area, which was the primary criterion for eligibility in the regional health surveillance program that was initiated in 2017, Diego was accepted. He was scheduled to be re-tested by the public institution in 2020, as planned, but the Covid-19 pandemic disrupted the regional healthcare system, and the analysis was postponed. The following year, he was tested and the PFOA level in his blood had halved.[78] The fact that he was living out of the contaminated area was probably relevant to this reduction. By changing water sources, his PFAS levels decreased. For him, the results of the analysis provided "confirmation"[79] that significant amounts of these chemicals had stopped entering his body. He believed that by consuming his PFAS-free vegetables and abstaining from drinking contaminated water, his organism was capable of gradually eliminating these substances.

> My mom, just to let you know, had thyroid problems years ago, and no one could think that it was related to this because it wasn't known back then. When you think about it now, you immediately imagine that it could be the reason, but even my sister had abnormal values, well, nothing too evident, obviously not something visibly wrong.[80]

Thyroid-linked symptoms are common among the impacted communities and PFAS' exposure is associated with increased thyroid hormone levels in adult females (Lewis et al., 2015). Given that the (eco)toxicological effects of PFAS as emerging contaminants are not yet comprehensively understood, the connection between PFAS exposure and these specific conditions remains a subject of debate (Andersson et al., 2019). This uncertainty is exacerbated by the concept of *toxic layering*[81] - the accumulation of various factors and agents that complicates the identification of cause-effect relationships - which stands in stark contrast to the experiences of Rimar-Miteni workers over the decades. Among the employees, the highest recorded PFOA concentration ever detected in human bodies has been registered, reaching 91,900 ng/mL (Girardi et al., 2018). In this context, I came across a newspaper interview with a doctor from Zimella, a small village in the province of Verona located in the red zone. The

[78] The reader can find the PFAS half-lives in the 2.1 section.

[79] "So, this is confirmation that we're not really consuming polluted things because otherwise it would definitely be... And well, we were also very careful about what we were drinking…". "E quindi questa è una conferma che comunque non stiamo mangiando cose inquinate perché sennò sarebbe sicuramente... E ecco, siamo stati molto attenti anche a cosa bevevamo…" (Diego, 21 November 2022).

[80] "Mia mamma, per dirti, ha avuto problemi alla tiroide anni fa e nessuno poteva pensare che fosse correlato a questo perchè non si sapeva dopo. Pensandoci, ti viene subito da immaginare che sia per quello, ma anche mia sorella aveva valori sballati, eh però insomma, nulla di eclatante, ovviamente da vedere fisicamente che stai male" (Diego, 21 November 2022).

[81] I will examine the *toxic layering* in the next section.

local doctor shared a conversation with one of her patients who, like many others, was employed at the Miteni plant:

> I asked him [the employee] if he noticed his colleagues' breasts in the dressing room… "How do you know?" he astonishingly replied. I explained to him that was an effect of the hormonal alterations. "That's true, everybody had tits and we were ashamed of it."[82]

In my perspective, breasts embody the dual role of the trans-corporeal trajectories of this group of compounds. Not only do they act as a signal of their presence in the latter case, but they also operate as contaminators while breastfeeding. In fact, it is also through gestation and lactation that children can be born already containing PFAS in their bodies. However, the male reproductive system is also impacted by "forever chemicals" exposure. As Carolina, a farmer from the red zone, told me, two of her friends had children suffering from testicular cancer, while her sons had relevant levels of PFAS in their blood. Indeed, these chemicals are also associated with male fertility issues due to their impact on reducing testosterone activity, causing various medical conditions.

Concerning this topic, Eric shared his experience with me after a long conversation. I met him at the social farm where he works. Eric is a man in his forties who has spent his life living in the orange zone, where he has drunk PFAS-free tap water. A few years ago, he joined this social farm situated within the red zone, employing 3 to 7 individuals depending on the season. This certified organic enterprise spans around 10 hectares and shares borders with nearby conventional farming activities. It also includes greenhouses and a dedicated shop frequented by a loyal customer base seeking seasonal vegetables, which are also supplied to organic retail outlets. Eric showed me around while explaining their project. Surrounding us, I saw the undefined plain of the Po Valley. We are far from the hills visible around Vicenza, and I could not discern any highways or industrial zones. In his office, as our conversation approached the end, he opened up about the more private aspects of his encounter with PFAS. He shared that, following the discovery of the contamination and after facing challenges in conceiving and bringing a pregnancy to term, he and his partner began to question the connection between the presence of per- and polyfluoroalkyl substances and their reproductive challenges. As he hesitantly told me:

[82] «A uno di loro ho chiesto se, quando erano in spogliatoio, non avesse notato colleghi con le mammelle… 'E lei come fa a saperlo, dottoressa?' mi ha risposto sbalordito. Gli ho spiegato che quello è un effetto delle alterazioni ormonali. 'E' vero, avevamo tutti le tette e ci vergognavamo'» (Pietrobelli, 2018).

> [My son] was already born... but I mean, just because it happened immediately after [the discovery of the contamination], I wondered if the reason why we also had so much trouble bringing a pregnancy to term was also due to the fact... I always, even in Vicenza, for example, drank tap water [...] But isn't it possible that this stuff here is also what we're drinking...[83]

Eric's way of speaking conveys a palpable sense of vulnerability and uncertainty.[84] I sense anxiety in his experience, particularly concerning fertility and the ability to bear children. His words also highlight a lack of trust in institutions regarding the absence of PFAS in the tap water of the orange zone. Indeed, according to the Veneto Region, the water coming from the public aqueduct in the orange zone has always been free of PFAS. However, for decades, the residents of the 30 municipalities located in the red zone have been unknowingly consuming contaminated tap water. For this reason, the lack of trust in public institutions has exploded in the recent years. In addition, facing challenges in carrying a pregnancy to term is an abnormal burden that Eric perceives as common among the individuals he knows from impacted areas. As mentioned, the disturbance of the thyroid hormone level balance plays a crucial role in fetal development. In the context of the Veneto contamination, these anthropogenic chemicals have been linked to an increased likelihood of being born small for gestational age (Manea et al. 2020). For prospective parents, such experiences could cause psychological distress.[85] As explored by Zamperini et al. (2021c),

[83] "[...] era già nato... però voglio dire, ma proprio perché è successo subito dopo io mi son chiesto se il motivo per cui magari avevamo anche fatto così tanta fatica ad avere una gravidanza che arrivasse a termine, fosse dovuto anche al fatto... Io sempre, anche a Vicenza, per esempio ho sempre bevuto acqua del rubinetto[...] ma non è che sta roba qua è anche per quello che che beviamo…" (Eric, 2 March 2023).

[84] During the encounters I had, the uncertainty surrounding medical conditions related to PFAS exposure was also a subject of irony. As Cristina replied when I asked if there were any medical conditions in her family: «No, no, let me tell you as a joke. So, my father has four children, and one time he asked me, you know, what do these PFAS do? Well, one of them is fertility problems. Well, my dad said (laughs) this as a joke... but yeah, he said, well, apparently it didn't affect me…» (Cristina, 13 February 2023) "No, no, guarda te lo dico come battuta. Dunque, mio padre ha quattro figli, una volta mi diceva insomma, cosa fanno questi PFAS? Ma guarda uno è problemi di fertilità. Vabbè, mi fa mio papà (ride) questo proprio, detto a livello di battuta… però sì, lui dice vabbè, evidentemente a me non è toccato…".

[85] A mother told Marcos Orellana, the Special Rapporteur on the implications for human rights of the environmentally sound management and disposal of hazardous substances and wastes, during his visit, "Can you imagine what it means for a mother to realize she has poisoned her children through her own breast milk?" (Orellana, 2022, p. 5).

> From a psychological perspective, a pregnant woman residing in a polluted environment may perceive herself as being the source of contamination for the unborn child. This engenders a sense of guilt that will be present in the experience of every other mother who, on a daily basis, while preparing meals for her children, will be plagued by the dreadful doubt of potentially exposing them to toxic substances.[86]

Needless to say, as parents, discovering the contamination of their children is a traumatic experience (Menegatto et al., 2022). From generating life to transmitting harmful substances, the maternal body changes its features. In keeping with the capitalistic Zeitgeist, the female body has been impacted at the core function of reproduction in the contaminated areas. Following this exegesis, Stefania Barca's reflection on the uncompensated work of women helps to shed light on this issue. Drawing on Selma James and Maria Rosa Dalla Costa's analysis, Barca explores one of the central principles of the Capitalocene-Anthropocene: reproductive labour, referred to as «the basic capitalist commodity,» is not only unpaid but also lacks any social recognition (Barca, 2020, p. 28). Reproductive justice is also what many parents sought in the contaminated areas. Within these communities, the parental work has been highly overwhelmed by the contamination leading to the formation of the Mothers NoPFAS (Mamme NoPFAS) movement.

It is in 2016, three years after the discovery of the per- and polyfluoroalkyl substances presence in Veneto, that the Mothers' movement saw the light. By playing a fundamental role in the process related to raising awareness of the contamination, they can be considered one of the most important bottom-up movements among the actors involved in this environmental justice case. In the same year, with the Marcia dei Pfiori ("Pflowers' March"), a bicycle demonstration along the streets of the red zone, this social movement began its intense journey of mobilization and engagement (Lanzavecchia et al., 2022). This group of women was established due to the damaging effects of PFAS on mothers' bodies and in response to the high PFAS rate recorded in children. Despite their significance and role, within the complex and intricate context of PFAS Land, according to the farmers' perspectives, Mothers NoPFAS are responsible for the pervasive feeling of stigmatisation that the agricultural sector has faced. During my meetings with farmers, I observed that the people I engaged with did not only express significant concerns regarding the potential for the contamination but also exhibited apprehension about

[86] «Da un punto di vista psicologico, una donna incinta che vive in un ambiente contaminato può scoprirsi essa stessa ambiente inquinato per il proprio nascituro. Si genera, così, un senso di colpa che si ritroverà nell'esperienza di ogni altra madre che quotidianamente, sistemando in tavola le pietanze per i figli, sarà attanagliata dal terribile dubbio di rischiare di metterli a contatto con sostanze tossiche» (Zamperini et al., 2021c, p. 149).

the possibility of being identified as "contaminated." Being labelled as located in the most affected zones, or worse, in the red zone, is a label that the farmers suffer from. This marker permeates their relationships with the soil and crops they cultivate, ultimately reaching the retail establishments and markets where they engage with customers. In addition, these anxieties are influenced by the regulatory apparatus and the chemical and physical features of PFAS.

Before returning to the connections between the agricultural sector and Mothers NoPFAS, which I will address in section 3.5, and questioning the victimisation of farmers, the next two sections will delve into this sense of isolation, stigmatisation, and uncertainty that have defined the experiences of farmers. In the next pages, I aim to further describe such a milieu through the concepts of *toxic Layering* and the *Limit*.

3.3 Toxic Layering

Adriana together and her husband Paolo run an organic-certified farm in the red zone. The family-run business was inherited from Adriana's grandparents. The couple welcomed me into their house, located nearby their crops. We sat at the kitchen table. They told me how they have been contacted by the Local Health Units (ULSS) and accepted to join the farmers' biomonitoring study in the 2015-2016 timeframe[87] while other farmers refused to take part in the program. In 2017, they decided to construct a well, also taking into consideration the presence of PFAS, which they have been monitoring for several years. In aiming to describe the toxic landscape in which they stand, Adriana touched on two of the concepts that I consider important to understand the conditions of the communities in the impacted areas. Without naming them, she alluded to the notion of *latency* - that I discussed in the previous section - and the concept of *toxic layering*.

> In itself, the residue of a particular herbicide, rather than a treatment product, is not harmful. The problem lies in the accumulation of all these residues. There's a bit of one, a bit of another, a bit of this, and then you add a PFAS, and you add this... in the end, what you end up ingesting is potentially hazardous in the long term. You won't see it today or tomorrow, but maybe when you become elderly, those little ailments start appearing, like blood pressure issues, thyroid problems, and so on, you know? That's why, as soon as we

[87] see Ingelido et al., 2020 and section 2.6.1.

> could, we informed ourselves about the condition of our water table. We were already making an effort to keep our vegetables as clean as possible, and at least we found out that we are not introducing something else that was beyond our control...[88]

What makes it even more difficult to confirm a causal relationship between contaminant exposure and specific medical conditions is the proliferation of toxic chemicals that characterised a particular area. Following Goldstein & Hall (2015), this condition is known as *toxic layering* and it represents a specific context in which the accumulation of various interwoven industrial toxins complicates the identification of casualties. In other words, this concept refers to the situation in which various sources of toxicity create a sort of "background noise" that makes it impossible to identify a clear correlation between exposure to a specific harmful substance and a particular medical condition. As reported by Renfrew and Pearson (2021), per- and polyfluoroalkyl substances' contamination are «usually layered onto or intersects with a myriad of other forms of pollution, as well as other types of resource conflicts and environmental inequalities» (p. 158).

