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Risky plastics and the limits to consumer responsibilization†

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Abstract

This paper highlights the limitations of the use of risk in plastic governance. First, plastic risk categorizations adapt, evolve, and shift, which creates ambiguities and insecurities for consumers about the responsible choices to be made. Second, the risk frame requires consumer agency to mitigate risk, a privilege many cannot afford. Third, the use of risk in plastic governance cedes power to dominant market actors who possess the capacity to blame others and use guilt appeal to alleviate their responsibility. The concluding remarks point to the importance of changing our minds about plastics. The argument is to stop thinking that plastics are flexible and malleable.

Impact statement

Plastic governance is fragmented and seems inefficient to curb the global production of plastics. Focusing on the use of risk in plastic governance, this paper highlights issues associated with categorizing some plastics as risky objects whilst allowing plastics with low harmful effects to be marketed as acceptable or reasonable.

Introduction

Since the 1960s, when plastic litter was identified in marine systems, plastics have turned into complex social and environmental problems (Evans et al., 2020; Hawkins, 2020; Nielsen et al., 2020; Shittu, 2021; Smith and Brisman, 2021; Hardesty et al., 2022; Shipton and Dauvergne, 2022; Wagner, 2022).

In response to complex problems, neoliberal governance regimes invoke markets and use risk as "disciplinary tools" (Foucault, 1978) to achieve desired public outcomes. The use of risk to govern transformative plastic actions, however, seems to have limited impact on the plastic catastrophe (Dauvergne, 2018, 2023; Nielsen et al., 2019, 2020; Cherrier and Türe, 2022; Tiller et al., 2022; Pathak, 2023). Drawing on risk governance and neoliberalism literature, this paper highlights the limitations of the use of risk in European plastic governance. The paper is structured as follow. The first sections reveal the use of risk in European plastic governance and highlights how it has created a fragmented governance and an increasing reliance on consumer responsibility to mitigate plastic risks. The following sections discuss the limits to consumer responsibilization around plastic risks. The concluding remarks point to the importance of changing our minds about plastics. The argument is to stop thinking that plastics are flexible and malleable. From this, we can understand that the use of plastics points to the possibility of an inflexible and destructive end.

Risk and plastic governance

The use of risk as a technique of neoliberal governance is well established and has been noted in the context of plastic governance (O'Malley, 1996, 2004; Galvin, 2002; Scott, 2007; Dean, 2010; Pitts-Taylor, 2010; Drake, 2011; Lavrence and Lozanski, 2014; Bloom, 2017; Ansell and Baur, 2018; Cherrier and Türe, 2022). It is characterized by a governance *through* risk rather than *of* risk (Scott, 2007; Brown et al., 2013). In plastic governance, the use of risk allows to organize "wicked" plastic problems (Wagner, 2022) into manageable "risk objects" (acceptable, tolerable, intolerable, disputed) (Ansell and Baur, 2018, p. 411). Through risk assessment or risk factors, heterogeneous plastics (polymer) and plastics with added chemicals (monomers, plasticizers) are grouped into categories, and the ones that have a similar probability of risk in the future are extracted and profiled as risky plastics. A hazard ranking model for plastics, for instance, was developed to create plastic labeling regulation in Europe (Lithner et al., 2011). Categories of acceptable, tolerable, intolerable, disputed risky plastics are established based on the notion that

humans and the environment can assimilate a certain amount of pollutant or dose before harm occurs (Liboiron, 2016). In this manner, the carcinogenic risk of PVC plastic materials is associated with a threshold of exposure to the substance (Meikle, 1997; Westermann, 2013). This threshold assigns risk to plastics when harm is "observable, measurable and traceable by laboratory" (Liboiron, 2016, p. 9) and allows plastics with low harmful effects to be marketed as acceptable or reasonable. Based on this threshold, the European Commission Regulation 10/2011 can authorize certain plastics to be produced and used in households, even when such plastics with added chemicals are in direct contact with food (plastic food contact materials - FCMs) (Van Hoeck et al., 2011).

