SPECIAL PIECES

Measures of future health, from the nonhuman to the planetary
An introductory essay

Abou Farman, Richard Rottenburg

In July 2014, the Rockefeller Foundation and the British medical journal *The Lancet* convened a commission of fifteen researchers and policy makers to meet at the foundation's famous Bellagio Center, an impressive property overlooking Lake Como in northern Italy. The group included experts in a diverse range of fields, from medicine, epidemiology, and public health to conservation, biodiversity, earth systems, and environmental health. The charge was to investigate the links between 'human well-being' and the earth's natural systems, or, more precisely, between climate change, resource depletion, and human health.

In a series of reports (and a manifesto!) issued a year later and announced to the world through simultaneous events in New York City and Johannesburg, the commission declared the launch of what it called a 'new' field of medicine (Whitmee et al. 2015; Horton et al. 2014). Without making any reference and possibly oblivious to James Lovelock's (1991) earlier call for planetary medicine, they named it 'planetary health'. This new field is declared to be based on the 'understanding that human health and human civilization depend on flourishing natural systems and the wise stewardship of those natural systems' (Whitmee et al. 2015, 1974). Citing significant gains in health and development metrics – life expectancy, extreme poverty, hunger, education levels, and human rights – the authors broach what they perceive to be the key paradox of their report: progress in some realms means regress in others. They demonstrate how advances in measures of health relate to measures of resource depletion, degradation of ecosystems beyond sustainability, and pressures on the earth's

biophysical systems, including climate change and ocean acidification. Titled *Safeguarding Human Health in the Anthropocene Epoch*, the report declares a tension between development and health in temporal terms, that is, in relation to 'the future' (Whitmee et al. 2015, 1973). Andrew Haines, the chair of the commission and a professor at the London School of Hygiene and Tropical Medicine, echoed this idea to *Scientific American*: 'We may have mortgaged the future in attaining our current level of health and development. … [Conventional health measures] assume that any benefit to health is good and can be sustained indefinitely, and our contention is that may not be possible' (Umair 2015).

It is not clear who 'we' refers to in these statements. Who mortgaged the future? Whose current level of development? Whose future health? Although the disproportionate distribution of externalized harms to poor people around the world is gestured at (and an independent opinion piece in the journal vaguely points fingers at 'neoliberalism and transnational forces' [Horton et al. 2014, 847]), the official reports refrain from even mentioning capitalism, overconsumption, extractivism, corporate profits, or wars and global militarization.1 Questions about the inequalities and power relations underlying universal claims to humanity are by now commonly raised in most debates, as they are in anthropology in general and in the anthropology of health, humanitarianism, and development more specifically (Fassin 2011; Feldman and Ticktin 2010; Little 2003; Mamdani 1972; Redfield 2013; Rottenburg 2009; Ticktin 2011; Langwick 2018a).

The Bellagio report's core assertion is that there is a tradeoff between measures that improve human health and the deteriorating health of the earth over time. Two points are striking: first, the questioning of the absolute value of human health, and second, the charge to 'account for future health'. This creates a breach in a long-standing assumption that has connected progress and well-being, and promised the future as the rosy-cheeked culmination of human technical mastery over the environment, that is, that more development would lead to better health. Whereas progress has been at times resisted and subjected to questioning, the report makes health itself a fraught question socially, historically, practically, and metaphysically. In view of the wider critical and political current that has challenged the humanist foundations of liberalism, and considering the new politics and alliances that climate awareness has been producing, questions about health and its future forms and measures generate interesting entailments of their own: What would it mean to consider some benefits to human health as not automatically 'good'? Which ones? And whose? What

---

1   For example, the US military is the largest single institutional consumer of oil in the world (Union of Concerned Scientists 2014). Similarly, there has long been an imbalance in the overconsumption of resources such that the richest fifth consume up to sixty-six times as many resources as the poorest fifth (Population and Development Program 2006).

kinds of measures and indicators does one use in the calculus of future health? How does one calculate the temporalities and the social and political relations implicated in the conjunction of future and health? Health policy and health governance have been subjected to ample critique (Biehl and Petryna 2013; Farmer 2001; Lakoff and Collier 2008), but how will biopolitical regimes be able to discount what Monica Greco (2004) calls the 'meta-value' of health?

The authors of the first reports on planetary health refrain from inquiring into the deeper problematic of the paradox that advancements in the field of human health entail considerable damages in other fields. To start with, most such advances have been assessed on the basis of technoscientific methodologies that restrict what counts as evidence to those things that can be identified as variables in a function through experiments, measurements, or calculations. Yet a number of researchers have made a strong empirical case that a reified focus on metrics and evidence-based medicine as value-free, objective assessments tends to ignore important contextual factors in health and neglect the very people they purport to serve (Biehl 2016; Erikson 2016; Rottenburg et al. 2015). At the same time – and epistemologically thornier as a problem – the public recognition of the fact that we do live in a time of accelerated global warming could only be established through the same technoscientific methodologies and epistemic framework. What's more, the technoscientific methods and procedures that facilitated and accelerated the damaging of the earth are the same ones that allow this very diagnosis; equally, they are the procedures through which some solutions are proffered and others rejected. The way out of this aporia does not seem to lie in the continuous pursuit of the one and only method for all times (in the literal sense of *meta-hodos*), because two fundamental issues are challenged at the same time. For our case at hand this means: the definition of human health as metavalue and of modern technosciences as meta-*meta-hodos* are being questioned simultaneously and can no longer stabilize each other (Putnam 2002, 137–45). To concede that it is impossible to identify the one and only right way of gaining knowledge of the world ultimately implies that we as humans cannot rely on the assumption that there is only one purchase on reality out there. We must rather concede that with different methods and at different scales of time and space different realities eventuate.

With millions of dollars already committed by the Rockefeller and Gates foundations and the founding of new research projects organized around the concept of planetary health and the decoupling of health and development it implies, it may be too soon to assess the actual changes in policy, the effects of any transdisciplinary research networks, or any new assemblages that might emerge. Nevertheless, these efforts indicate an important change in notions of health and visions of the future as well as in the relevant measures that are meant to bring them together. It should be obvious – given the title of the main report – that such

ideas come to make sense in the context of a worldwide reckoning with what has been called the Anthropocene, the designation of a new geological era constituted by human-driven changes in the earth system that seem to have put everything and everyone indiscriminately at risk. The planetary imaginary of the Anthropocene, linked to the anticipation of future global doom, has shifted health thinking to different orbits. Previous shifts in conceptions and formations of health have been traced through histories of colonial, public, international, world, and global health (Adams 2015; Brown, Cueto, and Fee 2006). These expansions in the notion and ambit of health work have been primarily mapped in spatial terms, articulating around the tensions between geopolitical formations such as empires and nations and some wider image of humanity that transcends the local boundaries of such histories, formations, and peoples. While continuing to emphasize the need to transcend national, identitarian, and geopolitical interests, the shift to planetary health, framed as it is by the Anthropocene, is organized around temporal rather than spatial scales. What is at stake is not just health but future health.