In addition, the context of uncertainty related to cumulative toxic levels is aggravated by human habits like tobacco or alcohol consumption, and unhealthy diets (Goldstein, 2017). This is the case exemplified in the so-called "Terra dei Fuochi" ("Land of Fires"),[89] an area located in the Campania Region, that has been subjected to the socio-environmental consequences of illegal waste trafficking and mismanagement resulting from criminal organization activities. For these reasons, this territory and its communities may be considered part of one of the most relevant examples of toxic layering within the Italian borders. Due to the characteristics of chemical substances and the criminal network connections between the Campania and Veneto regions (Belloni, 2012), the PFAS-related contamination has been compared with this case of environmental injustice (Orellana, 2022; Pietrobelli, 2023).

In the Campania Region, throughout the years, diverse research has been conducted to estimate the link between toxic exposure and the adverse toxicological effects within the local

[88] "Di per sé il residuo di un determinato diserbante, piuttosto che prodotto di trattamento non fa male. Il problema è la somma di tutti questi residui. Rimane un po' di uno, un po' dell'altro, un po' di st'altro, ci aggiungi un PFAS, ci aggiungi questo… alla fine quello che vai assumere è potenzialmente pericoloso sul lungo termine. Cioè non lo vedi oggi, non lo vedi domani, ma magari quando diventi anziano mi iniziano a venirti fuori quei piccoli acciacchi, la pressione, la tiroide piuttosto che…capito? È per questo che noi comunque ci siamo informati appena abbiamo potuto su come era messa la nostra falda per l'acqua. Già comunque faticavamo per tenere più pulita possibile la verdura, almeno abbiamo anche appurato che non stiamo dando un altro tipo di cosa che non dipendeva da noi…" (Adriana, 17 December 2022).

[89] This name is attributed to the presence of fires generated by waste that was dumped and intentionally set on fire by criminal organizations.

communities. During the 2010s, an intense epidemiological debate involving different institutional authorities was constantly at the centre of public opinion (De Rosa, 2018). However, some research (Alberti, 2022) has listed three obstacles to determine this causal link: the presence of diverse and multifactorial pathogenesis, the heterogeneity of the environmental exposition and the population that has been taken into consideration, and the different distribution and concentration of pollutants that are in most of the cases unknown. But overall, the media reports and the political authorities identified the "Land of Fires" population's lifestyle as the main reason behind their widespread health problems (Caggiano & De Rosa, 2015). Nevertheless, the Naples metropolitan area and the Caserta province – the territory of the "Land of Fires" – have one of the country's highest mortality rates due to malignant tumours (Cazzolla Gatti et al., 2022). But cancers were not the only health problem. Different medical conditions were spread among those communities. Beyond the high cancer rate, the ISS detected strong evidence of various respiratory diseases, such as asthma, and other conditions including diabetes, prenatal infections, and congenital malformations (Mesumeci et al., 2014). In the Rimar-Miteni contamination case, similarly, the absence of scientific certainty due to the lack of knowledge regarding the substances and the institutional (Menegatto et al., 2022; Zamperini et al., 2021) and industrial will to minimize the problem (Fazzini, 2023), coupled with the extensive layering effects of the PFAS Land, has created a confluence of suspicion and panic. For instance, according to Zamperini et al. (2021b), during the initial phase of the biomonitoring program within the red zone communities:

> [...] the healthcare approach was characterised by downplaying the risks while being poorly informative. Even representatives of the local administration conveyed reassuring messages about the excellent quality and purity of the "Mayor's water" [tap water]. As a result, there seemed to be no particular reason to worry. However, citizens' perceptions drastically changed upon receiving the laboratory test results via mail. The realization of being threatened by a harmful agent now found concreteness in the numerical data, which were significantly above the minimum safety thresholds. Despite being in a scenario where the term "PFAS" still represented an unknown, and anomalies such as diabetes or cholesterol couldn't be confidently attributed to it, subsequent discussions with healthcare professionals were unsatisfactory. The communication style was perceived as inadequate on various levels: in multiple instances, to reassure the interlocutor, the issue was downplayed by referring to average reference values, even though they were still well above the minimum safety thresholds. Moreover, an aspect that caused significant dismay was that many individuals were associated with abnormal values to unhealthy personal

lifestyles that needed improvement.[90]

This lack of communication led to situations of further uncertainty, mental distress, and loss of trust in the same governmental apparatuses.[91] In light of this, between November and December 2021, Marcos Orellana, the Special Rapporteur on the implications for human rights of the environmentally sound management and disposal of hazardous substances and wastes, visited the impacted communities confirming how «the authorities failed to warn the residents of the affected areas and to disseminate information about the pollution and the risks to residents' health posed by perfluoroalkyl and polyfluoroalkyl substances» (Orellana, 2022, p. 6).

[90] «A detta degli intervistati, in questa fase iniziale, la presa in carico sanitaria è stata caratterizzata da un approccio minimizzante per quanto riguarda i rischi e nel contempo scarsamente informativo. Anche i rappresentanti delle amministrazioni locali si adoperarono con una comunicazione pubblica veicolante messaggi rassicuranti circa l'ottima qualità e la salutare purezza "dell'acqua del Sindaco". Così, sembrava non esserci particolare motivo per preoccuparsi. L'impressione dei cittadini mutò drasticamente al momento della ricezione, attraverso mezzo postale, dei risultati degli esami di laboratorio. La percezione di essere minacciati da un agente nocivo ora trovava una concretezza nei dati numerici, molto superiori alle soglie minime.Pur all'interno di uno scenario dove la parola "Pfas" rappresentava ancora un'incognita a cui, per esempio, non si potevano attribuire con certezza i valori anomali di diabete o colesterolo, i colloqui successivi con gli operatori sanitari risultarono insoddisfacenti. Infatti, la modalità comunicativa è stata vissuta dagli interessati come inadeguata a vari livelli: in più occasioni, per rassicurare l'interlocutore, la sdrammatizzazione del problema è stata operata facendo riferimento a valori medi di riferimento, nonostanti questi fossero comunque ben al di sopra delle soglie minime di sicurezza; per di più – e si tratta di un aspetto che ha destato particolare sconcerto –, molti utenti si sono visti associare i valori anomali a stili di vita personali poco salutari e quindi da migliorare» (Zamperini et al., 2021b, p. 156-157).

[91] According to Menegatto et al. (2022, p. 9), «With regards to the biomonitoring test, many parents affirmed that "in the absence of information about health effects or clear guidelines regarding how people can protect themselves, testing could do more harm than good because test results could merely raise concerns without any helpful support offered"».

Figure 7: Fields from the red zone (Spring 2023, photo by the author).

While visiting farmers, I had the chance to listen to the description of different levels that compose the toxic layering of PFAS Land. In this biogeochemical milieu, as suggested by Murphy (2015): «'toxic' becomes a calculated regulatory condition, rather than a chemical property» (p. 110). Furthermore, from the farmers' viewpoint, "forever chemicals" pollution is regarded as an additional ecological concern that blends and merges with various other environmental issues. As outlined, the Pianura Padana and PFAS Land specifically become an ecological arena where globally shared conditions typical of Anthropocene-Capitalocene – the effects of anthropogenic global warming such as droughts, extreme climatic phenomena, and the Covid-19 pandemic (just to mention a few) – intertwine with more rooted and localized events, such the consequences of the intense levels of industrialisation.

Considering this, most of the farmers were worried about the human-induced overheating effects.[92] Indeed, they perceive themselves as victims of multiple phenomena. In spring 2023,

[92] Two farmers out of ten were hesitant to assert that the effects of climate warming were due to emissions produced by human activities.

Carolina, the owner of the largest agricultural business I visited, admitted that they were frightened, "because last year there was a severe drought. SEVERE. And this year it is worse if it doesn't start raining. This year will be worse."[93] Thus, the agricultural sector condition is aggravated due to multiple factors. Among her colleagues, they

> [...] often talk about it, in short... The feeling is exactly this for everyone, that is, farmers are always pointed out as significant polluters, while in reality, they are also victims even in the broader discussion... On a larger scale, related to climate change and so on, but also in this specific case, they are truly and entirely victims [...] there's no way out, that's it.[94]

In a related vein, Francesco told me:

> [...] we had an incredibly challenging summer concerning water. It didn't rain, not at all. It's good to have had water with PFAS during this kind of summer because it didn't rain, you know... But the tanneries never stopped, and they use liters and liters of water to make one piece of leather. I mean, this is something I didn't know, but I believe it's also pollution, even though it's considered acceptable... [...] We keep talking about PFAS, filling our mouths and eyes with it, but we need to look everywhere else too, I mean, everywhere... Not just focusing on that and forgetting about everything else...[95]

Additionally, 2022[96] marked the least rainy year in Italy since 1961, with a -22% deviation from the 1991-2020 climatological average, and precipitation below the norm by -39% from January to July. These anomalies were most pronounced in the North (-33%), followed by the Centre (-15%), and the South and Islands (-13%) (SNPA, 2023). Studies indicate that Po River flow is predicted to decrease during summers, raising the probability of droughts, while it is expected to increase during winters (Vezzoli et al., 2016).

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[93] "Semo veramente preoccupati, eh. Semo preoccupati, perché l'anno scorso è stata una siccità solenne. SOLENNE. E quest'anno è peggio se non si mette a piovere. Quest'anno sarà peggio» (Carolina, 3 March 2023).

[94] "[...] noi ne parliamo spesso insomma... La sensazione è proprio questa, di tutti, cioè che gli agricoltori vengono sempre indicati come grandi inquinanti e mentre in realtà sono parte lesa anche nel discorso più... Più in grande dei cambiamenti climatici e via dicendo, ma anche in questo caso qui sono proprio parte lesa totalmente, ma non... [...] non c'è via d'uscita, ecco" (Cristina, 13 February 2023).

[95] "[...] abbiamo avuto un'estate assolutamente difficile per quanto riguarda l'acqua. Non ha piovuto, non ha fatto un cazzo. Ben venga avere avuto anche l'acqua col PFAS quest'estate perché non ha piovuto, eh... Però le concerie non si sono mai fermate e per fare una pelle utilizzano ettolitri di acqua. Cioè è una cosa che io non sapevo, però io credo che sia inquinamento anche quello che però perché quello va bene. [...] ci siamo riempiti la bocca, riempiti gli occhi con sto PFAS, ma dobbiamo guardare anche tutto altrove, cioè dappertutto... Non solo focalizzarci lì e dimenticarci di tutto il resto…" (Francesco, 5 December 2022).

[96] Research estimated that in the 2022 summer around 61,000 lost their life in the period between 30 May and 4 September 2022 only in Europe. In 2022, it was found to be the warmest year since 1961 (Ballester et al., 2023). Therefore, the current summer of 2023 is offering a wide range of extreme weather events, such as hailstorms and heat waves.

Shifting the gaze from global trends to local occurrences, one example of such events was the incidental fire of a paint factory located in the red zone that impacted the agricultural sector in the middle of the hot summer of 2022. It was the first day of July when the incidental fire of Isello Vernici occurred. This company is engaged in the production of paints and other chemical materials and is located in Brendola, a municipality within the red zone, in the province of Vicenza. Incidentally, it caught fire, generating black smoke visible from kilometres away, which had a negative impact on the summer season revenues of numerous agricultural businesses. Substances such as benzene, benzo(a)pyrene, dioxins, and furans have been released from the combustion of this industrial plant (Milioni & Rosso, 2022; VicenzaToday, 2022) causing concerns among the local communities. The release of these toxic substances alerted local authorities, leading to the temporary closure of farms in the nearby area for a few days. As in the case of Adriana and Paolo, together with Francesco and Monica – two distinct farmers who are also engaged in social and educational activities – this event demonstrates the vulnerability of small size agricultural businesses in this highly anthropized context. Indeed, according to them, institutional measures consisting of closing businesses and carrying out biochemical monitoring triggered clients' scepticism and disrupted the seasonal income of farmers. As Francesco angrily told me, he could not have access to his crops until the analysis was carried out by the local health service (ULSS).

> So, let me tell you honestly, it scared me... considering that we are very lucky [sarcasm], well... unlucky in a way... [...] it's a shitty place, you know? [laughs]... That time, the fire at the Isello Vernici factory scared us much more personally. It completely disrupted all our crops for a week or more in the middle of summer [...]. For about a week or 10 days, until the local health service (ULSS) came out to conduct analyses of the products in the field and provided us with the data from the analysis [...] of our products... the ones we had contacted them about, that's what we were most interested in knowing... what the hell had fallen from the sky after that factory caught fire…[97]

[97] "Allora ti dico sinceramente, mi ha spaventato.... visto che noi siamo molto fortunati, [...] a noi ha spaventato personalmente molto di più l'incendio dell'Isello vernici. [...] Fortunati, nel senso che siam proprio sfigà... è un posto di merda, ok? (Ride) [...] Quella volta ci ha spaventato molto di più l'incendio dell'Isello vernici qua. Quello sì, ci ha bloccato tutte quante le coltivazioni per una settimana o di più in piena estate [...]. Una settimana o 10 giorni, fino a che non sono usciti dall'Ulss a fare le analisi dei prodotti fuori in campo e ci hanno restituito i dati, cioè dell'analisi [...] Dei nostri prodotti... noi quello che avevamo contattato noi, era quello che ci interessava di più sapere... cosa cazzo era caduto dal cielo dopo che aveva preso fuoco quest'azienda…" (Francesco, 5 December 2022).

