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Ontological overflows and the politics of absence: Zika, disease surveillance, and mosquitos

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ABSTRACT
In STS, there has long existed an unease about the analysis of powerful actors and dominant technoscientific narratives. A core concern for the field has been how particular objects, phenomena, and people are excluded from technoscientific realities. However, a key problem in dealing with exclusion in STS is that our methods call us to 'follow the actors,' which often leads to reifying our interlocutors' matters of concern. This paper proposes an analytical strategy that turns our analytical attention to the actors' work rendering things absent—a strategy of analyzing ontological overflows. The aim of this analytical move is to shift focus from construction to de-construction and to highlight the importance of processes of exclusion. By exploring the actors' making of the absence of Zika—and by extension, the construction of the absence of various technoscientific phenomena—an analytical strategy is outlined that allows us to attend to the overflows of technoscience. Four types of overflows are analyzed: conglomeration, exclusion, scarcity, and indeterminacy, each illustrating how the making of absences shapes technoscientific objects. For instance, the decision of what counts as a thing, the handling of absent data, and the translation of computational uncertainties into absence of prediction. This analytical strategy highlights where there exist spaces for power and choice—where choices can be made, by whom, and by what means. By analyzing the making of absence, we can explore how objects, phenomena, and people are marginalized or rendered absent in technoscientific processes.

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Introduction: epidemics, absences, and overflows

The fear of global disease outbreaks looms large on the horizon of contemporary society, not least since the Covid-19 outbreak emerged as a global health threat in the early 2020s (cf. Caduff, 2015). In a world of heightened awareness, institutions

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and practices of disease surveillance—working tirelessly to discover new disease threats—have emerged as key arbiters of global health security (Lakoff, 2017).

The constant question of disease surveillance organizations across the globe is when and where the next health threat will emerge (cf. Lee, 2021a, 2023) The detection of a new epidemic is dependent on a huge amount of work from a multitude of actors, ranging from testing at the local doctors' office, vigilance by surveillance of sentinel animals, microbiology laboratories, and different centers of disease control (see for instance Caduff, 2015; Lakoff, 2017; Keck, 2020; Kelly *et al.*, 2020; Kameda *et al.*, 2021).

The presence of disease is hugely momentous. The identification of a new disease can lead to lockdowns, vaccination programs, mask mandates, travel restrictions, closing of public spaces, and so on. However, the flip side is just as true: the absence of an epidemic is oftentimes just as momentous as its presence. The proclamation that no disease outbreak can relax all of these restrictions and return life to the everyday. Deciding the presence or absence of an epidemic often has weighty consequences.

Furthermore, proclaiming an epidemic or a pandemic is an ontological event, which produces a global technoscientific object. That is, an epidemic emerges as a thing when experts decide that it exists, and ceases when the experts decide that it does not (Lee, 2021a; cf. also Lakoff, 2017, pp. 7–8). For instance, when the WHO decided that Covid-19 was a pandemic in March 2020. This was an ontological event. Thus, in delineating existence from non-existence, presence from absence, actors make a cut between existence and non-existence of a phenomenon.

This article takes an interest in the work to delineate an epidemic by deciding where the epidemic is enacted as *not* present. It traces the multitude of practices that enact a pandemic as absent. Hence, it takes an interest in the politics of exclusion and othering by following the actors' ontological work, what Lynch has called ontography (cf. Woolgar and Pawluch, 1985; Lynch, 2013; Woolgar and Neyland, 2013). That is, the article follows the practices of excluding things, and the production of the *absence* of an epidemic.

In this article, I join the rich tradition in STS that asks how we can attend to the invisible and absent. My proposal is to attend to the politics of the absent, by paying attention to *ontological overflows*. In doing this, I aim to join the fertile and insightful discussion about the ontological politics—that is the intertwining of technoscientific practices with power relations—of invisibility and fractionality in STS (Star, 1991; Mol, 1999, 2002; Star and Strauss, 1999; Law, 2002). I want to ask what would happen if we freed our analytical gaze from the things that the actors' eyes and hands are trained on. Stayed situated with the actors—but looked the other way—toward practices of excluding, cutting, removing—the practices of making absences.

To demonstrate the usefulness of this methodology, I trace the enactment of the Zika pandemic of the mid-2010s to demonstrate that through tracing ontological overflows—we can trace a different politics of exclusion in technoscience. Empirically, I analyze the practices of delineating the absence of an epidemic by following the work of tracking and mapping a Zika epidemic at the European Centre for Disease Control and Prevention (ECDC)—one of the main health security actors in Europe (see also Lee, 2021b, 2021a).

Analytical perspective: overflows and absences

In STS, there is a long tradition of caring for invisibility, othering, and weak actors. We have asked ourselves time and time again: What about the things and people that do not fit (Star, 1995; Bowker and Star, 1999; Bowker, 2000)? What about the invisible actors on the margins (Star, 1990, 1991; Star and Strauss, 1999)? The things that are at the margins of the network (Lee and Brown, 1994; Latour, 2012)? The manifest absences or otherness (Law, 2004)? In Law's words, how do we attend to the 'enactment of *presence*, *manifest absence,* and *absence as otherness*' (Law, 2004, p. 84 my emphasis). In this article, I want to join this discussion about exclusion, and in particular to think through the ontological politics of making absence in practice (cf. Mol, 1999). I want to care for the entities—here a shorthand for all of the heterogeneous things, objects, subjects, phenomena, animals, and people—that are made absent in practice (Latour, 2005a).

The challenge of absences: a constant methodological problem in STS seems to stem from following the concerns—the eyes, hands, and actions—of our interlocutors. As Bowker and Star describe it, 'By the very nature of the method […] we shared the actors' blindness. […] We will see the blind leading the blind' (1999, pp. 48–49). As analysts of technoscience, we tend to care for our interlocutors' matters of concern (cf. Latour, 2004; de la Bellacasa, 2011). That is our methods—initially developed to take seriously the practices of scientists—became centered on the construction of facts and artifacts in practice, and accordingly became fine-tuned to trace the assembling of things that our interlocutors care for (Knorr-Cetina, 1981; Latour and Woolgar, 1986; Traweek, 1988). That is, we have taken to heart that nature, society, actors, nature, and agency are all radically assembled in practice, but the objects of our analytical attention rarely vary: our objects of concern match those of our informants. The blind leading the blind.

There are at least three problems that stem from this methodological reflex of following the actors.

The first problem is empirical. In our analyses, how can we empirically care for the many, many things that are made absent in technoscience? As Frickel writes '[W]e study processes of becoming or emergence, far more than processes of winnowing or submergence' (Frickel, 2014, p. 87; cf. also Croissant, 2014; Rappert, 2010). How do we then attend to things that are made absent by the eyes, and hands of our interlocutors and therefore, outside our attention? How can we attend to the objects that are made absent?

The second problem is methodological. Our attention to our interlocutors' enactment of things tends to leave behind those things that are excluded from the dominant technoscientific realities. As Bowker and Star have observed, faithfully following how our interlocutors' assemble objects produces blindness to objects that are excluded by our interlocutors (1999, pp. 48–49). Our interlocutors stay steadily focused on their matters of concern—and too often our analyses do too.

The third problem is theoretical. When we remain faithful to our interlocutors' constructions. We do not venture into the 'undiscovered continent' of action (cf. Lee and Brown, 1994). We follow the rails of the network. We map the territorialized spaces that our interlocutors have colonialized. We follow the construction and enactment of particular objects that our actors care for. But, we do not follow other lines of sight, other lines of flight.

In proposing the concept of *ontological overflows*, I want to draw attention to these practices and processes of producing exclusions—the becomings of absence. The move to analyze overflowings draws on Callon's (1998) work on framing and overflowing. However, the concept of overflowing that I introduce here is pointing in the opposite direction. Both versions of overflowing have a similar starting point: some things are outside the network or in Callon's terms outside the 'frame.' However, Callon's interest in overflowing lies in how 'economic externalities' that are seen as being outside the market are brought into the 'frame' of economics through identification and measurement. He is thus primarily interested in the *constitution* of the present. I want to point in the other direction. Where Callon seeks to highlight processes of how the excluded are brought into the fold and *stabilized*, I want to highlight how the excluded are removed and *destabilized*.

Thus, examining ontological overflows is about examining the processes of omission and exclusion of objects, things, and people. However, my interest is neither in cataloguing what kinds of absences exist (absences as a noun) nor is it in defining what qualities these different absences have (absences as adjective). Rather my interest lies in highlighting the processes through which absences are *produced by actors* (absences as a verb). I want to use ontological overflows to direct our searchlights to the treason, *trahison*, of translation (cf. Callon, 1984; Law, 1997).

