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Preventing the Unpreparable. Catastrophe Thresholds from Covid to Climate

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Abstract

This article analyses thresholds of catastrophe guiding measures to fight the Covid-19 pandemic and climate change. It argues that in both cases thresholds express the proposed interaction between the security technologies of prevention and preparedness. Preventive measures are supposed to slow down the infection dynamic and the rise of global temperatures, so that strategies of preparedness are able to cope with the remaining adversities: effectively treating patients and successfully adapting to climate change. The transgression of the catastrophe threshold thus marks the point when crisis dynamics become uncontrollable. The goal is to prevent the unpreparable and to prepare for the unavoidable. A moral economy of life underpins this rationality by providing a backstop against an excess of biopolitical elasticity in setting the threshold. The paper contributes to debates in security studies and the sociology of risk by showing how prevention and preparedness, which are often assumed to be opposing rationalities, come to operate in the same security assemblages. In addition, the paper criticizes the ways in which the focus on the catastrophe threshold silences death and suffering below the threshold and fails to provide guidance for situations when the threshold is already breeched. Considering the advanced state and the peculiar temporality of the climate crisis, the paper analyzes a shift from "pre" (*pre*paredeness, *pre*vention) to "re" (carbon *re*moval, ecological *re*mediation and *re*paration) in the contemporary politics of environmental security.

Keywords: Social theory; sociology of risk; critical security studies; resilience; environmental security.

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In recent years, debates on security in the social sciences have focused on various forms to act on future threats in the present (Amoore & de Goede, 2008; Aradau & Munster, 2011; Opitz & Tellmann, 2015). Preventive techniques like precaution and preemption seek to avoid these risks altogether (Ewald, 2002; Massumi, 2007). Other strategies seek to prepare for unavoidable high-impact events by making socio-technical infrastructures more resilient and improve the readiness of emergency responses (Lakoff, 2007; Collier, 2008; Folkers, 2019; Keck, 2017). Scholars have pointed out the different rationalities and practical options that inform techniques of prevention on the one hand and preparedness on the other (Bröckling, 2012). They have tracked back the genealogies of these techniques (Collier & Lakoff, 2015; Leanza, 2017), have illuminated their main fields of application and their concrete procedures (for an overview see Anderson, 2010). However, there is considerably less scholarly work on the way these two technologies of security work together in more or less coordinated ways (see however Fearnley, 2008).

This article addresses this issue by drawing attention to two cases in which prevention and preparedness techniques are inherently entangled: the governance of the Covid-19 pandemic and the politics of climate change. To do so, the paper focuses on the role of thresholds of catastrophe to illuminate the systematic way prevention and preparedness interact in these cases. The notion of the catastrophe threshold is briefly mentioned in Niklas Luhmann's (2003, pp. 11, 159) sociology of risk. However, Luhmann does not elaborate the concept further. Accordingly, it has gained little resonance in sociological debates on risk. In this article, I come back to this notion to show how it mediates between prevention and preparedness techniques and is in turn defined through the interaction of these rationalities. To avoid a harmful event or process from becoming catastrophic, preventive measures should mitigate the harm below a certain point — the catastrophe threshold — for preparedness and adaptive strategies to successfully cope with the remaining adversities.

Social scientists studying catastrophe have always maintained that no (natural) event is a catastrophe in and of itself (Felgentreff & Dombrowsky, 2008). The cases analyzed in this paper seem to be particularly good examples of the social co-production of catastrophes. Neither the climate crisis nor the Covid pandemic are singular events that suddenly manifest as a disaster. Rather they are more (climate) or less (Covid) "slow emergencies" (Anderson et al., 2020) that may be relatively harmless until they suddenly escalate if no protective measures are taken. Once they have gained enough momentum, it becomes very hard, if not impossible, to effectively curtail their effects. Accordingly, the question of the catastrophe threshold frequently becomes a public "matter of concern" (Latour, 2004) in climate and pandemic politics. During the Covid crisis we witnessed an increase in the number of public debates negotiating the degree of catastrophe societies are able and willing to endure as well as about the thresholds where the effects of the pandemic become intolerable. Similarly, since the beginning of global climate politics, experts and politicians have explicitly debated how much global warming is tolerable and how much climate change mitigation is necessary.

As I will show, the setting of catastrophe thresholds involves both moral and managerial reasoning. On the one hand, the threshold provides a sense of "biopolitical elasticity"[1] in the face of adversities. On the other hand, the threshold works as a normative backstop against too much elasticity. As such it is informed by a moral economy of life for which it is imperative to care for individual lives in peril and to protect the existence of the human species as a whole. Catastrophe thresholds thus express both ethical limits and the limits of control. They define

1. I owe this formulation to an insightful remark by one of the anonymous reviewers for this paper.

the manageable as well as the morally bearable.

This paper will look at the negotiations of thresholds from a second order perspective. It is thus not my intention to evaluate the catastrophe thresholds but to analyze their social constitution and effects. However, by making explicit the rationality behind operative catastrophe thresholds, it becomes possible to criticize contemporary ways of apprehending and managing catastrophic situations: to illuminate their limits, gaps and blind spots. In this way, the paper contributes to recent calls to critically engage with the social uses and abuses of "disaster" (Hagen & Elliott, 2021). I will show how the current definitions of catastrophe provide a selective social framing that abstracts from situations below and above the threshold. It silences death and suffering below the threshold ranging from the ordinary Covid victim to the ecological stress that acceptable global heating induces. In addition, it fails to provide guidance in situations when the threshold is already breeched. According to some climate scientists, the amount of carbon stored in the atmosphere is already enough to exceed the threshold of the climate catastrophe. Accordingly, the combination of prevention (mitigation) and preparedness (adaptation) needs to be supplemented by techniques like carbon removal, ecological remediation and reparation. This implies a shift from the pre- to the re- in the contemporary politics of environmental security.