On the same occasion, Monica shared on social media the letter containing the results of the biochemical tests made by the local health service, in vain.

> No lies, if I had two customers, it was a lot. So, I immediately called the local health service (ULSS) to have the fruit and vegetables analyzed, and they took samples from everything... and there was absolutely nothing... but it was useless to put out the letter [...] signed by the ULSS because there was nothing... [...] practically, that whole season was lost. We had watermelons, all the summer produce, and everything from the summer season was lost…[98]

Paolo experienced the same feeling of helplessness.

> [...] In Vicenza, in fact, people, the customers, told us that the ash had arrived, however, we didn't notice anything, but obviously [...] all the customers were worried, some even said they won't buy our products anymore. They said, "If you buy from others, we'll buy, but if it's yours, we won't buy it anymore" ... like, everyone was like that. But you know... we do home deliveries, and we sent a photo of the ARPAV cloud through WhatsApp. [...] When there's fear, you know... people just don't understand anything. You can explain it to them repeatedly, but there's no way... and we also experienced a drastic decline there. Even the markets around... it was a disaster…[99]

In contrast, an event characterised by a different temporal and spatial dimension such as the Covid-19 outbreak had completely different outcomes. In most cases, the pandemic changed clients' attitudes toward farmers located in the contaminated area. For this reason, the amount of work increased for most of the farmers I met. According to them, clients looked for solutions to avoid any contact in crowded places such as supermarkets. They turned to local farmers to receive vegetables during the period in which the containment measures were taken by the Italian government. Thus, agricultural businesses implemented or reinforced delivery systems

[98] "No balle, se ho avuto due clienti è stato tanto. Al che ho chiamato l'ULSS immediatamente a far analizzare la frutta e la verdura e sono tutti fuori hanno fatto i campionamenti... e non ghe xera assolutamente niente... però non è servito a nulla mettere fuori la lettera [...] firmata dal'Ulss perché non ghe xera niente… [...] praticamente quella stagione lì è stata persa. Avevamo angurie, tutta la roba estiva, tutta roba estiva è stata persa…" (Monica, 12 January 2023).

[99] "[...] a Vicenza infatti la gente, i clienti ci dicevano che è arrivata la cenere ma da noi non è arrivato niente, però ovviamente [...] tutti i clienti preoccupati, alcuni clienti sono venuti a dirci "ma non compreremo più roba vostra, se comprate da altri compriamo se è vostra non la compriamo più"… cioè tutti così…. Ma tipo…noi facciamo consegna a domicilio e abbiamo mandato via WhatsApp la foto dell'ARPAV della nuvola. [...] quando c'è paura quando eheh… non capisci più un tubo, puoi spiegargliela e rispiegargliela, ma non c'è verso… e anche lì abbiamo avuto un calo allucinante. Anche i mercati in giro.. un disastro…" (Paolo, 17 December 2022).

to meet the demands. Following Francesco, nobody seemed to care about PFAS contamination during the confinement measures at the beginning of the pandemic in 2020.

> For example, with Covid, no one gave a damn about PFAS anymore... [...] red zone, everything you want, but the Covid... that thing, that bomb that exploded bigger than PFAS... PFAS have been going on for years... Covid was a matter of a week, and I quadrupled what I sold in a week in a month... four times more because we were doing home deliveries. So, just one week of lockdown was enough.[100]

In the same manner, for Eric, per- and polyfluoroalkyl substances were forgotten by clients.

> I mean, you know, after that [the beginning of the Covid-19 outbreaks], there was that, so you see that sometimes one thing cancels out the other, and then you no longer worry about the thing that was there before, right? PFAS were totally forgotten during the Covid era, right?[101]

Nevertheless, both the PFAS molecules and the strain of virus Severe Acute Respiratory Syndrome CoronaVirus 2 (SARS-CoV-2) share many common features. At first glance, just to mention a few common characteristics, these entities are both invisible to the human eyes, potentially hazardous to human and nonhuman bodies, and capable of traveling through them. On one hand, "forever chemicals" are the product of scientific research; they are human-made substances created by a specific group of individuals, and they have entered the human body through various pathways that constitute the consumerist neoliberal society. On the other hand, following Anna L. Tsing (2015), Eben Kirksey (2020) considers SARS-CoV-2 a "multispecies assemblage" emphasising its interplay between political, economic, and ecological influences that converge to frame living entities. Covid-19 refuses both the natural/biological and human-made/cultural dichotomies showing that the social and biological cannot be separated from each other (de Chadarevian & Raffaetà, 2020). Per- and polyfluoroalkyl substances transition from being abiotic to acquiring agency by acting as endocrine disruptors in both human and non-human bodies. However, according to Jane Bennett (2010), even abiotic matter can exhibit vitality. Her definition of vitality outlines that nonhuman entities are characterised by a certain

[100] "Per esempio, con il Covid non gliene fregava più un cazzo a nessuno del PFAS... [...] zona rossa, tutto quello che vuoi però il Covid... quella cosa, quella bomba che è esplosa più grossa del PFAS.... il PFAS sono anni... Il Covid è stata questione di una settimana e ho quadruplicato quello che vendevo in una settimana in un mese... quattro volte di più, perché facevamo la consegna a domicilio. Allora è bastata una settimana di lockdown" (Francesco, 5 December 2022).

[101] "Cioè, voglio dire dopo c'è stata quella, quindi vedi che poi sono anche cose che una cancella le altre poi uno non si pone più il problema di di quella cosa che c'era prima, no? I PFAS sono stati dimenticati totalmente in epoca in epoca Covid, no?" (Eric, 2 March 2023).

vitality that embodies «the capacity of things - edibles, commodities, storms, metals - not only to impede or block the will and designs of humans but also to act as quasi agents or forces with trajectories, propensities, or tendencies of their own» (2010, vii). To explain her argument, Bennett makes different examples. One of these is omega-3, which she believes to be a compelling illustration of how nutrients can possess agency beyond their surroundings functioning as a resource for human actions. One of the critiques of Bennett's concept of vital matters was offered by Abrahamsson et al. (2015). According to them, associating omega-3 with vital forces might result in oversimplification. Outlining how Bennett has based omega-3's vitality disentangling from the methodological specificities of the original research she referred, Abrahamsson et al. (2015) explain how it would be more relevant to discard the concept of "agency" and shift the focus to "modes of doing." Indeed, Abrahamsson et al. argue that it is unfeasible to assert the independent agency of omega-3. Instead, the data indicates that this compound does not exist as an isolated entity; rather, it is part of various contextual relationships (Abrahamsson et al., 2015). In contrast to the SARS-CoV-2 agency, I argue that it is more pertinent to underline the trajectories of PFAS as conduits through which the vitality and agency of others are expressed. This approach will support the explorations related to chemical relationships these substances engender. It is by observing how per- and polyfluoroalkyl substances catalyse and organise themselves both within and outside of living organisms, their materiality takes on political significance.

However, it is worth mentioning that these two *actants* have collided in the human bodies resulting in harmful effects in the PFAS-exposed communities. Indeed, a higher risk of mortality from Covid-19 has been observed within the Veneto population in the contaminated areas. As mentioned earlier in the second chapter, a general immunosuppressive effect of per- and polyfluoroalkyl substances has been observed (Catelan et al., 2021), contributing to the exacerbation of the toxic layering in this region.

In the next section, I will explore the effects of the mapping process on the PFAS Land. In this context, public institutions have established boundaries to address the substances within the affected municipalities. I will show how the regional government's demarcation process and its institutional failure to support farmers are connected to the downplaying of the PFAS presence, leading to increased vulnerability and division within the communities. Following

this exegesis, in the upcoming section, I will explore how the notion of *Limit* – the third L – has interfered with small-sized farming businesses.

3.4 Limit and Uncertainty

By extending its impact across various environmental systems, the petrochemical violence linked to PFAS exposure spreads across "nebulous boundaries" in human and nonhuman bodies (Renfrew & Pearson, 2021). In this sense, delving into the concept of toxic layering and the mapping process of the contaminated areas helps to grasp the idea of *Limit* within the agricultural sector. Nevertheless, the limit in the PFAS Land develops through multiple levels. It has not only marked the biopolitical landscape by defining what and who falls inside or outside a specific - regulatory and chemical - space, but it is also intertwined with an intricate web of emotions and behaviours, encompassing stigmatisation and isolation.
After more than eighty years since their invention, PFAS could be regarded as a «new ontological condition on earth» (Masco, 2021, p. 133). Indeed, these substances have become ubiquitous markers of human beings' passage on the planet and are entrenched in the planetary ecologies and in all the entities that participate in them. Partaking in the biogeochemical cycles and bioaccumulating in bodies, there is no way for such compounds to escape from their context. Thus, they lack proper boundaries entering living and non-living bodies by following different time scales – and diverse *longue durée* dimensions – that change according to their carbon-fluorine chains of PFAS (Papadopoulos, 2021). Due to these characteristics, this contaminated landscape is not confined to narrow limits; its trajectories establish connections that surpass the spatial and temporal boundaries mapped by the regional government. De facto, the SARS-CoV-2 virus and per- and polyfluoroalkyl substances were and are somehow similarly confined within artificial boundaries based on arbitrary technoscientific parameters, which resulted in a profound fracture between the inside and outside. This interpretation translated into a forced downsizing of presence for both these non-human entities, an underestimation that caused further forms of violence and discrimination.
In the case of PFAS contamination, the map produced by the regional institution determined which communities had the right to participate in the health surveillance program and which did not, solely based on their place of residence chosen by the proximity to the sources of

contaminated water.[102] Additionally, based on several preliminary conversations with activists and other individuals related to the agricultural sector, it is worth noting that the Italian territory lacks analysis centres that offer PFAS-level testing in human blood for individuals residing outside the red zone (Pietrobelli, 2023). For years, those who resided outside of the red zone - be it in the orange, yellow, or green zones - had no means of determining the amount of PFAS in their body. The communities neighbouring the red zone were excluded from these measures. Such biopolitical division left individuals who lived in the nearby impacted areas unaware of whether they carried pollutants in their bodies, increasing fragmentation and uncertainty within the population. Only recently, in May 2023, the regional health monitoring initiative was extended to the orange zone. However, although access to the previous health monitoring program was free for residents in the red zone, communities in the orange zone are now required to pay a fee of 90 euros. Moreover, according to data collected by the region in May 2023, only 42 citizens expressed interest in participating in the initiative (Regione Veneto, 2023) while the contacted population amounts to 171,201 individuals (Pietrobelli, 2023a). Before returning to farmers, it is important to emphasise that these numbers can shed light on various aspects of how communities have perceived these institutional initiatives. In my perspective, what stands out most prominently is the substantial ten-year delay in implementing the expansion of the health surveillance program following the contamination discovery and a five-year gap since the inception of the health surveillance program among residents in the red zone.

These institutional decisions were experienced as a form of violence by the communities (Zamperini & Menegatto, 2021). For the agricultural sector, the boundaries imposed by the Veneto Region resulted in a complex network of vulnerability and stigmatisation. To understand these viewpoints, I take again the PFAS-Covid-19 dichotomy as a starting point. From the biopolitical management point of view, the health emergency related to the recent pandemic and the institutional decisions taken for the "forever chemical" contamination in Veneto showed many analogies. The most apparent similarity lies in the territorial division into coloured zones. Since March 2020, the Italian government has divided the country into various zones, much like the PFAS Land. The Covid-19 map in Italy also featured different coloured areas (red, orange, yellow, and white). In both instances, the separation was determined by

[102] As also reported by Orellana (2022), «not everybody who was exposed has been able to determine the concentration of these substances in their blood, as only residents in the critical red area born between 1951 and 2014 have access to screening. Residents in nearby ("orange" and "yellow") areas are also excluded from screenings» (p. 6).

specific geographical units such as regions, provinces, municipalities, and, in rare cases, municipal districts. Additionally, it was based on numerical criteria, specifically the number of Covid-19 cases and the quantity of detected PFAS. Likewise, when it comes to the levels of contaminants in farmers' and residents' blood, or in PFAS concentration in irrigation water, food, or soil, it is always a question of thresholds, the core of environmental regulations. As Max Liboiron (2021) has shown, thresholds are where policy, accountability, and responsibility intersect, and they are linked with allowable pollution. This is the base of the permission-to-pollute system in which,

> specific quantities of contaminants are allowed legally in bodies of water, human bodies, air, food, and environments. This way of governing pollution is relatively new, but it is premised on an old colonial system of land relations where the land is a Resource (Liboiron, 2021, p. 39).

