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Experiences of living within PFAS-polluted environs: a systematic review

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Abstract

This article examines victimization caused by corporate environmental crime related to per- and polyfluoroalkyl substances (PFAS) pollution. The system-atic qualitative literature review and thematic synthesis of 27 studies from the USA, Australia, Italy, Sweden, and the United Kingdom aimed to identify critical areas of concern by analyzing the experiences of fence line commu-nities and workers exposed to PFAS. The analysis revealed five stages of the PFAS adaptation process: pre-discovery, discovery, lifestyle change, change in social networks, and restitution. In each of these five phases, unique lived experiences faced by those exposed to corporate environmental harm are highlighted, and physical, psychological, emotional, and socio-economic consequences are discussed. Based on the findings, a conceptual framework of corporate harm adaptation consisting of the five phases was developed to enhance understanding of the complexities and broader impacts of PFAS pollution on those exposed to it. This review highlights the importance of recognizing and addressing the multifaceted harms of PFAS pollution and emphasizes the need to expand the knowledge base on corporate crime through an improved understanding of the victim experiences and conse-quences of PFAS pollution. This study serves as a reminder of the need to consider the multifaceted experiences of affected fence line communities and workers in addressing corporate environmental crimes.

Keywords Corporate environmental crime · Victimization · PFAS · Lived experiences · Corporate harm adaptation process · Systematic review

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Introduction

Research on corporate crime has grown significantly since the 1940s (Dodge, 2020), with a focus on investigating the magnitude, driving factors, and reactions associated with corporate wrongdoing (Braithwaite, 1985; Sutherland, 1945). However, there has been less attention paid to the experiences of victims and the extent and diversity of harms (Dodge, 2020; Natali, 2023), resulting in a significant gap in criminological studies referred to as the 'Black Box of Neglect' by Dodge (2020). Victimology research has primarily focused on how victims experience and adapt to traditional crimes, often perceiving corporate crime as only having economic consequences, and largely overlooking critical areas with 'non-ideal' victims, such as workplace safety, and environmental harm (Croall, 2007; Hall, 2013; McShane & Williams III, 1992). Oversimplified definitions of 'crime' and 'victim' have led to a lack of acknowledgement, understanding and representation of the diverse individuals impacted by corporate environmental harm (Button et al., 2014; Dodge, 2020; McShane & Williams III, 1992; Natali, 2023; Whyte, 2017). While progress has been made in green criminology towards understanding the implications of environmental crime on humans, animals, and ecosystems (Dodge, 2020; Gerber & Weeks, 1992; Moore & Mills, 1990; Natali, 2023), a gap remains in comprehending environmental victimization from a victimological standpoint. Thus, echoing a body of studies, victims of corporate environmental crime often go unnoticed or are marginalized, lacking suitable recognition and redress (Croall, 2007; Dodge, 2020; Geis, 1973; Gerber & Weeks, 1992; Hall, 2012; Moore & Mills, 1990; Natali, 2023; White, 2010).

Despite these challenges, there has been substantial progress in understanding victimization and the complex nature of harm in corporate environmental crime. Walklate (2024) emphasizes the growing recognition of victim narratives within discussions of human rights and criminal justice, with Pemberton et al. (2019) documenting the rise of narrative victimology to enrich our understanding of historical injustices. Studies by Cook and Walklate (2019), and Doyle et al. (2021) delve into victim stories, highlighting agency and the significance of lived experiences in addressing crime and social harm. Concurrently, a burgeoning field of narrative green victimology, exemplified by works from de Froideville (2022), Natali (2023), and Natali and de Nardin Budó (2019) employs innovative methods to capture environmental victimization experiences. Natali (2023) employs photo elicitation to shed light on victimization caused by industrial pollution that had remained invisible since the early 1960s in Huelva, Spain. Whereas, Natali and de Nardin Budó (2019) employed a visual and sensory approach to demonstrate that asbestos continues to be a significant issue in Casale Monferrato (Italy), even years after its ban in 2005. In a case study documenting the Havelock North (New Zealand) drinking water crisis, de Froideville (2022) employs life history sketches to highlight the far-reaching impact of the crisis. These contributions collectively deepen our understanding of victimization across diverse contexts. Moreover, attention has turned to the dynamic nature of corporate environmental harms (Arnone & Iliopulos, 2012; Davies, 2018; Forti & Visconti, 2019). Forti and Visconti (2019, p. 74) coined the term 'corporate crime shapeshifting' to underscore the urgency of addressing evolving harms. Davies (2018) illustrates the gradual nature of pollution, akin to slow violence (Nixon, 2011), while Arnone and

Iliopulos (2012) advocate for a holistic understanding of harm. Their approach to viewing harm as a network helps us understand and prevent crimes better than just addressing compartmentalized parts. Renfrew and Pearson (2021, p. 148) further underscore the complexity of harm with the concept of a 'toxic continuum,' emphasizing victims' adaptive responses to changing circumstances (Menegatto et al., 2022). These advancements collectively contribute to a more nuanced understanding of corporate environmental harm, victimization, and justice.

While progress has been made in documenting firsthand experiences of those exposed to corporate environmental crimes, ongoing marginalization persists due to limited statistics, restricted empirical research, and inadequate legal focus on victimization (Button et al., 2014). Fear of retribution hinders reporting of such crimes, stemming from concerns among impacted communities, industry workers, and governments (Hall, 2013; Williams, 1996). The omnipresence of environmental health issues makes it difficult for victims to perceive them as a result of crime (Martinez-Alier, 2003; Nixon, 2011). Adding to this complexity, corporate entities and, in some cases, government entities employ strategies to deliberately obscure causality and harm, contributing to an atmosphere of silence and indifference among those experiencing degradation of their home environments (Williams, 1996). Power dynamics among stakeholders complicate documentation of experiences and formulation of effective responses (Dodge, 2020; Fleetwood et al., 2019). In this multifaceted landscape, victimization is not a passive incident; rather, it emerges as an active sociopolitical process interwoven with power dynamics, mechanisms of control, and acts of resistance (Natali, 2023; Pemberton et al., 2019), crucial for acknowledging state involvement in corporate environmental harms (Tombs & Whyte, 2014).

Methods for collecting information on victimization have often failed to fully capture the various types of harm caused by corporate toxins and their immediate and long-lasting effects (Dodge, 2020). Societal determinants that cause toxic exposure disproportionately harm lower socioeconomic groups, further disempowering potential victims of corporate environmental harm by asserting their right to a healthy environment (Maani et al., 2023; Prüss-Üstün et al., 2016). Additionally, the concept of structured vulnerability, affecting nearby communities, consumers and workers, emerges as a critical factor in understanding the uneven distribution of corporate crime victimization, characterized by class and gender disparities (Jou & Hebenton, 2017). Studying victimization by corporate environmental crime requires employing innovative scientific methods (Stauffer, 2015), to uncover valuable insights into the experiences of victims, and to bring to light what is currently hidden from view (Davies, 2018; Dodge, 2020; Gottschalk & Tcherni-Buzzeo, 2017; Stake & Trumbull, 1982).