My position is radically practice-oriented, and builds on pragmatic actor-network sensibilities focused on actors and materialities of research (Callon, 1984, 1998; Latour and Woolgar, 1986; Latour, 1987; Mol, 1999, 2002). This means that I view absences as produced by actors—they are becomings. From this perspective, absence does not pre-exist practice but is always becoming in relation to our interlocutors' normativities about what—in their view—*should* exist (cf. Bergson, 1944, p. 296–).

Thus, following ontological overflows means looking towards processes of exclusion and cutting—without presupposing what normativities have shaped them. In this pragmatist vein, tracing ontological overflows means refraining from bringing preconceived notions about the nature of absence to our analysis. We need to follow overflows empirically. That is, we need to follow actors' work, through actions, utterances, inscriptions, and documents—without becoming blinded by the matters of concern of our interlocutors.

Distinctions: ontological overflows and agnotology

Some distinctions must be made here: A parallel mode of inquiry to this material-semiotic tradition has a long-standing interest in how social interests have shaped knowledge production (Barnes, 1977; MacKenzie, 1978, 1981; Collins, 1981). Building on this tradition, researchers from fields such as STS, philosophy, and sociology have taken an interest in how strong actors strategically work to suppress knowledge (cf. Proctor and Schiebinger, 2008; Kourany and Carrier, 2020). This tradition is born from an interest in drawing 'attention to a kind of non-knowledge that is systematically produced through the unequal distribution of power in society' (Hess, 2022, p. 142). These studies of the production of (non-)knowledge have led to important research, for instance, about the production of non-knowledge about climate change (cf. Oreskes and Conway, 2011).

However, there are crucial differences in how the world is apprehended and explained when analyzing ontological overflows and when analyzing the production of non-knowledge. On the one hand, by analyzing ontological overflows—and in this drawing on actor-network sensibilities—the explanation of why exclusion happens must remain open. We must remain impartial to what can be causes and effects—eschewing using preconceived notions as the explanation of why things happen (Latour, 2005b). On the other hand, the agnotological tradition—we might call it the social interest tradition—sees the empirical world through a particular lens, with a predetermined intent to explain how unequal power relationships and social interests lead to the production of non-knowledge. This difference in modes of explanation is an age-old discussion in STS, where each camp has made compelling arguments for their preferred mode of exploration (Callon and Latour, 1992; Collins and Yearley, 1992).

In my view, the making of absence is not always tied to powerful interests that aim to produce ignorance. That a thing is made absent or invisible in practice does not require a powerful actor that through unequal power relationships suppresses knowledge, undoes science or produces ignorance. *What shapes the making of absences must remain an empirical matter, not a matter of first principles.*

A second crucial difference between attending to ontological overflows and agnotology is the shift from epistemology to ontology. My focus on the ontological politics of overflows builds on the important shift in analytical perspective—from apprehending the world as the construction of knowledge—

epistemology—to analyzing the enactment of ontologies (cf. Haraway, 1991; Harding, 1991; Mol, 1999). Thus, ontological overflows focus on what objects are enacted as absent in practice, while the social interests explanations highlight how strong actors strategically suppress particular knowledge (cf. Oreskes and Conway, 2011; Hess, 2016). The analytical lens shifts from producing non-knowledge to producing ontological absences.

My aim is to develop overflows an analytical strategy for understanding the ontological politics of technoscience. To understand how things are cut from the dominant technoscientific realities. As Puig de la Bellacasa (2015) phrases it, I want to 'draw attention to the significance of practices and experiences made invisible or marginalized by dominant, "successful", forms of technoscientific mobilization' (p. 692) (cf. de la Bellacasa, 2011, 2016). Thus, this text is about politics and power in science and technology. It is about tenuous objects, about exclusion on the sidelines of enactment (cf. Mol, 1999).

Absences in practices: a methodological reflection

But what does it mean trying to break free from the actors' matters of concern? Still being situated with the actors, while looking the other way? Paraphrasing Bowker and Star: How do we avoid becoming the blind that follows the blind? In this case, it means looking in the other direction, toward the disassembling of things. What do the actors choose to ignore? What do they cut from the assemblage? Thus, tracing ontological overflows is about reconfiguring your matters of concern, freeing them from the actors' matters of concern, and looking the other way, toward ontological overflows.

In practice, multiple overflows demand our attention. Below, I attend to a few. Attending to different types of overflows aims to sensitize our analytical minds to the processes of exclusion (cf. Blumer, 1954). They are not meant as an exhaustive taxonomic exercise—reifying absence-making into a definite typology. There can be an infinite number of overflows. The overflows I propose here are not the final destination, they are a starting point. Below, I attend to four different modes of overflowing that can be useful for tracing processes of absence-making: overflows of exclusion, overflows of scarcity, overflows of conglomeration, and overflows of indeterminacy.

The story begins: the Zika pandemic, the Rio Olympic Games, and the ECDC

In the case of a pandemic, the presence of disease is the primary matter of concern: counting cases, making maps of the disease, making epidemic curves, and assessing risks (Lee, 2021a). But in all this making of presence, there is a multitude of ontological overflows being made. Here, I attend to some of these overflows by tracing the processes of excluding, othering, occluding, and eliding. There are multiple—perhaps even innumerable—overflows at play in assembling the absence of Zika: absence of cases, absence of data, absence of Zika transmission risk, absence of the *Aedes aegypti* mosquito, and the absence of risk. As I show below, all of these absences are assembled into a coherence in practice: what is assembled as the absence of Zika.

My account starts at the ECDC, in January 2017. At the time, the fear of widespread Zika transmission in Europe was still tangible (see Figure 1). The ECDC published weekly updates about the number of cases, and there was a palpable worry that the ongoing Zika epidemic would become a pandemic following the Olympic Summer Games in Rio de Janeiro that were held in August 2016.

The number of Zika cases in the EU reached a peak in conjunction with the Rio Olympic Games. During this period, the number of cases in the EU was counted in the hundreds. The fear was that the disease would become locally spread in the EU and not just be transmitted in conjunction with travel to countries where Zika was already endemic, like Brazil. The concern was that Zika would become widespread in Europe—perhaps transmitting sexually, from mother to child, and via mosquitos. This was partly because Zika is transmitted by the mosquito *Aedes aegypti*, also known as the Yellow Fever Mosquito, whose range is limited in Europe, but also an increasing fear that Zika could be transmitted by the related Asian Tiger Mosquito, the *Aedes albopictus*, whose range extends over much of Mediterranean Europe.

Tracing the assembling of a pandemic

We enter this story during my fieldwork at the ECDC. The analysis then branches out into relations to algorithms, computations, and infrastructures

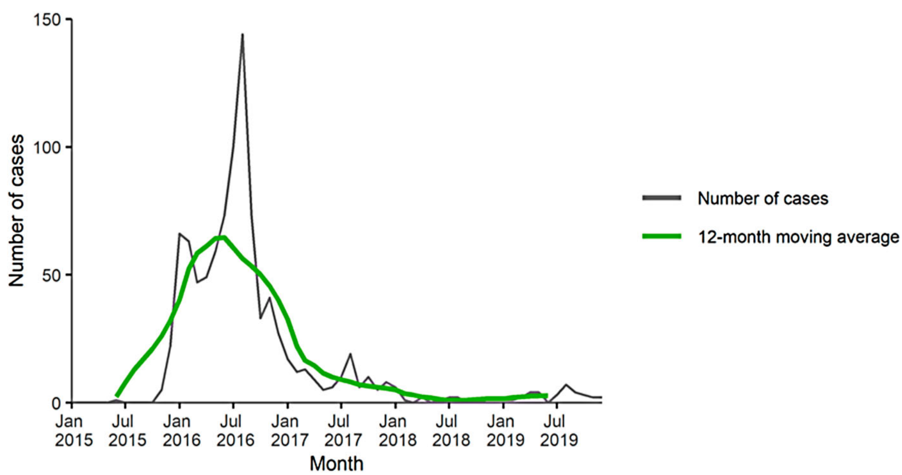

Figure 1. Zika virus cases by month in the EU from 2015 to 2019 (European Centre for Disease Prevention and Control, 2021, p. 3). Reproduced with permission.

that stretch out in faraway times and places: into medical laboratories, into jungle expeditions, and even leaving Earth to journey into satellites in space. My fieldwork started as part of a larger project which examined how new information infrastructures were used for disease surveillance. The project started in 2015 with a preliminary study into so-called infodemiology—the use of various information infrastructures to track disease. However, the fieldwork that this article draws on started in 2017 at the ECDC, and continued with varying degrees of intensity until 2021, to investigate the use of information infrastructures in disease surveillance.

