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The (Un)making of a Toxic Event. The Case of PFAS in Germany

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Johanna Kramm

Institute for Social-Ecological Research (ISOE), Hamburger Allee 45, 60486 Frankfurt am Main, Germany; johanna.kramm@isoe.de; https://orcid.org/0000-0002-2725-9907

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Abstract

Chemical pollution in social science scholarship is often described as invisible, inversed, normalized, imperceptible, unacknowledged, and unspectacular. This short communication explores conditions of visibility of chemical contamination. Drawing on Barry (2017) and Babri et al. (2022), these conditions are conceptualized as events of first and second order. This paper aims to explore events of toxic chemical pollution and how visibility is achieved during these events, taking the chemical contamination of PFAS (per- and polyfluoralkyl substances) in Germany as a case. The chemical group of around 10,000 per- and polyfluoralkyl substances, known as PFAS, is widely used in various applications. PFAS are persistent and can be found ubiquitously in the environment; however, there exist several hotspots. Drawing on first research results, the paper will outline initial analytics to explore the (in)visibility of toxic events and the chemical geographies involved. Toxic events exist in a continuum, ranging from anticipation and risk calculation to total surprise and ignorance. They are not predetermined to become toxic events; an occurrence might be significant on a local scale while remaining a "non-event" on a larger scale. Different trajectories have to intersect to transform a first-order event into a second-order event with broader reach and vibrancy. Still, the PFAS case demonstrates that toxic events are finite.

Keywords toxic pollution, events, PFAS, visibility, chemical geography

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1. Introduction: The Invisibility of Chemical Pollution

The chemical group of around 10,000 per- and polyfluoralkyl substances, known as PFAS, is widely used in various applications to make materials dirt-, grease-, and water-repellent, as in the case of outdoor clothing or food packaging. However, due to these characteristics, they hardly biodegrade in the environment and can accumulate in organisms (Brunn et al., 2023). PFAS can be found in the food chain and even human blood (Göckener et al., 2020). They are released into the environment in several ways, including during production and after use, as in the case of firefighting foam. PFAS-containing foam was used in firefighting exercises and subsequently entered the groundwater (Brunn et al., 2023). In Germany, sites with higher contamination are associated with, for example, military sites and airports (due to firefighting exercises), production sites, and sites where PFAS-contaminated paper sludge was applied to agricultural land, as in the case of Rastatt, southern Germany.

Like plastics, PFAS are persistent and can be found ubiquitously in the environment. However, unlike plastics, PFAS are not visible. In an interview with an official from the PFAS office from the District Rastatt, I mentioned that I have been researching plastics for the past five years. He stated that the detection of PFAS contamination in his region occurred around the same time as the first public media reports on plastics in the environment. However, while plastic pollution rapidly gained attention in science (Bakhshoodeh & Santos, 2022), the media (Völker et al., 2020), the public (Kramm et al., 2022), and politics (Kramm, 2024), the public and media attention for PFAS remained low. His diagnosis: "It's the visibility."

Indeed, while images of dead seabirds with stomachs full of plastics or a sea turtle with a straw in its nose have become a hallmark of global plastic pollution (Henderson & Green, 2020), driving efforts to eliminate plastic waste, PFAS contamination has stayed below the radar of the media and public in Germany in recent years.

The lack of visibility regarding PFAS pollution in Germany reflects the characterization of chemical pollution in social science scholarship: as invisible, inversed, normalized, imperceptible (Murphy, 2006), unacknowledged (Renfrew & Pearson, 2021), unspectacular (Nixon, 2011), with delayed effects, and therefore often eluding political accountability (Mansfield, 2021). Rob Nixon (2011) coined the notion of "slow violence" to address this phenomenon. He states (2011, p. 2): "By slow violence, I mean a violence that occurs gradually and out of sight, a violence of delayed destruction that is dispersed across time and space, an attritional violence that is typically not viewed as violence at all."

Most PFAS do not exhibit toxicity in the same way as substances like arsenic, where contact can be fatal. Instead, PFAS follow slow violence, interfering with human health by reducing the effectiveness of vaccinations, increasing susceptibility to infections, raising cholesterol levels, or reducing birth weights (Brunn et al., 2023). "The results from worldwide human biomonitoring studies indicate a general background contamination [with different PFAS] … of people all over the world" (Göckener et al., 2020). This ubiquitous background contamination remains invisible. However, visibility is crucial for transforming a problem into a political issue (Barry, 2013).