Planetary health also scales out horizontally beyond species boundaries because what is at stake is declared to be the fate of life itself, not just the health of populations. Similar to other shifts that have come to think biology symbiotically (Margulis and Sagan 1995), epigenetically (Lock and Nguyen 2010), or through a multispecies perspective (Helmreich and Kirksey 2010), this also signals a move to take health thinking beyond the individual human, beyond the species invoked in the universalism of secular humanist epistemes that centered at once on anthropos as the agent and end of history and on anthropos as the molecularly or genetically determined being of late-twentieth-century biology (Palladino 2016; Rabinow 1999). Although the focus in the commission's reports falls back to center on 'human health' and 'human civilization', there is a clear call to situate human health within a wider interspecies and biophysical environment that can include such things as air and ocean currents, landscapes, microbial growth and adaptation, chemical flows, and climate imbalance that bear on human health. The globality of our condition as it affects health and well-being may be found not in discrete bodies or even biological pathogens but in particulate matter carried in media we simply refer to as water or air or soil, which encompass the globe and for a variety of reasons produce varying adverse health conditions. Research done under Mike and Kim Fortun's project 'The Asthma Files' (n.d.) shows the incredible range of factors, from food to road infrastructures, that affect respiratory illnesses. Similar projects on air, atmosphere, and chemical infrastructures by anthropologists like Tim Choy (2015) and Michelle Murphy (2013) have documented some of the complexities of these effects on other (deadly) environmental illnesses, from cancer to cardiovascular diseases to unclassified infections. Through the planetary lens, the health of humans is not easily separated from the fate of bees, the levels of carbon, or biospheric adjustments far above the plane of earthly life.

In its first publications in *The Lancet*, the commission – convened by the journal and the Rockefeller Foundation – included two original research reports both funded in part by the Gates Foundation. The reports were meant to exemplify the kinds of investigation and measures required to quantify connections between temporal and processual scales. The first report (Smith et al. 2015) examined the effects of the worldwide decrease of animal pollinators, such as bees, on nutrition and health. Framed in the context of larger anthropogenic extinction processes that have 'reduced the populations of mammals, reptiles, amphibians, birds, and fish by an estimated 50%' since the 1970s (Smith et al. 2015, 1970), the main thrust of the report is that such losses will likely comprise a substantial part of the global burden of disease. In the case of pollinators, this future could mean 1.4 million additional deaths a year from vitamin A and folate deficiencies, which have been linked to noncommunicable and malnutrition-related diseases like heart disease, stroke, and certain cancers (Smith et al. 2015). The second report concludes that increasing concentrations of atmospheric carbon dioxide will lead to massive zinc deficiencies, which are in turn related to disease burdens, especially maternal and child health. By 2050, the authors conclude, 138 million additional people will be affected by zinc deficiency linked to atmospheric carbon (Myers et al. 2015, 641).

What kinds of measures (metrics) are these? And what kinds of measures (plans) might be put into place in reaction to them? How convincing can these measures (both metrics and plans) be? The answers are still unclear, and that is part of the challenge. What gets folded into the notion and circumscriptions of 'future' will in part shape how and which future is made visible and reacted to. At any rate, these attempts will not really change the fact that the future is largely independent of human predilections, predictions, and plans. Decisions to be made regarding the future are empirically underdetermined and, at these cross-species and temporal scales, radically so. The expansion of temporal, processual, and spatial scales may give a wider view of the processes involved and foster larger notions of health and well-being but may also make prognosis and planning even less reliable.

At first glance, this anthropocentric temporality, this scaling up and out beyond the species to the planet, might seem like an opportunity to counter certain biopolitical imperatives. Biopolitics tends to reify the value of human life as such while instituting global measures of control, extraction, and surveillance that differentially distribute the resources of life and death along structural lines, inherited from histories of empire and race and now perpetuated through the global spread of market capitalism and NGO governance. Some critiques of global health and surveillance of infectious and viral diseases have brought out this aspect of current health regimes, emphasizing, for example, how the efforts to monitor pandemic threats organized under the umbrella of global health tend to protect richer, urban, often European and North American centers in terms of 'biosecurity' while putting into place

surveillance schemes and burdens of control on other parts of the world (Lakoff 2010). While the shift to planetary health could be a means to counter these developments, it seems beset by the same pitfalls. UC Davis's One Health Institute (https://ohi.vetmed.ucdavis.edu), for instance, seems like a remake of global pandemic surveillance and control of viral outbreaks in places that used to be called 'the Third World'. Modeling and computational simulations that visualize and so dramatize the catastrophic deaths contained in and by the future – deaths-in-waiting – feed into calls for biosecurity (Gates Foundation 2018), a sequence that Bill Gates and his influential foundation continue to repeat and promote (Sun 2018). Looking at the recommendations and projects emanating from the commission founded in 2014 at the Bellagio Center and the health organizations, researchers, and coalitions that have taken up the 'planetary health' mantle (including Panorama, the Gates Foundation, the University of California, and One Health [see Ticktin, this volume]), it is hard not to note the prominence of the private sector, the call for corporate involvement, the use of finance mechanisms, the increased focus on surveillance mechanisms, and the (re)turn to technofixes and advanced technoscientific approaches via nanotechnology, geoengineering, satellite imaging, algorithmic prognostications based on big data, and a range of other digital or computational techniques (see Duclos and Erikson, this volume).