This article seeks to address the dearth of knowledge on corporate environmental crime victimization in the context of per- and polyfluoroalkyl substances (PFAS) pollution. This group of over 10,000 synthetic chemicals, known for their persistence, bioaccumulation, and toxicity, have been linked to liver disease, cancer promotion, infertility, hormone and immune system disruption (EEA, 2019, 2023). Their resistance to degradation and high mobility through industrial processes and consumer products result in daily exposure for communities near pollution sources. PFAS contamination is challenging to remediate due to its pervasive presence in groundwater,

surface water, and soil. International regulation of PFAS varies, with only a limited number subject to restrictions or bans under global agreements. Reviews of industry documents have revealed that chemical companies often withheld critical information related to PFAS risks from employees, governments, and the public (Gaber et al., 2023). Yet, research into the experiences of individuals victimized by PFAS contamination remains limited, with a notable absence of comprehensive studies exploring the psychological, social, economic, and behavioral consequences of exposure (Legg et al., 2022, 2023). Furthermore, most existing meta-analyses and reviews tend to focus on environmental contamination broadly, while a systematic review focused specifically on the lived experiences of communities and workers affected by PFAS is notably absent (Couch & Coles, 2011; Legg et al., 2023; Schmitt et al., 2021).

We aim to provide a nuanced understanding of the impact of PFAS pollution on these communities by shedding light on their narratives. The scarcity of qualitative studies on people living in PFAS-polluted environments underscores an unaddressed issue, rendering their perspectives and experiences invisible. Our primary research question intends to bridge this gap: What is the impact of residing in PFAS-polluted environments on fenceline communities and workers' lives? The study investigates the following sub-questions: How do affected communities and workers navigate life within contaminated environments? How do they connect their comprehension of PFAS impacts (physical, psychological, environmental, and socioeconomic) with their lived experiences of suffering and injustice? How do they respond to these threats and harms? Do they undergo various adaptation phases and, if so, what are they exactly? We identified five stages in PFAS contamination using a qualitative systematic literature review, reflecting the dynamic experiences of PFAS victims.

The article is structured as follows. Section "Methodology" outlines the methodology of the systematic review and thematic synthesis. Section "Results" delves into the results and offers an in-depth exploration of the five distinct PFAS adaptation phases. The Discussion section then reflects on the implications of these results, after which the study's limitations and conclusions follow.

Methodology

The aim of this study is to investigate the lived experiences of fenceline communities and workers exposed to PFAS. Lived experience is defined as personal knowledge gained through direct involvement in everyday life in PFAS-polluted areas (Oxford University Press, 2023). Fenceline communities are directly affected by emissions from chemical industry companies, military bases using PFAS firefighting foams, or industrial landfills. Workers include current and former employees of the chemical industry, military bases, or firefighters. We conducted a qualitative systematic literature review of studies published in English that documented the experiences of residents and workers exposed to PFAS. The review encompasses research conducted between January 1, 1965, and December 31, 2022. The study followed the PRISMA guidelines (Page et al., 2021) and was registered with PROSPERO (CRD42023341012). Each line of text was independently and inductively coded based on its meaning and content using Atlas.ti. Direct quotes were derived from 27

qualitative studies (Online Resource 1). We grouped the codes into a hierarchical tree structure, resulting in 153 codes and 1191 quotations. Afterwards, we conducted a thematic synthesis to identify recurring themes and patterns, which helped develop the conceptual model of a 5-phase PFAS adaptation process.

We selected the systematic qualitative literature review methodology for our examination of the lived experiences of people exposed to PFAS contamination due to its capacity to capture the complex narratives and diverse perspectives of those affected. While quantitative methods may provide statistical information, they often fall short in comprehending the complexities of lived experiences. Similarly, case studies offer in-depth analyses, but they may lack generalizability. Ethnographic research, while rich, can be time-consuming. A systematic qualitative literature review, by synthesizing findings from multiple qualitative studies, achieves a balance between breadth and depth, enabling a thorough examination of qualitative data while ensuring methodological transparency and rigor. Consequently, we believe that this approach is the most suitable and effective for our study, providing valuable insights into the human dimensions of PFAS contamination.

Results

Five PFAS adaptation phases

The conceptual framework (Fig. 1) of the five PFAS adaptation phases (pre-discovery, discovery, lifestyle change, living with PFAS, and restitution) demonstrates a dynamic process influenced by the interaction between communities, workers, and PFAS pollution. PFAS pollution caused a loss of trust and innocence, leading to increased demand for environmental protection. Reinterpreting the situation, reorganizing roles, and perceptions of fault, and taking action are critical to addressing physical, psychological, and socio-economic impacts. The five phases are characterized by changes in trust in institutions, knowledge, lifestyle, social networks, and the environment, and reflect the process through which communities and workers navigate and adapt to living within PFAS-polluted environments. In what follows, the five themes and 34 subthemes that recurred in the papers are explained.

Phase 1: pre-discovery

Before communities and workers become aware of PFAS contaminants, they may spend decades in the pre-discovery phase. Initial information about the presence of PFASs is often communicated at the end of this phase, leading to disbelief, denial, risk acceptance, and loss of trust.

The first subtheme – invisible enemy – refers to affected individuals describing the contaminated environment as an ‘enemy’ or as ‘hostile,’ with the presence of PFAS being compared to an ‘undetonated bomb,’ taking half a century to realize the existence of this ‘invisible enemy’ (Menegatto et al., 2022, p. 13). Invisibility goes hand in hand with slow-onset pollution, resulting in anger and feelings of betrayal upon discovering the companies’ negligence (US HCOR, 2019, p. 7). Residents criticized

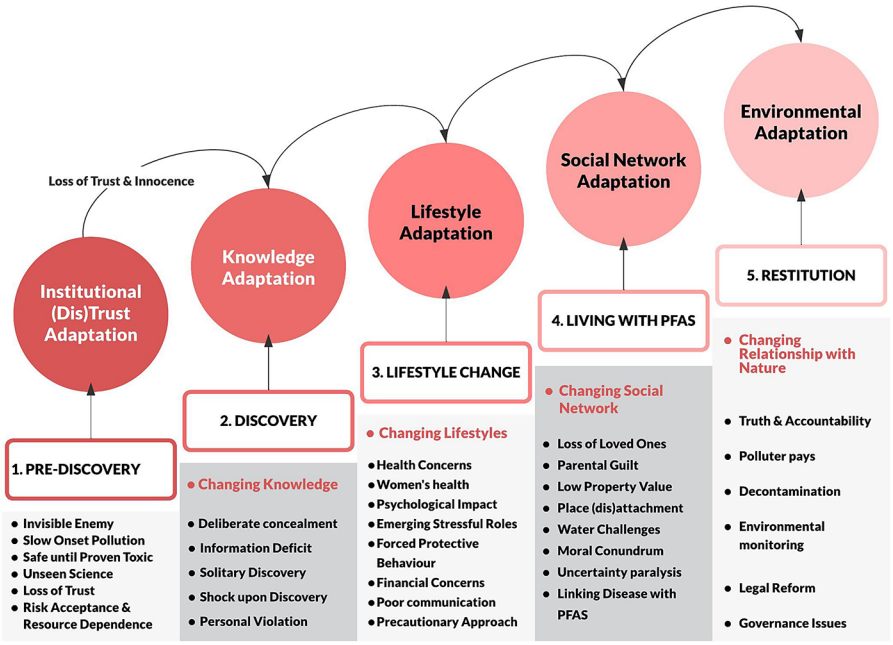

Fig. 1 Conceptual framework of the five PFAS adaptation phases

the idea that PFAS chemicals were considered 'safe until proven toxic' and countered it by emphasizing the potential risk and impact on human health, particularly their children's. They also expressed concerns about the lack of comprehensive testing methods to assess various types of PFAS (US HCOR, 2019; Wickham & Shriver, 2021).