The use of risk in plastic governance mobilizes market actors (e.g., producers, distributors, consumers) to rationally act on unacceptable, "bad" plastics (e.g., BPA, PET, single-use) whilst privileging "good" plastics (e.g., non-BPA, recycled, reusable plastics) (Hultman and Corvellec, 2012; European Commission, 2018a, 2018b; OECD, 2018; Watkins and Schweitzer, 2018; Nielsen et al., 2019; Cherrier and Türe, 2022, 2023). Because "risk is looked upon as a force which can generate desirable actions in the face of challenge" (Galvin, 2002, p. 120), the role of governance is to delineate risks and to ensure that information about risk is sufficiently disclosed so that market actors "can do the job of maintaining stability through their disciplinary mechanisms" (Brett, 2017, p. 1118). For instance, under the European Classification, producers and distributors need to ensure that consumers are informed of plastic risks as prescribed by the Labeling and Packaging (CLP) legislation, itself governed by the harmonized hazard classifications assigned by the European Chemical Agency (ECHA) and the Globally Harmonized System of Classification and Labeling of Chemicals (GHS) (Lithner et al., 2011; Groh et al., 2019). Auditing, consultancy agencies and control provide the auxiliary support that imposes a high-risk perception on "bad" plastics, and market actors are assumed to adjust and act rationally on it. Intermittent state interventions such as public policy levies and/or bans on single-use plastic bags, plates, straws and cotton buds (European Commission, 2018a, 2018b; OECD, 2018) are stitched eclectically to these market-based disciplinary mechanisms to steer transformative plastic actions (Peck et al., 2013). In 2016, for instance, the French government banned thin (below thickness of 50 microns), non-compostable plastic bags at supermarket checkouts, leaving producers free to market thicker plastic bags, which led to an increase in the consumption of thick plastic bags that consumers are encouraged to reuse but might not (Cherrier, 2006).

Since expert thinking, state of knowledge, and socio-environmental conditions are constantly evolving and changing, risk categorizations of plastics are revised, updated and constantly subject to adjustments. For instance, the risks of insufficient and inefficient recycling infrastructure for plastic waste became pronounced when China stopped plastic waste import in January 2018, leading to an overflow of plastics to Vietnam and Malaysia (Brooks et al., 2018; Liang et al., 2021). These "new" risks challenged the categorization of some plastics as a resource for industry and called for a readjustment of the plastic recycling loop. In addition, recent risk assessments completed by ECHA (2019) propose to add microplastics as high-risk materials. Recognizing the risks of ingestion, resistance to environmental degradation and fragmentation into smaller nanoplastics, the report suggests banning added microplastics in products such as cosmetics, detergents, agricultural products, and paints. The suggestions to tackle microplastics are however ambiguous and do not account for the unintentional release of microplastics from tires and brake wear, from synthetic textiles and from artificial turf (Kole et al., 2017; Kramm and Völker, 2018; Letcher, 2020). When scientific information and risk assessments are ever-changing, market actors might feel it necessary to ask which risks are to be prevented or minimized and which risks are tolerable.

Fragmented plastic governance and consumer responsibilization

Risk is "a flexible and diverse technology" that serves the broader political environment in which it is set (Scott, 2007; O'Malley, 2009, p. 64), which creates a highly fragmented and uneven plastic governance (Dauvergne, 2018, 2023; Nielsen et al., 2019). For instance, some toxic plastics can be banned in one region or country but dumped on the markets of another region or country, such that China's ban of plastic waste caused increased plastic flux in Vietnam, Malaysia and other Asian countries from 2016 to 2018 (Liang et al., 2021). In addition, some bans might cover one toxic or threatening plastic item deemed a threat to public health, but tens of hundreds of other plastic materials, equally or even more dangerous, and not covered in any bans, could be produced tomorrow. As a result, single-use plastics are condemned for causing risks (OECD, 2018), but reusable plastics are celebrated (Beavis, 2020), Lego Blocks are applauded for inspiring creative children (Gauntlett, 2014), industrials are embracing plastics in 3D printing (Berman, 2012; Park, 2014; Petersen et al., 2017), and plastic production and consumption continue to increase (Kowsari et al., 2023).