The point of this special issue is neither to present arguments in support of planetary health nor to critique it as a concept or project.[2] But planetary health, its measures, and its futures allow a way into discussions we initiated in 2015 at the New School and that continued with a larger group in Berlin in the fall of 2016 and at a final meeting in New York in 2017. Under the heading 'Measures of Future Health', this special issue inquires into the metrics and measures through which 'future' and 'health' are conjoined. How might this conjunction open up new possibilities for thinking about how notions of health and well-being are

---

2   The recently published study by the historian of science Suman Seth (2018) on the entanglements of medicine, race, and empire offers solid reasons for caution and skepticism toward any offer entailing universal claims to prognosticate better future health for all grounded in biology. Seth meticulously demonstrates how medical practice in the lands colonized by Europeans during the eighteenth century (his focus being the British Empire and mainly the West Indies), while their purpose was to improve medicine, also slowly prepared the biological racism that culminated during the nineteenth century. He writes: 'It was far from natural, for example, for visitors to the New World to regard all the peoples they met as belonging to a single group. The Baron de Lahontan, traveling through Canada in the late seventeenth century, identified what he understood as eighty-five different "nations". By contrast, for Immanuel Kant, in 1777, one needed only to speak of a single "copper-red" American race, one of only four major divisions of humanity. At some point during the eighteenth century, eyes that saw near-innumerable cultural differences among non-European peoples began only to see physical commonality' (Seth 2018, 346).

changing as data, technologies, concepts, and practices scale up and out to the planetary beyond regional, epidemiological, and geopolitical delineations? How do 'future' and 'health' articulate as research projects, and how do the imaginaries associated with each concept – future and health – cross species boundaries and merge with nonhuman, nonbiological, and algorithmic systems in sites such as finance, social media, robotics, nanomedicine, and even search engines? These questions gain salience as searches and algorithms come to constitute the new media of data collection and techniques for prognosticating futures, evaluating current states of health, or taking measures to counter threats.

On one level, the theme – measures of future health – continues dominant debates about healthy futures in which the social and environmental conditions of individual bodies and delineated human populations are at stake. This is the long-standing terrain of medicine, public health, international development, and global health. On another level, it lends momentum to debates wherein the concept of health is at once destabilized and expanded to incorporate larger and wider fields, referring not just to human health and medicine but to its relation to climate, environment, and nonhuman species, including, as Sandra Calkins describes in her article, the new life of genetically modified plants and animals, in her case the emblematic and culturally rich but apparently nutrient-deficient banana plant. In this midst, new notions of the human and humanity are emerging, which surely will have consequences for approaches to health. At one end, as Abou Farman and Vincent Duclos illustrate, the biological and digital have collapsed into each other to such an extent that health can no longer be considered a matter of biological life alone; at another end, as Ticktin argues, our conception of the biological has been expanded far beyond species lives or populations so as to incorporate natural phenomena on vast temporal and physical scales, where bodily health becomes part of the processes of the ecosystem or of the biosphere or is conceived of in terms of a new geological era named 'the Anthropocene'.

The political and social dimensions of these ideas get played out in contests over local and global regimes of knowledge, evidence, and power that not only place sovereignty at stake – as global health has – but that may reveal new ways of conceptualizing health and well-being. In her article, Susan Erikson takes up contests over 'futures' and 'measures' through the notion of reckoning – which aside from its theological overtones refers to counting, taking account of, and directing calculations toward future improvement. Erikson examines how the financialization of pandemic response raises the specter of dehumanizing health and bypassing decision making by elected local officials and governments, let alone by those affected. The contribution by Celia Lowe, focusing on Indonesia and its response to international demands over the bird flu panic, further shows how such conflicts can imply contests over the foundational notions of health, illness, and causality and not just disagreements over the proper measures to be taken at local or supralocal levels.

Thus, we examine the terms used in the title of this special issue – 'measures', 'future', and 'health' – through three problematizations: the underdeterminacy of the future (or its contingency) and modalities of prognosis and planning developed to counter contingency; the rise of the planetary imaginary, in this case translated as the growing awareness of the relationship between human and planetary health in the Anthropocene; and the collapse of the carbon barrier, or the posthuman imbrication of biological and nonbiological processes through new methods and technologies such as algorithms and nanomedicine. The authors of the five research articles of this collection are in alphabetical order: Sandra Calkins, Vincent Duclos, Susan Erikson, Celia Lowe, and Miriam Ticktin; their work is followed by a think piece by Abou Farman, and then by an afterword by Julie Livingston.

The underdeterminacy of the future

We start from the observation that although the future cannot be predicted, it is often being designed according to the prognosis carrying the highest probability of outcome. The empirical underdeterminacy of the future has long been subject to various modes of forecasting with related evidentiary practices, of which experimentation (Shapin and Schaffer 1985) and statistical calculation (Desrosières 1998; Hacking 1975) have emerged as the dominant modes, resulting in diverse prognostications of behavior patterns and assessments of risk. The distinctions between these scientific modes of forecasting, which include genetic prognosis (Lock and Nguyen 2012), or 'divination', as it's been called by Whyte and colleagues (2018), keep being both reconfirmed and recontested (Beisel, Calkins, and Rottenburg 2018). As this and other relevant scholarship has shown, among the prominent aspects that have allowed the formation and operation of global health – following on colonial and international health – have been the focus on universalizable measures and the proliferation of measurement tools and data-collection protocols. The dominance of metrics (Adams 2016; Rottenburg et al. 2015) and the implied commensurabilities and standardizations have allowed measures to be deployed across cultures, nations, and socialities; these measures have become crucial for the emergence of a global health sector that relies on managing data across scales and instituting uniform practices across geographies. Measurements and health, or public health and statistics, as argued by George Canguilhem (1998), and later by Michel Foucault (2003) and many others working along their lines (Rose 1990; Hacking 1990; Desrosières 1998; Szreter 2005), have long been entwined with biopolitical governmentality. Colonial medicine already had a global vision and did undertake to measure and count health across boundaries and territories (Geissler, Rottenburg, and Zenker 2012; Tilley 2011). Thus, discourses of evidence-based policy and practices of data collection have long been shaping approaches to health at the national and global levels (Power 1997; Shore and Wright 2005; Strathern 2000), crosscut with racial ideologies and class inequalities. In this midst, many scholars have questioned the accuracy

of quantification and the applicability of collected data, as well as the very notions of equivalence, commensurability, and objectivity in this field (Jerven 2013; Rottenburg 2005; Porter 1996; Timmermans and Mauck 2005).

This issue explores how calculating the future – the dynamics between the future's openness and its predictability, its contingencies and determinacies – is shaping notions and practices of future health in ways that provoke the rethinking of such concepts as sovereignty, biopolitics, and technopolitics. The aspiration is to examine more concretely how measurements, prognostications, and evidences build particular futures and 'healths', or versions of health, and how these practices and logics affect the notion of health and its capacity to incorporate or exclude various human groups and the health of other species, be it individual animal or plant species, or entire ecologies. At the same time, the authors explore how new notions of future health transform social arrangements and ideas of justice. We inquire into the conditions of possibility for imagining and making ethical and political claims on these futures.