An important point of departure was that a pandemic is assembled in many ways, using various infrastructures and tools, and many types of data. Accordingly, tracing disease implicates an abundance of human and non-human actors: the pathogens themselves, such as viruses and bacteria. Experts in epidemiology, virology or medicine. Technologies of disease tracking, such as databases, genetic surveillance or even social media. Disease vectors such as mosquitoes, bats, birds or livestock. Tracing disease through these more than human relations fosters a practice of constant and eclectic experimentation in disease surveillance. Any conceivable resource available is harnessed to track down pathogens, and disease vectors, to bring outbreaks under control.

As a consequence of the eclectic methods of disease surveillance, the fieldwork strategy was by necessity one of multi-sited ethnography. This strategy puts the objects of investigation in focus over the site of fieldwork, tracing the action into the world system (Marcus, 1995). This strategy meant that I shadowed the making of various disease outbreaks through practices and infrastructures, as well as human and more-than-human actors.

The center of my attention in attending to these overflows in practice is my interlocutors' work to delineate an epidemic through what they call an 'algorithm.' An algorithm is a technoscientific object which has received quite some attention in later years (cf. Ziewitz, 2016). The word algorithm—like any word—has multiple meanings: In medical science, it can be a flowchart for treatment choices. For computer scientists, it means an iterative manner of solving a computational problem, often in code. For my interlocutors, an algorithm took the meaning of a patchwork of code, data sheets, flowcharts, maps, and risk models that resulted in a map of a disease outbreak. For them, it was a way to automate the work of delineating an epidemic. Here, I take an irreductionist stance to the object 'algorithm'—attempting not to reduce it to a simple definition—but to follow the partial relationalities of the 'algorithm' as it is assembled and branches out into time and space (cf. Latour, 1988; Strathern, 2004; see also Muniesa, 2019; Lee, 2021a for the problem seeing 'algorithm' as an analytical object 'out there,' as a stabilized object with inherent qualities).

The starting point for the fieldwork at the ECDC was three weeks of participant observation, and six months of meeting participation, interviews, and document studies. During the three-week startup period, I worked in the epidemic intelligence team. This team was tasked with surveilling the informational world for new disease outbreaks and used various informational resources to scour the news media, Twitter and reports from other disease surveillance organizations. The intent was to find the next disease outbreak. After my period in the epidemic intelligence team, I studied the work of the genetics team and genetic disease surveillance (Lee, 2021b). In sum, during my fieldwork, I followed the assembling of disease outbreaks through interviews, in meetings, participating in staff training, as well as by studying reports, publications, and news of different disease outbreaks.

Importantly, to understand the infrastructural work that was being done, it was necessary to follow the assemblage to other places and times. For instance, the use of computational models to predict disease risk led different research institutions to follow how the models harnessed particular mathematical models, satellite imagery, climate models, and so on.

The fieldwork came to explore news surveillance, genetic tracking of disease, algorithms for visualizing pandemics, and the use of social media, such as Twitter or TripAdvisor to find sources of disease. Where my informants and the infrastructural assemblage led, I followed (cf. Latour, 1987). In brief, I traced the assembling of disease outbreaks through a multiplicity of places branching out from particular rooms in the global disease surveillance apparatus to infrastructures stretching far away and back in time: into satellites in space, into nineteenth-century climate classifications, and into jungle expeditions to capture the infamous *Aedes aegypti* mosquito. This article drills down in a small subset of all these materials, to highlight how the *absence of Zika*, the white area on the global Zika map, was enacted (see Figure 2).

Importantly, during the fieldwork, I came to increasingly ask, what happens at the edge of the pandemic, outside of the web of established practices, matters of concern, and taken-for-granted objects? What about the absences, Otherings, and ontological overflows? What about all the processes that led to things being excluded and made absent?

Assemblages of absence

In assembling a disease outbreak, the absence of disease is produced alongside its presence. This does not mean that absence is in any simple sense a mirror image nor does it mean that absence is relational to presence in any straightforward way (cf. Law, 2002, 2004). But absence is always relational to actors' expectations of what *should* exist—their normativities of presence (cf. Bergson, 1944). The absence and presence of an epidemic, or potentially any object, are not two sides of a coin but are produced as a series of human and more-than-human relations. Sometimes versions of absence create boundaries

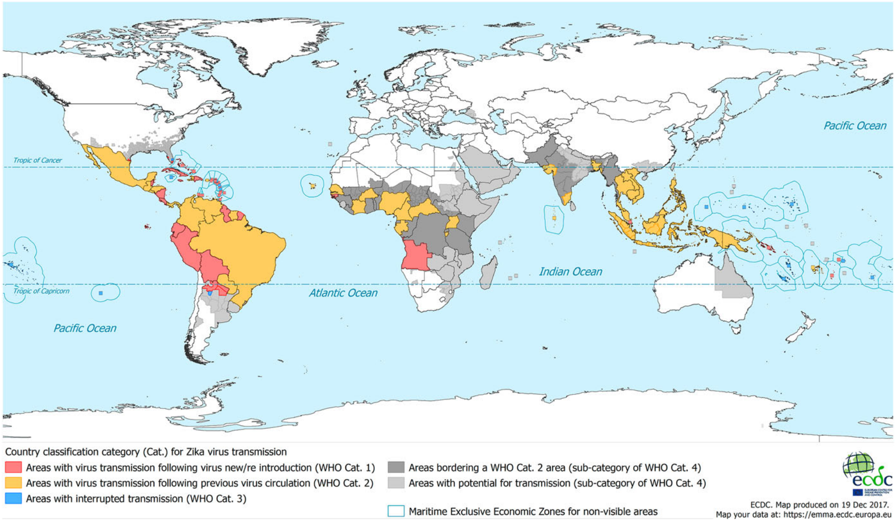

Figure 2. Worldwide Zika Virus Transmission 19 December 2017 (map obtained during fieldwork). Reproduced with permission.

around the Zika outbreak and sometimes versions of absence are folded into the presence of the outbreak.

Below we deal with four ontological overflows that are part of producing the absence of Zika. We deal with *overflows of exclusion*: how to decide which cases come to count, as well as which cases are not counted—which cases become cut (cf. Martin and Lynch, 2009). Second, we pay attention to *overflows of scarcity*. Here the analysis centers on 'no data,' and encompasses those times and places where no data are available, not an unusual state of the world when you are tracking a pandemic. Third, I highlight *overflows of conglomeration*. How certain versions of absence become dominant and visible, and others subsumed and invisible (cf. Mol, 2002). It deals with the practices of computer modeling to predict the risk of the disease vector. What is the potential for Zika transmission here? Fourth, we deal with *overflows of indeterminacy* where no prediction is possible. The places and times where we are stuck in a place of uncertainty.

Overflows of exclusion: what comes to count as a disease case?

Counting disease cases in space and time is central to disease surveillance. A large amount of work goes into finding and counting cases at the ECDC. During my period of fieldwork in the epidemic intelligence team, each morning started with the team updating the case counts of the diseases that we were currently tracking: Zika, Yellow Fever, and Chikungunya in Brazil; the plague in Madagascar; Legionella in Dubai; and Salmonella in Europe. The mundane work entailed checking the published number of laboratory-confirmed cases on the websites of different disease surveillance organizations around the globe. It also entailed scouring news reports, databases, and epidemiological email lists connecting various actors in disease surveillance for emerging disease outbreaks. The number of cases of Zika both in the EU and globally was treated with solemn importance (see Figure 3).

However, my informants' minds and hands—and therefore, my eyes and hands—were focused on enacting the *presence* of a Zika outbreak. My informants' attention and work, the searching eyes, and hands of disease surveillance globally, were trained on the presence of cases. And my attention, alongside theirs, was likewise focused on the same thing.

However, to be counted as a disease case, the disease case in question needed to become a confirmed case. It needed to be either confirmed by the epidemic intelligence team—this was done using websites that were deemed trustworthy, such as the Brazilian health surveillance secretariat, the *Secretaria de Vigilância em Saúde* or the case needed to be ascertained by communication with relevant authorities in other countries. This could entail checking uncertain case numbers by following up with emails or calls to the health authorities of other countries to confirm their laboratory status. A confirmed case was a number that was constructed by lots of work in laboratories, clinics, and government agencies. If it had not been confirmed yet it was put in a different category, and instead joined the group of suspected, but unconfirmed, cases (cf. Martin and Lynch, 2009). At the ECDC, the unconfirmed cases were sometimes

Figure 3. Zika virus cases in the EU in 2017 (European Centre for Disease Prevention and Control, 2019, p. 3). Reproduced with permission.

counted in the assessments of the development of disease, but always to answer the question: ‘Is it confirmed?’