A fragmented plastic governance empowers the plastic industry to thwart critics and shift responsibility to consumers as a solution to mitigate the plastic catastrophe (Dauvergne, 2018; Cherrier and Türe, 2022). Corporations can exploit ambiguous rules and miss deadlines to continue producing and selling plastic items (Dauvergne, 2018). As Dauvergne (2018, p. 26) emphasizes "legal loopholes, poor monitoring and inconsistent implementation" with plastic legislation are common across countries. At the same time, corporations communicate their "good" actions as they try to innovate to increase plastic recycling rate, implement waste-collection systems and develop new packaging designs (Caruana and Crane, 2008; Cherrier and Türe, 2022). In these communications, corporations not only engage the consumer but also invoke the consumer as the figure for whom they act (Evans et al., 2017; Cherrier and Türe, 2022). In this manner, the expansion of warning plastic labels including "plastic containing BPA," "PET plastic," "made with Bisphenol A" and the development of new markers for ("reusable") plastic packaging (Van Asselt et al., 2022) or plastic bottles (Burrows et al., 2022) impose a responsibility for consumers to become informed, to carefully read labels, and to make choices in accordance with their willingness to bear risks for their health and for the environment (Mykitiuk, 2002; Giesler and Veresiu, 2014; Cherrier and Türe, 2022; Döbbe and Cederberg, 2023). In this manner, "when we see discarded plastic bags, bottles or food packages, we can relate our own use of the same objects to potential consequences" (Nielsen et al., 2019, p. 6).

The use of risk in plastic governance inevitably puts pressure on the consumers to make responsible plastic choices. Consumers might enact responsible plastic choices during sporadic consumption choices (e.g. PET plastic or not), in their everyday life (e.g., Plastic-free life: myplasticfreelife.com) or through challenges (e.g., Plastic Free Challenge: plasticfreechallenge.org; plastic free July), events (e.g., plastic free picnic) or collective engagement (e.g.,

fishermen collecting plastic) (Heidbreder et al., 2020). Consumer responsibilization around plastic risk is reinforce through societal celebration and rewards (Giddens, 1999). Plastic recycling is associated with feeling good about oneself (Vining et al., 1992; Tierney, 2015) and zero-plastic homes are celebrated as mindful, responsible and meaningful ways of living (Johnson, 2013). In accepting and enacting moralized and publicly celebrated plastic actions, responsibilized consumers are part of the solution to social and environmental plastic problems (Giesler and Veresiu, 2014; Borg et al., 2020; Cavaliere et al., 2020; Cherrier and Türe, 2022, 2023; Döbbe and Cederberg, 2023).

Consumer responsibilization around risky plastics

Plastic governance relies on three prominent risk disclosures (Cherrier and Türe, 2022; Shipton and Dauvergne, 2022).

First, plastics as *pollution* points to the spatiality of plastics as "matter out of place" (Douglas, 2003; Barnett et al., 2016) and reinforces socio-cultural categorizations like dirt and pollutions (Douglas, 2003) and dichotomies of order/disorder (Cherrier and Türe, 2022). Risks of pollution emerged in the 1960s when plastic fragments and pellets were detected in surface waters in the Sargasso Sea. Risk assessments of plastics infiltrating Ocean and landfills have since been used to guide plastic governance. For instance, around 60% of plastics are estimated to be discarded in landfills or in the natural environment (Geyer et al., 2017) and by 2050, it is predicted that plastics will outweigh the fish in the ocean (Ellen MacArthur Foundation, 2016). Plastic governance tends to associate these risk assessments to single use products and mobilizes consumers to think and make decisions in the present, in terms of questions about the future, including the harms that can be averted (Rose, 1998). For instance, micro-plastic beads are found in toothpaste and face and body scrubs, and consumers are informed that most of these beads get washed down the drain and into the environment (Paterson, 2019). Likewise, waste management institutions and not-for-profit organizations guide consumers to mitigate plastic pollution by using appropriate plastic disposal conduits and participate in land and marine plastic cleanups and recovery (Brown et al., 2016).