In the emerging framework of the planetary, health is reconceptualized not just epidemiologically at population levels crucial to biopolitics but through interspecies dependencies, planetary scales, and nonbiological entanglements, and this at a time when the future horizon is spread tensely across the increasing contingency and incalculability of vast, complex processes and the limited human powers of prognostication, a situation of 'radical disproportions' (Danowski and de Castro 2017, 18). For future health and life to make sense as analytical concepts and guiding principles for how to live, a globe-spanning chronoscape of at least several generations, if not several centuries, must be considered. Though he has no particular interest in health, Bruno Latour raises the question of temporality and data in *Facing Gaia* (2017), as he explores the research that claims we have reached the highest levels of CO_2 in 2.5 million years. The imperatives or imaginaries that come with such scales of time and matters of concern – that humans are to blame, humans must act, yet it's too late to act – drive some humans crazy. That scale of temporality makes forecasting more fraught, suspending us in uncertainty between fact and value, between prognosis and course of action.

Prognosis is a calculative practice that presupposes and occupies the space between contingency and predictability and thus could only become a key governing modality once the future became disconnected from the teleologies of religion and otherworldly futures. Reinhart Koselleck (2004, 9–25) traces prognosis as a kind of rational forecasting back to the early modern period in Europe, when knowledge of the future as expressed in divination and controlled by the church became contested by the emergent modern state. The political art of calculating the probability of future events began to establish itself as the powerful

counterconcept to prophecy and radically reconceived the future as principally unknowable, or, as Koselleck (2004, 18) writes, 'the future became the domain of finite possibilities arranged according to their greater or lesser probability'. Under this new epistemic regime, political interventions into the course of history could only be justified by reference to the likelihood of a particular future as it emerges out of an already known past: 'Prognosis produces the time within which and out of which it weaves, whereas apocalyptic prophecy destroys time through its fixation on the End' (Koselleck 2004, 19).

Hence, prognosis opens up the future yet at the same time introduces the past into the future as a limiting factor, as the pattern from which aspects of the future may be discerned and future action planned. Today, in the early decades of the twenty-first century, prognosis continues to be a mode of interpreting the past in order to determine the limited range of possible future-oriented actions, but with some notable shifts. For example, today's alarming calls to prevent climate collapse and extinction are based on previous similar events gleaned from the fossil record and combined with climate science, that is, knowledge of the workings of gases and energy at a biospheric level that allow a modeling of the past for prognostications about the future. Furthermore, these contemporary prognostications also indicate that the level of unpredictability has increased and that the level of possible damage has exploded. Today's prognoses are yet again overdetermined by catastrophic futures, but this time the causes of eschaton are not directly framed as human moral failures in their dealings with one another but rather as human violations of the planet. What's more, the scale of projected catastrophes tends to be so vast as to place modern notions of progress and a meaningful future in doubt. Finally, algorithmic forecasting, as it currently emerges, is sometimes announced as marking the end of probabilism as we have known it since the onset of modernity. It is celebrated as signaling the beginning of a radically different and superior way of dealing with the indeterminacy of the future. For the time being, though, it seems impossible to tell how far the ambivalent excitement about Artificial Intelligence (AI) and Machine Learning (ML) will be confirmed by what eventually will happen with algorithmic forecasting.

In focusing on the underdeterminacy of futures in relation to current measures of health, we search for ways to go beyond the unhappy binary of progress or catastrophe. More importantly, we want to move beyond the either-or dichotomy between, on the one hand, ongoing modernist attempts to conceal or even defeat indeterminacy and, on the other, the celebration of contingency and emergence. The aspiration in this issue, then, is to examine more concretely how measurements, prognostications, and evidence build particular futures and how these practices and logics affect the notion of health and its capacity to incorporate or exclude various human groups and the health of animal species, plants, or environmental phenomena. (On medical prognosis and the body, see Jain [2013] and Farman [2017].) Duclos, for instance, directly addresses the impact of health measurements and modeling in

relation to prognostic mistakes made by Google Flu Trends. As part of 'a recent proliferation of digital platforms aimed at mapping, monitoring, and predicting infectious diseases', Google Flu Trends tried to predict the onset of flus by crunching data from social media and search terms. Duclos recounts the difficulties of digital prognostications in a social media environment as they fell into the trap of their own circularity, creating the very behavior they hoped to track neutrally and sorting through social virtual action as though it were offline biological behavior. Erikson cautions that the financialization of future health through a gambling mechanism that bets on the possibility of a catastrophic infectious event may not allow for the proper health assessment or response to such an emergency. Rather, the disconnect between the measures used and measures to be taken suggests a future in which not only is health instrumentalized by finance – and that might be bad enough – but also the measures that shape prognosis and action might not even be connected to health at all; that is, the assessment of risk and the call for a payout may have nothing to do with any of the events on the ground.

New (global) assemblages – for example, related to climate change, global health, postgenomic forms of belonging, or new financial orderings – emerge full of contradictions and in tension with one another. They require decisions that need to be justified in various fora through different modes of justification. At the bottom of the struggle for the best justifications lies the question about assumptions regarding criteria that distinguish good from bad evidence. The added difficulty in these times concerns not only the unpredictability of the future but also the temporal scales: effects of climate change, industrial waste, or radioactivity not only come from a deep past but have a deep future, their effects lasting beyond human experience and capacity to calculate or perceive them.

Health in this setting cannot be contained by definitive measures, as it becomes a function of social, environmental, and planetary adaptability (see Greco 2004, 10). The greater the openness to multiplicity, it would seem, the greater the possibility of future health. The parameters within which technoscientific measurements produce best evidence, therefore, seem to raise semantic, ethical, epistemological, and ontological questions that cannot be answered when valuation and facticity are held apart and the possibility of multiple ontologies is excluded. We assume here that more radical questions need to be asked about the conditions of possibility for imagining and making ethical and political claims on the future, with the difficult acknowledgment that life itself may at times be the harm, that, as Latour (2017) frames it, nature does not bring peace.

The planetary imaginary

Clearly, the notion of health has expanded beyond the modern medical model based on manifestations of particular diseases in discrete forms. Health has come to encompass the epidemiological entanglements of life as such, of biology, of biospheric and biochemical processes, to the point where people speak of 'planetary health'. Imagined beyond the specific formations that have preceded and followed the institutional call for planetary health, the planetary as an invocation has the potential to fold in possibilities of thinking health outside the determinations and priorities of technoscience, NGO governmentality and participation, big data, and global finance (see Adams 2016, 169–71). There is perhaps a welcome opening in this whiff of transcendence, but its outcome will yet depend on who else heeds the call, what else might get organized under the umbrella term.