Producing a confirmed case of Zika meant confirming the disease in bodily fluids, rather than just relying on a symptomatic diagnosis. Making a confirmed case built on detecting the disease by different methods in different body fluids —in serum or plasma, in saliva, in urine or in semen. The timing of the tests was also important. At the onset of Zika symptoms certain methods were understood as reliable, while later on in the disease onset, other types of tests were seen as effective (see Figure 4). For example, in the acute phase of Zika, during the first five days of symptoms, PCR tests using genetic technologies were seen as dependable, while during the convalescent phase serology using antibodies was seen as more useful.

The absence of cases was produced in parallel to the confirmed and suspected case numbers. Sometimes, the *un*confirmed cases were counted as ‘zero cases’—they were folded into absence of Zika—but sometimes they were counted as a case. The inclusion or exclusion of a case depended on the situation and how the numbers were to be used. The number of non-confirmed cases in the steady stream of information that entered the ECDC was discussed and tracked, they were the source of questions and worries, but it was the confirmed cases that were most often counted as cases, while suspected and unconfirmed cases became part of Zika absence. When the cases became classified as not-case, they became part of an *ontological overflow*, sorting them out of being a disease case.

However, even confirmed cases became ontological overflows, *not cases*, at certain points in time. For instance, when so-called travel-related cases of Zika—when someone had contracted the disease outside their home country

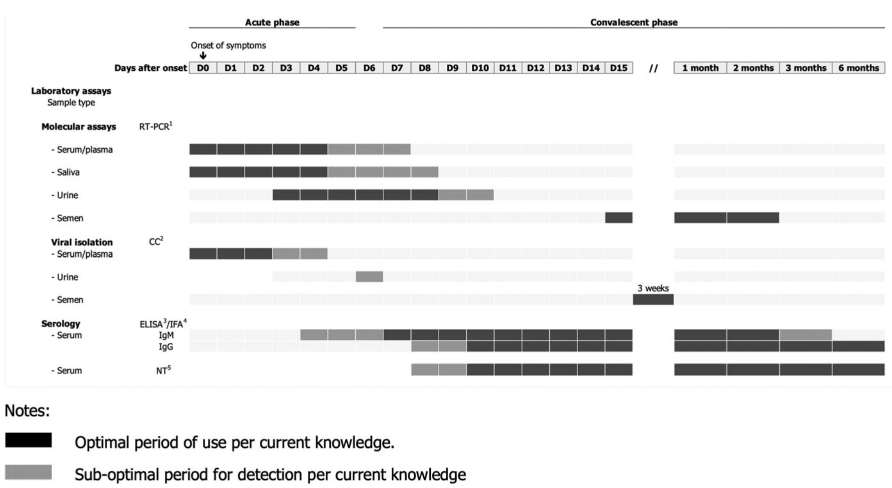

Figure 4. Timeline of the optimal periods of use for different test types (European Centre for Disease Prevention and Control, 2016, p. 4). Reproduced with permission.

—were counted they were sometimes argued to be more appropriately seen as non-cases. This was because they were not seen as showing the *endemic*, local spread of Zika. This was, for instance, the case in a situation with my interlocutors when cases were to be counted in Pakistan. Actors in the WHO argued that two travel-related cases of Zika were to be counted as cases, and therefore, they would show an active spread of Zika in Pakistan on the Zika world map. While actors at the ECDC argued that it was absurd to count two travel-related cases toward active spread in that region (cf. Lee, 2021a).

The status of the cases and their counting were constantly being negotiated and decided in practice.

The counting of cases and the enactment of the presence and absence of Zika was not straightforward, and multiple versions of the presence or absence of cases were constantly negotiated. Was it a suspected case? Was it laboratory-confirmed? Was it travel-related? Should it count in assembling the outbreak? Or was it a non-case? These questions were constantly navigated by the actors at the ECDC. There was always room for negotiation, doubt, and assessment of trust (cf. Garfinkel, 1963). The presence or absence of Zika cases always needs to be enacted in practice.

Thus, this first version of the absence of Zika concerns the cases that do not become counted. That is excluded from becoming an object. This is an *overflow of exclusion*. How certain things are sorted out as non-objects. How they are excluded from particular enactments of the world. This version of overflow directs our attention to practices of sorting things *out*. To the objects that become deemed as not objects. Paying attention to the *overflows of exclusion* directs our attention to what is not counted as an object in practice? What do actors not count as an object, a thing of the right type? How and where do actors exclude things from objectness?

Overflows of scarcity: absence of data

> *Thibault and I are looking at the large wall screen where Bernard is displaying several excel tables of cases and flowcharts of the Zika algorithms (both names are pseudonyms). He clicks between the tabs in the excel database. Thibault and Bernard are discussing how to automate the global Zika map. They are in agreement and seem to think almost everything about the algorithmic automation is straightforward. I'm trying to keep up. However, at one point in going through the database, Thibault brings up the example of Chad, one of the poorest countries in the world.*
>
> *'There is no data from Chad,' Thibault tells me.*
>
> *What Thibault is pointing out is that the absence of data creates a blind spot in the surveillance system. Chad is said to be such an epidemiological blind spot. Regardless of the quality of the Zika algorithm, the rigor of case definitions, and the depth of expert judgment—certain places don't have good disease surveillance data.* (Fieldnotes from the ECDC)

* * *

This brings us to another overflow: *overflows of scarcity*. If you revisit Figure 3, you will see that certain countries on the map are striped, which denotes 'no data reported.' Another absence of Zika. We start tracing this overflow at a meeting that occurred during my fieldwork at the ECDC. I joined my informants Thibault and Bernard in a meeting where they were discussing what they had dubbed 'the Zika algorithm' (see Lee, 2021a). Thibault and Bernard had been discussing how to construct an algorithm to automate the production of the global map of the Zika pandemic. At the time, the ECDC published the Zika map on a weekly basis. And it took time and resources for the epidemic intelligence team to update it. So, for Bernard and Thibault algorithmic automation made sense in the long term, but it also led to a lot of challenges.

At the time of the meeting, Bernard had been working for months to create the Zika algorithm, and different disease surveillance organizations around the world had expressed interest in implementing this new algorithmic methodology. It would be a load off the epidemic intelligence team to automate the process. Assembling an outbreak takes a lot of work—and automating the process seems attractive in some rooms and situations.

Our second ontological overflow thus concerns data absences. Another challenge is surveilling the world for disease. How to deal with those areas of the world—like Chad—that don't have data? As we can see in the map below (see Figure 5), northern Chad was classified as having no Zika risk. White, just as, for instance, southern France. However, in contrast to Chad, France is seen as having good surveillance data. But they are still both white spots on the map. They both show an absence of Zika.

Chad and France are both classified as having no Zika risk. White denoting 'Zika absence.' The algorithm that Bernard and Thibault are constructing lumps together a literal white spot on the map—'no data'—with countries that report zero cases. 'No data' is classified in the same category as 'zero confirmed cases of Zika.' The absence of data about Zika becomes equated with no confirmed disease cases.

This we might call an *overflow of scarcity*, which is folded into the absence of Zika. These overflows highlight when things are excluded from thingness because of lack: There is no data (Rappert, 2010; cf. Frickel, 2014).

Overflows of conglomeration: risk and mosquito models

But more overflows in the assembling of the absence of Zika emerge here. If we return to the map in Figure 5, we can note that southern Chad—which has no surveillance data—is tinted gray by the Zika algorithm, nevertheless indicating that there is a *risk* of transmission of Zika. However, the gray color, rather than being based on counting confirmed cases in time and space, is based on several different resources: statistical modeling of the disease vector's habitat, the

Figure 5. Crop of the current Zika State (see Figure 2). Reproduced with permission.

spread of the dengue disease, a world climate classification first constructed in 1884, satellite climate imaging, entomological literature about mosquito presence, and mosquito traps around the world (cf. Lee, 2021a).

But that also means that the white area on the map—the absence of Zika—includes all those resources to produce the absence of Zika risk. The absence of Zika not only contains the absence of laboratory-confirmed cases or the absence of disease surveillance data. The absence of Zika also encompasses modeled absence of Zika risk. The absence of Zika multiplies again. Here, the Zika algorithm pulls in other computations, models, classifications, and datasets—to model the absence of Zika risk.