> When my babies were growing inside my womb and I was drinking this water, what imprint did that leave on their development? And how will that play out for the rest of their lives? No one can answer those questions right now, and because they can't answer those questions, I don't feel that anyone can say this water is still safe to drink (Wickham & Shriver, 2021, p. 12).

Unseen science is closely intertwined with the loss of trust. 'Unseen science' is the deliberate concealment of scientific evidence by the chemical industry, hindering public awareness and effective regulation (US HCOR, 2019; Wickham & Shriver, 2021). Many studies have been conducted over the past six decades, demonstrating that PFAS are toxic, persistent, and bio-accumulative, which the companies concealed, leading to a loss of institutional trust (Richter et al., 2018). Most studies, with a total of 82 quotes, demonstrated a loss of institutional trust by fenceline communities after discovering that the chemical industry and government were aware of PFAS contamination for a long time (Altman, 2008; Banwell et al., 2019, 2021; Calloway et al., 2020; Judge et al., 2016; Legg et al., 2022; Menegatto et al., 2022; Seeger, 2021; US HCOR, 2019; US NEJAC, 2004; Wickham, 2020; Wickham & Shriver, 2021).

An Australian community expressed a loss of trust in institutions that knew about PFAS contamination from firefighting foam for a long time prior.

> You've got the Prime Minister giving them [Defence] $50 million to fight you in court. So, the whole country is against you, basically. There is a lot of love loss, and no respect for the government or Defence. As I said, it changes your whole belief system. … They [Defence] were trying to downplay it. They've lied to us directly. I have zero faith in the Department of Defence. I have zero faith in the political system (Legg et al., 2022, p. 6).

Affected communities felt betrayed by the chemical industry and governments, leading to skepticism and a demand for accountability (Legg et al., 2022; Tingler, 2021). However, in some instances, economic reliance and resource dependency on industries that use PFAS led to risk acceptance and a reluctance to challenge the pollution despite awareness of the potential risks (Menegatto et al., 2022; Richter et al., 2018). Chemical industry workers and 'the DuPont family' were key groups that struggled with resource dependence. Judge et al. (2016, p. 340) defined 'DuPont family' as a "participant or someone in their family working for the company." A mother, whose son worked with DuPont, stated:

> It sounds like they are trying to prove DuPont is wrong, but, you know, what would our community have done without DuPont being down there. I don't know what we'd do if DuPont shut down. I really don't (Judge et al., 2016, p. 342).

The same study discussed the Ohio River Valley community 'unfortunate trade-off' between jobs at DuPont and a healthy environment (p. 342-3). A DuPont contractor could not: "afford to lose DuPont … DuPont came here because no place else in the United States would accept them" (p. 342). A former DuPont employee expressed "a lot of concern about this and what effect it might have on DuPont," he added "maybe there's a problem there, maybe there's a danger, but we got a make a living" (p. 342). A resident had no "ill feelings towards DuPont because. . without them [they] would be hurting for jobs" (p. 342). "Nobody wants to work minimum wage fast-food restaurant jobs all the time. And yet, Washington County is considered one of the worst air-polluted counties there is, so [residents] pay a price for that … So, you see it as a tradeoff" (p. 343).

Phase 2: discovery

At the end of the pre-discovery phase initial information on PFAS contamination is communicated or discovered, but very little knowledge is conveyed. Thus, in the discovery phase, the community recovers from the initial shock and starts to seek more information from the chemical company and government; however, further communication is characterized by concealment, shock, and uncertainties.

The first subtheme is the deliberate concealment of information by government agencies, such as the Australian Defence Force (ADF), and corporations, such as 3 M

and DuPont, which has led to a lack of trust and frustration among affected residents (Altman, 2008; Australian Government, 2016). The failure to disclose contamination, the monopolization of analysis capabilities, and changing minimum exposure levels have exacerbated the issue, leaving communities confused and exposed to harmful substances (Altman, 2008; Australian Government, 2016; US HCOR, 2019; Wickham & Shriver, 2021). Additionally, the intentional concealment of evidence and community resignation to the situation have hindered efforts to address the root causes of contamination (Altman, 2008; Seeger, 2021). Public meetings can contribute to collective ignorance if communities are baffled with technical jargon.

> Now they have their technical guys and they came down to a meeting with our elected officials as a closed meeting…They put out all this techno-babble-jargon and didn't explain it to anybody…[W]hen you deal with the public, you can go two directions: you can baffle them with that kind of bullshit or you can explain it to them in terms they will understand. And Chemours did the opposite. They baffled them (Wickham & Shriver, 2021, p. 771).

Wickham and Shriver (2021, p. 771) provides an account of deliberate concealment as a "strategy to repress residents' ability to make their own determinations about the risks." The choice of meeting venue facilitated the deliberate concealment of information. "Chemours officials held a town hall meeting in a church in Bladen County." Then, "Chemours used a mediator and carefully screened questions." In the meeting, a resident said "'No, that's not correct' … because [DuPont] was just lying about everything. And so, yeah, [he] got kicked out of there. [he] got kicked out of there!" These factors highlight the need for transparent communication, community engagement, and co-production (Agyeman, 2013; Jasanoff, 2004).

Second, various communities faced challenges and uncertainties because of information deficits about various aspects of PFAS contamination. Conflicting perspectives on indoor air pollution, the lack of information on the safety of tap water in schools, especially for vulnerable populations, and limited research on the effects of PFAS chemicals can create uncertainty and concern (Altman, 2008; US HCOR, 2019). The absence of trusted sources to understand product risks further compounded community concerns (Oksas et al., 2022; Wickham & Shriver, 2021). Insufficient responses and incomplete data from government bodies and regulatory agencies amplify public mistrust and hinder progress in effectively tackling contamination (Australian Government, 2016; US HCOR, 2019). Information deficits regarding health effects are prominent, with the most notable concern being the absence of cancer investigations linked to high PFAS exposure (Oksas et al., 2022; US HCOR, 2019; Wickham & Shriver, 2021). Uncertainty is compounded by ever-changing minimum risk exposure levels. One affected resident explains that "DHHS lowered the initial health advisory from 70,909 ppt to 140 ppt. This drastic change raised alarm bells in the community and sparked a lot of community concern and mistrust" (Wickham, 2020, p. 29). To address these challenges, some studies recommend increased transparency, comprehensive testing, enhanced access to information, along with community involvement, thorough research, and the dissemination of reliable information (Banwell et al., 2019; CHE et al., 2006; Menegatto et al., 2022; Moreno & Beierle,

2007; Tingler, 2021). Bridging the information gap is essential for empowering individuals, protecting public health, and fostering trust in the face of environmental contamination.

Third, some communities grappled with contamination issues in isolation and with limited resources (solitary discovery). Legg et al. (2022) emphasize the lack of accessible assistance, leaving affected fenceline communities to their own devices and adversely impacting their mental health. One resident recounted the following:

> There is no one you can go to. You can get on Defence's website and NSW EPA's website and that's it. And if you do call them, you get someone who is clueless to what you're talking about. So, everyone is just left to their own devices, which again, is not good for mental health (Legg et al., 2022, p. 5).