Second, plastics as *hazardous* points to the material composition of plastics and positions plastics as health threats to humans, animals and marine ecosystems. Plastics as hazardous can be traced back to the 1970s when industrial workers in Western Germany and the US exposed to PVC plastic materials were found to suffer from a rare cancer of the liver (Meikle, 1997; Westermann, 2013). For instance, the potential carcinogenicity of plastics sparked technical risk assessment and probabilistic estimates of the harmful effect of exposition to PVC plastics on human health. Plastic governance relies in these carcinogenicity risk assessments to warn about individual exposure to the substance so that plastic problems were understood as the result of poor consumption choices and usage. Today, plastics as hazardous materials span multiple levels of consumer actions and practices (e.g., cooking, working, consuming, grooming, cleaning). For instance, numerous scientific reports and statistics are highlighted by online cooking sites (e.g., mamandz.com; mamanyoupie.com) to guide consumers around the imperative to reject plastic to protect children, family members and loved ones. These sites refer to the technical aspects of phthalates and bisphenol particles and enumerate distinct plastic items including cooking bags, disposable plastic trays and plastic dishes that put "our children" at risk.

Third, plastics as *unmanageable waste* points to the temporality of plastic waste and highlights the myth of its disposability (Hammer et al., 2012; Cherrier and Türe, 2022). Under this rubric, plastics, once discarded, do not fade away but remain in the environment despite recycling infrastructures and systems of plastic revaluation. Plastic as unmanageable waste is a relatively recent risk linked to the failure of current recycling infrastructure to circulate high volume of plastic waste (Liang et al., 2021) and different risk assessment and campaigns have since been developed to raise awareness of the risk. One illustration is the "Plastic Overshoot Day," a measure calculated by Earth Action Network to mark the day when plastic production exceeds global capacity to manage plastic waste effectively (https://plasticovershoot.earth/). Plastics as unmanageable waste create a crisis of legitimacy for waste management and recycling processes and mobilize consumers to reduce plastic consumption and, when possible, adopt a zero-plastic lifestyle.

As plastic materials become entrenched in risks of pollution, toxicity and unmanageability, consumers are responsibilized to make rational plastic choices to protect their health, maintain spatial order, and respond to inadequate recycling infrastructures. Various authorities and expert systems legitimize the idea that plastic problems are issues of individual consumer conducts (Cherrier and Türe, 2022; Shipton and Dauvergne, 2022). For instance, policymakers sanction plastic littering as consumer misconduct, even though inappropriate waste pathways and other material circumstances (e.g., wind, rain, climate) play a central role in plastic pollution (Wagner and Broaddus, 2016). Likewise, corporations produce zero-plastic products and retailers offer bulk-buying as consumption choices for consumers to reject plastic packaging (Cherrier and Türe, 2022).

Yet, this paper argues that the use of risk in plastic governance can only spur limited change because (1) plastics transgress risk categorizations, (2) it requires agency to engage with risks and (3) the risk frame nurtures dynamics of blame. The next section explores such limits.

The limits to consumer responsibilization around risky plastics

Plastics transgress risk categorizations

Barthes's (1957) account of "le plastique" warned of the ability of plastic to take a life of its own. Plastic, Barthes explains, can take on, adopt, and transform into an infinite variety of forms and functions. Because plastics can substitute for almost anything, it is a "passengerial marketplace icon – an artifact that, while marketable and complexly meaningful in its own right, is characterized by its furtive omnipresence in consumer culture" – with agency "to travel through the environment".

As plastics move through the environment, it transgresses risk categorizations. When single-use plastic straws were banned in France, plastic moved to markets of reusable plastic straws (Cherrier and Türe, 2022). These reusable plastic straws are however inconvenient to wash, and consumers might end up using them once and throw them away. Likewise, bans on single-use plastic bags led to the development of biodegradable plastic bags, which poses threat for seagrass meadows (Balestri et al., 2017). That is, when plastic governance identifies risks and prohibits targeted single-use plastics, and as industrials are mobilized to innovate and create substitutes to these targeted plastics, there is a continuous recreation or replenishment of plastic potentials.