My informants' understanding of mosquitos, and in particular, the *Aedes aegypti* species is key to understanding this flurry of risk computation (see Figure 6). Importantly, apart from sexual transmission and transmission from mother to child, Zika is transmitted by the *Aedes aegypti*. The modeled risk for disease transmission—or the absence of risk for transmission—is assembled based on this assumption.

One layer of the mosquito risk modeling that is included in the Zika map, is the so-called Köppen-Geiger global climate classification map, which was first created in 1884, and has been updated over the years. The version used in assembling the Zika map was updated in 2007 (Peel *et al.*, 2007). The Köppen-Geiger classification divides the world into climate zones (see Figure 7) based on, for example, temperature and rainfall. By drawing on the Köppen-Geiger map, the assembled ECDC Zika risk map includes assumptions about mosquitos thriving in certain climate zones. The assumption is that Zika risk exists where the climate zones are amenable to certain types of mosquitos.

On the map of Zika risk in Figure 5, we can observe that the risk for Zika in Chad follows the boundary between the red and orange climate zones in the

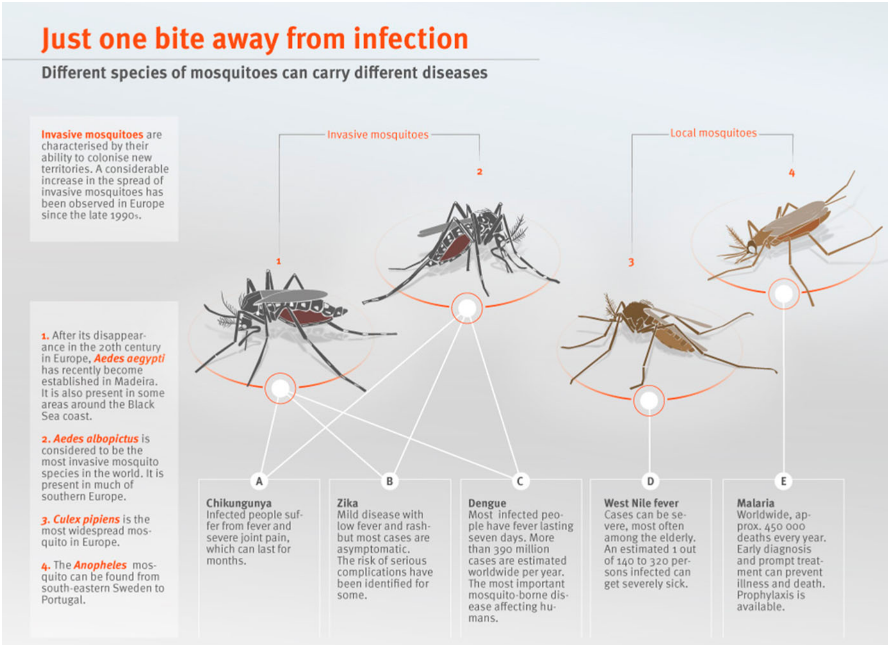

Figure 6. Infographic from the ECDC (Mosquito-borne diseases: An emerging threat, 2014). Reproduced with permission.

Köppen-Geiger map below (Figure 7). The absence of Zika risk thus includes a particular climate classification.

But the multiplicity of the absence of Zika risk does not end there, the modeled risk of Zika transmission—and its absence—also includes two computational models.

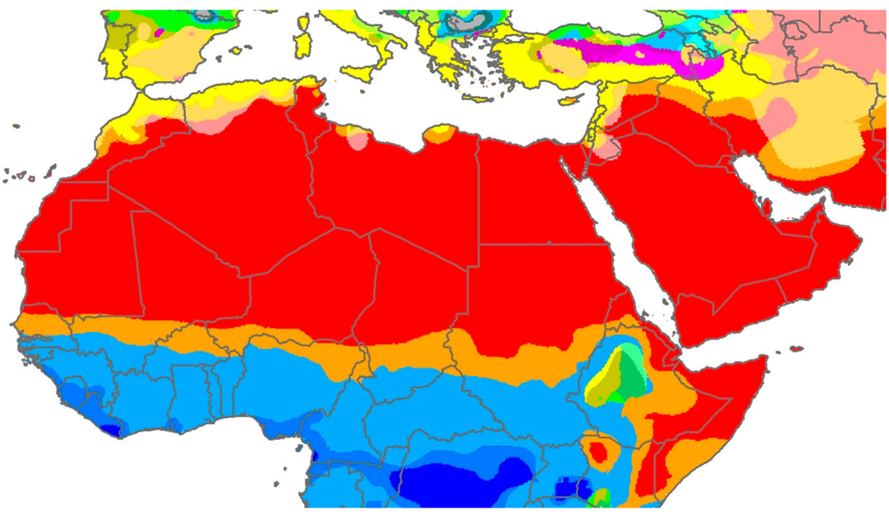

Figure 7. Updated Köppen Geiger map (Peel *et al.*, 2007). Reproduced with permission.

Apart from the Köppen Geiger map, my interlocutors, Bernard, and Thibault had decided to include (1) a model of the geographical range of the *Aedes aegypti* and (2) a model of Dengue fever risk in the Zika risk computation. The first model aimed to compute the presence of the *Aedes aegypti* mosquito, and the second attempted to compute the risk of Dengue fever, which is transmitted by the same mosquitos as Zika. These two maps were layered with the Köppen-Geiger map to produce the map of Zika risk. But also, the absence of Zika risk. In Figure 8, we can see the *Aedes aegypti* model in action (on the left), and the overlaying of the Köppen-Geiger map with the *Aedes aegypti* model (on the right).

The two risk models were produced by a group of geographical risk modelers at Oxford University. These modelers combined climate data with mosquito sightings to model risk. That is, they used mathematical and statistical methods to predict for example where the *Aedes aegypti* roams, where the *Aedes albopictus* thrives, and, in line with how the transmission risk was understood, where the risk of Dengue and Zika transmission existed.

The *Aedes aegypti* model and Dengue model were closely intertwined with each other, built on the same type of modeling, and drew on the same sets of data. The two different maps were produced using the same general methodology and data sources.

First, they included datasets on the presence of the mosquitos by compiling the geographical locations where they had been found. In the case of the *Aedes aegypti* maps, the modelers used several strategies. One strategy was to create a bespoke database using published literature in PubMed, Web of Science, and Promed. Furthermore, the modelers drew on geographical data about the environment, climate, geography, and population. These data were

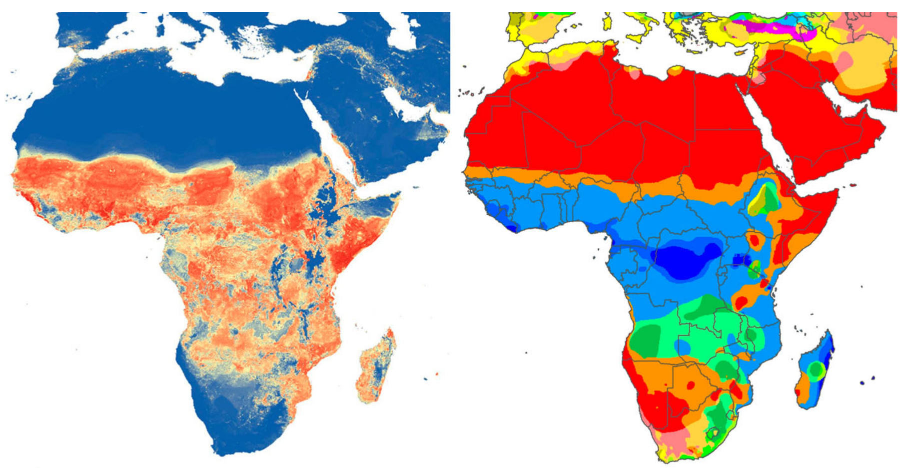

Figure 8. (Left) Reproduction of the Aedes aegypti model. (Right) Köppen-Geiger map. Reproduced with permission.