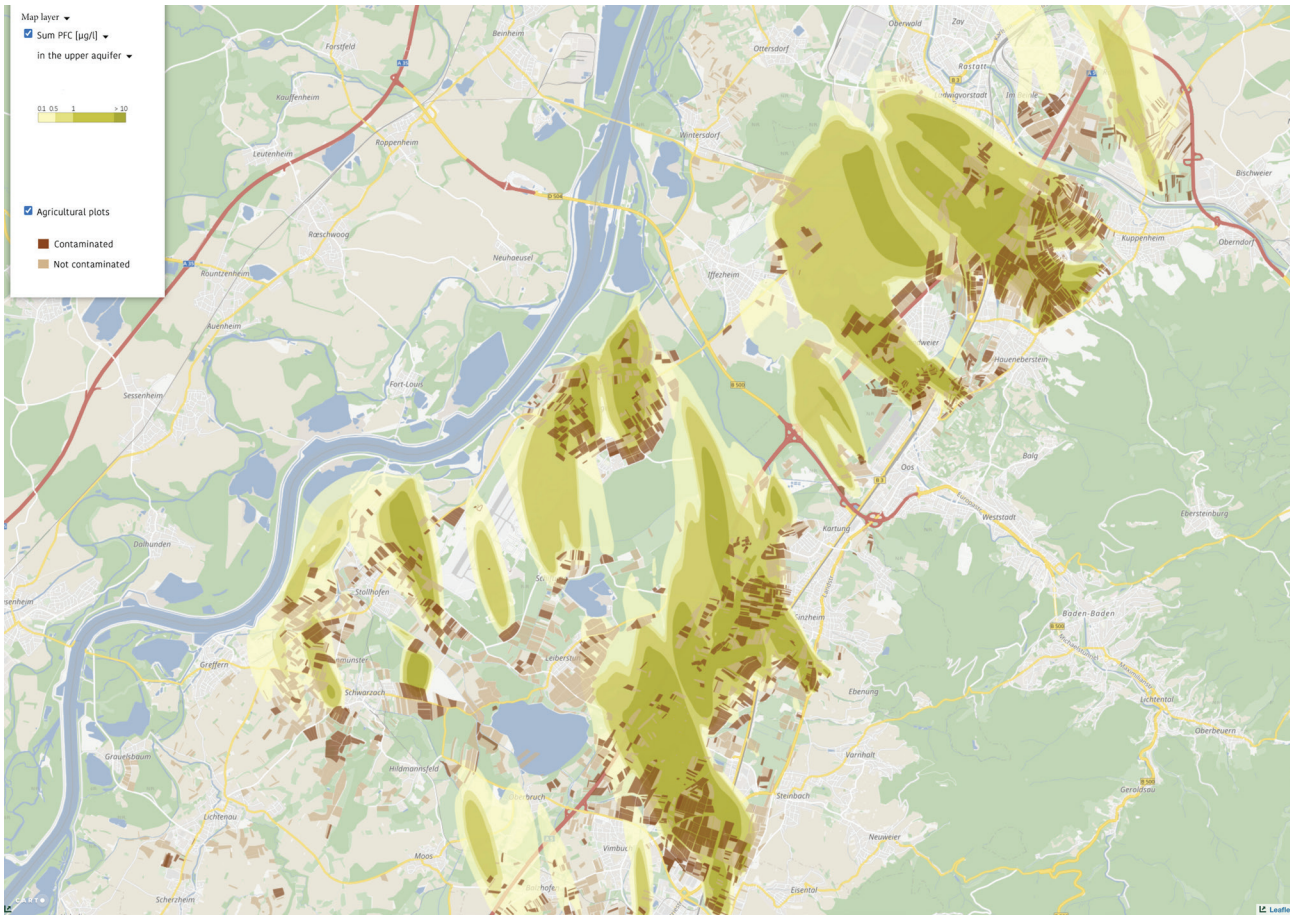
While acknowledging the invisible character of PFAS contamination and the experience of everyday exposure, I also argue that chemical pollution has moments of visibility. Drawing on Andrew Barry (2017), I understand these moments as *events*. Therefore, this paper aims to explore events of toxic chemical pollution and how visibility is achieved during these events. Thus, in what follows, I aim to sketch out the conditions of toxic events, taking the case of PFAS contamination in Rastatt, Germany, as a focal point.