A key aspect of this constant unleashing is that plastic transgresses risk categorization. The capacity for plastic to move along is hard to undo because of its embeddedness to the social organization of health, order and convenience, each of which has been essential for the historical propagation of plastics. In health care, most of the devices including "syringes, tubes, oropharyngeal cannulas, suction probes, catheters, packaging of saline solutions and medicines" as well as "respirators, thermometers" are made totally or partially of plastics (De Sousa, 2020). Increasingly affordable 3-dimensional printing technologies provide an additional pathway for plastics to reinforce its presence in the healthcare industry (Javaid et al., 2022). Studies also report that plastic packaging continue to be perceived as more efficient than cans made from metal to protect the quality of food and maintain its freshness over time (Peters-Texeira and Badrie, 2005). Plastics have also become key to the social organization of spatial ordering and cleanliness. Plastics are "fundamental to the functioning of modern supermarkets" (Nielsen et al., 2019, p. 8). Essential to the logistic and transportation of goods, plastics also live in household objects used for ordering such as Tupperware, laundry baskets, picnic coolers, luggage, food wrapping, and so on (Meikle, 1997; Shittu, 2021). Colored plastics, "characterized by high impact resistance, resistance to abrasion, and the action of hot and detergent materials" and "inexpensive, lightweight and easy to carry," are some of the most popular materials used to create boxes, wardrobes and other furniture that help organize children's bedrooms (Antonenko et al., 2021). Plastic bins are also essential for the placement and movement of waste in the household (Cherrier and Türe, 2022). Plastics have also contributed to the expectations and standardizing of convenience. One clear illustration is the propagation of single-use plastics designed to provide the conditions for modern convenient living.

Rooted in the social organization of health, order and convenience, plastic transgresses risk categorizations and consumers need to negotiate between plastics as useful and healthy material and plastics as toxic and environmentally destructive. Yet, the negotiation between plastics as beneficial and plastics as risks is "challenging and conflictual" (Sattlegger, 2021, p. 821). Disposable face masks are a clear illustration of plastics transgressing risk categorizations. During the COVID-19 pandemic, governance regimes called upon consumers to adopt risk mitigation behavior by purchasing and using personal, single-use protective plastic items, notably face masks, hand sanitizers, disposable gloves and visors (Areni and Cherrier, 2022). Whilst these consumption practices were legitimized by governance regimes and health experts (e.g., the World Health Organization), face masks were concurrently blamed for causing environmental risks and pollution (Aragaw, 2020). Plastics might thus present benefits in some practices or context but risks in other practices or context. Consumers might oppose plastic packaging when seeing plastic items floating in rivers and oceans but be reluctant to reject plastic packaging when considering the risks of food contamination and toxicity. And when public water is contaminated, bottled water in plastic bottles swirl to human health (Holt, 2012). In this manner, consumers who lack the capacity or competence to assess the tradeoffs between the benefits versus the risks of plastics might struggle to enact responsible plastic actions.

From the above reflection, consumer responsibilization around plastics through risks of pollution, toxicity and unmanageability might fuel societal controversies, ambiguity and even paralysis. To enact responsible plastic actions, consumers need guidance from policymakers and corporations around how to reconfigure new material relations embedded in the social organization of health, order and convenience. As Sattlegger (2021, p. 841) explains, "withdrawing is a double-sided process of detaching and attaching, removing constraints and building new ones." Plastics will continue to plunge deeper into all aspects of our everyday life as long as its associations with the social organization of health, order and convenience endures.