I will now first systematically introduce and distinguish between prevention and preparedness technologies by showing their historical emergence and the security dispositives they are embedded in (1). I will then show how prevention and preparedness interact in the governance of the Covid pandemic by drawing attention to the catastrophe threshold indicated by the now famous "flattening the curve" diagram (2). In the last section, I will argue that the 1.5°C or resp. 2°C climate goal constitute a catastrophe threshold below which societies can prepare for the new normal of a hotter and more turbulent climate. In addition, I will discuss an alternative climate catastrophe threshold that suggests that we might have already crossed the threshold.

1 Prevention and Preparedness as Technologies of Security

While some forms of preventive and preparative practices may be found throughout history, the emergence of preparedness and prevention as reflected security technologies is a rather recent phenomenon. Michel Serres (1995, p. 45) once remarked that the contemporaneity of discrete elements is an effect of the assemblage they belong to. In this way, preparedness and prevention are contemporary security technologies because they are part of a larger security dispositive: population biopolitics on the one hand and the biopolitics of "vital systems" (Collier & Lakoff, 2015) resp. the security dispositive of resilience (Folkers, 2018) on the other hand.

Population biopolitics slowly emerged out of the modern arts of government since the 17th century (Foucault, 2004). With the advent of the biological understanding of life (Foucault, 1966) and the figure of the population as the subject/object of governmentality (2004, pp. 77–79), biopolitics came into being. Through a series of crisis events life became a political problem. The cholera epidemic in the 19th century, for example, revealed the systematic patterns of how an infectious disease affects the population (Rabinow, 1995). Such insights depended on population statistics and the "avalanche of printed numbers" (Hacking, 1990, p. vii) — birth and death statistics, numbers on employment and diseases — during the 19th century. Through the application of the calculus of probability, these numbers not only provided information about past events and the current state of the population, but also about its future. Actuaries started to use statistics in estimating the frequency and probability of risks and ways

to insure these risks (Ewald, 2020).[2]

Statistical knowledge constitutes the cognitive framework for biopolitical interventions aiming to ameliorate social hardship and improve public health. Many of these interventions were explicitly designed to work preventively. As Mathias Leanza (2017, pp. 95–214) has pointed out, the three main areas of biopolitical prevention in the 19th century were, *firstly*, modern regimes of welfare enacted by the providential state (Ewald, 2020) through the technology of social insurance. *Secondly*, various forms of eugenics tried to prevent what they believed to be degenerative tendencies within the population (Weingart et al., 1988). And, *thirdly*, public health measures ranging from vaccination campaigns to hygiene measures like the establishment and improvement of sanitary infrastructures started to systematically fight infectious diseases (Latour, 1984; Gandy, 2004; Sarasin et al., 2007).

The biopolitics of vital systems emerged at the beginning of the 20th century. The First and Second World Wars were defining crisis events that revealed emerging risks in complex technological societies. Military and economic experts started to recognize that both warfare and civilian life depend on a series of global resource and commodity flows (Folkers, 2019) as well as on what Stephen Collier and Andrew Lakoff (2015) call "vital systems" like traffic, water and electricity supply, government, and industrial production. The breakdown of these systems could severely harm the population whose life increasingly depended on infrastructural services for their survival (Folkers, 2017b). However, the systems are not only critical for the life of the population but also for the "life" of other systems. It turned out that these systems are so interdependent that weak points, disruptions, or bottlenecks in one place could quickly spread among the network of systems to create major damages.

With vital systems as new objects of security concern, new forms of knowledge emerged. Statistical knowledge is still important to assess the criticality of infrastructure, bottlenecks in logistical networks and the supply of vital materials. However, this knowledge is increasingly embedded in new forms of systems thinking that emerged since the end of the Second World War (Collier & Lakoff, 2015). The analysis of systemic vulnerabilities, is supposed to identify the impact of certain catastrophic events (from a nuclear missile strike to a flood) on interconnected systems by either geographically mapping a certain area (Collier & Lakoff, 2008) or by assessing how a disruption affects the temporal operations of vital business or government processes (Folkers, 2017a). The susceptibility of a system, and not just the probability of risks that might affect it, became the focus.

By abstracting from the source and focusing on the impact of a "generic" threat on the system, it became possible to plan for a variety of different disaster events like natural catastrophes, terrorist attacks or infrastructural breakdown with the same security techniques. Accordingly, the interventions of vital systems security focus less on preventing relatively rare but nevertheless severe and (seemingly) unavoidable events. Instead, the objective is to properly prepare for these events. This involves, on the one hand, structural provisions to increase the resilience of systems: reducing interdependencies and avoiding bottlenecks — a strategy that Collier and Lakoff (2008) call "distributed preparedness" — as well as establishing redundancies and stockpiles of critical materials (Folkers, 2019; Keck, 2017). On the other hand, preparedness encompasses organizational measures, like devising emergency response protocols and conducting regular emergency exercises (Ellebrecht et al., 2013).

2. Vital population statistics are of course still important for contemporary security dispositives as evidenced by the role of statistical numbers during the current Covid pandemic, though statistical knowledge is now increasingly supplemented by computer generated simulations (Opitz, 2017).

There is no historical succession between the two security dispositives. Vital systems security has not simply superseded the biopolitics of the population. Rather, both can often simply operate in parallel since they focus on different kinds of events (statistically normal, regular vs. rare and catastrophic events) and have different objects of protection (population vs. vital systems). However, there are also cases where both preventive as well as preparedness technologies work together to govern complex emergencies. This is especially obvious in public health emergencies like a pandemic because it affects the population but — as biosecurity experts now frequently argue — can only be managed effectively by preparing the public health infrastructure for these events (Lakoff, 2008). In the next section I will turn to the Covid-19 pandemic to show how prevention and preparedness come to interact and how this produces a distinct threshold of catastrophe.