Within the framework of the neoliberal regulatory system, endocrine disruptors like substances dumped by Rimar-Miteni are discharged into the environment, surpassing boundaries and adhering to the notions of «danger is in the dose» and the «solution to pollution is dilution» (Vandenberg, 2014 in Liboiron, 2021, p. 17). By doing so they become a threat to human and nonhuman health. As Max Liboiron[103] well explained, the petrochemical apparatus functions based on the concept of "assimilative capacity," which has played a pivotal role in shaping the existing "permission-to-pollute system." Within the industrial framework, the notion of assimilative capacity emerges as a primary driver of operations, suggesting that environments can tolerate a specific level of contaminants before adverse consequences become apparent. According to Liboiron, environment is seen as a "sink" for the colonial exploitation of Indigenous *Land*. When the quantity of discharged substances exceeds the limits established by regulatory surveillance systems, it signifies the crossing of the "threshold of harm", also named "threshold theory of pollution." Considering this, it is the dosage that determines whether a substance is considered "safe." For Liboiron, the assimilation theory effectively transforms bodies of water and various environments into reservoirs for waste disposal, embodying a colonial objective. The concept of Tolerable Weekly Intake (TWI) serves as a pertinent example within this theory, representing an interesting tool employed by regulatory surveillance systems to preserve the matrix of polluting trajectories underpinning the capitalist system.

[103] Liboiron's analysis on the connections between pollution and colonialism is mainly based on their activities at CLEAR (Civic Laboratory for Environmental Action Research) that I will describe later.

Figure 8: Farmland in the red zone (December 2022, photo by the author).

While in March 2023, the EPA unveiled its proposed National Primary Drinking Water Regulation (NPDWR) pertaining to six PFAS compounds (PFOA, PFOS, PFNA, HFPO-DA, also known as GenX, PFHxS, and PFBS) in groundwater, surface water, and drinking water (EPA, 2023), there are currently no federal drinking water standards in the United States. Indeed, every state has set different limits. The situation is similar in the European Union member countries and at the regional level in Italy. In a context where no regulations were in place concerning PFAS at the time of the 2013 contamination discovery and considering that their production had commenced in the 1960s without adequate discharge controls, the Veneto regional government displayed reluctance in setting limits. As in the US, where the institutional regulating response was «slow and fragmented» (Refrew & Pearson, 2021), the Italian authorities have been blamed for the same reasons. Therefore, due to their undefined number, monitoring and tracing PFAS compounds constitutes a challenging process, exacerbated by the absence of analytical standards for many of these substances (Cordner et al., 2019). Indeed,

over the years, the context of uncertainty appears to be further aggravated by the regulatory apparatuses which, in the case of per- and polyfluoroalkyl substances, support the industrial-driven production of scientific ignorance (Goldstein, 2017). In light of the geographical extent of the contamination and following the PFAS slippery features, the endeavour to detect the impact of chemicals on ecosystems requires robust environmental monitoring and reporting infrastructures. According to Papadopoulos (2021), it is where the limitations of ecological chemistry appear as it necessitates extensive participation from various stakeholders, including state agencies, governmental and intergovernmental institutions, industry, and private sector organizations. By cooperating in such monitoring infrastructures, these entities often fail or even undermine the monitoring process. In these scenarios, institutional and complex historical relationships between different actors play an equally important role in shaping the landscape of empirical norms and possibilities in scientific production (Richter et al., 2018). Needless to say, because of this framework, farmers found themselves in a surreal and unsettling situation. Only two of the farm businesses I visited had been operating for decades taking the activities from the previous generations. Additionally, there were others that were established years before the discovery of the PFAS pollution in Veneto. Diego and Claudia's agricultural business was the only one to begin its activities after 2013, the year of the publication that marked the initial recognition of per- and polyfluoroalkyl substances contamination (Polesello et al., 2013). These two farmers decided to rent a small piece of land in 2016. One year later, the regional mapping process was carried out. As a result of this division, the couple found itself catapulted into the red zone. Their aim was to focus on zero-kilometre agriculture to provide fresh products to the local communities. However, "the concept of 'kilometre zero' had become a disadvantage. Therefore, we decided that if there was polluted water, we probably had to reconsider and change our location."[104] Claudia and Diego were worried about being a source of contamination, so they started to pay for annual well water analysis by themselves. They discovered that their well was in a low-PFAS area at the edge of the polluted aquifer. In contrast to other farmers, they decided to publish the analysis results on their website. Nevertheless, in most cases, checking the presence of contaminants and publishing the analysis results was not enough to avoid being labelled as polluted. Eric explained that being present at the local markets with their products from the red zone.

[104] "Noi siamo arrivati qua con l'idea di fare agricoltura a km zero per servire un prodotto fresco al territorio. [...] [Q]uindi il chilometro zero era diventato un svantaggio, allora noi abbiamo voluto dire beh, allora intanto se c'era nell'acqua inquinata, probabilmente anche noi dovevamo ripensare e cambiare posto" (Diego, 21 November 2022).

> [...] was like having a star attached. I mean, you were from [city], and [city] is a red zone. Okay? So, being from [city], within the red zone, meant really being marked, even now, even now.[105]

For Eric, the comparison to the "Star of David" indicated the stigma and marginalization his business endured when being labelled as contaminated. While dealing with contaminations and toxic legacies, stigmatisation represents a challenging task that contributes to the intensification of social and environmental inequalities (Kryder-Reid & May, 2023). Among the farmers I encountered, this situation was prevalent. Indeed, the same sense of marginalization was experienced by Francesco, whose farm has been a part of the regional PFAS detection program since 2015. During our preliminary phone conversation, he emphasised that the enterprise he is employed at has been affected not only by the pollution caused by "forever chemicals" discharge, but also by the apprehension fuelled by this contamination. Over the past few years, Francesco, who works on a social and educational farm employing six permanent workers and occasionally accommodating up to ten individuals, also began monitoring the presence of PFAS by covering the analysis costs independently. The business in which he works is a certified organic company that is in partnership with a social cooperative where they offer people with disabilities an environment to learn and work. They produce a wide variety of greens to supply both organic shops in the province and their own shop. He informed me that the network of the retailers they provide organic products to frequently faces difficulties in selling their items. By looking at the name of the municipality where vegetables are cultivated, clients prefer not to buy them.[106] As they were labelled as contaminated despite their effort to show a low level of PFAS, this customer choice has been a harsh blow to Francesco's farm. In many cases, the solution could have been to go to agricultural markets far from the impacted areas to take advantage of the distance. While discussing this potential strategy, Monica referred to a colleague and said to me:

> For example, they, on the other hand, haven't experienced a decline in their clients because he [the farmer] only goes to markets. So, when you go to certain markets outside of here, they don't ask you "Where are you from?". And this helps because it was also suggested

[105] "era come se avessi la stella attaccata. Cioè, tu eri di [nome di città], e [nome di città] è zona rossa. Ok? e quindi, essendo di [nome di città], zona rossa, era veramente essere marchiati ma ancora adesso ancora adesso" (Eric, 2 March 2023).

[106] "What I can tell you is that it crippled us, because we started out with very good sales. Then there was an increase of this problem related to PFAS. And this has put us more and more in a real red area. And so we go to deliver to [organic chain store's name] but we have been told several times, "look that your products are hard to sell, because we have to write that you are Brendola" (Francesco, 5 December 2022)

> to me to go to markets if I wanted to sell more. Apart from the fact that there are two of us, I mean, so it's not like I can go to the market... right?[107]

This strategy is not always effective since clients may still recall that a farm is situated in the red zone, even though it is favoured by numerous enterprises.

When I was about to leave Francesco, he showed me a laminated paper displaying the results of their analysis, which was placed on the shop counter. Within the affected areas, contradictions emerge as a common practice. On one hand, there is a lack of trust in institutions and assurances because the contamination is intricate, following the complexity of the contaminant and the "toxic layering" of the region. On the other hand, farmers disclose their analyses, seeking transparency with their customers, which institutions have avoided.

During my fieldwork, it was clear to me that being in the red zone has exacerbated stigmatisation among and towards the same impacted communities. What I want to outline here is how PFAS controls on farming products or water have always been carried out on farmers' own initiative. During these years, each business arbitrarily decided when, how, and to whom to turn to verify the presence of contaminants in their vegetables. Due to the underlying situation characterised by fear and the novelty of the topic - additionally, as previously mentioned, there is an ongoing legal trial - I found it challenging to clearly understand if all the farms I encountered had genuinely checked for the presence of PFAS in their environment. As indicated earlier, the information provided, and farmers' actions often appeared contradictory. Each farm took different measures to try and contain the spread of PFAS, but all of them accepted the minimal presence of the contaminants. Some farmers had their well water analysed, while others opted to directly test their products. As Francesco did, some even published their analyses in their shops. In contrast, Monica, the only farmer I met from the orange zone, told me that

> When I presented the analyses to the local health authority, they told me that I was one of the few who submitted them. However, I mean... I don't mind... since I consume the products here, it's right for both my protection and that of the customers because I put

[107] "Ecco loro, ad esempio, non hanno subito il calo della clientela perché lui va in giro solo a mercati... E quindi quando vai a certi mercati fuori da qua non è che ti fanno la domanda "da dove vieni?" E questo aiuta perché anche a me è stato proposto di andare a mercati se volevo vendere di più, a parte che siamo in due voglio dire, quindi non che posso andare al mercato.... no?" (Monica, 12 January 2023).

> myself out there, I don't work with other people in the shop and hide... I mean, and that's fair.[108]

There has never been an obligation to share or submit analyses to local authorities. However, as Monica later explained to me, she also published the analyses on Facebook, but she subsequently chose to retract them due to the "confusion" they caused among customers.

> And so, we have also avoided posting them, not hiding them, precisely because they would be read... you don't even know the initial parameters, you don't know anything, and you don't know the comparisons with others, so it doesn't make any sense at all...[109]

The contradiction emerging from Monica's words aptly represents the behaviour of the farmers I have encountered. In the absence of any institutional support, their prevalent long-term strategy has been to avoid talking about the PFAS issue to safeguard their economic revenue.

> Yes, to some extent, it has been mentioned less on TV, and also, we avoid discussing the issue, so it's better not to talk about it... you know, the saying 'Out of sight, out of mind'... something like that...[110]

Following the need to preserve the relations with customers, some farmers deliberately bypassed discussing the issue, refraining from mentioning any analyses and often glossing over the topic. I argue that this was also why most farmers I contacted either did not respond or chose to decline my proposal to meet with them. In this regard, another leitmotiv that summarises the farming sector predicament is the term "illusion," seen as a form of self-deception. As Zamperini et al. (2021b) pointed out:

> Self-deception, or optimistic illusion, is thus a process of self-confidence construction that assists in navigating and taking action despite a hostile environment. It becomes evident here that the universe of environmental contamination is a multi-verse, inhabited by administrators with health governance expertise, experts with their scientific-probabilistic

[108] "[...] quando presentavo le analisi all'ULSS mi diceva che ero una delle poche che le presentava in ogni caso. Però voglio dire... A me non interessa... siccome io le cose qua le mangio e quindi è giusto sia per una tutela mia sia anche per un cliente, perché mi ghe metto la faccia non xe che in negozio go altre persone che mi scondo... Cioè, ed è giusto." (Monica, 12 January 2023).

[109] "[...] e quindi abbiamo anche evitato di mettere, ma non per nasconderle, proprio perché verrebbero lette.... non sai neanche i parametri iniziali, non sai niente, non sai i confronti con gli altri, quindi non ga proprio senso…" (Monica, 12 January 2023).

[110] "Sì, un po' è stato toccato meno in tv, un po' anche noi evitiamo la questione e quindi va meglio se non lo dici… della serie Occhio non vede cuore non duole….una cosa del genere…." (Adriana, 17 December 2022).

> background, consciously concerned citizens, and even citizens encapsulated within a state of "knowing and not-knowing."[111]

In this context of uncertainty, what makes the farmers' decisions more complicated is their inability to cope with the analysis results. Private companies involved in testing the PFAS presence were not in charge of giving instructions to them. Thus, as Francesco explained to me, farmers were often unable to comprehend the results they received. After having switched off my microphone, he told me that PFAS analysis reports were not "like the results of blood tests with asterisks"[112] that indicate anomalies in their values. Due to this fact, he observed that the numbers printed on the laminated paper in his shop were a source of suspicion and panic among his clients. The latter were unable to understand the numbers presented in the document, and consequently, they frequently became sceptical and chose not to buy products from his store.

Similarly, in the case of Adriana, the construction of a new well taking into consideration the PFAS presence underlying the groundwater basin and emphasising transparency were not enough to avoid scepticism.

> [...] Taking advantage of the PFAS issue - anyway, it was a well that, to some extent, could get contaminated - we had a new well built on our property, deeper than usual, okay? So, we invested more, of course, to ensure that the groundwater below wouldn't be easily contaminated... and well... despite all this, people still didn't trust us. Then there were those... I invited them to come to the farm, invited them to see the test results... but at some point, I stopped showing them the analyses because it was pointless. I mean, if you trust me and what I say, great, otherwise, so be it. There's no point in showing you everything and still having you there with a sceptical face... [nervous laugh].[113]

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[111] «L'autoinganno, o illusione ottimistica, è quindi un processo di costruzione della fiducia in se stessi che aiuta a orientarsi e agire nonostante un ambiente ostile. Emerge qui chiaramente come l'uni-verso della contaminazione ambientale sia un pluri-verso, abitato da amministratori con competenze di governance in materia di salute, esperti con il proprio bagaglio scientifico-probabilistico, cittadini consapevolmente preoccupati, e pure cittadini incapsulati dentro una condizione di "sapere e non-sapere"» (Zamperini et al., 2021b, p. 164).