The Australian Government (2016) report echoes this sentiment, recounting the desperate call by affected communities for systemic testing, only to be met with indifference from authorities, prompting communities to conduct their own testing at great expenses. This pattern is replicated among Alaskan Natives, who bore the burden of traveling to NEJAC meetings and undertaking their own research (Altman, 2008). The quest for knowledge and clarity extends to social media platforms, as Seeger (2021) highlights the struggle of communities to find reliable information about well water safety. A community member from Michigan Town stated that "the biggest problem is misinformation… that's the biggest challenge today, and it's divisive." (Seeger, 2021, p. 164). Washburn (2014) underscores the frustration of consumers deciphering product labels and conducting extensive research to ensure their safety. US HCOR (2019) sheds light on the challenges faced by victims seeking justice, with lawyers unwilling to take on well-funded corporations. Furthermore, to test if one's serum tests high levels of PFAS remains a daunting task, perpetuating a sense of fear and uncertainty. Morello-Frosch et al. (2009) recognize that conventional research protocols exacerbate the problem of solitary discovery and proposes innovative approaches to address current challenges. Through this, fenceline communities turn to unconventional sources, including the Internet, to seek information and solace (Menegatto et al., 2022).

Shock-upon discovery is the fourth prevailing issue in most studies. The shock of discovering high levels of toxic chemicals in their bodies evoked anger and frustration within the community, leading to a loss of trust in the authorities (Wickham, 2020). Some explain the results as extremely unique because rarely do you find 99% of the people in a population with the same toxin (US HCOR, 2019). The emotional impact of these findings cannot be understated, leaving individuals feeling lost and devastated (Menegatto et al., 2022). Mothers expressed deep concern about passing these toxins to their children and their potential impact on their development (US HCOR, 2019). Communities in Maine and Wilmington were shocked upon discovering that PFAS and other toxic chemicals were present in her body.

> I was recently tested for toxic chemicals in my body, along with 12 other Mainers. The results were shocking and scary. Thirty-five of the sixty-seven chemi-

> cals were found in my body, including … Teflon chemicals, and toxic flame retardants, known as PBDEs. (Altman, 2008, p. 260).
> I talk with them [residents] and I know they're scared to death. They're scared for their children that have been drinking this. They're scared! (Wickham & Shriver, 2021, p. 774).

As a fifth subtheme, some studies shed light on the impact of personal violation due to exposure to toxic chemicals. Personal violation is illustrated by using phrases like 'chemical trespass' (Morello-Frosch et al., 2009), "this poison in my drinking water" (US HCOR, 2019, p. 15), "I felt that my body, my privacy, my family had been stolen; it is as if thieves came into my home from the tap" (Menegatto et al., 2022, p. 10), and "these chemicals don't belong in my body or anyone else's." (Altman, 2008, p. 261). Menegatto et al. (2022) describe the emotional consequences and feelings of fear and devastation, US HCOR (2019) reveals stories of individuals battling cancer and Tingler (2021) provides a personal account of the impact of contamination on women's fertility and reproductive health. The combined stories serve as a powerful call to action, urging regulators to understand the deep sense of personal violation caused by toxic chemical exposure.

Finally, most of the studies highlight a range of perspectives and experiences related to changing knowledge about chemical exposure and health impacts. Increased knowledge influenced personal decisions, resulting in avoiding exposure by changing dietary habits or avoiding certain products (Altman, 2008; Washburn, 2014). The focus on consumer products was not simply to educate consumers but to mobilize and organize them towards advocating for comprehensive chemical policy reform (Altman, 2008). Several studies also highlight the importance of community engagement and discussion in understanding the diversity of chemical exposure levels, while also highlighting how different personal journeys are (Altman, 2008; Washburn, 2014). Victims of chemical exposure, such as those affected by contaminated water or toxic chemicals, have found strength in sharing their stories and supporting others (Calloway et al., 2020; Seeger, 2021). These stories shaped knowledge and motivated action, but the journey towards change was not without obstacles. Regulatory agencies often dismissed community concerns, even when respected individuals with a deep understanding of their community's health raised them (Altman, 2008; Wickham & Shriver, 2021). Moreover, political pressure and industry interests also influenced the policy response to chemical issues (Wickham & Shriver, 2021). Overall, the results illustrate a multifaceted process of changing knowledge about chemical exposure and its consequences. It involves community engagement, sharing personal experiences, overcoming obstacles in the regulatory and political realms, and making individual choices to mitigate exposure.

Phase 3: lifestyle change

The lifestyle change phase represents a phase when communities and workers (were forced to) adapt their lifestyles to cope with new circumstances and manage the physical, psychological, and socio-economic impacts of PFAS pollution. They recognize the necessity of coexisting with PFAS and make efforts to reorganize their family

and work routines. We first discuss these impacts and then discuss their adaptations to them.

First, health concerns related to chemical exposure have raised alarms among affected communities. Residents express worry about the long-lasting effects of chemicals in their bodies and those of their children, feeling like they are living with a ticking time bomb (Legg et al., 2022). The presence of PFAS in the bloodstream has been linked to various health problems, including learning and memory issues, hormonal disorders, reproductive problems, and cancer (Altman, 2008; Legg et al., 2022). Severe health issues, such as respiratory distress and pulmonary oedema, have been observed in highly exposed workers (Lewis & Kerby, 1965). Studies on the health effects of these chemicals have yielded inconsistent results (Australian Government, 2016). Disagreements exist among experts regarding the health effects of PFAS exposure, with some disputing claims of no adverse effects (Altman, 2008). Lack of scientific certainty exacerbates the fear and concern of residents, who are left with unanswered questions about the potential health consequences of long-term exposure to contaminated water (Australian Government, 2016; Seeger, 2021; Vousden et al., 2014; Wickham, 2020). The prevalence of cancer and other health issues in affected areas underscores the urgent need for a better understanding of health implications (Altman, 2008) and the dissemination of comprehensive information on potential health effects (Nilsson et al., 2022).

Second, Tingler (2021, p. 51) discusses the far-reaching gender-based health concerns faced by women exposed to PFAS. One of the women experienced "everything 'women' related" from "polycystic ovarian syndrome (PCOS). Endometriosis. [She] had four different surgeries on my uterus and ovaries and then finally had a hysterectomy". She raises concerns that "there are a lot of women in [her] area that have had a lot of problems with PCOS and endometriosis." She also adds "that could very well be C8[1] related, because there is no family history with any types of fertility issues." The victim reflects on the intergenerational impact, suggesting that her mother's exposure to C8 may have affected her own health as well as her sister's. Overall, Tingler (2021) underscores the urgent need for gender-specific PFAS research.

Third, PFAS exposure has far-reaching psychological impacts on individuals and communities, with individuals experiencing anxiety and anger, and a constant fear of health consequences (Legg et al., 2022). Australian Government (2016, p. 24) describes a personal account of "people … pacing the halls [at] night … fighting with their spouses… [and being] scared." A firefighter "worries a lot" about dying "early of cancer"(Anderson et al., 2017, p. 647). One resident says "I get anxious about things. I really get angry all the time and I can't cope with it" (Legg et al., 2022, p. 4). Deep resentment towards contaminated surroundings further exacerbates emotional distress. Another resident says: "I don't think I can word this strongly enough, but I absolutely hate this place. I hate everything it represents" (Legg et al., 2022, p. 5). The Australian fishermen community experience "increased mental fatigue … anxiety, depression, and personal sense of self-worth is increasingly challenged" (Australian Government, 2016, p. 34). The lack of support and accessible

[1] C8, Perfluorooctanoic acid or PFOA is one the better known and studied forms of PFAS, used as an industrial surfactant in chemical processes.

resources intensify the mental health burden faced by affected individuals, leaving them to navigate their struggles alone (Australian Government, 2016; Legg et al., 2022; Wickham, 2020). This psychological toll extends beyond individuals to entire communities, who share trauma and a sense of injustice (Banwell et al., 2021). The uncertainty surrounding health outcomes and the conflicting nature of their environment contribute to deep confusion and distress (Banwell et al., 2021). Some studies recommend urgent measures to provide comprehensive support services, effective communication strategies, tailored mental health resources, and public education on risks and fears to alleviate the psychological impact of PFAS contamination (Altman, 2008; Calloway et al., 2020).