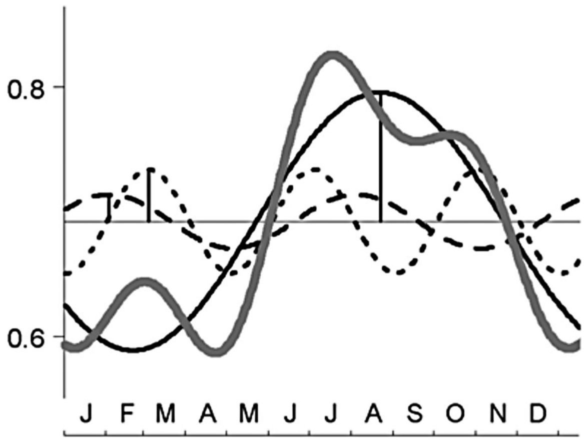

Figure 9. An example of Fourier-transformed climate data from (Scharlemann *et al.*, 2008). Reproduced with permission.

mathematically transformed, using Fourier transformation, into cyclical waveforms that could be correlated with the presence of the mosquitos (Figure 9).

The maps resulting from all these modeling endeavors were used to calculate the risk of Zika. Thus, the white area in northern Chad (Figure 5) not only contains the absence of cases or the absence of data. *It also contains the computed absence of risk for Zika transmission*.

The different versions of absence were assembled into one visible white absence on the Zika map, making different versions of absence invisible. These versions were subsumed under the general category of absence of Zika. The multiplicities of absence of Zika became *overflows of conglomeration*, where versions of objects are made absent based on a particular version becoming dominant. This type of overflow has been brought into focus by Mol (2002), who showed how fractionality and multiplicity of objects are coordinated in practice. Objects became more than one, less than many. And certain enactments become subjugated to the dominant version.

In this case, the multiplicities of absence are excluded based on conglomerating disease cases, multiple layers of climate data, mosquito sightings, jungle expeditions, and risk computations. All of these become ontological overflows in relation to the homogenizing and universalizing categories of the Zika map.

Overflows of indeterminacy: 'no prediction possible'

But the multiplicity of absence does not end here. In the absence of Zika is also included another absence: the absence of prediction. Here we are dealing with an *overflow of indeterminacy*. This overflow is not about missing cases, missing data or modeled absence of risk, but about the risk prediction models predicting neither absence nor presence. For instance, in the Dengue model, the absence of prediction looks like below (Figure 10). Note the gray parts in the map, which denotes 'no prediction possible.'

The reason for what the modelers dub 'no prediction' is given in another paper attempting to predict the habitat of the Tsetse fly, which emphasizes that all environmental conditions will not have been captured by the model and that when the environment is too different, they prefer creating a category of 'no prediction':

> Mapped outputs record the similarity of each pixel in an entire set of satellite images to the satellite-determined environmental characteristics of the training set sites. Obviously for this to be successful *the training set should have captured the entire range of conditions present throughout the area for which predictions will eventually be made. This is not always the case, and it is then preferable to identify in the output image a separate category of 'no prediction'* for those areas where the environmental conditions are some specific minimum distance (in multivariate space) away from any of the training set clusters (Rogers and Robinson, 2004, p. 144. My emphasis).

This means that the training set, that is the data about where the *Aedes* mosquito roams, does not encompass certain environments on the globe. When the 'environmental distance' distance is too great the uncertainty becomes too big. In such cases, the modelers opt for not predicting risk at all. An absence of prediction, an overflow of indeterminacy.

But further overflows are part of the absence of Zika. There are also limits to which satellite data is deemed interesting by the modelers. For the Dengue fever model, no climate data were downloaded above 90°N and below 60°S, which is visible as a sharp line cutting through the northern part of the world (Figure 10). Ocean areas and ocean tiles containing 'small islands,' were excluded from the climate dataset using a digital elevation model. Algorithmic 'quality control' excluded certain areas, due to, for example, cloud cover (Hay and Rogers, 2012, p. 19). The absences multiply. *Ontological overflows* abound.

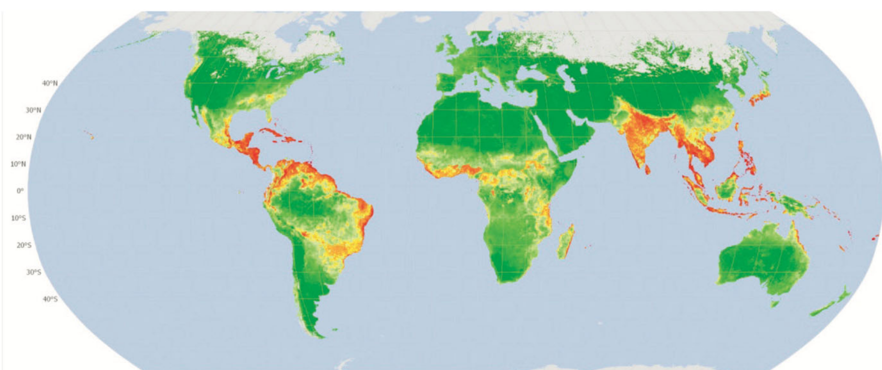

Figure 10. Climactic suitability of Dengue fever transmission (Hay and Rogers, 2012, p. 10). Reproduced with permission.

Overflows of indeterminacy point us toward the production of irresolution and uncertainty, toward the ambiguous, undetermined, and unresolved. Attending to how objects balance on the edge of becoming or not becoming. Resolution into an object or not an object is uncertain. The object is teetering on the brink of reality. The indeterminacies might never resolve (MacKenzie, 1998; Zehr, 2000; Vogel *et al.*, 2021). A veritable multitude of absences. And certainly, an overflow of conglomeration. The version of absence that is made manifest in the absence-of-Zika seems stable and coherent, while a multitude of absence versions are Othered, they are excluded and made absent (cf. Law, 2004).

Concluding discussion

The purpose of this article has been to articulate an analytical strategy that we can use to analyze the ontological politics of exclusion in technoscience. I have proposed that we can use a strategy focused on ontological overflows to pay attention to that which is cut and rejected from dominant technoscientific realities. To demonstrate the usefulness of this analytical strategy I have followed the production of the Zika epidemic at the European Centre for Disease Control and Prevention (ECDC) in the mid-2010s. In particular, I have paid attention to the practical production of the absence of Zika. What this analytical strategy offers is a systematic sensitivity to the various ways in which phenomena are excluded in technoscientific processes. Above, I have attended to four *ontological overflows*, four moments of exclusion, where things are cut from the epidemic—to produce the absence of Zika.

An important overarching point of departure has been how the complexity of modern disease surveillance—any complex global technoscientific object—abounds with *overflows of conglomeration*. Multiple versions of a phenomenon are folded together thus occluding particular versions of the world from view (cf. Mol, 2002; Lee *et al.*, 2019). The homogeneous image of the absence of Zika—the white areas that surround the epidemic on the map—obscures a multitude of exclusions, decisions, and assumptions that are part and parcel of the practices of exclusion in technoscience. The homogenization of different phenomena into a zone of absence of Zika, risks concealing many decisions and processes that are of great import for understanding and acting on phenomena—not least epidemics.

I also considered *overflows of exclusion*—the practices where it was decided if a disease case should count as a disease case or not, what Martin and Lynch have aptly titled ‘the practices and politics of counting’ (Martin and Lynch, 2009). In this, I highlighted the usefulness of attending to which cases are cut from a class of phenomena. I foregrounded the mundane work of exclusion: What does not count as a disease case for the actors? What exclusions do we see when we pay attention to how actors decide what does not count as a thing? What objects are thrown on the mundane scrap heaps of ontology? By following these mundane practices of exclusion, we can learn about the making of the *boundaries* of presence and absence. In the case of epidemics, the negotiation of these mundane boundaries becomes matters of great import leading to political and practical action. As we have seen during the COVID-19 pandemic, disease curves, epidemiological models, and political decision-making hinge on these mundane decisions of counting cases. What comes to count as a non-case is a momentous decision.

I also attended to *overflows of scarcity*. In this, I showed how the actors produced one object, *absence of data*, as a part of another object, absence of Zika. Attending to this type of overflow directs our attention to how actors produce and handle absences. How are absences put together? Are they brought into visibility by actors? Are they hidden away? In this case, actors' production of absence incorporated their normative expectations of what *should* exist—data about the *Aedes aegypti* mosquito—while simultaneously making some of these absences invisible. Thus, absence is produced closely intertwined with actors' normativities about what should exist in the world (cf. Lee and Björklund Larsen, 2019). What should have been present? For instance, during the COVID-19 epidemic, the lack of data from testing became a political hot potato—the testing data *should* exist, while in this case the lack of data from Chad during the Zika pandemic was passed over as regrettable and made invisible—there was an acceptance of absence. Thus, what the actors produce as an absence has both practical and political consequences for which technoscientific normativities become dominant—what is an absence worth caring for?