2. The Rastatt Case

The Rastatt region is one of the PFAS hotspots in Germany (Umweltbundesamt [UBA], 2020). It is a fertile agricultural region in the southwest of Germany. Between 2006 and 2008, a local compost trader from Bühl/Baden-Baden received very large quantities of paper sludge from different paper mills in Baden-Württemberg and other federal states. The paper sludge contained PFAS, as they are used to make paper and cardboard water- and grain-repellent, such as in pizza boxes or fast food packaging. The compost trader gave the paper sludge for free to the farmers, who applied a paper sludge compost mix as soil improver to their lands (Klatt, 2018). As mentioned above, PFAS are very persistent and mobile; thus they moved through the soil into the groundwater. At the end of 2012, the local water supplier detected them

in a well for drinking water generation. Subsequently, they were detected in more wells and in the soil and food in 2013. After the contamination of drinking water and food became known, comprehensive measures were taken by the local governments to protect the population in 2013/2014 (Klatt, 2018). In 2015, the PFAS administrative office at the Rastatt District was established. It is estimated that around 1,200 hectares in the area surrounding Rastatt are affected (Stadt Rastatt, 2022–2024, see Figure 1).

Figure 1 PFAS Contamination in the Region Around Rastatt



Note. Brown plots: land areas contaminated with PFAS, beige and greenish shading: groundwater plume containing PFAS. Source: Landesanstalt für Umwelt Baden-Württemberg (n.d.), PFAS-Karten Online. https://www.lubw.baden-wuerttemberg.de/wasser/pfc-karten-online

3. Toxic Events

Andrew Barry understands events "as moments in time, as points of interference between multiple trajectories, which may generate unexpected and emergent effects [and practices], as well as new spatio-temporal relations" (Barry, 2016, p. 4). In his manifesto for a chemical geography, Barry (Barry, 2017) explores the relationship between politics and chemicals, examining chemical events along several dimensions. First, Barry argues that events, such as an oil pipeline leak, are often anticipated in advance. "They are recorded in documents and research projects and risk assessments that are part" of broader regulation and safety measures (Barry, 2017, p. 14). Second, he suggests that events are inherently open in nature, meaning it is not predetermined whether an event will matter or simply become a "non-event" (Barry, 2017, p.15). The significance of an event is thus contingent upon various factors, including social, political, and environmental responses. Third, according to Barry, an examination of the causes of this event would need to take into account not only politics and social conditions but also the physical and natural processes and structures. Materialities of chemicals play a crucial role.

I use these three aspects of events to explore toxic events in the case of Rastatt. The "leakage" of PFAS was not anticipated in the same way as an oil pipeline leak might be. In the case of Rastatt, for several years, the compost trader supplied PFAS-contaminated paper sludge from the paper industry to local farmers as a soil improvement, unknowingly leading them to contaminate their fertile lands.

This event was not about anticipation but rather involved willful ignorance by the compost trader and the paper industry (Klatt, 2018)—ignorance as a way of not knowing and probably not wanting to know, driven by profit motives. Additionally, this event challenges ideas of circular material streams as envisioned by a circular economy, as toxic chemicals can make circularity harmful, as the "recycling" of paper sludge shows.

Addressing Barry's second point, which suggests that events are inherently open, the event of PFAS contamination started to matter to the local population and local politics only after the severity of the issue was discovered around 2013. By this time, the compost trader had been supplying the farmers with PFAS-containing soil conditioners for years (Klatt, 2018). Despite the local awareness, the discovery remained a non-event on a national scale, as this and other cases of PFAS contamination did not achieve widespread public attention until much later.

Regarding Barry's third point about interference between multiple social and natural trajectories, the material affordance of PFAS presents significant challenges. These substances are extremely persistent and highly mobile, meaning they can move through soil, seep into surface water and groundwater, and even transform into new, potentially more harmful metabolites and chemical compounds. The contamination became visible only in measurements of PFAS concentrations in the soil, water, plants, and blood conducted by the local government later on. The appearance of the soil, water, and plants remained unchanged. New practices emerged from this event, such as that the local farmers, but also the local population and the water supplier had to adapt to a "living with" the chemicals. For instance, a sophisticated monitoring system for agricultural products had to be developed and implemented (Stabsstelle PFAS am Regierungspräsidium Karlsruhe, n.d.). Michelle Murphy's concept of "alterlife" grasps these new conditions, describing how life forms become "entangle[d] … in each other's accumulations, conditions, possibilities, and miseries" (Murphy, 2017, p. 497).