[112] "come i risultati delle analisi del sangue con gli asterischi" (Francesco, 5 December 2022).

[113] "[...] Prendendo a balzo la storia degli PFAS - che comunque era un pozzo che un pochino che poteva succedere che veniva inquinato - abbiamo messo giù il pozzo nuovo sulla nostra proprietà più profondo del normale, ok? Quindi abbiamo investito di più ovviamente per poterlo fare in modo che la falda sotto sotto non era così, non poteva arrivare inquinamento velocemente praticamente… e niente…E nonostante questo ancora le persone non si fidavano. Poi c'erano quelli… Io li invitavo a venire in azienda, li invitavo a vedere le analisi…ad un certo punto ho smesso di mostrare l'analisi, perché tanto era inutile cioè…se ti fidi di me che te lo dico bene e sennò pace …perché è inutile che ti mostro tutto è ancora mi stai lì con la faccia da scettico…. [risata nervosa]" (Adriana, 17 December 2022).

Moreover, she blamed the clients for not being able to understand her analysis results and not acknowledging the ubiquitous presence of the contaminants.

> If it says zero, you can't tell me, "we are above, but not beyond the limit" [...] Then, I must say that the fact that we have contaminated aquifers is true... but if you inform yourself a little, PFAS are used by a lot of factories both in Italy and outside Italy, and unfortunately, PFAS pollution in water is more common than one would think. Here it is beyond normal, but if you look at European limits, there is still a certain amount tolerated because factories discharge. So, it's not like if you go and get vegetables from Sicily or Germany, you are a hundred percent sure that they don't contain PFAS...[114]

Thus, in the PFAS Land, allowable pollution limitations, namely Liboiron's "threshold theory of pollution", blur away due to lack of information, illusions or adaptation strategies. This practice reflects what I believe is their overall underestimation of the presence of per- and polyfluoroalkyl substances by public actors who failed to provide clear information and prompt support. This follows PFAS's slippery nature as residues that enables them to evade regulatory surveillance systems. According to Diego, this contamination

> [...] is a disaster that should make us think about future issues of this kind, because there will be so many pollutants around, but until you specifically search for that pollutant, you never find it in the analyses ... that was the problem with PFAS ... No one ever looked for them, and they didn't even know they had to look for them...[115]

One of these missing limitations, concerning the regulatory system of the agricultural sector and the identification of these pollutants is related to organic certification. As reported by Greenpeace (2023) and indicated to me by preliminary informants, the national organic certification regulations do not require any PFAS analyses for those seeking to certify their agricultural business as organic. Four out of seven companies I interviewed claimed to be organic certified. However, some of them admitted that, despite paying for the certification and adhering to its guidelines, their agricultural practices extended beyond what was required for

[114] "Se c'è scritto zero, non puoi dirmi: "siamo oltre non oltre il limite" [...] poi c'è da dire che comunque su sta storia che noi abbiamo le falde inquinate è vera… però se ti informi un pochino i PFAS vengono usati da un sacco di fabbriche sia in Italia che fuori Italia e purtroppo l'inquinamento di PFAS nell'acqua è più comune di quello che si pensa. Qui è fuori dal normale però se vai a vedere anche i limiti europei comunque ce n'è un tot tollerato perché appunto le fabbriche scaricano. Quindi non è che se tu mi vai a prendere la verdura dalla Sicilia o dalla Germania sei sicuro al cento per cento che dentro non ci siano PFAS…" (Adriana, 17 December 2022).

[115] "[...] è un disastro che deve far pensare a futuri problemi del genere, perché cioè di inquinanti in giro ce ne saranno tantissimi, finché non vai a cercare quelli inquinante specifico non lo trovi mai nelle analisi che... era quello il problema degli PFAS... E nessuno li ha mai cercati e non sapevano neanche di doverli cercare…" (Diego, 21 November 2022).

organic certification. Nonetheless, among the farmers that I met, this certification held different values. While most of them recognized the principles of organic farming, such as avoiding harmful herbicides and other chemical substances, they shared varied experiences on the topic. Carolina, who claimed to know many colleagues within the sector, told me that many agricultural businesses chose to apply for the certification "because it must be done to put the green leaf on the wine bottle."[116] For her, the staff responsible for the organic certification, namely the Italian "bio,"

> [was] not even aware, you know. Because they come to do the analyses personally, and they are not even aware... they are not even aware... [...] But maybe they are also from the same area, perhaps they visit the farms, they want the farms to keep working... Maybe they are also from the area and they know…[117]

The absence of any PFAS regulations in this process is a policy-related matter. It is precisely because of this gap in the process that Diego and Claudia chose not to pursue this certification. As indicated earlier, the couple claimed to follow agricultural principles that are distant from conventional agriculture and closer to organic practices. For this reason, they decided not to pursue the "green leaf," forfeiting the commercial benefits associated with being a certified organic farm.

Another technological limit[118] is related to the presence of PFAS in scanning and mapping private wells. Indeed, in 2017, in the occasion of the mapping process, wells and other water sources were listed and analysed to understand the presence of the pollutants. Due to the difficulties to list hundreds of unrecorded sources, this monitoring plan was criticised and deemed as precarious and incomplete by activists and local actors. The difficulties to scan the contaminated areas and listing wells dealt with the practices of hiding illegal constructions within private properties. Following what activists, agricultural sector-related personalities, and farmers told me, this lack of transparency made it difficult to understand the real presence of per- and polyfluoroalkyl substances within the large territory that was impacted. The habit

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116 "Perché va fatto per poter mettere la fogliolina verde sul vino" (Carolina, 3 March 2023).

117 "Non sono neanche consapevoli, Eh. Perché vengono fuori certificatori che non son neanche consapevoli... non sono neanche consapevoli… [...] Ma magari i xè anche della zona però te ve nelle aziende, te ghe caro che le aziende lavora... Magari i xe anche della zona e i lo sa ma…" (Carolina, 3 March 2023).

118 Related to the set of technologies employed by public institutions in detecting the PFAS presence, it is worth mentioning one of the findings from Girardi et al. (2018). Based on an epidemiological study conducted on Rimar-Miteni's workers' blood, the research estimated that one employee had the highest PFOA concentration ever recorded, reaching 91,900 ng/mL. The same study suggests that since this concentration remained unchanged after one year, it could be presumed that this figure represents the maximum measurement threshold of the instrument used.

of hiding that obstructs the identification of the contamination sources represents a further demonstration of the porosity and slippery features of PFAS contamination. It further illustrates inadequate efforts to establish limits within this chemical arena. This use is confirmed by Eric's words,

> I mean, there, it's all about practicality, and since you've already spent 100, you might as well spend 101. I mean, we even had a well dug [...] that goes down to 90 meters into the water table. And why... Well, I'm telling you, it hasn't been reported yet […] it's one of the practices that seem to be commonplace around here.[119]

Even though it was not officially documented, their well was constructed with the intention of avoiding contaminated water and the associated costly expense. This widespread practice of concealment intersects with the economic precarity of the agricultural sector. This aspect has been briefly described in the first section of this chapter, and it embodies a distinctive feature of the PFAS Land, which was unexpected before my interactions with farmers. Indeed, according to Diego, illicit practices in the agricultural world depend on the individual.

> All the [analysis] expenses were covered by us, and it depends on the sensitivity, because in agriculture, you see, certain limits don't exist. There are people who use very contaminated channels for irrigation. And even there, there isn't a clear regulation about what's there. Have you tested the water from that channel? No. You use it, you dispose of it because maybe you're growing cereals, and that's it...[120]

Once again, this serves as an example of how the concept of limit lacks the requisite attributes to effectively address the slippery presence of PFAS. Within this framework, the instances of illegal practices presented by Eric and Diego exemplify behaviours that align with particular social and economic contexts, which are pivotal within the agrarian neoliberalism framework. In the next pages, I will progressively delve into this subject. However, before entering the next section, it is crucial to highlight that having a "star attached" also entails fearing "persecutors." In particular, the upcoming pages are dedicated to the insights shared by farmers regarding the role of Mothers NoPFAS and their perception within the agricultural sector. I will not offer an

[119] "Lì voglio dire, si è andato molto per il pratico e quindi visto che tanto hai speso 100, spendi 101. Voglio dire e si è fatto costruire il pozzo [...] che va in falda a 90 metri. E perché... Ecco, ti dico che comunque non è denunciato ancora… [...] è una delle prassi che comunque qua pare essere all'ordine del giorno" (Eric, 2 March 2023).

[120] "Tutto a nostro carico e dipende dalla sensibilità, perché poi cioè anche in agricoltura, appunto, non essendoci certi limiti. C'è gente che usa canali molto sporchi per dar da bere. E anche lì, non c'è un regolamento chiaro su cosa c'è, hai analizzato l'acqua di quel canale? No. Tu la benti, la butti perché magari fai i cereali e quindi bene o male…" (Diego, 21 November 2022).

exhaustive description of the Mothers NoPFAS movement in this thesis. Nevertheless, in aiming to explain the convergence of blame and stigmatisation experienced by farmers, the next section outlines the role of this activist group and how it intertwines with the small-size agricultural enterprises in the contaminated areas resulting in the fragmentation of the impacted communities.

Figure 9: A channel cuts the farmland in the red zone (Spring 2023, photo by the author).

3.5 "Have there been any Mothers NoPFAS who mentioned our company's name?"

Anthropogenic and environmental disruptions together with their ecological and climatic consequences are social justice issues often linked to health problems that affect specific communities (Armiero, 2021; Barca, 2020; Bullard, 2000; Navas et al., 2022). In the context of PFAS-related contamination, I already mentioned how the parental role has been affected and how Mothers NoPFAS played and play a prominent role in seeking justice for the

communities. However, there are numerous NGOs, social movements, and other actors involved, coming from diverse backgrounds. Not only are there names from international and national environmental activism, such as Greenpeace and Legambiente,[121] but also associations from the scientific sphere, such as ISDE (International Society of Doctors for Environment) and Medicina Democratica. Furthermore, there are movements such as Coordinamento Acqua Bene Comune di Vicenza and Verona, which are dedicated to safeguarding water as a common resource, ethical purchasing groups like Rete Gas Vicentina, as well as organisations including Cillsa (Cittadini per il Lavoro, la Legalità, la Salute e l'Ambiente) and Pfas.land - the latter acting as an aggregator for disseminating information and fostering community engagement - just to mention a few.

As reported in the second chapter, despite being completed in 2019, the analytical data and georeferencing information of the matrices analysed in the "Sampling Plan for Food Testing for Perfluoroalkyl Substances," conducted by the Veneto Region in 2016-17 in the municipalities of the red zone were initially not made public. The region opposed the publication of the findings and only thanks to the efforts carried out by the Mothers with Greenpeace that appealed to the court, the results were published two years later in April 2021. For these reasons and their leading role, the Mothers No PFAS stand out as one of the most active and relevant groups. Despite being a heterogeneous group of people, the members of this movement share common experiences of parenthood, uncertainty, and the fact that they became unwitting participants in the contamination of their children's bodies. They have aimed and continue to aim at updating the current PFAS limits to achieve the "PFAS ZERO" objective, namely the zero-concentration limits. To this end, over the years, the Mothers have made a significant impact on the Rimar-Miteni affair in Veneto. For instance, since 2016, they have had meetings with Luca Zaia, the governor of the Veneto region; Robert Bilott, the American attorney involved in the US DuPont's trial; and two Italian environment ministers[122] (Mamme NoPFAS, n.d.). Furthermore, they have been received by the European Parliament in Strasbourg and have established connections with other social-environmental grassroots movements, such as the No Ilva Committees, to form "Mamme da Nord a Sud," a network of mothers engaged in various environmental justice cases across Italy (Rete 'Mamme da Nord a Sud', 2019).

[121] Legambiente is an Italian environmentalist organization founded in 1980, which currently comprises 18 regional branches and 1000 local groups (Legambiente, n.d.).

[122] These are only few of the encounters that they had through the years, for more details visit: https://www.mammenopfas.org/la-nostra-storia.

As previously stated, being parents, especially mothers, within the PFAS Land, means also delivering "forever chemicals" to future generations and it is associated with a perpetual sense of guilt for having contributed to the contamination of their children or directly exposing them to contamination (Menegatto et al., 2022; Zamperini & Menegatto, 2021). According to a mother,

> There is a tragic reality, and the situation is beyond our control. I can't manage it. I feel powerless. And I feel so guilty towards my children because I gave them so much freedom: breastfeeding, natural foods, all these things, thinking I was doing the right thing. I feel guilty and helpless.[123]

For these reasons, many of Mothers NoPFAS perceive the issue of contamination with deep personal involvement (Zamperini et al., 2021a). Before meeting farmers, I was already aware that the affected communities had responded to the contamination by radically altering their lifestyles and habits. Menegatto et al. (2022) confirm this scenario, indeed, according to a father from the affected areas: «At the beginning, we eliminated local market foods, or in any case, any food that we knew came from the polluted area» (p. 12). Thus, residents began to make more health-conscious decisions and embraced a "healthier way of living" to protect themselves and their loved ones (Menegatto et al., 2022).