Fourth, the emergence of stressful roles in various contexts affects individuals' lives, leading to emotional distress and burnout. Environmental contamination disrupts established routines, introduces new roles, causing daily distress and upheaval (Legg et al., 2022). According to an affected mother who "faced increasing stress when taking up the role of 'supervisor', […] these new roles include teaching the children to be careful what water they drink, to take bottled water everywhere, and not to drink tap water in schools, gyms, and football clubs." (Menegatto et al., 2022, p. 11). Families affected by contaminated water sources often face inadequate support, relying solely on bottled water, while their requests for assistance go unanswered (Australian Government, 2016). Logistical challenges, such as accessing clean water, further exacerbate stress (Tingler, 2021). Moreover, pregnancy is now viewed as a medically monitored state, leading to increased stress for expectant mothers who research potential chemical exposures (Oksas et al., 2022; Washburn, 2014). First responders grapple with the responsibility of maintaining clean gear to prevent further risks, highlighting the need for consistent enforcement, and addressing burnout concerns (Anderson et al., 2017; Seeger, 2021). External support and community solidarity play crucial roles in alleviating the burden associated with these emerging stressful roles (Oksas et al., 2022).

Fifth, forced protective behavior has been observed in various studies. The Australian Government advised residents not to consume bore water, fish caught in the affected area, or eggs from backyard chickens that had consumed bore water (Australian Government, 2016). The Australian Government (2016) provided free potable water to residents, relying on bore water as the only source of drinking water. However, some affected families only received bottled water instead of water tanks, leading to emergency self-financed installations (Australian Government, 2016). In Wickham (2020), PFAS pollution prompted the provision of bottled water and installation of reverse osmosis systems in affected homes. Other forced protective behaviors include avoiding smoke-filled environments, minimizing plastic usage, researching product labels, and adopting healthier alternatives (Anderson et al., 2017; Banwell et al., 2019; Oksas et al., 2022; Washburn, 2014). In other communities, PFAS pollution has led to a forced reduction in water usage owing to scarcity (US HCOR, 2019), proactive monitoring for testicular cancer (Judge et al., 2016), enhanced safety protocols in the workplace (Judge et al., 2016), and reduced purchase of products made from synthetic chemicals (Washburn, 2014). These studies illustrate the diverse contexts in which forced protective behavior manifests itself in the form of lived experience. Communities affected by PFAS contamination undergo significant lifestyle changes

and adaptations in response to the health risks posed by contamination (Australian Government, 2016; Legg et al., 2022). Backyard chicken owners modified their practices, restricting the chickens' freedom to roam and changing their diet (Australian Government, 2016). The fishing industry experienced financial difficulties and a loss of access to traditional fishing grounds, leading to economic strain (Australian Government, 2016). Individuals became more cautious about product usage and seafood consumption (Oksas et al., 2022; Washburn, 2014). Overall, exposure to PFAS contamination resulted in lifestyle modifications and community engagement to address ongoing challenges (Anderson et al., 2017; Banwell et al., 2021).

Sixth, financial strain, leading to significant economic distress, took a toll on the mental health and well-being of the affected population, causing anxiety, depression, and increased stress (Banwell et al., 2021). The US cost of healthcare associated with PFAS is estimated to reach billions of dollars annually, emphasizing the urgent need for financial resources and support (US HCOR, 2019). The scale of contamination overwhelmed state resources, requiring significant funding for the investigation, remediation, and identification of responsible parties (US HCOR, 2019). A major financial strain for affected families is the inability to afford proper filtration systems for safe drinking water (Australian Government, 2016; US HCOR, 2019). In Australian Government (2016), the closure of commercial and recreational fisheries and oyster harvests resulted in loss of livelihoods, disrupted businesses and financial hardship for fishery communities. Also, the contamination reduced property value, causing substantial financial losses for property owners. Additionally, the embargo on the use of boreholes resulted in a reduction in water yield, requiring quicker and more costly implementation of a new water source. These studies demonstrate the diverse and complex nature of financial problems.

Seventh, poor communication and lack of transparency are causes of significant distress and confusion among affected communities. In the case of environmental contamination, residents express frustration with the absence of reliable sources and informed officials (Legg et al., 2022). The Australian Government's response to the Senate Committee report highlights instances of inadequate communication such as unanswered letters and inconsistent representations, leading to community alarm (Australian Government, 2016). The distribution of undated fact sheets and reliance on social media through intermediaries has further exacerbated this situation (Australian Government, 2016). The absence of context-specific information and the complexity of scientific language left individuals with unanswered questions (Vousden et al., 2014). Similarly, during a water contamination crisis, residents felt misinformed and encountered difficulties in accessing reliable information (Seeger, 2021). Ineffective public meetings, technical jargon, and contradictory statements by officials contributed to the erosion of trust and frustration (Wickham, 2020). When blood test results revealed contamination, participants struggled to interpret the data because of a lack of comparative benchmarks or clear explanations (Altman, 2008; Vousden et al., 2014):

> I remember looking at this [letter], and I still don't know what this means other than my numbers are much higher. I remember that being somewhat disap-

> pointing–not that the numbers are higher … it's just that I didn't have context within what that means. (Vousden et al., 2014, p. 6)

Finally, the findings indicate the problem of not invoking the precautionary principle for the chemical industry but invoking it for communities. The principle was intended to be applied before toxic, persistent, and bioaccumulative chemicals were produced and released into the environment. Instead, the principle was invoked by temporarily closing commercial and recreational fisheries and suspending oyster harvesting (Australian Government, 2016). This belated precautionary approach caused frustration: "[The precautionary approach] has not only shut everything down but also puts our lives on hold. Why? Because it is still leaching from the base, and they do not know how to contain it" (Australian Government, 2016, pp. 19–20). Post-hoc applications of stringent closures to limit further health harms and liability were perceived as an overreaction, foreclosing other life activities.

Phase 4: living with PFAS

During the living with PFAS phase, communities and workers accept and integrate the presence of PFAS into their daily lives, although it comes with challenges and adjustments. The adaptation process includes changing the prevailing social network to cope with long-term PFAS pollution.

First, in a series of heart-wrenching accounts, individuals share their personal stories of the loss of loved ones, reflecting the anguish and grief they endured. After unexpected deaths, communities grapple with immense grief and question the role of PFAS contamination (Banwell et al., 2021; Calloway et al., 2020). The environmental pollutants and toxic substances caused millions of premature deaths annually and affected marginalized communities and children disproportionately (US HCOR, 2019).