Finally, I attended to *overflows of indeterminacy*. Here I highlighted how actors at the ECDC handled computational and predictive uncertainty in practice. In this, I showed how the actors translated predictive uncertainties into absences-of-prediction, and how these absences of prediction, in turn, were translated into absence of Zika. That is, the absence of prediction about the range of mosquitoes translated into an absence-of-Zika risk. By paying attention to overflows of indeterminacy we learned about how actors make uncertainty part of the world—or not. In this case, the actors' setting of *thresholds* of uncertainty and certainty, became translated into the absence and presence of Zika risk. How then do actors handle uncertainties or certainties in practice? In an increasingly algorithmic and predicted world, these practices of setting thresholds of prediction and risk are hugely political. How actors handle these indeterminacies has consequences for how epidemics are handled. For instance, the uncertainty or certainty of the multitude of models of the COVID-19 pandemic induced both political action and inaction at different times (cf. Engelmann *et al.*, 2022). Thresholds of uncertainty or certainty produce action.

In conclusion, my intention here has been to propose an analytical strategy paying attention to overflows and the production of absences to better understand the high-tension zones of technoscience (cf. Star, 1990). The production of absence is closely tied to questions of practical and political import—there be dragons in the white areas on the map. The analytical strategy of paying attention to overflows and absences has shown how we can attend to some politics of technoscience. Thinking about what is made to overflow and what is made absent is about the politics of exclusion—about boundaries, normativities, and thresholds.

In my case, the actors constantly struggled with performing reality, making ontologies, in their mundane everyday practices. Is the case laboratory-confirmed? Is the geographical area too far north or south to be included? Is the area at sea level? Is something an object or the result of noise? In sum, to demonstrate the usefulness of paying attention to ontological overflows, I followed the actors' practices to decide where the epidemic was not present. I followed their construction of the absence of Zika, to shed light on the various overflows and absences that were enacted in tracing the epidemic.

I join several others in arguing that STS needs to pay more attention to the flip side of construction—the de-construction of phenomena, objects, and people. This perspective shift—paying attention to overflows rather than enactments—allowed me to pay attention to what was excluded and cut from the Zika epidemic. My hope is twofold: first, we can use this strategy to break free from the matters of concern of the actors, to highlight the processes of exclusion and cutting and the objects that are cut (cf. Star, 1990, 1991; Bowker and Star, 1999; Latour, 2012). Second, we can create not only construction stories but stories about the destruction and cutting of phenomena (cf. Frickel, 2014). To use a strategy that highlights cutting and overflowing rather than construction and framing (cf. Callon, 1998). To highlight exclusion rather than construction (cf. Callon, 1984).

However, attending to overflows can never be a conclusion, but must be a starting point for understanding how things are excluded. Tracing overflows means to trace how certain objects in the world (data, animals, people, and countries) become excluded in practice. By attending to overflows I want to continue the work in STS to remain inclusive of the missing masses—analyzing truths and falsities, agencies, natures and societies, multiplicities and fractionalities, as well as the objects that are excluded by our interlocutors. By attending to overflows we can continue to attend to the silenced, excluded, and othered.

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References

Barnes, B. (1977) *Interests and the growth of knowledge*. London: Routledge.

Bergson, H. (1944) *Creative Evolution* (New York: Random House).

Blumer, H. (1954) What is wrong with social theory? *American Sociological Review*, 19(1), pp. 3–10. doi:10.2307/2088165

Bowker, G. C. (2000) Biodiversity datadiversity, *Social Studies of Science*, 30(5), pp. 643–683. doi:10.1177/030631200030005001.

Bowker, G. C. and Star, S. L. (1999) *Sorting Things Out: Classification and its Consequences* (Cambridge: MIT Press).

Caduff, C. (2015) *The Pandemic Perhaps: Dramatic Events in a Public Culture of Danger* (Oakland: University of California Press).

Callon, M. (1984) Some elements of a sociology of translation: Domestication of the scallops and the fishermen of St Brieuc Bay, *The Sociological Review*, 32(1), pp. 196–233. doi:10.1111/j.1467-954X.1984.tb00113.x.

Callon, M. (1998) An essay on framing and overflowing: Economic externalities revisited by sociology, *The Sociological Review*, 46(1_suppl), pp. 244–269. doi:10.1111/j.1467-954X.1998.tb03477.x.

Callon, M. and Latour, B. (1992) Don't throw the baby out with the bath school! A reply to Collins and Yearley, in: A. Pickering (Ed.) *Science as Practice and Culture*, pp. 343–368 (Chicago: University of Chicago Press).

Collins, H. M. (1981) Son of seven sexes: The social destruction of a physical phenomenon, *Social Studies of Science*, 11(1), pp. 33–62.

Collins, H. M. and Yearley, S. (1992) Epistemological chicken, in: A. Pickering (Ed.) *Science as Practice and Culture*, pp. 301–326 (Chicago: University of Chicago Press).

Croissant, J. L. (2014) Agnotology: Ignorance and absence or towards a sociology of things that aren't there, *Social Epistemology*, 28(1), pp. 4–25. doi:10.1080/02691728.2013.862880

de la Bellacasa, M. P. (2011) Matters of care in technoscience: Assembling neglected things, *Social Studies of Science*, 41(1), pp. 85–106. doi:10.1177/0306312710380301

de la Bellacasa, M. P. (2016) Ecological thinking, material spirituality, and the poetics of infrastructure, in: G.C. Bowker *et al.* (Eds) *Boundary Objects and Beyond* (The MIT Press). doi:10.7551/mitpress/10113.003.0005.

Engelmann, L., *et al.* (2022) Domesticating models: On the contingency of Covid-19 modelling in UK media and policy, *Social Studies of Science*. doi:10.1177/03063127221126166.

European Centre for Disease Prevention and Control. (2016) *Interim Guidance for Healthcare Providers and Zika Virus Laboratory Diagnosis*. Technical Document. Stockholm: European Centre for Disease Prevention and Control, p. 5.

European Centre for Disease Prevention and Control. (2019) *Zika Virus Disease: Annual Epidemiological Report for* 2017. Annual Epidemiological Report. Stockholm: European Centre for Disease Prevention and Control.

European Centre for Disease Prevention and Control. (2021) *Zika Virus Disease: Annual Epidemiological Report for* 2019. Annual Epidemiological Report. Stockholm: European Centre for Disease Prevention and Control.

Frickel, S. (2014) Absences: Methodological note about nothing, in particular, *Social Epistemology*, 28(1), pp. 86–95. doi:10.1080/02691728.2013.862881

Garfinkel, H. (1963) A conception of, and experirncnts with, "Trust" as a condition of stable concerted actions, in: O.J. Harvey (Ed.) *Motivation and Social Interaction: Cognitive Determinants*, pp. 187–238 (New York: The Ronald Press Company).

Haraway, D. J. (Ed) (1991) Situated knowledges : The science question in feminism and the privilege of partial perspective, in: *Simians, Cyborgs, and Women : The Reinvention of Nature*, pp. 183–201 (New York: Routledge).

Harding, S. (1991) Feminist standpoint epistemology, in: I. Bartsch, and M. Lederman (Eds) *The Gender and Science Reader*, pp. 145–168 (London: Routledge).

Hay, S. and Rogers, D. J. (2012) *The Climatic Suitability for Dengue Transmission in Continental Europe* (Stockholm: ECDC), pp. 1–27.

Hess, D. J. (2016) *Undone Science: Social Movements, Mobilized Publics, and Industrial Transitions* (Cambridge, MA: MIT Press).

Hess, D. J. (2022) Undone science and social movements: A review and typology, in: *Routledge International Handbook of Ignorance Studies*, 2nd ed. pp. 167–177 (Routledge).

Kameda, K., *et al.* (2021) Imperfect diagnosis: The truncated legacies of Zika testing, *Social Studies of Science*, 51(5), pp. 683–706. doi:10.1177/03063127211035492

Keck, F. (2020) *Avian Reservoirs: Virus Hunters and Birdwatchers in Chinese Sentinels Posts* (Durham: Duke University Press).

Kelly, A. H., *et al.* (2020) Uncertainty in times of medical emergency: Knowledge gaps and structural ignorance during the Brazilian Zika crisis, *Social Science & Medicine*, 246 (February), pp. 1–9. doi:10.1016/j.socscimed.2020.112787

Knorr-Cetina, K. (1981) *The Manufacture of Knowledge: An Essay on the Constructivist and Contextual Nature of Science* (Oxford: Pergamon Press).

Kourany, J. A. and Carrier, M. (Eds) (2020) *Science and the Production of Ignorance: When the Quest for Knowledge is Thwarted* (Cambridge: The MIT Press).