In this context, on one hand, grassroots movements such as Mothers NoPFAS, emerging after the discovery, can be viewed as a community response, justified by the distressing experience tied to the contamination. On the other hand, their attitude and communication style have been perceived as "alarmist" by farmers and detrimental to part of the category. In this complex terrain, certain segments of the agricultural sector have been labelled as polluters by activist groups. This is one consequence of the fear and uncertainty that has spread in the contaminated areas due to the lack of institutional support. In this sense, Zamperini et al. (2021) explain that the Mothers NoPFAS are seen as a «threat, as they raise an issue related to numerous local productive activities (such as agriculture and livestock farming) that support segments of the

[123] «Esiste una realtà tragica e una situazione che è al di fuori della nostra gestione. Io non posso gestirla. Mi sento impotente. E mi sento tanto in colpa nei confronti dei miei figli perché ho dato loro molto spazio: all'allattamento, ai cibi della terra, a tutte queste cose, credendo di far bene. Mi sento in colpa e mi sento impotente» (Zamperini et al., 2021b, p. 159).

population».[124] But, at the same time, they are considered «a point of reference for the community».[125]

Figure 10: A fountain located in red zone with a sign: "water not subject to potability checks" (March 2023, photo by the author).

I met Monica on a cloudy afternoon in January 2023. She runs a business with her daughter Laura, offering various activities for children in collaboration with social cooperatives. They cultivate four hectares in the orange zone, at the intersection of residential and industrial areas, juxtaposed with the squared and cultivated landscape. Just a few hundred meters away, trucks and cars pass by one of the main thoroughfares of the province. In the opposite direction, intensive and conventional farming land stretches as far as the eye can see. In this context, her farm offers a meeting point for many people, not only clients but also children and families that come to join educational activities. After engaging in a conversation with Monica, she

[124] «Infatti, le "mamme No Pfas" sono anche viste alla stregua di una minaccia, poiché sollevano una questione connessa a numerose attività produttive del posto (per esempio l'agricoltura e l'allevamento), da cui dipendono segmenti della popolazione» (Zamperini et al., 2021a, p. 183).
[125] «le madri sono diventate un punto di riferimento per la collettività» (Zamperini et al., 2021a, p. 183).

surprised me with an unexpected question: “Have there been any Mothers NoPFAS who mentioned our company’s name?”.[126] This query made me realise another aspect of the farmers’ challenges related to cultivating in this context of constant fear. It was not the scepticism related to the Mothers NoPFAS presence that surprised me; instead, it was Monica’s question itself. When I turned off my microphone, she asked me if her farm belonged to a list made by the Mothers. Her fear was centred around being labelled and listed as contaminated by them. This made me wonder if any of the businesses that ghosted or declined to meet me were also apprehensive about this possibility, and it opened my eyes to the intricate relationships within the PFAS Land.

Tellingly, most of the farmers I met had no direct contact with this social movement, but they believed that this group of women[127] was responsible for spreading alarmism and fear related to agricultural activities. Within the perspectives and experiences of farmers, the presence of Mothers NoPFAS was constant during the interviews. For Adriana, the community’s recognition of the presence of per- and polyfluoroalkyl substances was gradual, and the people around her remained calm,

> Then, various movements of Mothers NoPFAS and others started, and they practically began to insist a lot on the issue, especially regarding the children, but in a sort of obsessive way, not making any distinctions, not doing anything different, just continuing headlong, and that’s when panic set in. So people started to be terribly afraid of everything growing in the area, and it’s natural that the people who were still calm, those who trusted us because they knew us for years and to whom we also showed the analyses, kept coming back. However, many new customers who didn’t know us preferred to go to Prix, preferred to go to Tosano,[128] not even knowing where the vegetables come from and how they were treated, rather than running the risk of getting vegetables with PFAS...[129]

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[126] “Allora ci sono state, ma la sincerità però, Mamme NoPFAS che hanno fatto nome della nostra azienda?” (Monica, 12 January 2023).

[127] As outlined by Zamperini et al. (2021a), this activist group is also composed by a limited number of fathers while maintaining its female root.

[128] Prix and Tosano are retail companies.

[129] “Poi sono iniziati i vari movimenti delle mamme NoPFAS e quant’altro che praticamente hanno iniziato proprio a spingere tantissimo sulla questione per il discorso dei bambini, ma proprio in modo maniacale, nel senso che non facendo nessuna distinzione, non facendo niente, cioè continuando ad andare avanti a testa bassa, praticamente e lì si è creato panico... cioè le persone hanno iniziato proprio ad avere una paura tremenda tutto quello che è coltivato in zona e quindi vien da sé che le persone che comunque erano abbastanza tranquille che si fidavano di noi perché ci conoscevano da anni gli abbiamo anche mostrato le analisi e hanno continuato a venire. Tanti, invece che noi magari non ci conoscevano e iniziavano ad essere nuovi clienti, preferivano andare al Prix, preferivano andare al Tosano e non sapendo neanche che da dove arriva la verdura e da cosa era stata piuttosto che il rischio di prendere della verdura col PFAS… ecco…” (Adriana, 17 December 2022).

By changing his tone of speaking, Francesco showed a sense of frustration talking about the Mothers. Despite agreeing with them and understanding their effort, he believed that "they have created an impressive state of fear."[130] As I was starting the sentence to ask him if communities should "accept" the presence of PFAS, he interrupted me.

> No, we shouldn't accept the fact that *shit* has been dumped for years, but we shouldn't turn it into a tragedy either. I don't know how to explain it to you. This constant talk about PFAS, about all these issues, has really harmed our company. I am speaking from a business perspective right now. When we display a label saying, "agricultural product from [name of a city]," even if it's certified organic or anything else, people associate it with [name of a city]. So, let's just erase [name of a city] from our lives…[131]

Thus, farmers expressed fear of declining earnings, leading to a multifaceted relationship with their communities, which have encountered the contamination in various ways. Like residents, they have also experienced a sense of frustration and helplessness. Furthermore, the lack of financial support from institutions has exacerbated these sentiments. These emotions have led to fragmentation and isolation not only within the agricultural sector but also across the entire affected communities. Amidst this mix of emotions, contradictions emerge.
Francesco pointed out that PFAS pollution is just one element of the toxic layering that constitutes the polluted backdrop of the Po Valley.

> So, I totally agree with the Mothers NoPFAS... but only to a certain extent, you know? Because we can go around in circles all we want, but the sky we have is what it is. I mean, we're in the damn Po Valley, so we probably have one of the most industrialized places globally, I assume. And the more industrialisation, the more cars moving, the more factories working, and the more products getting released into the atmosphere, the waters, and everything else. Now we have PFAS, but a few years ago, you could just go see what was being discharged into the Agno River by the tanneries.[132]

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[130] "[...] per fortuna si inizia a capire... si inizia a capire perché non l'hanno ancora capito in tanti, o meglio tutti, che il cielo è uno e la terra è una. Se imputtaniamo quello che abbiamo dopo dove andiamo? dove cazzo andiamo a vivere? Cioè bisogna un po' capire anche questo. E quindi? E quindi ecco. Quindi sì, son d'accordo coi con le mamme No PFAS però hanno creato uno stato di paura impressionante" (Francesco, 5 December 2022).

[131] "No, non bisogna accettare il fatto che sia stata scaricata merda per anni, però bisogna non renderla una tragedia... cioè non so come spiegartelo... Questo continuo andare a parlare di PFAS, a parlare di tutte queste problematiche a noi hanno tagliato le gambe come azienda, adesso ti parlo come azienda in questo momento. Perché noi quando andiamo a esporre un cartellino con prodotto proveniente... prodotto agricolo proveniente da [nome di città], purché sia certificato bio, purché sia... cioè tutto quello che vuoi, ma viene da [nome di città], quindi [nome di città] cancelliamolo dalla vita…" (Francesco, 5 December 2022).

[132] "allora io sono molto d'accordo con le mamme PFAS, No PFAS... però fino a un certo punto, perché? Perché possiamo girarci attorno finché vuoi, ma il cielo che abbiamo è quello. Cioè siamo in una cazzo di Pianura padana,

These words embody the concept “whataboutism,” a concept that has been applied in the research of Pablo Lapegna and Johana Kunin (2023), who explored how herbicide use is institutionally justified in specific towns within the Argentine Pampas. What their research reveals is that the justification for the use of agrochemicals is embedded in national sovereignty and individual rights to prosperity, further complicated by farmers’ ambivalent feelings towards the Argentine neoliberal state. In this context, it is worth reporting what an Argentinian farmer said. According to him, if the local communities are exposed to harmful chemicals, «it is due to ‘‘a series of factors,’’ and not only because of glyphosate or other pesticides, which he saw as being ‘‘blamed for everything.’’» (Lapegna & Kunin, 2023, p. 6). In the same way, while PFAS have been dumped and diluted, entering the groundwater basin above the Rimar-Miteni plant, Francesco aimed to portray these contaminants as just one among several. By minimizing the per- and polyfluoroalkyl substances, he compared the adverse effects of disseminating these pollutants through the agricultural market to the routinized polluted backdrop of the Po Valley. His effort is an attempt to mitigate the prevalence of PFAS and prevent economic losses resulting from the panic and suspicion felt by the affected communities. As in the Argentine Pampas case, where «farmers also diluted the risks posed by pesticides by explaining that people live surrounded by many environmental hazards» (Lapegna & Kunin, 2023, p.9), Francesco seems to adopt a similar justification for per- and polyfluoroalkyl substances presence. In doing so, the dilution is repeated. For Lapegna and Kunin the «attempt to discredit those who raise concerns about pesticides by charging them with hypocrisy is another way of making quotidian toxic exposure acceptable in these kinds of towns» (2023, p. 6).

I will not further explore the distinction between the two cases, namely the herbicides’ usage in Pampas and the PFAS contamination cases. Nonetheless, in both situations, the environment serves as a “sink,” which is, as already mentioned, a space in which, following Liboiron (2021), the regulatory surveillance systems are founded on the concept of “assimilative capacity,” which constitutes the prevailing belief that the dosage determines whether a substance is deemed “safe.” To support my forthcoming discussion, I would like to emphasise two more differences between the Argentinian and Italian contexts. The first distinction lies in the essence of the substances involved: a group of synthetic substances viewed as harmful intruders - the

quindi abbiamo probabilmente uno dei posti più Industrializzati a livello mondiale presumo. E quindi più c'è industrializzazione, più ci sono macchine che si muovono, più ci sono fabbriche che lavorano e più ci sono prodotti che vengono scaricati nel cielo, nelle acque, in tutto quanto. Adesso ci sono i PFAS, qualche annetto fa bastava andare a vedere lungo il l'Agno cosa veniva scaricato dalle concerie” (Francesco, 5 December, 2022).

PFAS - versus a chemical utilized to enhance crop efficiency - the herbicides. The second distinction pertains to farmers' involvement with substances that are entirely dissimilar. While in both scenarios farmers endeavoured to reject the accusations to spread harmful substances with certain whataboutism, farmers from the PFAS Land have no benefits for the ubiquitous presence of these substances. Indeed, per- and polyfluoroalkyl substances are residues, by-products of chemical processes, deemed as waste, while herbicides in the Argentine Pampas are introduced into the environment by farmers to enhance agricultural production. For this reason, the involvement with their respective communities is diverse. Thus, according to Francesco, he and his colleagues

> [...] have tried many times to participate in some events with our water analyses in hand, to explain it, to promote, exactly that we... these are the waters, this is the land where we live, but this is what we use for various crops. However, there's never... I mean, there's always a lack of trust. Here are the analyses… because who knows where you got that water for the analysis, and instead, damn, the pump works perfectly, but we live off this, not me, but rather the 100 persons who come here to work, I mean, between work and assistance... there are about a hundred guys with disabilities here. This is what makes me feel a bit like this...[133]

As I listened to Francesco, I perceived his isolation and frustration arising from the lack of trust he experienced. At the same time, I believe that these are the results of the particular form of job blackmail that small sized agricultural enterprises have faced over the years. I believe there is a lack of understanding regarding the sense of isolation and helplessness experienced by the agricultural sector, resulting in fractures among the impacted population. The failure of the Veneto region, municipalities, and public institutions to promptly inform the communities, the scarcity and lack of clarity in providing information about the level of PFAS in products, water, and agricultural soil, as well as the absence of any epidemiological study on the local population tested during the health surveillance program - all highlight the disconnect between the impacted communities and the government authorities. Amid this chaotic situation, social movements - especially the Mothers NoPFAS - have played and continue to play a crucial role

[133] "Noi abbiamo provato tante volte con i nostri, con le nostre analisi delle acque in mano a partecipare a qualche serata, a spiegarlo, a pubblicizzare, appunto che noi… queste sono le acque, questo è il terreno dove viviamo, ma questo è quello che noi utilizziamo per le varie coltivazioni... però non c'è mai... Cioè ci si fida sempre poco. Ecco delle analisi perché si, chissà dove hai preso quell'acqua per fare l'analisi e invece cazzo va benissimo la bomba, però noi ci viviamo di questo, ma non io, i 100 ragazzi che vengono qui a lavorare qui, cioè tra il lavoro e assistenza... c'è un centinaio di ragazzi con disabilità qui. E' questo quello che a me fa un po' così... quello che a me fa... ecco…" (Francesco, 5 December 2022).

in promoting knowledge and advocating for the rights of the impacted communities. However, from my perspective, the practices of blaming farmers for being contaminated and spreading PFAS among the communities reinforced the neoliberal apparatus in which Rimar-Miteni's deadly routinized practices have been carried out for decades. At the same time, following Lapegna and Kunin (2023), labelling individuals who express concerns about the effects of PFAS exposure as "alarmist" is an endeavour to undermine their credibility, serving as another method to normalise the toxic routinized exposure. As I believe that the farmers I met are not polluters, condemning the entire agricultural sector by generalizing responsibilities diverts attention from the actual sources of pollution, the Rimar-Miteni plant. Therefore, in my view, fear, panic, and scepticism, along with contradictions, ambiguities, and hesitations - which are sentiments felt by the affected communities - all stem from the hiatus exacerbated by the absence of institutional initiatives and the reliance on individual choice and will inherent in the neoliberal system.