As one alternative, one might point to how a similar set of issues around health and the planet has been activated through questions about decolonizing knowledge, indigenous sovereignty, and stewardship of resources (Bryant-Tokalau 2018). It is important to note that these often have not been academic exercises but connected to specific struggles against rampant extractivism and political repression, from the Dakota Access Pipeline (DAPL) in the United States to soy and palm oil plantations in the Amazon to seabed mining in the Pacific Islands. Indeed, in at least one interesting instance, the relation between resistance and climate change has been measured: in a talk delivered at the American Geophysical Union, the geophysicist Brad Werner calculated that direct-action activism has a larger impact on sustainability than environmental management (Romm 2012). In some quarters, this political vision has been taken deeper into epistemic realms, promoting epistemologies, ontologies, and worldviews that allow for the recognition of the rights of environmental features such as rivers, mountains, and forests (de la Cadena 2010; Greco 2004; Million 2013; Youatt 2014; also see Ticktin, this issue).

This epistemic commitment to approaches that have from the outset assumed the connection of environment to health – and that run parallel to other reclaimings of alternative medicine and knowledge, such as Ayurveda (Halliburton 2009) and Chinese traditional medicine (Zhan 2009) – is not a path recommended by the commission or other backers of planetary health so far. For despite what the name might suggest, planetary health does not hark back to an ideal preindustrial and premodern mode of living in harmony with nature, nor does it call for the recognition of natural resources as entities that have the right to be protected, or attempt to revalue knowledges that have been cut off, derailed, frozen, and closed off by European modernity under the categories of tradition and superstition and thus prevented from unfolding under the same institutions and regimes as health and medicine in their official forms. It seems, in fact, that the calls for planetary health have generated proposals that have made no commitments to those knowledges, since the

causation of the identified paradox – improved health for (some) humans comes along with the damaged health of the entire earth – has not been addressed accordingly. It seems that the proposals collected under the rubric of planetary health tend to go in a different direction: a computational, digital, financial, and synthetic one. For example, amongst the initiatives endorsed by the backers of Planetary Health is the development of pandemic insurance to mitigate health risks in Africa (Rodin 2015), an approach examined by Erikson in this issue. Thus, the danger is that under a new universal imaginary – the abstraction of the planetary and the hopes of salvation by technology – racialized pasts and class inequities get tirelessly repeated.

Building on notions of social (Castoriadis 1988; Taylor 2003) and technoscientific imaginaries (Jasanoff and Kim 2015; Marcus 1995), we consider a planetary imaginary in which collective life is understood, researched, and experienced in relation to planetary processes and where basic questions about existence are answered and understood in relation to the same. The term 'imaginary' does not mean that the relations and their representations are false or merely ideal; bypassing both constructivism and positivism, it denotes a particular representational and affective order through which the world is apprehended and under which actual practices are organized. The symbolic understanding of the planetary entails biological, social, and even molecular notions of deep interrelatedness among large non-species-specific forces, processes, and events. At the opening of this introduction, we mentioned Lovelock, the scientist best known for the controversial Gaia hypothesis; he was also the first to use the term 'planetary medicine', by which he referred in part to the interconnection, for example, of genes, cells, and the planet such that the weak intermolecular forces that keep the molecules of cell membranes together are susceptible to environmental conditions such as temperature, salinity, acidity, and so on; in another of his examples, he explores how the health of the planet depends on the health of microscopic marine algae (Lovelock 1991, 181). Thus it would seem that for planetary health, these kinds of connections would have to have their own measures.

When we talk about a planetary imaginary as constituting future health, we are not talking about global health. We are talking partly about the symbiotic entanglement of the earth's biospheric processes and its biological life forms. But we are also referring to the relationships between competing epistemes, unmeasurable timescales, and, as Ticktin points out, reconceptualizations of basic categories, such as the human, and what ought to matter for humans or what happens when humans are invoked as a category within the planetary. Thinking about animal rescue or bee habitats, one might ask what planetary health means with respect to the commitment of resources. Save some bees or save some humans? How do we know what will be better in the long run? For the planet? Who defines what the planet is and how best to protect its integrity and balance? Does the planet itself become a political

subject – the rights of Gaia – whose interests must be evaluated, rather than a passive biochemical surface for instrumental use? Does the planet's right to health supersede ours? Who defines these rights, and on the basis of what measurements? If scientists like Haines, quoted earlier, are finding ways to question progress and growth in relation to health, it is surely because the planetary imaginary and its temporality (and data) have compelled them to. A symbiotic planetary politics of health would recognize the total interconnectivity of health- and illness-producing systems, thereby bypassing the focus on norms and deviations, or the normal and the pathological.

Some of these ideas are brought out in the Ugandan context by Calkins's article on cultural and molecular visions of growth, banana health, and national projects. Calkins explores how a health problem, specifically an apparent or measured lack of vitamin A in some Ugandan populations, is being addressed by adding beta-carotene, a precursor of vitamin A, to genetically modified bananas, with the goal of improving the condition of both the banana and the nutritional status of those people in Uganda for whom bananas are a staple crop. Calkins compares this 'unlinear' and universalist model of intervention to a more 'rhizomatic' and culturally specific notion of growth among Baganda, one modeled specifically on observations of the ecological behavior and form of banana plants. Implied in this analysis and echoed in a number of other contributions to this collection (Erikson, Livingston, Lowe) are questions about the limits and desirability of control and growth. Can we be healthy without growth? Without the growth of microbes? What kind of growth do we have in mind if it is not Darwinian growth, based on maximizing the number of offspring? If symbiopolitical interdependency means letting go of a realm of governance over nonhuman life (or parts thereof), then what kinds of proliferations, of forms of life and life forms, would we be facing? That could mean considering a version of Lovelock's ideal of homeostasis, a system of balances, but taken in terms both of value and fact; the cost of such balance is the reckoning not with death but with the fact that *zöe* transforms and *zöe* kills. A happy homeostasis may not be life's strong suit. The Marxian materialist question would take this problematic another way and ask: without a change in the infrastructure of capitalism and hypermilitarized global security apparatuses, can a planetary imaginary really disrupt notions of progress and imperatives of growth, and change the direction of development and extraction?