Issues of consumer agency

Instead of questioning plastic as a macroscale problem, the focus on risk individualizes the problem to one of personal responsibility and freedom of choice. Risk is inherent to freedom of choice – by freely deciding to choose one action over another, one takes a risk. Under neoliberal governance, consumers are responsibilized to self-evaluate the risk outcomes of their actions on their microenvironment and society (Giesler and Veresiu, 2014; Cherrier and Türe, 2022). The individualization and privatization of risk mobilizes information-seeking consumers who develop risk-awareness and become skilled at weighing up risk espoused by expert systems and dissident organizations, so that they can make responsible choice so as to reduce, if not avoid, risks for negative outcomes.

As a result, the use of risks in plastic governance assumes individual agency to engage with risks and to rationally decide one action over another (Cherrier and Türe, 2022). Human agency refers to individuals' ability to intentionally pursue interest and to have some effect on the social world (Battilana, 2006). In consumer research, human agency is frequently described in terms of choice, autonomy, responsibility or self-determination (Bhattacharjee et al., 2014) – as defined by Arnould (2007, p. 97), agency is "the physical or mental ability, skill or capability that enables actors to do something. The actor is assumed to proceed under his or her own volition, or at least without the permission of another." Accordingly, responsible plastic actions stem from consumers endowed with agency to act on risks of pollution, toxicity and unmanageability.

Yet, consumer plastic decisions are embedded in socio-cultural and economic conditions and constrained by issues of structural inequalities (Connolly and Prothero, 2008). Bans on disposable plastic straws are a salient example of a system regulating plastics based on risks without considering individual circumstances (Jenks and Obringer, 2020; Hemsley et al., 2023). Although these bans aim at mitigating ocean pollution and are widely legitimized using images and videos of turtles dead from ingesting plastic straws, they further marginalize "a critical mass of people who already live more precarious lives than their peers" (Jenks and Obringer, 2020, p. 152). Plastic straws are not simply a convenience for disabled people but provide freedom and ability to nourish themselves independently. The bans on plastic straws hinder people with disability to consume in restaurants and bars and their alternatives, such as straws made with bamboo or metal, can increase the risks of choking (Jenks and Obringer, 2020). Framing plastic packaging as risky materials and mobilizing consumers to wean themselves off single-use plastic via bans and regulations can thus intensify exclusion and social inequalities and amplifies prejudices.

Another issue is that engaging with risks is a privilege many consumers cannot afford (Cherrier and Türe, 2022). The enactment of responsible decision around plastics demands time (e.g., going to a plastic-free shop), energy (e.g., evaluating different plastic-free products), financial means (e.g., plastic-free products are expensive) and capacities to create and innovate (e.g., learn about zero-plastic cooking). A clear illustration is the need for consumers to

become risk experts in assessing PET bottled water versus bioplastic versus refillable aluminum bottles (Tamburini et al., 2021). It is therefore dysfunctional to promote plastic risks without providing the material, social and cultural tools to empower and guide the reshaping of consumers' relation with plastics. Consumers might also experience risk engagement fatigue, saturation or paralysis because they do not have the capacity to assess overlapping, often ambiguous risks within their everyday life and may struggle to see the outcome of their risk mitigation choices (Eckhardt et al., 2010).

These issues around consumer agency emphasize that the use of risk in plastic governance needs to be reconsidered and tempered in light of networks of heterogenous consumers and dynamics of authority, control and socio-technical assemblages affecting any given plastic consumption (Sattlegger, 2021). Plastic governance need to evaluate whether risk-based regulations and bans are accurate and fair to all citizens. This would require building up a detailed account of each plastic object, their unique characteristics and use and whether substitute items will be inclusive or exclusive.

Risk transfer and blame

Shifting blame is another key issue of consumer responsibilization around plastic risks. Plastics have subverted all aspects of modern life and risks of pollution, toxicity and unmanageability have infiltrated consumers' everyday talk. Such talk suggests that there may be "good" and "bad" behavior and people can be judged along a good–bad continuum and plastic choices reflect the degree to which they know and act upon the knowledge that we need to "make a real dent in plastic consumption at the global level" (Graham, 2023). Individual efforts for "doing the right thing" is inevitably linked to a fear of "something going wrong," which encourage market actors to observe and blame those who do not enact good plastic actions. This is because risk appeals to "choice" and those "who have failed in the face of 'known' risk by making unwise or even culpable choices" are blamed for negative consequences and thus are faced with the added burden of moral reproach (Galvin, 2002, p. 113).