To sum up, following Lapegna & Kunin (2023), I argue that the agrarian neoliberalism within the PFAS Land develops in three main pathways of action: the absence of clear state regulation and assistance, the reliance on corporate self-regulation, and a *laissez-faire* approach that accentuates individual accountability. By invoking the words of David Harvey (2005), it is worth repeating that the process of neoliberalization

> [...] entailed much 'creative destruction', not only of prior institutional frameworks and powers (even challenging traditional forms of state sovereignty) but also of divisions of labour, social relations, welfare provisions, technological mixes, ways of life and thought, reproductive activities, attachments to the land and habits of the heart. In so far as neoliberalism values market exchange as 'an ethic in itself, capable of acting as a guide to all human action, and substituting for all previously held ethical beliefs', it emphasises the significance of contractual relations in the marketplace (p. 3).

Indeed, contaminations represent the acknowledgment of «chemically induced precarity in the contemporary» (Bond, 2021, p. 391) that is influenced by both capitalistic and neoliberal relations. Thus, the intention of this thesis goes beyond the mere portrayal of farmers as victims of the "eco-capitalist realism" paradigm (Barca, 2020), which represents the contemporary adaptation of Mark Fisher's capitalist realism (2009). Fisher's paradigm lies in the lack of new narratives regarding alternatives to the capitalistic system. Stefania Barca (2020) revised this concept considering the practices of greenwashing and green capitalism, and views economic growth as the exclusive intrinsic value of human existence. Instead, my intention is to delve

deeper into perspectives beyond the neoliberal and capitalistic milieu. My aim is not solely to emphasise the tension between perpetual economic growth and the planet's resource constraints – namely Eriksen's double bind (2016) – but rather, I intend to introduce an alternative framework as I conclude my exploration of the PFAS Land, a perspective in which capitalism and neoliberalism are not perceived as "monolithic" but rather as arenas for devising new strategies and seeking alternatives to them (Liboiron, 2021).

In the next last section, I will attempt to further go beyond seeing farmers as victims. I will attempt to offer a direction that diverges from the neoliberal framework, which can be considered novel within the context of the PFAS Land, as I conclude the chapter.

3.6 Leaving the PFAS Land

During one of my last encounters, I met Cristina in the heart of the red zone. As she welcomed me into her kitchen, my attention was drawn to the display of hunting rifles in a cabinet and a plaque with a quote attributed to Benito Mussolini, hanging on the wall. Her farm has passed into the hands of various generations, moving to different geographical areas, but always producing the same products. Thus, it has decades of history. As I engaged in conversation with her, much like I did with Carolina, we discussed environmental issues and the climate crisis. Cristina subtly expresses her scepticism regarding the anthropogenic origins of the overheating climate effects we are experiencing, while acknowledging their existence. She informed me that her farm has two wells from which water is drawn - one is deeper, reaching 90 meters, while the other remains at a depth of 20 meters. She commissioned water analysis for both wells, hoping to observe a reduction in PFAS concentrations. Disappointingly, she told me that over the years, there has been no substantial decrease in the levels of the chemicals, leaving her somewhat disheartened. For Cristina, there are different responsible parties:

> [...] those directly responsible, those responsible for the omission, or even for having turned their heads. And I'm not even wondering what they turned their heads for, because then you're stirring up a hornet's nest.[134]

[134] "[...] responsabili diretti e responsabili anche per omissione o anche per aver girato la testa. E non sto neanche lì a domandarmi in cambio di cosa hanno girato la testa, perché poi vai a mettere le mani in un vespaio" (Cristina, 13 February 2023).

A complex network of actors involved in the decades contributed to the maintenance of the polluting activities of Rimar-Miteni. In this sense, Cristina's words recalled what Eric mentioned at the beginning of this chapter. As discussed in the second chapter, the Ecological Operational Unit of the Carabinieri (NOE) reported that the Rimar-Miteni management was aware of the situation yet allowed the proliferation of BTF, its derivatives, and PFAS contamination without bringing the matter to the attention of public institutions. Indeed, over the course of decades, Rimar-Miteni has cultivated uncertainty among the affected residents by actively contributing to the propagation of "coerced ignorance." Similar to the Italian factory, chemical enterprises like DuPont, Chemours, 3M, and Solvay[135] are suspected of fostering uncertainty by playing a role in generating and disseminating ignorance within the communities affected by PFAS (Cordner et al., 2019; Lanzavecchia et al., 2022; Richter et al., 2018; Wickham & Shriver, 2015). By spreading denialism, they covered economic interests while not taking measures to avoid the spread and the harmful effects of these synthetic chemicals. According to Cristina,

> In the end, one is defenseless in the face of these things precisely because they are unforeseen. It's the same old story of the big fish eating the small fish, and here individuals or even companies are the small ones in comparison to industrial giants who always manage to come out unscathed. Nevertheless, the point is that they don't bear the costs of the damages they cause.[136]

Within the PFAS Land, I argue Michelle Murphy (2021) and Max Liboiron (2021) can offer a precious alternative scenario that goes beyond to the victimisation of farmers, and their identification as target community. By changing the approach towards toxic biogeochemical milieu and chemical relations I believe that, especially while taking into consideration persistent organic pollutants such as per- and polyfluoroalkyl substances, once having entered the gate of mass production and consumption of chemicals across the last century, it is impossible to return back to the prior biogeochemical dimension (Papadopoulos, 2022). It is impossible to imagine a future that is identical to the past and the present.

[135] This company is not mentioned in the works of the scholars I cited. However, the situation unfolding in Spinetta Marengo, Alessandria, in the Piedmont Region, appears to bear some resemblance to what happened in the Veneto Region.

[136] "alla fine si è inermi davanti a queste cose, proprio perché non si è calcolati. è il solito discorso che il pesce grande mangia il pesce piccolo e qui i singoli o anche le aziende sono dei piccoli rispetto a dei colossi dell'industria che cascano poi sempre in piedi, comunque, ecco loro non pagano i danni che fanno" (Cristina, 13 February 2023).

«Yet the river and lake floors are not frozen in time - they continue to move and flow» writes Murphy (2015, p. 107). For this reason, I argue that it would be a mistake to consider that a magic spell will remediate the water cycle, the soil, and the nonhuman and human bodies impacted. I think it would be misleading to believe that a "forever solution" is possible.[137] Following Tsing (2015), dealing with precarity and toxicity by carrying out ecological reparation practices represents an example of the pursuit of life within the ruin of the present time. Thus, living on a damaged planet entails generating new modalities of cohabitation and adaptation that are placed on the opposite of the petrochemical economic system, yet still acknowledge the vitality of the nonhuman world, whether constituted by chemical substances or living organisms.[138] As argued by Papadopoulos (2021), these possibilities require a long-term change. What is needed are new forms of chemical cooperation and to put ecology at the centre. This strategy «involves holistic life-cycle practices, an intensive ecological approach to scale, and distributed invention power» (Papadopoulos, 2021, p. 58). In this scenario, what existed before the "creative destruction" brought by neoliberalism is not only a nostalgic and blurred memory but could be an inspiration to take new paths. As in the case of DuPont, the Italian factory operated within an institutional *laissez-faire* context (Lanzavecchia et al., 2022). Moreover, since the beginning of PFAS production, the presence and health consequences of these anthropogenic chemicals have been systematically minimised and hidden. Starting in the US, this toxic regime is a result of the concealment and control measures employed by the chemical industry and the regulatory system concerning information about chemical formulations, usage, and health and environmental impacts (Richter et al., 2018). This is why within the PFAS Land «not only do people drink contaminated water, but they also make others drink it.»[139] Therefore, as mentioned in the last part of the previous section, I believe that providing support to small size agricultural businesses would have encompassed not only recognizing the gradual and disjointed institutional response - which is also part of the established practices of the chemical sector - that has unfolded over the years but also acknowledging the broader economic and social impact of the contamination.

As reported by Cordner et al. (2019), chemical giants have influenced water guidelines for PFAS through both direct and subtle approaches. Additionally, it is a common practice that

[137] I referred to what a resident in the Peshtigo area (Wisconsin, US) said to Pearson & Renfrew in an interview, "they've poisoned our water with a forever chemical, so we want a forever solution" (2023, p. 58).

[138] «[...] if there is no peace through chemistry then there will not be any» (Papadopoulos, 2022, p. 117).

[139] «Nella vicenda PFAS, non solo si beve acqua contaminata ma si fa bere acqua contaminata» (Zamperini et al., 2021b, p. 160).

these corporations often monitor the diffusion of the toxic substances that they produce. By doing this they assess their own misconduct. According to Lanzavecchia et al. (2022), it was economically advantageous for Miteni to opt for contamination instead of self-reporting the pollution that had been affecting the surrounding areas of the chemical plant and groundwater for decades. In order to manage the agricultural sector that was irreversibly contaminated, the institutional strategy was to emphasise individual responsibility and self-regulation by businesses. Moreover, in my view, the current neoliberal economic paradigm that sustains the agricultural system in the Veneto region was probably the reason behind the lack of a cohesive response from the sector. In the context of the interviews, I carried out, farmers told me that they were scarcely communicating with each other. Within the fragmentary context of the impacted communities - namely the lost geographies (Vallerani & Varotto, 2005) of the contamination - their only networks and points of reference were often trade associations.In light of this, I agree with Max Liboiron (2021) arguing that not only «embracing an idea of pollution as bad relations that can exceed scientific evidence of harm is exactly what we need» (Liboiron, 2021, p. 19 footnote), but also that a shift in terms of how entrenched power structures are seen is required. In the last chapter of her book, she reflects on the fact that

> Often I hear scholars and activists alike talking as if capitalism (or patriarchy or racism, but mostly capitalism) is a solid monolith that we must dash our soft bodies against, to little avail. But that characterization gives capitalism and colonialism more power than they merit by erasing not only their diversity, but also the patchiness, the unevenness, and the failures of those systems to fully reproduce themselves. It erases the other kinds of economies and L/land relations that happen within, alongside, and in spite of capitalism, the university, and colonialism. So let's not (Liboiron, 2021, p. 130).

For Liboiron, colonialism and its pollution can be engaged with anticolonial technologies. In this sense, by describing an example of this set of technologies, the Civic Laboratory for Environmental Action Research (CLEAR), she proposes "anticolonial sciences as knowledge system." Their analysis is mainly based on their activities related to this laboratory, a feminist, anti-colonial, marine science space that studies plastic pollution in Newfoundland and Labrador, on the ancestral homelands of the Beothuk, today located in Canada. What they practice aim

> [..] to transform every moment of every aspect of our research, from how we pay people, to sampling methods, to peer review, into good relations with L/land and against dominant scientific relations with L/land based in separation, universalism, maximum use, unfettered access, standing reserve, and proofs of harm (among other things) (Liboiron, 2021, p. 133).