2 Flattening the Curve, Prepping the System

With the beginning of the pandemic, the "flattening the curve" diagram became an almost ubiquitous tool to make sense of the challenges ahead.[3] The diagram shows two statistical curves, one bell shaped curve that stretches above, and another one that remains below a straight, sometimes dashed line. I will treat this diagram as a "diagram" in a Foucauldian sense: an "ideal form" (Foucault, 1995, p. 205) for the functioning of governmental technologies that allows a description of the complex and often contradictory efforts to manage the pandemic in a coherent way. Although the "flattening the curve" diagram is just an abstract sketch, and of course not the only rationale during the pandemic, it still displays a crucial tendency that informed the governing of the pandemic: Namely that the countries in the North-Atlantic world have only tried to flatten the pandemic curve below a certain threshold and never pursued a "zero-covid" strategy.[4]

2.1 How Prevention and Preparedness Interact

What makes the diagram so particularly revealing for the purpose of this paper is that it allows the interaction between prevention and preparedness, and between population biopolitics and the biopolitics of vital systems to be illuminated. This interaction is partly hidden by the fact that the slogan "flattening the curve" focuses attention on the infection rates within the population and thus on the many preventive measures to mitigate the spread of the disease we all know all too well: social distancing and quarantine for the infected, masks and hygiene, lockdowns of public life and remote work etc. However, the straight line in the diagram representing the health care capacity, and thus the state of preparedness of vital systems, is no less relevant for understanding the "flattening the curve" logic. The health care capacity functions as a yard stick or a limbo bar for the belly of the population. It thus allows for an indication of a threshold of catastrophe. The threshold is reached when the infection dynamic exceeds the health care

3. The wording "flattening the curve" was introduced in an article of *The Economist* (2020) that picked up and slightly modified a graphic published in a report by the US Centers for Disease Control and Prevention (CDC, 2007, p. 18).

4. Since the article focuses on the conceptual implication of the "flattening the curve" rationality, and considering that all readers of the paper will have been exposed to endless reports on the pandemic in recent years, I will restrict reference to empirical evidence to the footnotes. I will focus on the developments in Germany. However, I assume that, because of the prominence of the "flattening the curve" rationality, similar patterns can be found in other countries, too.

capacities. This in fact means that the protection of the health care system becomes a priority in the government of the pandemic.[5] The diagram thus represents both population biopolitics and the biopolitics of vital systems in a single frame.

But what are the interdependencies between preventive techniques of population biopolitics and the relative (un)preparedness of vital systems the diagram indicates? What happens when the curve exceeds the line? And why is this catastrophic? A first set of interactions concerns the ability of public health authorities to surveil, track and control the infections dynamic within the population. For example, the test capacities often reached their limit with rising infections making it difficult to identify and to isolate infected people as well as to get a clear picture of the general situation (Hackenbach, 2020; Ärzteblatt, 2020). Similarly, scientists, public health officials and politicians argued that infection rates need to be kept below the point where the public health authorities can trace the contacts of infected persons to disrupt the chains of infection and thus prevent the further spread of the pandemic. Without the surveillance infrastructure of public health authorities there is a risk of losing control of the pandemic which could result — as simulations suggest (Scarselli et al., 2021) — in a steep growth in infections.[6] The capacities of vital systems become a parameter in the modelling of infection dynamics within the population and for implementing restrictions to curb infections. These two examples show that population control directly depends on vital systems. Without the knowledge infrastructures of public health there could not even be population numbers: there is no curve without the line.

The central reason why the intersection between the line and the curve marks the threshold of catastrophe is because it signals the point when the capacity to effectively treat patients that severely suffer from Covid-19 runs critically short.[7] Patients' lives directly depend on health infrastructure, on the availability of intensive care units, ventilators, and of course trained personal. The health system has to cope with a problem quite common to public infrastructures. It has to deal with an unexpectedly high "load". However, in contrast to, say, a traffic system, congestion in the health system does not just mean that a few people get to work late, but that they, in the worst case, die because they have to wait for a ventilator to become available again. This means that beyond the catastrophe threshold health care systems become overloaded, which will eventually also lead to higher mortality rates at the level of the population.

The many bottlenecks in the public health system that contributed to extreme stress on health care system capacity thus revealed the relative levels of unpreparedness for the pandemic in many countries (for the German case see Mezes, & Opitz, 2020). Hospitals did not have

5. At the beginning of the pandemic, the German Chancellor Angela Merkel stressed this when she said: "Our approach must be based on the consideration that we do not overload our health system [...]. The advice and the recommendations on how to proceed are always based on the question of how we ensure that our health system is not overloaded during the time we have to deal with the virus." (2020b, author's translation)

6. In October 2020, with infection rates surging in Germany, Angela Merkel referred to the limits of contract tracing as a central rationale for implementing lockdown measures. "The most important tool — I talked about this many times — to contain a pandemic is to track the contacts of every infected person. But precisely this most important instrument is no longer available in many places because the health authorities have reached the limit of what they can track. This means [...] that the chains of infection can no longer be broken and that we have lost the control over the spread of the virus. This needs to change. [...] And this means that the curve needs to be flattened to restore traceability [...]. As you know, the threshold we have set for this is at around 50 new infections per 100,000 in seven days" (2020a, author's translation). It, however, took several months until Germany reached the proposed traceability threshold again.