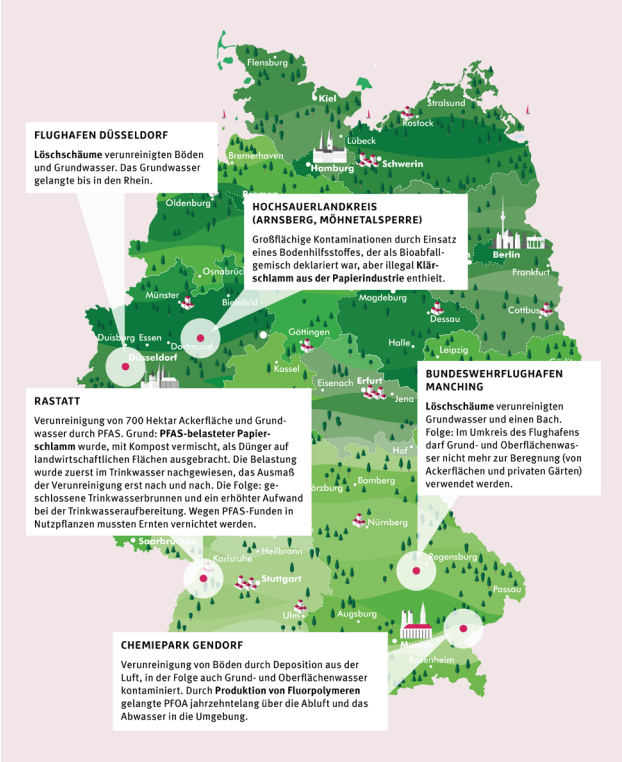
4. Visibility of Toxic Events

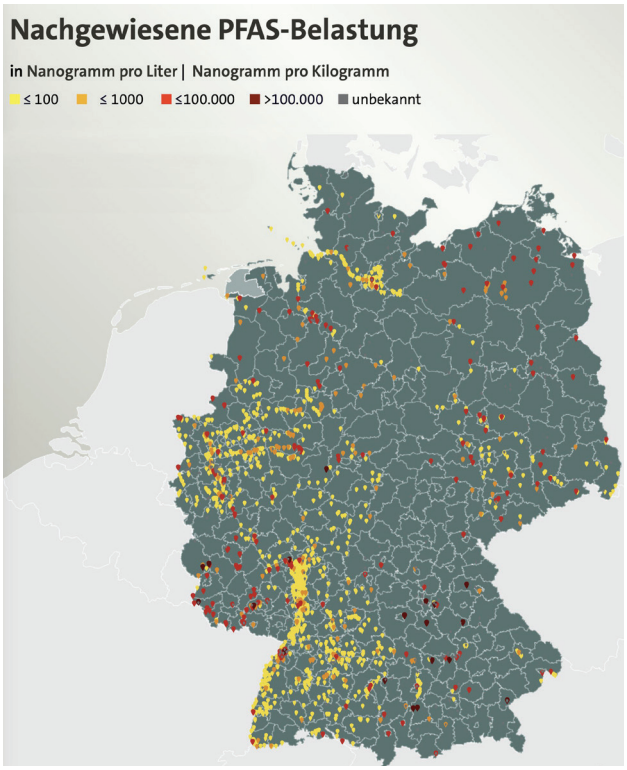
How can these events be made visible? Renfrew and Pearsons (2021) identify different trajectories that need to intersect to make chemical pollution visible and accountable, thereby transforming it into a *toxic event* in the sense of a spectacle. These trajectories include measuring toxicity or identifying contaminated sites through scientific research, voicing concerns by pressure groups, developing narratives of chemical pollution by the media, addressing pollution through regulatory action and the chemicals themselves with their specific characteristics of persistence, mobility, transformability, and/or bioaccumulation.