The use of risk in plastic governance cedes power to dominant market actors that possess the capacity to blame others and profitably shift negative consequences to counterparties (Cherrier and Türe, 2022). Blame in the context of plastic is evidenced in corporate communication that scapegoat consumers for plastic pollution (Cherrier and Türe, 2022) and use guilt appeal for achieving desirable outcome (Muralidharan and Sheehan, 2018). Through blame dynamics, corporations contain responsibility for plastic risk mitigation within households, which in turn reinforces the rollback of government authorities as guarantors of the public good (Cherrier and Türe, 2022). Blame is also in the discourses of anti-plastic advocates and activists who assign an undifferentiated moral obligation to reject plastic to all individuals (Malier, 2021). Through blame, social groups who might not be able to modify their consumption habits are accused of polluting the oceans and exposing their household members to toxic plastics. For instance, plastics are harnessed the packaging industry and created the convenience of a throwaway living for women entering the workforce and encouraged to use single-use coffee cups, plates, bags or disposable cleaning products (Thompson, 1996). The convenience of single-use plastic items often comprises the material reality of being a good (juggling) housewife (Thompson, 1996) and its categorization as risk objects automatically responsibilizes this social group, independent of underlying structural inequalities linked to gender, race and social status (Hawkins, 2020; Cherrier and Türe, 2022). By putting responsibility on consumers through risk, plastic governance obscures inequalities and differential access to the marketplace (Gibson, 2023).

Conclusion

Plastics have gained immense practical importance, and there are inherent and systematic limitations on how (and whether) we can (should) end plastics. To mitigate the plastic catastrophe, plastic governance commonly relies on risk to trigger transformative market actions. This paper argues that the use of risk to govern plastics tends to shift plastic problems to consumer responsibility, which might slow down, if not obstruct, possibilities to mitigate the plastic catastrophe.

Exploring the diversity of plastics and their agency to act in unexpected ways, reveals that the risks of plastics, because of their material characteristics, molecular composition, size and density, are unquantifiable, unmeasurable and univocally uncertain. The variety and complexity of plastics cannot be easily managed because once produced, plastics are embedded in material interactions and planetary processes that are beyond our human control. With plastics, the presumption that uncertainty can be translated into risk becomes untenable. Because plastic risks are unquantifiable, unmeasurable, and uncertain, suggests a "paradigm shift."

To tackle the plastic problem, we need to counter the idea that plastics are manageable, flexible and adaptable materials. The word "plastic" has come to describe materials whose form can be changed and molded, and which are derived from fossil fuels. Over the last 60 years, these plastic materials have smoothly, and somewhat imperceivably, been adopted by consumers for their light weight and affordability to make life more comfortable, cleaner and convenient. Today, the versatility, flexibility and adaptability of these "fantastic" (Mossman, 2008), at times "provocative" (Lie et al., 2020), plastic materials must be challenged.

The question being raised here is one of transformation or transition in the way we understand plastics. It is about a fundamental change of mind. Malabou (2000, p. 204) explains that "things that are plastic preserve their shape, as does the marble in a statue: once given a configuration, it is unable to recover its initial form." Plastics have flexible qualities, but "once the molecules synthesize into the carbon–carbon bonds, they can never go back to their original form" (Halland, 2019, p. 40). Plastic and flexibility, versatility and adaptability are not the same thing. Plastics, once produced, have consequences that do not allow turning back.

Reconceptualizing plastics as inflexible substances allows possibilities to change the ways politics, businesses and managerial models approach and use plastics. Inflexible plastics involve a deepened understanding of the liability and costs of circulating and removing plastics. It opens the possibility for very large improvement in public policy. Inflexible plastics constrain rather than unable the creation and recreation of neoliberal system that demand unending flexibility and adaptability. On this view, ending plastics entails establishing a new understanding of plastics, a change of world view, and a new learning of the inflexibility of plastics.

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