7. Merkel stressed that this is precisely the situation to be avoided during the pandemic: "The standard remains that the infection dynamics must remain so moderate that our healthcare system can provide the best possible treatment for every infected person" (2020c, author's translation).

enough equipment to treat Covid patients effectively. More importantly, professional health care workers, especially nurses trained in intensive care, proved to be the central bottleneck within the health care system. In many countries it turned out that the health care system was not robust enough to withstand the shock of the Covid pandemic because decades of austerity politics and commercial accounting procedures had increased the "efficiency" of the health care sector at the expense of its resilience. The public health crisis thus aggravated a latent care crisis. Big governmental biosecurity preparedness strategies could not compensate for the structural brittleness of the health care sector because, while they sometimes did prepare for a pandemic they were not prepared for this particular pandemic as Andrew Lakoff (2020) has shown with regard to the US Strategic National Stockpile.

2.2 The Moral Constitution of the Threshold

A threshold of catastrophe does, however, involve more than a quantitative measure resulting from the interaction of two security rationalities. It also has a moral dimension. Luhmann (2003, pp. 11, 159) even suggests that in situations near the catastrophe threshold, quantitative risk assessments lose their persuasiveness. But what is the moral problem here? People dying is always a social tragedy. However, after more than 200 years of population statistics societies have learned to regard mortality as a normal and normalized phenomenon of a population. Emile Durkheim (2014, pp. 85–107) famously argued that within a certain range high statistical rates of adversity have an immunizing effect on society because they help to cool down moral sentiments and prevent overly strict normative regimes that are detrimental to the "normalcy" of society or, respectively, the "health" of the social organism. During the pandemic a similar pattern became visible. Covid-related deaths came to be seen as a regretful but utterly expectable outcome of rising infections that in themselves hardly caused much moral outrage on a politically significant level.[8] Soon after the first lockdown, calls for a "return to normalcy" became louder and more frequent, even though such a return to normalcy implied a normalization of high infection and death rates rather than a simple return to the *status quo ante*. Experts from all walks of social life started to problematize the "risks" of pandemic risk prevention: risks of economic losses, risks for civil liberties, risking the education of the youth etc.[9] In this view, the comprehensive "immunization" of the *population* against the pandemic would have auto-immune effects on *society*. However, the catastrophe threshold also works as a normative backstop against the functionalism of social systems and their spokespersons. Informed by a certain moral economy of life, it defines limits to the biopolitical elasticity of pandemic management.

A hitherto little-known medical procedure became the scenery for this moral economy to crystalize. In some of the most tragic moments during the pandemic, health care system overload made explicit medical decisions necessary about which patients to treat at all. The name for the medical technique supporting such decisions is triage. Triage is a cognitive strategy to deal with a moral dilemma: too many patients for too few health care workers. Triage emerged in the context of military medicine in the 19th century and is a common practice in catastrophe medicine (Ellebrecht, 2009; Redfield, 2008). Here, triage mostly seeks to identify the patients that — for example after a major traffic incident — need priority treatment to counteract the

8. In the runup to the 2021 German federal election, no relevant political party tried to elevate the Covid-related deaths to a central election campaign issue.

9. Mezes & Opitz (2020) discuss joint scenarios by public health experts and economists that sought to identify strategies to limit the pandemic as well as the economic repercussion of lockdowns.

intuitive tendency of first responders to focus their attention on people who just happen to scream the loudest. In the course of the pandemic, triage should thus help to identify patients with the highest probability to benefit from treatment and to distinguish them from those that were likely to die anyway. However, most public debates did not perceive and discuss triage as a necessary response to a moral dilemma but as a moral catastrophe in and of itself. This problematizations manifest a latent moral economy of life where the problem is not that people die *per se*, but that death could be directly attributed to conscious decisions. This attribution establishes a nexus between life and decision that forecloses the possibility to normalize death as a merely regrettable casualty of the pandemic. This explains why the overload of health care capacity also indicates a moral catastrophe threshold. It marks the point where normal death increasingly becomes decisioned dying.[10]

The widespread moral sentiment according to which it can never be justified to choose who will have to die stems from a normative order that Didier Fassin (2012, p. 249) describes as "biolegitimacy". According to this order, human life is the highest moral good. As such, life is incommensurable. Not even other lives can outweigh a human life. Biolegitimacy thus focuses on individual life and not so much on the general well-being of the population like traditional population biopolitics at least until the first half of the 20th century. Hannah Arendt (1958) associates this idea of life as the highest moral good with Christianity. However, for centuries, and in fact until this day, people in Christian dominated countries saw no moral problem in sacrificing life for the greater good. Only after the Second World War did the idea of life as the highest value gain traction and so became associated with concrete humanitarian practices (Fassin, 2012) even though it is of course, like many other values in contemporary societies, frequently violated.

Fassin and others have illuminated the importance of this moral order for humanitarian practices and international organizations like Doctors Without Borders (Redfield, 2013). However, they have also emphasized the "normative paradoxes" (Honneth & Sutterlüty, 2011) that go along with it. Fassin identifies an ideological function of "humanitarian reason" when he argues that the idea that all human lives are of highest moral value suggests a state of equality that conceals the actual inequalities in highly stratified capitalist societies:

> Humanitarian reason, by instituting the equivalence of lives [...] allows us to continue believing — contrary to the daily evidence of the realities that we encounter — in this concept of humanity which presupposes that all human beings are of equal value [...]. Thus, humanitarian government has a salutary power for us because by saving lives, it saves something of our idea of ourselves (2012, p. 252)

Arguably, the popularity of government restrictions, especially in the beginning of the pandemic,[11] stems from their live-saving, humanitarian appeal that provided a sense of social belonging and equality absent in normal times. Of course, it quickly turned out that the poor and people of color were disproportionally affected by the pandemic.[12] The specific catastrophe threshold suggested by the "flattening the curve" rationality — the intersection of prevention, preparedness and biolegitimacy — does not take into account the way social inequality

10. With the availability of vaccines for the populations in rich countries, the relation between life and death becomes more individualized, since — apart from a few regrettable cases — dying from Covid comes to be regarded as an individual decision.