To analytically grasp the interferences of these multiple trajectories, I propose thinking of events in terms of *first and second order*. First-order events can be understood as the directly experienced contamination at specific sites such as Rastatt. Second-order events, on the other hand, assemble all these different events of contamination and connect them through visualization and narrative. Drawing on Babri et al.'s (2022) concept of orders of material affordances, where each order builds upon the other, I argue that toxic events cannot be actualized until the first-order events are recognized and made evident.

In the case of PFAS, the mapping of the Forever Pollution Project created such a second-order event. The project, a collaboration between journalists and scientists, aimed to map and report on PFAS contamination across Europe. When it launched in February 2023, it generated extensive media coverage and unprecedented media interest in the PFAS issue. Central to the event was a map that visualized contaminated sites and projected areas likely to be contaminated. Suddenly, it became clear that PFAS contamination was not limited to five hot spots, as outlined on a previous map of the German Environmental Protection Agency, but was a nationwide and even European-wide phenomenon (see Figure 2).

Figure 2 left *Map German Environmental Protection Agency with Five Hotspots*
Figure 2 right *Map of Forever Pollution Project With 1,500 Hotspots*





Note. Figure 2 left: From Umweltbundesamt [UBA], 2020, p. 24. https://www.umweltbundesamt.de/publikationen/schwerpunkt-1-2020-pfas-gekommen-um-zu-bleiben

Translation of the text:
Düsseldorf Airport: Firefighting foams contaminated soil and groundwater. The groundwater reached the Rhine.
Hochsauerland district (Arnsberg, Möhnetalsperre): Extensive contamination due to the use of a soil additive that was declared as mixed organic waste but illegally contained sewage sludge from the paper industry.
Bundeswehr Airport Manching: Firefighting foams contaminated groundwater and a stream. Consequence: In the vicinity of the airport, groundwater and surface water may no longer be used for irrigation (of farmland and private gardens).
Rastatt: Contamination of 700 hectares of farmland and groundwater by PFAS. Reason: PFAS-contaminated paper sludge was mixed with compost and spread as fertilizer on agricultural land. The contamination was first detected in drinking water, and the extent of the contamination only gradually became apparent. The result: Closed drinking water wells and increased costs for drinking water treatment. Because PFAS was found in crops, harvests had to be destroyed.
Chemiepark Gendorf: Contamination of soil through deposition from the air, subsequently also contaminating groundwater and surface water. For decades, PFOA was released into the environment through exhaust air and wastewater from the production of fluoropolymers. The company has been cleaning up the site since 2001.

Figure 2 right: From The Forever Pollution Project, national map by NDR, WDR and Süddeutsche Zeitung, Nachgewiesene PFAS Belastung [Measured PFAS contamination] as cited in Pilz et al., 2023. https://www.ndr.de/fernsehen/sendungen/panorama/archiv/2023/Jahrhundertgift-PFAS-Wie-verseucht-ist-Deutschland,pfas104.html

Translation of the text:
Measures PFAS contamination, in nanograms per liter/in nanograms per kilogram; grey: no data.

The timing of the campaign was intentional, released just weeks after a restriction proposal for the entire substance group of PFAS was submitted to the European Chemicals Agency in January 2023 (ECHA, 2023). The restriction proposal sets out a three-stage plan for phasing out the use of PFAS in products. First, PFAS should be banned within 18 months for applications in which it can easily be substituted, such as packaging and cosmetics. Secondly, for applications for which alternatives are about to be developed, PFAS should be banned within five years. Thirdly, for applications for which no alternatives currently exist, such as medical devices, a period of 12 years is proposed (ECHA, 2023).

An officer for chemical policy of one of the state ministries of the environment noted in an interview, "When the Forever Pollution Project launched their campaign, this was an event because it drew so much attention to this issue, which is usually absent in the public discourse." The officer further explained, "it helped to bring the topic onto the political agenda and to garner support for the PFAS restriction proposal among the state ministers of the environment at the conference of environment ministers."

However, media attention is finite. When I met the official of the state environmental ministry again a few months later, he said: "All the momentum of the Forever Pollution Project has faded away. The consensus regarding restricting PFAS, which seemed strong in spring, is now cracking."