Lakoff, A. (2017) *Unprepared: Global Health in a Time of Emergency* (Oakland: University of California Press).

Latour, B. (1987) *Science in Action* (Cambridge, MA: Harvard UP).

Latour, B. (1988) *The Pasteurization of France* (Cambridge: Harvard University Press).

Latour, B. (2004) Why has critique run out of steam? From matters of fact to matters of concern, *Critical Inquiry*, 30, pp. 225–248.

Latour, B. (2005a) From realpolitik to dingpolitik or how to make things public, in: B. Latour, and P. Weibel (Eds) *Making Things Public: Atmospheres of Democracy*, pp. 4–31 (Cambridge: MIT Press).

Latour, B. (2005b) *Reassembling the Social: An Introduction to Actor-Network-Theory* (Oxford: Oxford University Press).

Latour, B. (2012) Paris, invisible city: The plasma, *City, Culture and Society*, 3(2), pp. 91–93. doi:10.1016/j.ccs.2011.11.002

Latour, B. and Woolgar, S. (1986) *Laboratory Life: The Construction of Scientific Facts*, 2nd ed. (Princeton, NJ: Princeton University Press).

Law, J. (1997). *Traduction-Trahison: Notes on ANT*. Available at: http://www.comp.lancs.ac.uk/sociology/papers/Law-Traduction-Trahison.pdf.

Law, J. (2002) *Aircraft Stories: Decentering the Object in Technoscience* (Durham, NC: Duke University Press (Science and cultural theory)).

Law, J. (2004) *After Method: Mess in Social Science Research* (London: Routledge (International Library of Sociology)).

Lee, F., *et al.* (2019) Algorithms as folding: Reframing the analytical focus, *Big Data & Society*, 6(2), pp. 1–12. doi:10.1177/2053951719863819.

Lee, F. (2021a) Enacting the pandemic: Analyzing agency, opacity, and power in algorithmic assemblages, *Science & Technology Studies*, 34(1), pp. 65–90. doi:10.23987/sts.75323.

Lee, F. (2021b) Sensing Salmonella: Modes of sensing and the politics of sensing infrastructures, in: N. Witjes, N. Pöchhacker, and G.C. Bowker (Eds) *Sensing In/Security: Sensors as Transnational Security Infrastructures*, pp. 97–131 (London: Mattering Press).

Lee, F. (2023) Detecting the unknown in a sea of knowns: Health surveillance, knowledge infrastructures, and the quest for classification egress, *Science in Context*, pp. 1–20. Available at: https://doi.org/10.1017/S0269889723000133.

Lee, F. and Björklund Larsen, L. (2019) How should we theorize algorithms? Five ideal types in analyzing algorithmic normativities, *Big Data & Society*, 6(2), pp. 1–6. doi:10.1177/2053951719867349.

Lee, N. and Brown, S. (1994) Otherness and the actor network: The undiscovered continent, *American Behavioral Scientist*, 37(6), pp. 772–790. doi:10.1177/0002764294037006005.

Lynch, M. (2013) Ontography: Investigating the production of things, deflating ontology, *Social Studies of Science*, 43(3), pp. 444–462. doi:10.1177/0306312713475925.

MacKenzie, D. A. (1978) Statistical theory and social interests: A case-study, *Social Studies of Science*, 8(1), pp. 35–83. doi:10.1177/030631277800800102.

MacKenzie, D. A. (1981) *Statistics in Britain, 1865-1930 : The Social Construction of Scientific Knowledge / Donald A. MacKenzie* (Edinburgh: Edinburgh University press).

MacKenzie, D. A. (1998) The certainty trough (Chapter 15), in: Williams, R., W. Faulkner, and J. Fleck, (Eds) *Exploring Expertise: Issues and Perspectives*, pp. 325–329 (London: Palgrave Macmillan).

Marcus, G. E. (1995) Ethnography in/of the world system: The emergence of multi-sited ethnography, *Annual Review of Anthropology*, 24(1), pp. 95–117. doi:10.1146/annurev.an.24.100195.000523.

Martin, A. and Lynch, M. (2009) Counting things and people: The practices and politics of counting, *Social Problems*, 56(2), pp. 243–266. doi:10.1525/sp.2009.56.2.243.

Mol, A. (1999) Ontological politics: A word and some questions, in: J. Law, and J. Hassard (Eds) *Actor-Network Theory and After*, pp. 74–89. (Oxford: Blackwell)

Mol, A. (2002) *The Body Multiple: Ontology in Medical Practice* (Durham: Duke UP).

Mosquito-borne diseases: An emerging threat. 2014. *European Centre for Disease Prevention and Control*. Available at: https://www.ecdc.europa.eu/en/publications-data/mosquito-borne-diseases-emerging-threat (accessed 6 May 2021).

Muniesa, F. (2019) Societe du comportement, information de la sociologie, *Zilzel*, 2019/1(5), pp. 196–207.

Oreskes, N. and Conway, E. M. (2011) *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Climate Change*, Reprint ed. (New York, NY: Bloomsbury Publishing).

Peel, M. C., Finlayson, B. L. and McMahon, T. A. (2007) Updated world map of the Köppen-Geiger climate classification, *Hydrology and Earth System Sciences Discussions*, 11(5), pp. 1644.

Proctor, R. and Schiebinger, L. L. (Eds) (2008) *Agnotology: The Making and Unmaking of Ignorance* (Stanford, CA: Stanford University Press).

Puig de la Bellacasa, M. (2015) Making time for soil: Technoscientific futurity and the pace of care, *Social Studies of Science*, 45(5), pp. 691–716. doi:10.1177/0306312715599851

Rappert, B. (2010) Revealing and concealing secrets in research: The potential for the absent, *Qualitative Research*, 10(5), pp. 571–587. doi:10.1177/1468794110375229

Rogers, D. J. and Robinson, T. P. (2004) Tsetse distribution, in: I. Maudlin, P.H. Holmes, and M.A. Miles (Eds) *The Trypanosomiases*, pp. 139–179 (Wallingford: CABI Pub).

Scharlemann, J. P. W., *et al.* (2008) Global data for ecology and epidemiology: A novel algorithm for temporal Fourier processing MODIS data, *PLoS One*, 3(1), pp. e1408. doi:10.1371/journal.pone.0001408.

Star, S. L. (1990) Power, technology and the phenomenology of conventions: On being allergic to onions, *The Sociological Review*, 38(1 Supplement), pp. 26–56. doi:10.1111/j.1467-954X.1990.tb03347.x.

Star, S. L. (1991) The sociology of the invisible: The primacy of work in the writings of Anselm Strauss, in: Maines, David R (Ed) *Social Organization and Social Process: Essays in Honor of Anselm Strauss*, pp. 265–283 (New York, NY: Aldine de Gruyter Hawthorne).

Star, S. L. (Ed.) (1995) *Ecologies of Knowledge: Work and Politics in Science and Technology* (Albany: State University of New York Press (SUNY series in science, technology, and society)).

Star, S. L. and Strauss, A. (1999) Layers of silence, arenas of voice: The ecology of visible and invisible work, *Computer Supported Cooperative Work (CSCW)*, 8(1), pp. 9–30. doi:10.1023/A:1008651105359.

Strathern, M. (2004) *Partial Connections* (Walnut Creek: Rowman Altamira).

Traweek, S. (1988) *Beamtimes and Lifetimes: The World of High Energy Physicists* (Cambridge, MA: Harvard Univ. Press).

Vogel, E., *et al.* (2021) Thinking with imposters: The imposter as analytic, in: *The Imposter as Social Theory: Thinking with Gatecrashers, Cheats and Charlatans* (Bristol: Bristol University Press). Available at: http://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-449933 (accessed 16 September 2021).

Woolgar, S. and Neyland, D. (2013) *Mundane Governance: Ontology and Accountability* (Oxford University Press). doi:10.1093/acprof:oso/9780199584741.001.0001

Woolgar, S. and Pawluch, D. (1985) Ontological gerrymandering: The anatomy of social problems explanations, *Social Problems*, 32(3), pp. 214–227. doi:10.2307/800680.

Zehr, S. C. (2000) Public representations of scientific uncertainty about global climate change, *Public Understanding of Science*, 9(2), pp. 85–103. doi:10.1088/0963-6625/9/2/301.

Ziewitz, M. (2016) Governing algorithms: Myth, mess, and methods, *Science, Technology, & Human Values*, 41(1), pp. 3–16. doi:10.1177/0162243915608948.