11. For the popularity of the measures in Germany see Juhl et al., 2020.

12. For the relation between social inequality and vulnerability to the pandemic in Germany see Butterwegge, 2021.

translates into different chances of survival. In addition, it normalizes deaths and severe illness caused by rising infections below the threshold. From this perspective it seems that the management of the pandemic was less about avoiding preventable deaths than it was about avoiding unpreparedness for illnesses, not just about protecting the population against the disease but about protecting the health care system against too many patients. Even though they were always at the center of attention, the preventive measures against the spread of the disease actually functioned as a supplement for vital systems security. The role of prevention became to make events preparable.

3 Temperature Thresholds, Tipping Points, and the Capacity of the Earth System

In the international climate regime prevention and preparedness go under the rubrics of climate change mitigation and adaption. Mitigation is about curbing greenhouse gas (GHG) emissions to stop global heating. Adaptation should prepare society for the threats that accompany global heating like rising temperatures and sea-levels as well as to extreme weather events, wildfires and draughts etc. As in the Covid-pandemic public attention still focuses on prevention, or, resp. on climate mitigation. Prevention has a slightly different connotation in climate politics because it does not respond to risks inherent in the dynamics of human populations but to environmental risks. Climate change is not a normal risk but an exceptional process in the conjoint history of human populations and the planet. Thus, preventive climate action follows a different historical variant of prevention: the precautionary principle.

The precautionary principle first emerged in German environmental law (Boehmer-Christiansen, 1994), namely in the *Bundesimmissionsschutzgesetz* or "clean air act" from 1974. The German name for the principle, "Vorsorgeprinzip", resonates with other forms of "Vorsorge" (provision or precaution) in German welfare politics (Folkers, 2020). However, its target was no longer "the population", "the economy" or socio-technical infrastructures, but "the environment" (Bond, 2018; Warde et al., 2018) as it emerged as an object of government in the 1970s. Precaution demands the avoidance of irreversible damages to the environment even when scientific certainty concerning potential threats is lacking. From German environmental law it quickly spread to global environmental politics (Folkers, 2018, pp. 263–272). In the 1980s it entered into international treaties for the protection of the North Sea and the ozone layer (UBA, 2001, p. 15). In the 1990s it became an important rationality in the framework convention on climate change (UNFCC).[13]

As it became clear that climate change was already happening, adaptation became an ever more important part of the international climate regime. Although climate change adaptation was already mentioned in the UNFCC agreement of 1992, it took quite some time until adaptation and climate risk preparedness were established as significant pillars in national and international climate politics. Only after the IPCC report of 2007 included a chapter on climate risks and adaptive strategies, climate adaptation gained more prominence (IPCC, 2007). The fact that it took 15 years since the ratification of the UNFCC to widely acknowledge the need for increased adaptation measures is certainly due to widespread concern that stressing

13. However, in the UNFCC, precaution should go along with cost-benefit assessments (Gupta, 2014, p. 66). This undermines the intention of the principle to avert catastrophic risks at all cost. As I will show below, economic cost-benefit calculations as well as precautionary reasoning still play a major role in setting climate thresholds.

adaptation diverts attention from the pressing need to curb emissions. The promotion of adaptation efforts usually comes with the assurance that climate risk preparedness is no substitute but only a necessary supplement to climate change mitigation (German Federal Government, 2008). Earth system scientist Hans-Joachim Schellnhuber describes the division of labor between mitigation and adaption as being about "avoiding the uncontrollable and controlling the unavoidable" (quoted in UBA, 2008, p. 13, author's translation). This implies that at a certain point climate change becomes too catastrophic to adapt to, or rather becomes catastrophic precisely because societies can no longer properly adapt to it. Again, it seems that preparedness and prevention both enact and are mediated by a threshold of catastrophe. But what is this threshold, how is it identified and accounted for?

3.1 Setting the Temperature Threshold

Already during the first waves of the Covid pandemic, climate scientists and activists started to circulate a diagram that applied the "flatten the curve" imaginary to climate change. The "flatten the climate curve" diagram also depicts two curves, a steep business as usual curve of GHG emissions and a flattened curve as a result of climate protective measures. And it also depicts a dashed line indicating the need to flatten the curve. There is no consistent designation for the dashed line. Sometimes it is called earth system capacity, in close parallel to the original "flattening the curve" diagram, while sometimes it just stands for a concrete climate target like 2°C or simply "Paris Agreement". Defining the climate catastrophe through a temperature threshold usually set around 2°C warming is certainly the most prominent and common expression of climate goals. The 2°C goal figures prominently in international climate agreements since the 2009 Conference of the Parties (COP) in Copenhagen and is reinforced by the 2015 Paris Agreement that promised to keep temperatures "well below" this threshold.[14]

The history of the 2° target goes back to the earliest climate sensitivity studies. Climate scientists estimated that a doubling of CO_2 concentrations in the atmosphere since industrialization would result in 2°C warming of global mean temperatures (Randalls, 2010, pp. 598 *ff.*). In the 1970s, US economist William Nordhaus picked this up as the baseline for one of his famous economic climate scenarios. However, Nordhaus dismissed the 2°C as an objective for climate politics arguing that the costs of achieving it cannot outweigh its benefits (Randalls, 2010, p. 599). Nordhaus is one of the most famous representatives of the breed of climate economists trying to identify the most cost-efficient climate politics. These economists don't restrict themselves to estimating the most efficient means to a given political end. By assessing the ratio between the economic cost of climate mitigation and the costs for climate change damages they want to figure the best ends, the most desirable climate goals. Cost-benefit calculations are still immensely important in climate change politics — even among advocates for ambitious climate goals. As Randalls points out, "defining the threshold in the damage function when costs rise rapidly could be a useful proxy for excessive anthropogenic interference" (2010, p. 601). Within the cost-benefit analysis tradition the disaster threshold becomes the point where climate risk preparedness measures and the cost of climate damages become too costly to be tolerable (Weitzman, 2009). Additional costs must therefore be accepted as an insurance premium against catastrophic climate change (Edenhofer et al., 2011).