Indeed, the petrochemical industry and companies using PFAS in their products have mobilized resources to oppose stricter chemical regulations. Industry associations are advancing a new narrative: PFAS restriction will put Germany's economy at risk and will lead to deindustrialization (Verband der chemischen Industrie [Association of the Chemical Industry, VCI], 2023a, 2023b). The industry rejects regulating PFAS as a group as it is a fundamental working material with excellent characteristics for many industry sectors, such as the machinery and electrical industry, or the mobility and medical technology sector. In their communications, environmental and human health consequences are hardly addressed.

5. Conclusion and Outlook

In this short communication, I have outlined initial analytics to explore the (in)visibility of toxic events and the chemical geographies involved. Toxic events exist in a continuum, ranging from anticipation and risk calculation to total surprise and ignorance. They are not predetermined to become toxic events; an occurrence might be significant on a local scale while remaining a non-event on a larger scale. Different trajectories have to intersect to transform a first-order event into a second-order event with broader reach and vibrancy. Still, the PFAS case demonstrates that toxic events are finite. The toxic event of PFAS, which was celebrated with visibility and publicity, has lost power. It seems as the PFAS contamination is slipping back into invisibility and new narratives of economic necessity are becoming strong. While toxic events have the potential to establish new narratives and practices, they require continuous effort to be reproduced and sustained. Although PFAS are highly stable, more durable associations are needed to maintain the visibility of toxic contamination as a prerequisite for political action.

The analytic framework sketched out here can be further refined by engaging with the concept of "slow emergency" (Anderson et al., 2019), which addresses situations characterized by attritional lethality while considering issues of justice and power relations. This approach offers ways to account for unevenly distributed temporalities and different modes of emergency governance (Anderson et al., 2019). By doing so, it can strengthen the conceptual repertoire of chemical geographies (Kramm, 2025).

References

Anderson, B., Grove, K., Rickards, L., & Kearnes, M. (2019). Slow emergencies: Temporality and the racialized biopolitics of emergency governance. *Progress in Human Geography*, *44*(4), 621–639. https://doi.org/10.1177/0309132519849263

Babri, M., Corvellec, H., & Stål, H. I. (2022). Material affordances in circular products and business model development: for a relational understanding of human and material agency. *Culture and Organization*, *28*(1), 79–96. https://doi.org/10.1080/14759551.2021.1986506

Bakhshoodeh, R., & Santos, R. M. (2022). Comparative bibliometric trends of microplastics and perfluoroalkyl and polyfluoroalkyl substances: How these hot environmen-

tal remediation research topics developed over time. *RSC Advances*, *12*(8), 4973–4987. https://doi.org/10.1039/d1ra09344d

Barry, A. (2013). *Material politics: Disputes along the pipeline*. Wiley Blackwell.

Barry, A. (2016). The politics of contingency: Events, travelling models, and situations. *Working paper of the priority programme 1448 of the German Research Foundation: Vol. 19.*

Barry, A. (2017). *Manifesto for a chemical geography*. Inaugural lecture, Gustave Tuck Lecture Theater, UCL.

Brunn, H., Arnold, G., Körner, W., Rippen, G., Steinhäuser, K. G., & Valentin, I. (2023). Pfas: Forever chemicals—Persistent, bioaccumulative and mobile. Reviewing the status and the need for their phase out and remediation of contaminated sites. *Environmental Sciences Europe*, *35*(1), 1–50. https://doi.org/10.1186/s12302-023-00721-8

European Chemicals Agency. (2023). *Per- and polyfluoroalkyl substances (PFAS).* European Chemicals Agency. https://echa.europa.eu/de/registry-of-restriction-intentions/-/dislist/details/0b0236e18663449b

Göckener, B., Weber, T., Rüdel, H., Bücking, M., & Kolossa-Gehring, M. (2020). Human biomonitoring of per- and polyfluoroalkyl substances in German blood plasma samples from 1982 to 2019. *Environment International*, *145*, 106123. https://doi.org/10.1016/j.envint.2020.106123

Henderson, L., & Green, C. (2020). Making sense of microplastics? Public understandings of plastic pollution. *Marine Pollution Bulletin*, *152*, 110908. https://doi.org/10.1016/j.marpolbul.2020.110908