Second, parental guilt emerges when parents discover that their children are exposed to PFAS: "it sickens me to think that I may have hurt my children by simply raising them to drink the tap water." US HCOR (2019, p. 8). Legg et al. (2022) highlight parental anxiety about bioaccumulation in children's bodies. The choices made during pregnancy and breastfeeding add to parental guilt, as mentioned by Washburn (2014). Altman (2008) shares the shock of a mother with PFAS in her body, who realizes the potential impact on their child via breastfeeding. Menegatto et al. (2022) illustrate the burden of being the source of PFAS exposure during pregnancy and breastfeeding, evoking intense guilt. One parent states guilt that she was "the first one to pollute [her] daughters with PFAS through pregnancy and then by breastfeeding" (Menegatto et al., 2022, p. 14). Another adds that she "breastfed [her] daughter until she was three, thinking [she] was doing [her] duty as a mother," but second-guessing her decision as possibly doing more harm than good (Menegatto et al., 2022, p. 14). Greater parental guilt occurs if children are younger (Seeger, 2021). These feelings extend to grandchildren (Banwell et al., 2019 and to other kids in the community who drink the contaminated water (Wickham, 2020). A lack of knowledge on the long-term effects of toxic mixtures exacerbates these feelings (Oksas et al., 2022; US HCOR, 2019).

Third, PFAS contamination reduces property values, inflicting financial and emotional distress on affected residents and discourages potential new residents, which affects the local economy (Australian Government, 2016). Failure to disclose contamination prior to property purchases exacerbates feelings of financial loss (Australian Government, 2016). Real estate agents have been criticized for not disclosing the contamination issue to buyers, while financial institutions have ceased lending for properties near investigation areas (Banwell et al., 2019). Abandoned houses can proliferate in stigmatized, contaminated zones (Calloway et al., 2020). Affected residents face uncertain futures, caught between affordable yet undesirable properties, and are unable to afford alternative housing due to depleted retirement savings (Banwell et al., 2021). Families find themselves trapped in devalued properties with burdensome mortgages and are unable to make improvements without overcapitalizing (Australian Government, 2016). Families are torn between their contaminated homes and the desire to be with loved ones. The mental health consequences for individuals facing property devaluation underscore the need for financial support and counselling services (Australian Government, 2016; Banwell et al., 2019).

Fourth, several studies emphasize the complex nature of place attachment and detachment from being torn between attachment to a contaminated, stigmatized place and the desire to leave (Banwell et al., 2021; Calloway et al., 2020). Residents struggle when confronted with contamination in a place that they value for reasons such as career or financial considerations, family ties, and cultural importance (Menegatto et al., 2022; Tingler, 2021). Indigenous communities express a cultural attachment to their now-contaminated lands (Banwell et al., 2019. Some residents refer to being in prison (Legg et al., 2022, while others contrast the beauty of the environment with the need for its restoration (Altman, 2008. Detachment is a complex and painful process owing to cognitive dissonance.

> This block of land has been my home, it's where I brought up my kids, its everything to me and yet at the same time it's a contaminated piece of land and you're holding these two things in your hand, and the confusion of it, these two opposing truths, it drives you nuts (Banwell et al., 2019, p. 36).

Fifth, water rationing and reliance on bottled water were common experiences for residents, reflecting the unreliability and perceived lack of cleanliness of the water supply. Contamination of water sources, including use for farming and inadequate water management, pose significant challenges for communities (Australian Government, 2016; Tingler, 2021). For instance, the contamination of Australian Tomago Sandbeds led to a 10% reduction in overall drinking water yields and a 15% decrease in peak production capacity, equivalent to 1.5 billion liters, accelerating the search for expensive, new water sources by 2–3 years (Australian Government, 2016).

Sixth, fenceline communities faced moral conundrums about using water that surpassed acknowledged contamination levels to raise cattle for beef production, leading to concerns about food chain safety and obligations to disclose water sources (Australian Government, 2016). This moral dilemma is intensified when residents engage in various interconnected farming activities: they are advised not to eat eggs or chickens, while dairy cattle graze on the plains (Australian Government, 2016).

Moral quandaries intensify when scientific studies shed light on the health risks of chemical contamination and advise on healthier, yet more expensive, PFAS-free choices (Washburn, 2014).

Seventh, communities affected by PFAS pollution are in a constant state of confusion and distress (Seeger, 2021; Wickham, 2020). "It's heartbreaking when somebody asks you like, well I've been drinking this water for this long. You know what's it's going to do to me? I don't know. That's not the answer" (Seeger, 2021, p. 168). The uncertainty about long-term health effects, the extent and duration of the contamination, the lack of and slow progress in comprehensive testing of soil, water, air, and blood, the absence of conclusive PFAS test results, and the absence of clear guidelines from authorities for fenceline communities further contribute to this state of uncertainty, fear, and vulnerability (Altman, 2008; Australian Government, 2016; Legg et al., 2022; Wickham, 2020).

Moreover, the challenge of establishing a conclusive link between PFAS exposure and health issues causes uncertainty and concern (Australian Government, 2016). While the limitations of current knowledge should be acknowledged, the suffering of those affected should not be downplayed, especially since research shows that PFAS result in adverse effects on human health (Wickham, 2020). Anecdotal information on health consequences and mental health pressures warrants further support. guidance and assistance, regardless of the established link (Banwell et al., 2021; Wickham & Shriver, 2021).

Finally, the phase of living with PFAS shows that environmental contamination, (mental) health risks, consumer choices, and economic limitations are intertwined. The studies which speak to these challenges also illustrate the power of community engagement, collaboration, and effective communication in addressing these intertwined challenges of PFAS-contamination (Altman, 2008; Australian Government, 2016; Legg et al., 2022; Seeger, 2021; Wickham, 2020).

Phase 5: restitution

The final phase represents the affected community's proactive response to address PFAS pollution to regain governance of the contaminated environment. This is the final stage of adaptation as victims seek restitution for their experiences throughout the PFAS continuum.

Truth and accountability is the first sub-theme in this phase. Testimonies before the US House Committee on Oversight and Reform emphasized the lack of corporate accountability, with community members urging companies, such as DuPont, to tell the truth and take responsibility for their actions (US HCOR, 2019). Personal testimonies highlight the desire for clean water without harming jobs and businesses, urging the chemical industry to prioritize community health (Tingler, 2021). Although not everyone felt anger or the need to sue, there was an expectation for corporations like DuPont to acknowledge their actions and take appropriate measures (Tingler, 2021).

> If your kids break something, smash something, spill something, we expect them to clean it up and make it right. […] I need them to stop avoiding that and just do the right thing. That is all they got to do. (US HCOR, 2019, p. 25)

A second subtheme that emerges is the 'polluter pays' principle which holds polluting entities accountable for the financial consequences of environmental damage caused by their actions. The Australian Government (2016) emphasized its commitment to this principle, urging the Defense Department to provide timely financial assistance to communities affected by pollution from the RAAF base. Concerns were raised regarding Defense's non-adherence to the polluter-pays principle, particularly regarding the use of Aqueous Film-Forming Foam (AFFF) containing toxic PFAS compounds. The government highlighted the need for appropriate waste management and sourcing alternative foam products to prevent PFAS contamination. Similar sentiments were echoed in the US HCOR (2019) with a focus on manufacturers and polluters. Advocates called for designating PFAS as hazardous substances, enforcing reporting and disposal practices under the Federal Clean Water Act, and making polluters such as DuPont and 3 M responsible for clean-up costs. The overarching goal was prioritizing public health and environmental well-being (Australian Government, 2016; Tingler, 2021; US HCOR, 2019).

Third, PFAS decontamination is highlighted in various studies and by different stakeholders. The Australian government emphasized the need for Defence to take responsibility for addressing contamination at the RAAF Base and implementing a combination of passive and active remediation for optimum effectiveness (Australian Government, 2016). The community affected by PFAS contamination in Northeast Cape urged the military to clean the area, emphasizing the need for responsible action and accountability (Altman, 2008). In the United States, advocates have urged the EPA to list PFAS as hazardous substances to facilitate cleanup efforts (US HCOR, 2019). The need for affordable and effective methods to remove PFAS contaminants from water sources and the importance of financial assistance for remediation efforts were also emphasized (US HCOR, 2019).