In this regard, what they practice stands in contrast to the industrial-oriented regulatory apparatus. Their reflections serve as the foundation for what Michelle Murphy (2021) suggests in the context of the environmental justice case of the St Clair River, as previously mentioned in Section 3.1. By proposing an unconventional approach to addressing PCB pollution in this area, Murphy identifies three epistemic habits that manifest petrochemical violence. These habits are interconnected and built upon each other, and their transformation is essential for reimagining «how industrial chemicals must be remodelled toward decolonial horizons of responsibility and better worlds» (p. 261). The first habit involves the importance of rejecting the portrayal of chemical substances as discrete entities. Murphy refers to the way the chemical industry presents chemicals as isolated individual molecules that are studied «one by one, as isolated entities of purely technical qualities without context» (Murphy, 2021, p. 261). The results of such technocratic practices align with what occurred in the area near the Rimar-Miteni plant, where communities have been living with the imperceptible yet deadly presence of PFAS. The disconnect between chemical infrastructures and the context in which they are produced and used is part of the association with discreteness in chemicals. This lack of visioning substances is due to the underestimation of the characteristics of "forever chemicals" that the contamination has exacerbated. As previously indicated, the Rimar-Miteni factory was constructed on top of one of the largest European groundwater basins. Thus, the location of the chemical plant has facilitated the contamination of an underground basin nearly as extensive as Lake Garda. In addition, these chemical substances went unregulated for decades. This fact is linked to the second epistemic habit. Thus, the second pattern outlined by Murphy involves how environmental monitoring and research infrastructures are conducted. As previously emphasised, the strategy of concealing chemical violence by public institutions has spread uncertainty among the affected residents. Furthermore, Rimar-Miteni's management was aware of the high levels of PFAS, BFT, and BFT derivatives, yet it did not prevent the expansion of the contamination. This practice encapsulates the presence of «infrastructures of not knowing» (Murphy, 2021, p. 262), which are responsible for strategies aimed at obscuring the decades-long matrix of polluting trajectories. This practice of obscuration represents the second epistemic habit and is linked to the third, which is related to the technoscientific

research approach. The latter is based on the premise that technoscientific research, aimed at investigating the presence of synthetic chemicals in the environment, often involves identifying and quantifying the damage caused by these chemicals to living organisms and ecosystems. According to Murphy (2021), this damage-based research draws attention to chemical violence by depicting lives and lands as pathological, harmed, and destined for irreparable conditions. In addition, as in the Rimar-Miteni case, the actions employed by governments to monitor chemical substances have proven ineffective in preventing PFAS's diffusion and their harmful effects. By refusing these three epistemic habits, Murphy aligns with the central arguments of Liboiron's work on pollution-colonialism. Both scholars call for the redirection of creative energy towards decolonial possibilities. Building on these reflections, Murphy presents an alternative model to the conventional way molecules have been perceived. This "altermodel of chemicals" recognises the interconnections between the land and the body and draws from a "multitude of knowledges." Similarly, Liboiron proposes anticolonial sciences as knowledge systems, «sometimes arrayed with, sometimes adjacent to, and sometimes explicitly against the knowledge systems of dominant science» (2021, p. 133). These alternatives are based on the participation of people and communities and are grounded in a shift in perspectives.

Similar to the case of PFAS contamination in the Veneto region, where petrochemical relationships disrupt both bodily functions and connections with the landscape, petrochemical relations disregard communities and their ways of life. In the case of the St Clair River and the PCBs' ubiquitous legacy, while acknowledging these dynamics, Murphy suggests an alternative:

> If this is so, then, let us pull our attention to these chemical relations back outward to the infrastructural register, back to the corporation and the state, and point out responsibilities for inheritance and disruption back at Monsanto. Instead of burdening injured bodies and lands with the work of representing this violence (as is the norm in damage-based research), can we make our chemical models point the violence back at perpetrators, not inside bodies? (Murphy, 2021, p. 273).

She calls for novel chemical-justice frameworks that shift the focus towards those responsible for the harm, rather than dwelling on what is happening within the bodies. To establish these new models, Murphy suggests that a reimagining of the extensive connections of industrial chemicals is necessary. Thus, these new connections to dismantle include not only those carried out by Rimar-Miteni management but also the financial capital and petrochemical-oriented infrastructural practices that require transformation. Indeed, as pointed out by Cristina, the

cascade effects due to the discharge of PFAS by chemical corporations should be seen and perceived as a systemic form to pursue financial interests, that require collective responses.

I would like to end this chapter where it started. At Diego and Claudia's farm, perhaps due to the small size of the company, and certainly due to their willingness, I encountered the greatest openness to talk. I consider the time they and other farmers have granted me a privilege that has allowed me to explore the PFAS Land. With Diego, during the initial interaction, the majority of my questions revolved around the per- and polyfluoroalkyl substances issue, later I focused to gain a deeper understanding of their cultivation practices. This led me to discover the existence of the *grelinette*, also known as broadfork, a soil-friendly gardening tool I had never seen before. Constructed from welded iron, it has a simple form and served as an artifact to allow to better comprehend the ethical principles of Diego and Claudia's enterprise.

I used the *grelinette* to help Diego prepare the soil for cultivation. We cleaned a small piece of his crops with the rake, and we moved the ground. For this latter task, we used this wide fork with multiple tines, an agricultural instrument invented in France that enables deep soil aeration without disrupting the diverse soil layers containing microorganisms crucial for cultivation. Diego explained to me that the *grelinette* I used had been custom-made by a Croatian craftsman specifically for his physique. Instead of using the plow, this tool turns and peels the clods letting oxygen and rainwater enter the soil saving labour and time. It replaces the use of agricultural machinery. When used, the living soil is not, in fact, uncovered and "broken" as occurs with plowing and the use of a shovel.

Figure 11: The Grelinette (March 2023, photo by the author).

«What soil is thought to be affects the ways in which it is cared for, and vice versa, modes of care have effects in what soils become» writes María Puig de la Bellacasa (2017, p. 170). Indeed, it is the practice of care at the core of using this tool. This implies decentering human agency and embracing «an ethical obligation and a practical labour» (Puig de la Bellacasa, 2012, p. 197). In other words, caring requires to be objected to care while looking after something or somebody else. In this line, the new ontologies that I am proposing are located at the opposite of the capital-oriented frame that characterises the fragmentation and violent practices that I explored in this thesis. By bringing alternative pathways to reverse the neoliberal culture towards novel ecological configurations, the soil, and other living entities may turn into material forces characterised by unlimited vitality and potentiality. To spawn this strategy, I believe that the words of Max Liboiron could shed light on this complex issue again.

> We is rife with such assumptions. A familiar, naturalized narrative about environmental pollution is that We are causing it. We are trashing the planet. Humans are inherently greedy, or wasteful, or addicted to convenience, or naturally self-maximizing, and are downright tragic when it comes to "the" commons. On the other side of the coin, We must rise up, work together, refuse plastic straws, act collectively, and put aside our differences (Liboiron, 2021, p. 23).

4. Conclusions

With this dissertation, I aimed to contribute to the understanding of per- and polyfluoroalkyl substances (PFAS) pollution in the Veneto region, Italy. Specifically, I attempted to fill the gap in social sciences research concerning the involvement of the agricultural sector in PFAS contamination across the provinces of Vicenza, Verona, and Padova. Additionally, my goal was to offer a comprehensive historical and social exploration that encompasses the establishment of the initial chemical facility through to the closure of the company responsible for the contamination. I situated this research within the theoretical frameworks of critical medical anthropology, science and technology studies (STS), and disaster anthropology. By tracing the trajectories of PFAS among farmers and beyond, I emphasised the importance of understanding various scales and intersections when discussing environmental justice.

Due to these properties, per- and polyfluoroalkyl substances are used in many industrial applications and are present in various goods and materials. Classified as Persistent Organic Pollutants (POPs), these compounds may persist in the environment and living tissues for generations. Due to these characteristics, they constitute a pervasive presence in the current epoch, with the ability to reach unexpected locations, travel through the Earth's water cycle and atmosphere, and enter the food chain. While generations of farmers may change, the PFAS legacy will remain embedded in the bodies and soil of the Veneto Region. Due to these reasons, an interdisciplinary and collaborative approach was required to comprehend and manage the problems associated with their diffusion and effects. Thus, in the case of this contamination, public institutions not only failed to provide a comprehensive epidemiological study on the impacted communities but also neglected the importance of social sciences in addressing the effects of PFAS contamination in the local population, especially within farming communities.

This dissertation consists of two main sections. In the first part - which represents the second chapter - I presented the historical and ecological dimensions of the contamination, considering PFAS's capacity to traverse the water cycle and their (eco)toxicity. First, I shortly presented their physical-chemical and technical properties, their occurrence and usage, and their (eco)toxicological effects. While tracing the history and evolution of per- and polyfluoroalkyl substances in the US and focusing on the history of Rimar-Miteni Spa, I described the origins of per- and polyfluoroalkyl substances production and contamination in the Veneto region. Beginning with its establishment as an initiative by the Marzotto family, I portrayed the various phases in the history of one of the leading players in the globalisation of the PFAS market.

Therefore, narrating the chronicles of these contaminants highlights the growing detachment between communities and landscapes over decades of rapid industrial expansion in the Po Valley region. I concluded this part of the thesis by examining the actions taken by public institutions following the discovery of contamination and the presence of PFAS in the agricultural sector.

The second part of the dissertation - which consists in the third chapter - was guided by two research questions: How did farmers experience the contamination? What do they think about what they have experienced? Indeed, I chose to adopt the ethnographic method due to the unique involvement that it provides. Despite the general reluctance I initially encountered contacting farmers within the orange and red zones, through several semi-structured interviews I documented what the small-size farming enterprises have faced and are facing while cultivating within the PFAS Land. Within the contaminated areas, small-sized agricultural businesses mostly consume and sell what they cultivate, frequently encountering precarity and uncertainty due to the PFAS contamination and the diverse backdrop of the Po Valley region. Right from the start, they have been undergoing a particular form of job blackmail marked by stigmatisation, contradiction, isolation, and helplessness. In this dissertation, I highlighted how the institutional effort to support the agricultural sector was and is lacking. To frame what I encountered during my fieldwork, I decided to use the three Ls, Latency, toxic Layering, and Limit, as elements of critical analysis of the experiences and perspectives of farmers. I used these concepts to discuss the pervasive impact of petrochemical violence associated with PFAS exposure. While Latency insisted on the temporal dimensions and uncertainty of chemical relations, toxic Layering made it challenging to establish a clear link between exposure and medical conditions. Other disruptive events and actors were taken into consideration to further depict the layered composition of the contaminated areas. In fact, I have argued how the mapping process carried out by public institutions and the institutional failure to support farmers exacerbated the vulnerability and division within communities. In this biogeochemical milieu, the internal and external boundaries of the PFAS Land, along with their biopolitical nuances cause violence for the affected communities. Indeed, the concept of limit interfered with small-sized farming businesses in the region, where the lack of clear thresholds and regulations lead to contradiction and confusion. The delayed institutional response and the challenges faced by farmers in addressing the presence of per- and polyfluoroalkyl substances met the technical limitations related to their presence. By highlighting the role of various actors, including Mothers NoPFAS, in seeking justice and advocating for safer environmental limits, complex relationships between affected communities, activists, and farmers, emerged in the

last sections of the second part. In conclusion, following Michelle Murphy and Max Liboiron, I attempted to offer alternative frameworks beyond the "monoliths" of neoliberalism and capitalism, and to overcome the farmer-victim dichotomy. Focusing on responsibilities, I argue for a shift in perspective towards addressing petrochemical relationships and advocating for ecological reparation practices. By empowering farmers, I outlined the need for new forms of chemical cooperation, placing ecology at the centre and challenging the dominance of the petrochemical economic system.

I believe that this thesis provides numerous starting points on which to base further and better-equipped research. Therefore, I acknowledge that this research faces limitations associated with the limited number of farmers I interacted with. What is reported in these pages cannot be sufficient to fully comprehend the complexity of the experiences and perspectives of the impacted agricultural sector. For instance, all the farmers who took part in this study are either employed or own small businesses with a maximum of 15 employees, and they cultivate fields of limited size, identifying themselves as practitioners of non-conventional agriculture. From my perspective, it would be essential to understand how companies with different types of cultivation and dimension of production have reacted to and experienced PFAS contamination. Hence, I consider the absence of livestock farming activities as a limitation of this research. Only the farmers who cultivate vegetables granted me access to their facilities, and among the farms I visited, only two have animals. However, the presence of chemicals in these animals was not monitored because they were not slaughtered but rather used for educational and social activities. From my preliminary interviews, multiple sources confirmed that the presence of per- and polyfluoroalkyl substances in the bodies of livestock led breeders to change their feeding and slaughtering practices in contaminated areas. Despite my efforts, I was unable to verify these adaptation strategies as I did not have the opportunity to speak with any breeders who produce animal-derived products. Overall, this dissertation is characterised by an anthropocentric focus that should be surpassed and reformulated, taking into account other living species and different methodological approaches.

The outcomes I presented, in turn, offer additional and plentiful trajectories of possible further research. The reflections outlined in this thesis are situated within the context of the Global North. However, as indicated, PFAS and their production are not confined to this geographic and regulatory context. While their invention and the political and social framework in which they initially developed and spread are European and North American, the dissemination and presence of these synthetic substances are increasingly becoming an issue that concerns non-Western countries. The Rimar-Miteni case offers an opportunity to consider where PFAS

production will end up as the phase-out of the Western chemical regulatory system progresses. In fact, as indicated, an Indian company won the Miteni Spa licenses, equipment, and machinery in a public auction, and it seems likely that they will export the production of PFAS to India.

In conclusion, the impacts of anthropogenic global warming on the agricultural sector are widely discussed (Adams et al., 1998; Vermeulen et al., 2012). It goes without saying that the presence of chemical substances, particularly Persistent Organic Pollutants (POPs), will play a pivotal role in shaping the future of agriculture. In the Po Valley region, these effects are already becoming apparent. As I illustrated, the presence of a hot and arid summer, with the absence of precipitation, as seen in 2022, can significantly disrupt annual agricultural production. Depending on the size of the farming enterprise, their vulnerability is further exacerbated under conditions of high and layered pollution. Furthermore, the heavily polluted and human-altered environment of the Po Valley region, combined with the significant industrialisation in this area, create an interesting setting where these factors converge in a region known for its strong agricultural focus. In my view, this context calls for additional research into how agriculture can adapt and develop resistance strategies against the influence of agro-industrial practices. These new opportunities necessitate an interdisciplinary approach, along with a more comprehensive consideration of relevant actors.

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