The collapse of the carbon barrier

Basic health care has been increasingly moving toward digitization. The World Health Organization now spends US$123 million alone on 'e-health', mobile devices (mHealth), big

data, and information systems (WHO 2017).₃ But the imbrication of electronic and digital systems with biological ones in the field of health goes beyond data collection and number crunching. Duclos's analysis of Google Flu Trends (GFT) makes this point in an interesting context. While GFT appears to be simply working as an algorithmic data-crunching mechanism, it functions on the very assumption that digital patterns of human behavior can stand in for biological vectors. In other words, it assumes that there is an easy translation between the digital/algorithmic and biological, one that can bypass the cultural. This is what Farman, in his analysis of nanomedical futures, calls 'the collapse of the carbon barrier', carbon being the basic substrate of biology. The overall claim here is that the move to e-health, digital health, nanomedical molecular devices, genetic engineering, and algorithmic disease surveillance via search engines and internet behavior cannot be understood only as an add-on to or technical enhancement of health measures. They both represent and produce the inextricable fusion of organic and nonorganic processes.

The posthumanism entailed in future health and its developing practices and tools forces an encounter not just with the nonhuman, zoonotic, or organic earth systems, as in One Health and planetary health, or only with 'morphological freedom' (Dolezal 2016), as in the transhumanist value of using biotechnology to shape the body and enhance its capacities at will. Rather, it references how nonbiological, nonorganic, synthetic, and computational processes have become deeply enmeshed with the biological. We are bringing attention here not only to shifts in scale and breadth but also to changes in the fundamental objects being assessed, measured, and deployed. When metrics move from dealing with quantities to dealing with data, in other words, with sets of information nuggets circulating on the internet in no time and often associated with the four big private US-based corporations known as 'GAFA' (Google, Amazon, Facebook, Apple), the nature of the relationship between data and the world changes because the algorithms needed to turn data into information have their own dynamics beyond metrics. This is not to add to the literature that sees algorithms as our new sovereigns (Barocas, Hood, and Ziewitz 2013). Undoubtedly, algorithms first of all are, as Nick Seaver (2017) argues, cultural objects in the sense that they are made, activated, and contested by their human animators; consequently, as others have shown, they repeat and reproduce their proclivities and prejudices (see for example Noble 2018). Nevertheless, when it comes to learning algorithms (machine learning and AI), there is a level of algorithmic autonomy when they run beyond human control. This makes algorithmic big-data processing – of the kind that learns to make decisions that cannot be shared with their creator-engineers – something more than just an analysis of indicators or indexes of, say, infant mortality. Even when they purport to be indicators, as in Duclos's

---

3   We thank Sarah Freeman for additional research on these figures.

analysis of Google Flu Trends or Erikson's analysis of financial instruments, they appear as drivers, independently operating agents moving in autonomous domains where decisions are made through data hitting up against other data through a chain of functions that, originally human made, come to change on their own without the permutations and effects being trackable, creating what the legal scholar Frank Pasquale (2016) calls 'the black box society'. For example, where epidemiology becomes algorithmic processing of nonbiological data, decisions and consequences are based on experts listening to the advice of data interpreted by AI, not experts assessing and acting within a bioenvironment.

Additionally, we note an important shift in technoscientific relations to the world from one of establishing laws, determining concepts, modeling, and so on to one of probabilistic correlations (versus causes), direct activation, and, more crucially, 'recursive' prognostication: that an algorithm's predictive activities can at the same time transform the world it is assessing and operating in (Connor 2009). A learning algorithm that tells you it knows what you might like is also transforming the world of 'what is liked in general' as you agree or disagree with it and thereby also train it to become less random in its prognostication. Thanks to the cartography of power between Wall Street and Silicon Valley in the United States of America, the mode of prognostication supervenes on the mode of production and searches, Facebook posts, and tweets have become the key means of gathering data and generating prognostications regarding selves, minds, and bodies. Here, the digital public – the searching animal, whose Aristotelian animal curiosity has been Googleized – faces not just data inequality and blind spots but also the literal multiplying of selves and bodies into clouds, servers, and networks in a way that makes the health of those (silicon-based) assemblages inseparable from the health of (carbon-based) human networks. Given the contemporary entanglement of technology and geopolitics, this state of affairs may be spreading worldwide. However, in terms of population numbers, it is still a minority that inhabits this brave new world, and it remains to be seen if it might forever remain limited to a global minority, as has been the fate of so many other infrastructures: clean tap water, flush toilets, health insurance, and medical services on a level considered appropriate in the United States.

It was notable that the day after the conference at the New School ended, a black mobile care van appeared parked nearby just outside Union Square in New York. With a white and blue band-aid cross as its emblem, it evoked the possibility of something like an anarchist health unit (fig. 1). It turned out to be a Samsung publicity van that equated the care of smartphones with health care, comparing device servicing with biomedical attention.
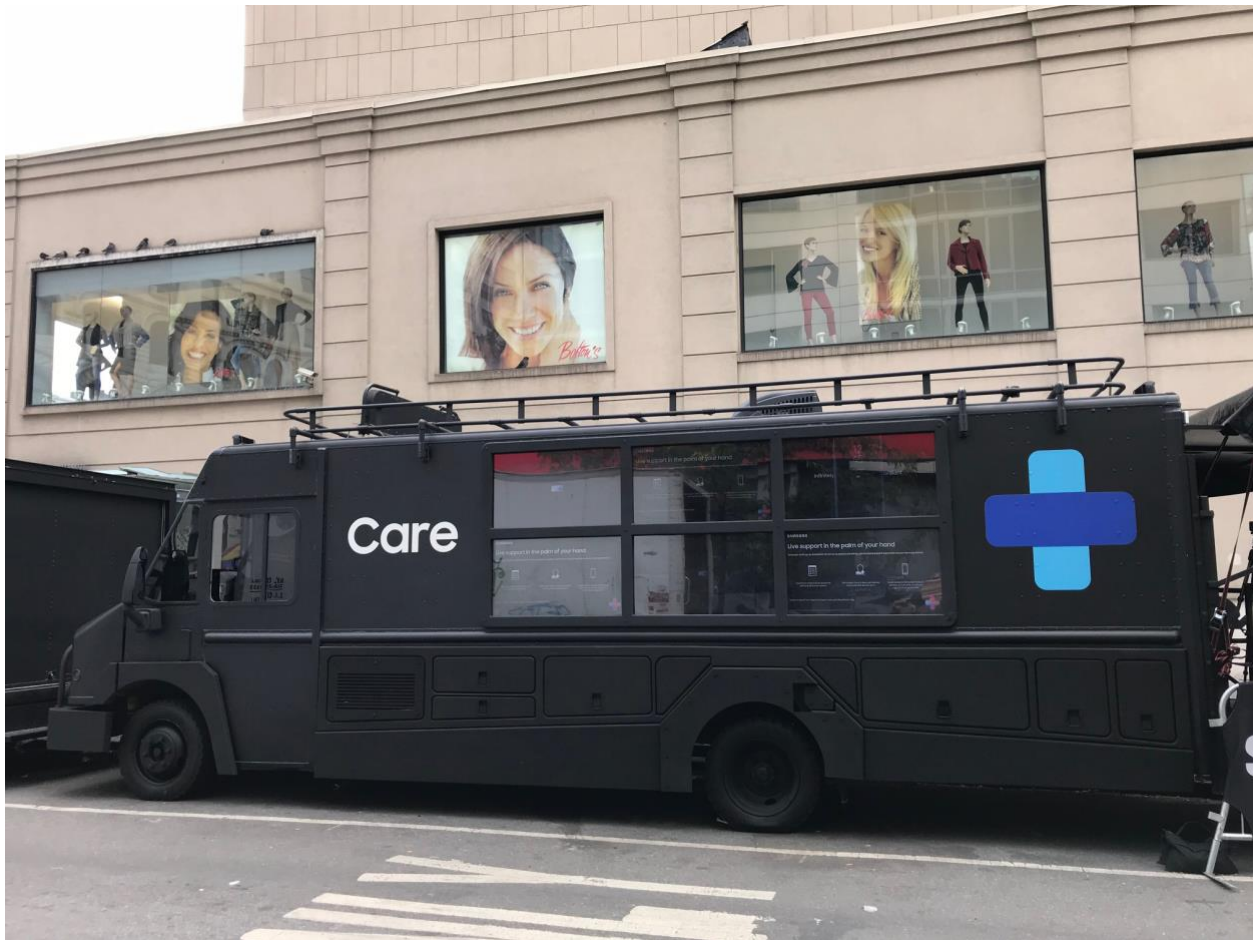
Figure 1. Samsung publicity van. Photo by Matteo Norzi.