Environmental monitoring of PFAS is the fourth element that relates to the phase of restitution. Stakeholders have called for immediate action from regulatory authorities through continuous monitoring, ongoing surveillance, comprehensive sampling, and active engagement with regulatory authorities to mitigate environmental impacts and protect public health(Australian Government, 2016; US HCOR, 2019; US NEJAC, 2004). Efforts to address PFAS contamination have highlighted the shortcomings of existing processes and the need for a change in regulatory approaches to environmental monitoring (Altman, 2008), which brings us to the fifth subtheme of legal reform.

Some affected communities propose legal reforms, guided by scientific input, community advocacy, and the need for alternative approaches to chemical regulation (Altman, 2008; Australian Government, 2016; US HCOR, 2019). The Australian Government (2016) recognized the urgent need for legal reforms to address pollution and contamination incidents caused by Commonwealth activities, including the appointment of a Commonwealth environmental regulator, legislation review for mandatory notifications, and granting state-based agencies a greater role. Altman (2008) emphasized the importance of scientific solutions, standardization, and settle-

ment reform in resolving disputes and regulating polluting products. Personal community stories highlighted the necessity of policy changes, citizen engagement, and tribal advocacy (Altman, 2008).

The final subtheme of the restitution phase is governance issues, which in the Australian case referred to a combination of challenges arising from the far-reaching yet partially unclear impacts of contamination, a lack of clear regulatory roles, inadequate communication, insufficient consultation of communities, and insufficient oversight (Australian Government, 2016). Comprehensive reviews of legislation, effective risk assessments, and community-based approaches were thus deemed essential in addressing PFAS governance issues (Australian Government, 2016). In the American context, governance issues were related to the fraught dynamics between humans and the environment, where the elevation of consumerism over citizenship has hindered collective efforts to address environmental issues (Altman, 2008). Ms. Luxton, a fenceline community member, urged the US government "to stop allowing industry to poison us with products that we don't necessarily need and put that money into research for things that can be a little more eco-friendly, humane friendly, too" (US HCOR, 2019, p. 25). This relates to the lack of application of the precautionary principle in using potentially harmful substances before determining their impact (US HCOR, 2019), and the need for eco-friendly alternatives (Altman, 2008; US HCOR, 2019).

Discussion

This article focuses on the under-researched topic of corporate environmental crime victimization, specifically related to PFAS pollution. This field has received limited attention (Croall, 2007; Dodge, 2020; Geis, 1973; Gerber & Weeks, 1992; Hall, 2012; Moore & Mills, 1990; Natali, 2023; White, 2010). In what follows, we highlight seven interwoven considerations which can aid understanding the complexities involved in amplifying victim voices to earlier track, minimize, and treat harms from toxins.

Corporate harm adaptation

Building upon the work of Forti and Visconti (2019, p. 74) who described corporate crime as 'shapeshifting', the findings of this article support that these transformations are influenced by the stage victims are in as they adapt to the evolving circumstances, often referred to as the 'new normal.' Through a process of corporate harm adaptation victims respond to new information and changing conditions. The five-phase PFAS adaptation conceptual framework helps researchers understand the changing nature of harm faced by victims. In corporate harm adaptation, victims' experiences with harm shift faster than interventions designed to address these harms.

This framework highlights the necessity for researchers and policymakers to possess current knowledge and acumen to identify the specific adaptation stage victims, as well as the type of harm they are currently experiencing. The PFAS adaptation phases also serve to enhance our understanding of the underlying nature of corpo-

rate harms. As illustrated by Arnone and Iliopulos (2012), harms function within a complex system and safeguarding individuals necessitates an understanding of the broader network or system. Our study identified the distinct phases and constituent elements within each phase. However, we have yet to explore the subsequent step of comprehending how changes within the system can trigger cascading effects that prompt victims to adapt and the harm to 'shapeshift,' as explained by Forti and Visconti (2019, p. 75).

Innovative methodologies, such as photo elicitation and itinerant soliloquies, through slow observations, as demonstrated in earlier studies, can also serve to supplement this methodology (Davies, 2018; de Froideville, 2022; Natali, 2019, 2021, 2023; Natali & McClanahan, 2020; Schoepfer, 2014; Van de Voorde, 2012). These methodologies enable documentation of the evolving experiences of victims, the process of adaptation, and the transformation of harms. Such approaches effectively uncover the multifaceted range of victim experiences and their evolution over time in diverse contexts.

Role of narratives vis-à-vis formalized data

Our second contribution centers on the role of narratives or personal lived experiences in driving societal change, compared to formalized data. Indeed, as Natali (2023) states, lived experiences hold more influential power to bring about transformation within the affected communities. Utilizing formalized data often fails to alter perceptions of risk (Natali, 2023), especially in cases where communities are already aware of the risks and have come to terms with them, as noted by Menegatto et al. (2022) and Richter et al. (2018).

Corroborating these findings, the scientific community should reconsider how it defines and classifies the knowledge necessary to drive societal change. This shift embraces unconventional scientific expertise (Stake & Trumbull, 1982). Curiosity and strategy regarding the kind of knowledge that compels both communities and regulators to truly comprehend the profound sense of personal violation arising from exposure to toxic elements is an important meta-consideration.

Unspoken, silenced or overshadowed narratives

This review also brought to light narratives that are rarely openly discussed or overshadowed by other prevailing viewpoints. An intriguing discovery emerged during the third phase of the study, which delved into lifestyle changes and their relation to the precautionary principle. The prevailing belief is that the precautionary principle has not been effectively applied in the context of PFAS (Cousins et al., 2016; Massarutto et al., 2022; Stewart et al., 2021). Massarutto et al. (2022) emphasized the need for Italian water authorities to embrace the precautionary principle to safeguard the public from PFAS exposure, underlining the principle of 'better safe than sorry.'

Our research revealed that an alternate narrative seldom paid attention to in mainstream media or scientific literature, is one that centers on post-hoc precaution as a governmental coping and compensating mechanism applied to victimized communities (without their consent) rather than to corporations. The reasons for this apparent

overcompensation of post-hoc precaution, not previously finding more prominence in public discourse, are not clear. Nonetheless, it is evident that RAAF Base Williamtown fenceline communities often perceived post-hoc compensatory precaution negatively, as it was enforced too late after harm had already occurred and was experienced to add additional hardship (Australian Government, 2016).

Exploring the stories and accounts that revolve around the unequal allocation of benefits, costs, and impacts of PFAS pollution can help avoid these indemnifying strict safety measures, which are often perceived as compounded harms by the community because they prevent people from living their lives (Dodge, 2020; Gottschalk & Tcherni-Buzzeo, 2017).

Non- or under-reporting corporate crimes

Another salient theme included how the chemical industry and government authorities often failed to promptly or comprehensively report corporate wrongdoing, as emphasized by Button et al. (2014). During the second phase (discovery), numerous cases showed that information was either not provided at all or was shared belatedly and in a manner that was difficult for the public to comprehend.

Across several studies, it has become evident that deliberate concealment of information by government officials and the chemical industry was prevalent. This intentional withholding of information was achieved through tactics, such as refraining from communication or presenting an incomplete narrative. Notably, instances such as Chemours' utilization of complex technical language to confuse the community and distort the actual message, as reported by Wickham and Shriver (2021), stand out.