14. Article 2 of the Agreement states the commitment to hold "the increase in the global average temperature to well below 2°C above pre-industrial levels and to peruse efforts to limit the temperature increase to 1.5°C above pre industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change." (United Nations, 2015, p. 22).

However, as we have seen with regard to the Covid pandemic, a threshold of catastrophe is never just the outcome of economic calculations and utilitarian considerations. The climate threshold does not just provide wiggle room for economically desirable pollution but also seeks to establish a biopolitical backstop to avoid both the unpreparable and the morally unbearable. In fact, the prominence of the 2°C goal increased with the growing awareness of the existential risks for life on this planet due to climate change. Through a series of studies and expert reports in the 2000s, it became more tangible what "dangerous climate change" that the UNFCC declared it wanted to avoid since the 1990s actually means: rising sea levels that could devour whole cities, droughts that threaten food and water security, wildfires, extreme weather ranging from heatwaves to extreme rainfalls and tropical storms, the accelerated extinction of species. The third official IPCC report in 2001, first presented the so-called "burning embers" diagram that showed that the risks of catastrophic climate change grow rapidly with global warming above 2°C (IPCC, 2001). At the same time, new paleoclimatic data suggesting that "recent" geological history never witnessed a warming of more than 1.3°C provided additional support for the 2°C as an unnegotiable catastrophe threshold. Scientists argued that even if one assumed that technologically advanced societies can prepare for slightly more warming, this would still render 2°C the upper limit for adaptable global heating (Tol, 2007, p. 426). Warming above 2°C would not only accelerate costs, it would threaten the very survival of mankind as we know it. Climate change politics could thus be framed as a biopolitics of survival which cannot solely rely on cost-benefit calculations but needs to resort to moral reasoning to avoid morally intolerable outcomes.

During the last decade, a third rationality which introduces a new biopolitical entity (planetary life-support systems) as well as a redefinition of the catastrophe threshold as a planetary tipping point (Lenton et al., 2008; Horn, 2021) gained more and more attention in climate politics. The notion of the tipping point emerged in the context of the reconceptualization of climate science through the Earth System paradigm (Schellnhuber, 1999). Earth System scientists no longer regard climate change just as a linear relation between rising atmospheric GHG concentrations and increased radiative forcing but as a complex ensemble of highly interdependent ecosystems and biogeochemical cycles (Dahan, 2010). Usually, the interactions between earth system elements have a self-regulating effect. However, like in every complex system, if these fine-tuned regularities get disturbed too much the self-regulating features can flip and negative (absorbing) becomes positive (amplifying) feedback (Clark, 2010). This flip happens at tipping points which scientists unsurprisingly assume to be at around 2°C warming (Knopf et al., 2012, p. 134). Tipping points are associated with so-called tipping elements like the ice sheet in polar regions, boreal and rainforests, and permafrost soils (Lenton et al., 2008). These elements usually dampen the effect of climate change by reflecting solar radiation and working as a carbon sink. But when they are damaged by climate change too much their regulating effect starts to reinforce global heating. The ice sheets can reflect less and less solar radiation which results in higher temperatures that again lets the ice sheets disappear. When forests lose their ecological integrity, especially through wildfires, they no longer act as sinks but become sources of CO_2 emissions. And the thawing of permafrost soils releases methane stored there for centuries. Beyond these tipping points, climate change will not just be cumulative, linear and slow but become abrupt, non-linear and fast.

There are several reasons why these dynamics are catastrophic. First, climate change would become self-sustaining. So even if societies would stop emitting any greenhouse gases, they couldn't stop temperatures from rising. Secondly, the changes would occur too swiftly to adapt. Climate risk preparedness measures demand fundamental changes to the human-built

world (climate resilient infrastructures and cities for example) which usually takes decades. The pace of climate change could thus overburden adaptive capacities. And, finally, in the worst case, global changes might become so severe that the planetary "safe operating space for humanity" (Rockström et al., 2009) shrinks further putting human life in tremendous peril. Similar to the Covid pandemic, the catastrophe threshold is defined in relation to the capacity of vital systems, in this case the planetary "life-support systems" (Young & Steffen, 2009) that make human life on earth possible. Humanity as a whole appears to be as dependent on external systems for survival (balanced temperatures, breathable air etc.) as Covid patients in intensive care units connected to ventilators. The decisive difference is of course that planetary life support systems, though influenced and disturbed by social action, are never fully under social control. The limits to adaptability that define the catastrophe threshold turn out to be the limits of the resilience of ecological and not just social systems.