Klatt, P. (2018). Der PFC-Skandal in Mittelbaden: Ein „Freilandexperiment" mit unbekanntem Ausgang [The PFC scandal in Central Baden: An "open-air experiment" with unknown results]. In Landkreis Rastatt (Ed.), *Heimatbuch 2018: Aktuelles und Wissenswertes* (pp. 201–220). Verlag Regionalkultur. https://www.landkreis-rastatt.de/site/kreis-rastatt/get/documents_E381771265/kreis-rastatt/Objekte/03_Aktuelles/PFC/Heimatbuch%20Landkreis%20Rastatt%202018_Der_PFC-Skandal_in_Mittelbaden_Patricia%20Klatt.pdf

Kramm, J. (2024). Agential cuts of regulatory science practices – the case of microplastics. *Environment and Planning E: Nature and Space*, *7*(3), 1245–1261. https://doi.org/10.1177/25148486231221020

Kramm, J. (2025). *Chemical geographies: Towards acritical geography of chemosocial relations* [Manuscript submitted for publication].

Kramm, J., Steinhoff, S., Werschmöller, S., Völker, B., & Völker, C. (2022). Explaining risk perception of microplastics: Results from a representative survey in Germany. *Global Environmental Change*, *73*, 102485. https://doi.org/10.1016/j.gloenvcha.2022.102485

Mansfield, B. (2021). Deregulatory science: Chemical risk analysis in Trump's EPA. *Social Studies of Science*, *51*(1), 28–50.

Murphy, M. (2006). *Sick building syndrome and the problem of uncertainty: Environmental politics, technoscience, and women workers*. Duke University Press; Walter de Gruyter GmbH. https://doi.org/10.1515/9780822387831

Murphy, M. (2017). Alterlife and decolonial chemical relations. *Cultural Anthropology*, *32*(4), 494–503. https://doi.org/10.14506/ca32.4.02

Nixon, R. (2011). *Slow violence and the environmentalism of the poor*. Harvard University Press. https://doi.org/10.4159/harvard.9780674061194

Pilz, S., Felke, C., Busch, L., Schneider, I., Wippermann, S., Bewarder, M., Edelhoff, J., Hoferichter, A., Drepper, D. (2023). Jahrhundertgift PFAS: Wie verseucht ist Deutschland? [PFAS, the poison of the century: How contaminated is Germany?]. *Das Erste, Panorama.* Norddeutscher Rundfunk. https://www.ndr.de/fernsehen/sendungen/panorama/archiv/2023/Jahrhundertgift-PFAS-Wie-verseucht-ist-Deutschland,pfas104.html

Renfrew, D., & Pearson, T. W. (2021). The social life of the "forever chemical". *Environment and Society*, *12*(1), 146–163. https://doi.org/10.3167/ares.2021.120109

Stabsstelle PFAS am Regierungspräsidium Karlsruhe. (n.d.) *Landwirtschaft: Sicherstellung des Verbraucherschutzes bei der Bewirtschaftung PFAS-verunreinigter Flächen*. [Agriculture: Ensuring consumer protection in the cultivation of PFAS-contaminated land] https://rpk.baden-wuerttemberg.de/abt5/referat-52-gewaesser-und-boden/stabsstelle-pfas/landwirtschaft/

Stadt Rastatt 2022–2024, https://www.rastatt.de/mein-rastatt/natur-und-umwelt/pfas-belastung

Umweltbundesamt. (2020). PFAS: Gekommen, um zu bleiben [PFAS: Here to stay]. *Schwerpunkt. Das Magazin des Umweltbundesamtes* 1/2020, 24. https://www.umweltbundesamt.de/publikationen/schwerpunkt-1-2020-pfas-gekommen-um-zu-bleiben

Verband der Chemischen Industrie e. V. (2023a). *Deindustrialisierung stoppen!* [Stop deindustrialization!]. *Brandbrief August 2023*. https://www.vci.de/vci/downloads-vci/publikation/politikbrief/pb-2023-04-deindustrialisierung-stoppen.pdf

Verband der Chemischen Industrie e. V. (2023b). PFAS: Pauschalverbot ist keine Lösung! [PFAS: A complete ban is not the solution!]. *Politikbrief Juni 2023*. https://www.vci.de/vci/downloads-vci/publikation/politikbrief/vci-pb-2023-3-pfas.pdf

Völker, C., Kramm, J., & Wagner, M. (2020). On the creation of risk: Framing of microplastics risks in science and media. *Global Challenges*, *4*(6), Article 1900010, 1900010. https://doi.org/10.1002/gch2.201900010