The consequences of deliberate concealment include leaving fenceline communities uninformed (Australian Government, 2016), information overload or even cases of misinformation (Altman, 2008, and decreasing trust and goodwill in those sharing science, by the affected (Oksas et al., 2022; Wickham & Shriver, 2021).

Denial of harm or evasion of accountability

During the 'living with PFAS' phase, communities faced formidable hurdles in establishing a definitive connection between PFAS exposure and resultant health problems. Some case studies (Australian Government, 2016; Banwell et al., 2021; US HCOR, 2019; Wickham, 2020; Wickham & Shriver, 2021) echoed the requirement to substantiate the health risks associated with PFAS. This requirement, however, serves as a strategy to divert attention from readily available information on PFAS toxicity. It also shifts the responsibility of proof to victims, who are already overwhelmed by complex and incomprehensible information. These findings parallel those of Williams (1996), revealing that such evasive tactics and denial of harm foster an atmosphere of silence and indifference. Additionally, these actions frequently lead to community frustration across various case studies, subsequently contributing to increased psychological distress (Australian Government, 2016; Banwell et al., 2021; US HCOR, 2019; Wickham & Shriver, 2021). Uncovering the experiences of victims when their reality is distorted through gaslight-

ing strategies presents considerable challenges because of their eroded trust in their perceptions.

'Non-ideal' victims of crime

The list of victims encompasses a broad and diverse range of individuals and groups, including entire communities affected by PFAS contamination, local business owners, and workers. The unique challenges of each of these victims often go unnoticed in research because they depart from the conventional perception of an 'ideal' victim.

In the 27 studies, only 56 quotes came from workers, with only four quotes from former DuPont employees (no quote from current employees). This underscores another distinctive subset of 'non-ideal' victims of crime that requires innovative approaches to know their stories. Strikingly, these individuals perceive themselves in a dual role as both victims and potentially even perpetrators (or exclusively as perpetrators). This dynamic adds to the intricate interplay emphasized by Whyte (2017) that victims of corporate crime are metaphorically 'wearing numerous hats.' They engage in complex social networks and play multifaceted roles within them.

This paper underscores the necessity to challenge simplified notions of 'crime' and 'victim.' This prompts a call for theoretical exploration to redefine these terms, particularly in the context of toxic trespass. These cases blur the lines between victims and perpetrators, involving overlapping victim groups that can encompass an entire community, or even extend globally. Existing research (Dodge, 2020; Natali, 2023) highlights the urgent requirement for methodologies capable of capturing the diverse profiles of 'non-ideal' victims.

Capturing the diverse landscape of victimization

Our research strategy involved adopting the concept of 'structured vulnerability.' To achieve this, we analyzed narratives from both affected communities and workers. This approach led us to uncover cases of 'non-ideal' victims, such as the 'Dupont family.'

Disparities linked to socioeconomic status and gender surfaced predictably in this study, as many other studies on environmental justice have shown (Nixon, 2011). It became evident that the impacts of PFAS exposure vary based on factors like income and sex, a notion previously established by Tingler (2021) and earlier reaffirmed by Jou and Hebenton (2017).

In line with Dodge's (2020) observations, our investigation uncovered a critical insight: The diverse forms of harm suffered by victims are exceptionally varied and unequally distributed. Existing studies tend to examine specific aspects of this harm, often overlooking a broader context. Consequently, conveying the true extent of victimization stemming from PFAS pollution is underexplored.

Limitations

While our study provides valuable insights into the lived experiences of fence line communities and workers exposed to PFAS pollution, we acknowledge several limitations regarding the generalizability of our findings. We limited our analysis to English-language publications, which could result in an incomplete representation of available research. Our study also had a skewed geographical distribution, with 20 studies from the US, four from Australia, and three from the UK, Italy, and Sweden. This overrepresentation of US studies could introduce a geographic bias and affect the review findings. Including grey literature, such as PhD theses and parliamentary hearings, expanded the scope, but could also introduce biases due to the absence of peer review. Additionally, the diverse methodologies employed in the qualitative studies reviewed enriched our dataset of victim narratives but posed challenges in integrating the findings and drawing unified conclusions. The inability to conduct a meta-analysis of qualitative results due to methodological disparities further complicates data interpretation. Furthermore, our reliance on qualitative data may limit the scope of our analysis compared to studies incorporating quantitative evidence. Moreover, the specific focus on PFAS-exposed communities and workers might not fully capture the experiences of other populations impacted by PFAS exposure or other pollution. Also, the experiences mentioned might not be typical for other groups impacted by PFAS exposure. Future research should aim to address these limitations by incorporating diverse geographic perspectives, integrating quantitative data, and expanding the scope to include a broader range of affected populations. This approach would enhance the generalizability and robustness of findings, contributing to a more comprehensive understanding of environmental crime victimization globally.

Conclusion

To address the lack of knowledge on corporate environmental crime victimization, this study systematically reviewed the extant narratives of individuals living in PFAS-contaminated environments. By focusing on how affected communities and workers perceive and interpret the harm caused by this pollution, the role of first-person experiences of living and working in PFAS-polluted environments complements corporate crime studies. PFAS exposure not only precipitated changes in victims' daily routines, consumption habits, and overall lifestyles but also physical, psychological, environmental, and socio-economic experiences of hardship and injustice. From this perspective, we addressed how fenceline communities and workers respond to the risks and negative consequences of PFAS pollution by forming groups to address water contamination challenges, seeking legal action, advocating for change, building support networks, and collaborating with experts. Our framework, with five phases of PFAS adaptation that individuals and communities experience when dealing with long-term exposure to PFAS pollution, can aid in analyzing other PFAS exposure cases. Potentially this 'corporate harm adaptation' process might apply to exposure to other toxins as well.

The study uncovers the adaptable nature of harm experienced by individuals across five stages: pre-discovery, discovery, lifestyle change, living with PFAS, and seeking restitution for affected fenceline communities and workers. Advocating for tailored inter-

ventions across diverse contexts, it emphasizes the pivotal role of lived experiences in driving societal change and validates the importance of inclusive justice approaches. Furthermore, it addresses underreporting and denial of corporate crime victims or harm. This has important policy implications because responsive regulation and environmental enforcement of these polluting industries necessitates insight into these diverse victims and harms. Lastly, it highlights disparities in responses to living with PFAS, dependent on socioeconomic status and gender, which should be taken into account when developing policies promoting resilience and environmental justice.

Moving beyond the realms of technical and scientific examinations of PFAS pollution, it is important to better understand the lived experiences, challenges, and responses faced by individuals, communities, and workers when confronted with PFAS contamination. Giving proper place to the emotional, psychological, and societal dynamics that underlie chemical exposures suggests that merely sociotechnical or legal frames are insufficient to correctly capture the range of disorientation, displacement, and damage vulnerable communities experience when poisoned. These findings hold particular importance for corporate environmental crime and victimization scholars because they emphasize the intricate dynamics of experiencing multifaceted harms arising from corporate environmental pollution, rather than such exposures being solely matters of fact.

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Data availability The datasets generated by coding of the review articles using Atlas.ti software, during the current study are available in the OSF repository, https://doi.org/10.17605/OSF.IO/HNZQ6.

Declarations

Ethical approval The research project was authorized by the Ethics Review Committee of the Erasmus School of Law, Erasmus University Rotterdam (#ETH2223-0178).

Informed consent Not applicable.

Statement regarding research involving human participants and/or animals Not applicable.

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