3.2 Above the Threshold

The question whether 2°C is an appropriate indication of catastrophic climate change (exploding costs, unpreparable and life-threatening climate risks, crumbling life-support systems) is of course still contested. Some climate economists still regard the 2°C goals as too costly, empirically unfounded and overly normative (Tol, 2007). For other climate scientists, activists, and affected parties it is not ambitious enough. Accordingly, during the negotiation for the Paris Agreement there was much disagreement concerning the appropriate climate target. Whereas the old industrialized countries prefer the 2°C goal, the Alliance of Small Island States (ASIOS) insisted to include the 1.5°C as a more ambitious goal in the treaty (Ourbak & Magnan, 2018). For them, the difference between 1.5 and 2°C is the difference between survival and their islands drowning in the ocean. And even a warming below 1.5° threatens the existence of myriad animal and plant species, and causes enormous human suffering as evidenced by the devastations climate change has already caused at a warming level of about 1°C. Just like during the Covid pandemic, the focus on a particular catastrophe threshold often loses sight of vulnerable humans and non-humans dying below the threshold, from the victims of tropical storms in the Caribbean to the symbiotic life complex of the Great Barrier Reef.

A different and even more ambitious catastrophe threshold currently discussed is 350ppm of CO_2 concentration in the atmosphere. The 350ppm threshold was introduced by climate scientist James Hansen (2008) and is currently promoted by climate activists like Bill McKibben's NGO 350.org. The 350 ppm advocates argue that above this threshold climate change will trigger critical tipping points especially if long-term effects are taken into account. What makes this threshold so particularly ambitious, and indeed threatening, is the fact that atmospheric CO_2 concentrations are already above 400ppm (450ppm is currently deemed to be the threshold for 2°C warming). Even as the 350ppm threshold was first introduced in 2008, there was a significant CO_2 overshoot. The only reason why catastrophic global heating has not yet manifested is the relatively slow "climate response time" (Hansen et al., 2008, p. 16). Oceans and ice sheets work as a buffer against rising temperatures. They delay global heating effects from rising atmospheric CO_2 concentrations for centuries. These gigantic earth spheres work as shock absorbers and stockpiles of the earth system. This suggests that we are already using up the emergency supplies of "spaceship earth". Soon these buffer capacities will be exhausted so that irreversible, rapid, and extremely dangerous climate change is no longer avoidable. That is why Hansen and other advocates of the 350ppm threshold urge taking immediate action to not only stop further emissions but to remove CO_2 already locked into the atmosphere through

reforestation and other Negative Emissions Technologies (NET).

In this scenario contemporary societies have already breeched the threshold of the climate catastrophe. We are no longer just facing and anticipating potential catastrophes. We are already navigating within "unsafe operating space" (Wakefield, 2020). The climate catastrophe is already here — both manifestly and latently. The effects we are currently witnessing — rising temperatures, more frequent extreme weather events — are only the tip of the melting iceberg, only a foretaste of the climate turbulences already caused by the carbon in the atmosphere. In these scenarios, the present comes to be experienced as an incubation time until the climate catastrophe becomes devastating. In this situation, the combination between prevention and preparedness no longer seems to be enough to avoid the worst. With the growing importance of NETs in climate politics (Field & Mach, 2017; Carton et al., 2020) a third strategy emerges to complement mitigation and adaptation: carbon drawdown, the removal of carbon from the atmosphere. This is no longer prevention nor preparedness but involves novel security technologies that might be called reversiveness. Like prevention, it seeks to avoid the worst, though — paradoxically — like preparedness it deals with unavoidable catastrophe situations. Yet unlike both prevention and preparedness it encompasses a new temporal orientation that not just looks ahead to the future, but also comes back to the residuals of the industrial past. It is not just a politics of the future. It is a way of coming to terms with a past that will continue to haunt the present for centuries to come (Folkers, 2021).

But what happens when the attempts to reverse the already committed climate change fail? What kind of political rationalities and imaginaries can guide a politics beyond the threshold of catastrophe? Since the 1970s, resilience thinking was established as a socio-ecological paradigm that promised to be able to provide guidance in situations of turmoil (Cooper & Walker, 2011). In contrast to management approaches premised on stability, resilience embraces the inherent fluctuations of social and ecological systems (Holling, 1973). Often, resilience designates strategies to enable the system to quickly bounce back after a shock. In this sense, resilience amounts to little more than preparedness. It is about taking precautions so that disturbances don't escalate into catastrophe. However, resilience thinking involves more than bounciness and preparedness. According to certain understandings of resilience, a crossing of the catastrophe threshold triggers a comprehensive reorganization of the system. In the famous "adaptive cycle" (Holling, 2001), such a transformative event kicks off the "release" and "reorganization" phase of adaption where the fallout from an ecological shock — for example a wildfire — becomes the nourishing ground for new ecological relations to unfold. While this "back loop" of the adaptive cycle is often neglected in contemporary approaches to resilience (Wakefield, 2020), it still provides one of the few governmental scripts to inform responses to situations beyond the catastrophe threshold. It becomes ever more likely that environmental security will have to include this facet of resilience which would imply that climate adaption cannot only be about system protection. It also needs to encompass systemic transformation without being certain what this transformation might entail and if and how it can be successful.

4 Conclusion: Catastrophe Beyond the Threshold

If you throw a frog in boiling water, it instantly jumps out. But if you put it in tepid water and just very slowly increase the temperature it will remain there even if the water starts boiling. Climate scientists frequently invoke the story of the boiling frog as a cautionary tale for humanity. Just like the frog, they suggest, societies have difficulties recognizing dangers that

are continuous, enfold slowly and can often only be felt after it is already too late. Societies therefore have to establish clear thresholds for triggering action before it is too late.