This was neither a stretch nor a metaphor, as increasingly selves are integrated into devices and externalized outside the human body that secular liberalism understands as the full and total container of the self. For the most part, both biomedical and critical approaches to these futures have focused on the problems of privacy and the threats (or benefits) of surveillance: the recent approval by the American Food and Drug Administration (FDA) of the first publicly available digital pill, an antipsychotic, is another mainstream example (Belluck 2017). This sophisticated technology, one of many such products in the works, is designed to monitor proper and timely intake of the pill to reduce the problems and costs of nonadherence. While the advocates laud this as a potential boost for public health, the ethical alarms have sounded about Big Brother inside the body: in this digital prosthetic creep, are we moving toward surveillance pills that transmit data from the body back out to monitoring agencies? The ontological, affective, and larger political questions are less prominent in the criticisms so far. In the affects and mechanisms of nano and informatic futures, also analyzed by Farman, we see a merger between very complex biodigital processes that render moot important distinctions between inside and outside the body, the biological

and digital body. What does this portend for new affects around health and illness, new subject formations, new forms of well-being?

Linked to planetary and multispecies future-making in its posthumanism, the fusion of the carbon-silicon substrates brings up questions similar to those raised at the heart of the planetary: Is this posthuman vision an insult to those suffering from deep and basic inequalities that can be addressed with current techniques, social interventions, or technologies? Are these new formations reproducing the conditions of ill health through the ongoing concentration of wealth and power in certain locations? Or, given the technoscientific, juridico-political, and sociocultural present, are these the only viable solutions for the future? Brought down to a more basic point, one might say that such objects as microbes, chemicals, algorithms, data, financial flows, and nanobots become manifest as key shapers of future health. The critical focus on the division between life and nonlife – also refracted as the division between life and death – invokes more than a postvital politics because it examines a politics in which the fragmentation of selves, actors, and ontologies opens up a space for new formations that only sometimes announce themselves through the overdetermined centrality of the notion of and desire for health in a biopolitical age, an age now being bypassed.

Sovereignty – global and local regimes

We would like to conclude by pointing out that the papers bring out new tensions between sovereignty and global or planetary health. Take the work of the national research institute in Uganda described by Calkins. Using globally developed molecular and genetic techniques, the institute is working to produce a 'public health banana' that is genetically bred to provide the micronutrient deemed to be missing from Ugandan diets and bodies. Or, for another example, take the national institute in Indonesia analyzed by Lowe. Working on bird flu, that institute invoked 'viral sovereignty' in order to withhold crucial samples from the global health community. One reason given, among other reasons, was to protect the country's own population by claiming that Western companies would come to control the vaccine and make it inaccessible to the country in the event of a pandemic. Thus, national sovereignty becomes imbricated with national health to create a politics of anti-imperialist resistance while also identifying a biosocial group – Indonesians, say, or Ugandans – as separate from the universal human body presented by globalized medicine (see Langwick 2018b).

Global health is one of the domains through which sovereignty has been challenged, such that national sovereignty is often overridden through global exigencies that, as Erikson and Lowe note, prioritize the health of some nations over others, often repeating older colonial hierarchies. In planetary health, that tension is far from resolved. As Ticktin elaborates in her

paper, the hopeful ideologies of a worldwide movement called One Health, which addresses the ways in which animal, human, and planetary health are interconnected, may repeat global hierarchies of power and sovereignty. While One Health's interspecies approach has potential for opening up new ways of thinking and doing global health, its assumption of a single biocommunicable planet obscures the fact that its projects are often literally built on old colonial infrastructures that are geared toward the surveillance of human populations. The globality of global health in its new planetary and biosymbiotic iterations ought not to be taken for granted. Whether it will end up reconfiguring health or sovereignty or bringing about better ways of dealing with health across borders and scales or whether that tension will simply be the site of biopolitical and technocivilizational conflicts remains to be seen.

It is clear in places like Botswana, described by Livingston in her forthcoming book and in the afterword to this issue, that impressive economic growth has brought improved health and well-being. Yet this has come at the price of ecological disaster, which is about to engulf everything, not just Botswana. Methane produced by bovine flatulence affects the atmosphere that wraps around us. Indeed, the understanding that development and health may be at odds was precisely the conclusion reached by the *Lancet* report, which explicitly stated that changes in the ecosystem could overturn nearly half a century of gains in human longevity and well-being. Unlike Livingston, the *Lancet* does not problematize the conditions and basic assumptions that produced the situation to begin with. For the problem is not just that development automatically leads to destruction, as planetary health graphics indicate (fig. 2). Rather, certain excesses – overconsumption, overproduction, overmilitarization – lead to destruction.