There are of course many differences between the Covid pandemic and climate change. Covid is a very recent phenomenon. Since its first outbreak in the Wuhan region at the end of 2019, it hit the entire world with multiple infection waves. This triggered rapid and, in many ways, hitherto unimaginable emergency responses like prolonged lockdowns and the closing of borders. In contrast, the climate crisis has its roots in the fossil industrialization of the 19th century and has been a political issue at least since the 1980s. However, there is no emergency response to the climate crisis that is comparable in scale and intensity to the Covid pandemic response (like, for example, shutting down coal power stations immediately, restricting air traffic, car-free Sundays etc.), arguably because the dominant public perception deems it to be quite far away. And while there is still hope that the pandemic will be over one day in the not-too-distant future, climate change is very likely to become a chronic condition for centuries to come.

Nevertheless, the Covid pandemic and the climate crisis are — in their own ways and according to their own pace — relatively slow emergencies. They don't come in the form of a single disruptive event that becomes immediately visible to the general public. Rather, they only become detectable by meticulously tracing invisible viruses and carbon molecules, by compiling infection statistics and historical weather data etc. They continuously aggravate until they become utterly uncontrollable and catastrophic. That is why in these cases the definition of thresholds seems so crucial — yet also why it is so necessarily intricate to identify them. Because a threshold is a matter of degree, it always comes with a whiff of arbitrariness.

I have argued that the thresholds of catastrophe in the Covid pandemic and in climate governance emerge out of the interaction between the security rationalities of prevention and preparedness. They are defined as the point when preparatory measures can no longer cope with the escalating crisis dynamic. The mission is thus to avoid catastrophe by preventing the unpreparable and preparing for the unpreventable. Beyond the threshold the quantitative increase — more infections, more CO_2 molecules in the atmosphere — qualitatively changes the crisis dynamic for the worse because it triggers systemic breakdown. In the Covid pandemic an overburdening of the public health system leads to more infections because public health authorities are no longer able to track down and disrupt the chains of infection which again causes more infections which in turn overburdens the hospital capacities and drastically increases the death toll. Similarly, climate scientists are afraid that at certain tipping points climate change will accelerate, become self-sustaining and utterly uncontrollable.

The threshold of catastrophe always has a moral dimension. It signals a point where adversities not only become uncontrollable but also morally unbearable. In the Covid crisis, the overburdening of the health care system and the need to decide who receives treatment and who is left to die untreated is widely perceived as a moral catastrophe that needs to be averted whatever it takes because human life is the highest, and therefore incommensurable moral good. In the climate crisis moral urgency is often associated with the fear that the survival of the human species as a whole is at stake. Thus, in both cases a moral economy of life provides a normative backstop against the biopolitical elasticity that modern societies allow themselves to secure the smooth operation of social life. It is worth pointing out that these moral economies of life are fairly recent phenomena. In their current form they emerged after the end of the Second World War with the rise of humanitarianism on the one hand and the threat of annihilation of the human species becoming thinkable with the prospect of thermonuclear war (Anders, 1980) on the other.

The designation of catastrophe thresholds seems to be inevitable. Contemporary societies need some kind of demarcation to immunize themselves both against external threats and their own cognitive and normative inertia in responding to creeping but nevertheless life-threatening situations. However, in their current form these thresholds also go along with at least two problems. They make it more difficult to properly attend to disastrous conditions *below* as well as situations *above* the threshold. The focus on vital system failure tends to lose sight of everything that is not deemed of systemic importance (from the death of old people to the disappearance of ecosystems that are not considered to be critical "tipping elements" in the Earth System). The concentration on thresholds cannot take into account the unequal exposures and vulnerabilities towards risks so that certain regions, social strata or communities may be catastrophically affected even though the general threshold is not breeched. Like other thresholds — for example for toxic substances in the environment — they tend to legalize, justify, or at least normalize the dangers below the threshold. Death and suffering *below the threshold* tend to be silenced: people dying from Covid after weeks in isolation despite receiving proper treatment, Long-Covid patients, small island states drowning in the ocean, species and whole ecosystems disappearing, but also the normalcy of social injustice even in the absence of pandemics and climate shocks. The moral economy of humanitarian biolegitimacy in the Covid pandemic as well as the moral commitment to secure the survival of mankind as a whole in the face of climate change — as legitimate as they may be in themselves — also have the tendency to prevent society from recognizing how its own structures contribute to everyday suffering.

Still, the planetary catastrophic processes are already too advanced to dismiss the politics of catastrophe and the security rationalities of prevention, preparedness and resilience. It is very likely that new emerging infectious diseases will haunt societies maybe sooner than later and it is beyond doubt that even below 1.5° or 2° C warming, climate risks will increase further. Considering the 350ppm theory, we may even be well *above the climate catastrophe threshold* already. From this perspective we are in the midst of a catastrophe that is very real but still mostly latent. This experience of the present as a prolonged delay, as an incubation time or a climate limbo transcends the "emergency imaginary" (Calhoun, 2004) societies have developed over the last decades. We are not just facing a potentially disastrous future but are caught in the meantime between past causes and future effects. This certainly makes new forms of security necessary beyond the phalanx of future oriented technologies like prevention, preemption, precaution, and preparedness. Rather than "pre", an appropriate prefix for the new era is "re": removal of atmospheric carbon to reverse the worst climate impacts, repair and reparations for those most affected by ecological catastrophes, remediation of devastated ecosystems and certainly also resilience. However, the meaning of resilience will have to change in this transition from pre to re. Resilience can no longer just be a form of preparation for adversities that enables the system to quickly bounce back and return to the *status quo ante*. Rather, resilience will have to become a form of transformative adaption to an ever changing and ever more threatening planetary environment. Situations above the threshold of catastrophe thus make necessary new security strategies beyond preparedness and prevention. However, these strategies will have to operate in a terrain utterly transformed by the events that lead to the crossing of the threshold and thus cannot promise a return to the pre-catastrophic condition but can only help navigate the calamities to come.

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