Figure 2. Screengrab of infographic from *The Lancet*, 'Safeguarding Human Health in the Anthropocene Epoch: Report of The Rockefeller Foundation–*Lancet* Commission on Planetary Health' (Whitmee et al. 2015).

So the question may be an old anthropological one about the 'nature' of things, recast here through the lens of future health: is that *excess* intrinsic to the nature of human development and growth? Or as Georges Bataille (1991) would have it, is this excess part of the excesses

and vitality of life itself? For Charles Darwin, excess was part of the law of nature that drives evolution: all species have to produce a great multitude of offspring. Only a small number would survive, and this would imply a universal struggle for existence (see Darwin and Costa 2009, 63–64). In an interesting twist, Dipesh Chakrabarty has suggested a link between this Darwinian credo and the emergence in Europe and North America of the nuclear family with two or even fewer children.4 The value attached to this parsimonious unit in these countries through the course of the twentieth century was partly rooted in the old distinction between subject and object, which also entailed the distinction between nature and culture and hence the possibility or even obligation to emancipate the human from nature by controlling it.5 Aided by modern medicine and developments in public health, the citizens of these countries began to disentangle themselves – or so they thought – from what Darwin explained as a condition of excess universal to all species. Even as in many quarters of Europe and North America the nuclear family was feared as evidence for the degeneration of the 'white race' and ultimately white extinction (Brantlinger 2003), the ideal of the nuclear family was spread to many parts of the world and was sometimes used as a racial ideology to curb the so-called excesses of non-European population growth and establish a planned and rational world.

As Achille Mbembe (2017, 66) writes about the colonial period: 'many [in Europe] firmly believed that the struggle for life was one that opposed fundamentally different human groups, peoples or races'. He quotes Paul Leroy-Beaulieu, who 'explained at the time that the colonial order was a way of ratifying the relations of power that resulted from such struggle', to make his own point that in this constellation colonization rather than procreation represented the power of reproduction. Europeans, appealing to a universal human history and the unfolding of universal reason, tried to move out of the logic of the natural history of biological life, until the question of the human impact on the biosphere shattered that dream: it turned out that the Western nuclear family was far more destructive to the planet. This disillusionment only began to strike the mainstream of the Western world some four generations later, and thus we now have cries for radically new understandings of health geared toward a *re-entangling* with nature.

---

4   One of us, Richard Rottenburg, had the privilege to speak with Dipesh Chakrabarty on related issues and it was he who drew our attention to Darwin's interpretation of excess as being intrinsic to all species.

5   Bruno Latour conceives the subject-object dualism to be the root cause for why modernity has gone wrong; he offers a short, bold, and easy-going summary of the long and intricate history of European philosophical controversies about and attempts to critically correct this dualism (Latour 1993, 49–90).

In the midst of this re-entanglement, the articles in this issue suggest, we need notions of health that don't reproduce easy validations of individual health as the obvious and key path to generalized well-being in the future; we also need approaches that don't prioritize technoscientific solutions, which in their political economies have often helped produce the conditions endangering planetary health. In the decoupling of epistemic and socioeconomic development from health, new orientations may be necessary in order to avoid the paradoxical drive that Livingston calls 'self-devouring growth' whereby the alleviation of misery and the increase in health lead to other forms of destruction that threaten all life. The entangled indeterminacy of health in general, as well as its measures, bestows on us the ethical demand to explore other concepts and approaches, and some of this work has been started by feminist scholars around notions of well-being and care (Murphy 2013; Puig de la Bellacasa 2017). In this issue, Ticktin traces transformations in the Euro-American notion and organization of care from welfare and humanitarianism, in which intervention was based on moral sentiment, to what she identifies as a third moment, in which the decisions for action seem to be based on biological ecology, since the imagined collectives of care include more than the human. Such possibilities compel us to explore how new notions of future health transform ideas of justice and alternative social arrangements and how they may set the conditions of possibility for imagining and making ethical and political claims on these futures.

Clearly, ethics in the futures of health is far from a simple matter. Health and well-being, though two different concepts produced through a range of assemblages, are connected in complex ways that make it difficult to measure each separately; it is equally difficult to measure the pattern and intensity of their conjunction. At any rate, if health and well-being are intertwined, then in Adorno's ethical question about the possibility of a good life in a bad one ('Es gibt kein richtiges Leben im falschen' [Adorno 1975, 42]) also lies coiled a question about the possibility of a healthy life in an unhealthy one. The challenge, then, may be not about how we measure but how we measure up to the moving horizon of the promises and pitfalls embedded in health and well-being. And at the heart of this challenge lies the fundamental dilemma that we can never be sure which proofs for promises of health and well-being we should trust when we inescapably need to trust some more than others. Because air, water, and landscape belong to all the species on the earth, we also must be able to hold one another accountable for how we deal with the earth. 'We' here refers to the humans as humans but also to humans as agentive partners or companion species to nonhumans. And 'accountable' refers to the critical tone all the contributions to this collection cultivate. When things go wrong and require interventions, it is difficult to avoid insisting that, against all insights into distributed agency that includes other-than-human entities, and against all insights into empirical indeterminacy, it might still make sense on the social and political level to recognize juridical entities, including collectives, that can be credited responsibility along with responsiveness.

About the authors

An anthropologist, writer, and artist, Abou Farman is author of the book *Clerks of the Passage* (Linda Leith Press, 2012) and *On Not Dying: Secular Immortality in the Age of Technoscience* (University of Minnesota Press, 2020). He is Assistant Professor of Anthropology at The New School for Social Research and founder of Art Space Sanctuary as well as the Shipibo Conibo Center of New York. As part of the artist duo caraballo-farman, he has exhibited internationally, including at the Tate Modern (London) and PS1/MOMA (New York) and received several grants and awards, including New York Film Academy and Guggenheim Fellowships. He is producer and cowriter on several feature films, most recently *Icaros: A Vision*.

Richard Rottenburg is Professor of Science and Technology Studies at Wits University. He is the founder of the Law, Organization, Science and Technology (LOST) research network. Inspired by social studies of science and technology, renditions of pragmatist social theory, and the material-semiotic approach, forms of technicization are at the heart of his current work. His inquiries foreground the making of evidence and infrastructure, and ask how related practices are mobilized to design and critique emergent futures. He is mainly known for his book *Far-Fetched Facts* (MIT Press, 2009) that crosses the boundaries between anthropology and STS and defines a new departure for the examination of science and technology beyond the West.

References

Adams, Vincanne, ed. 2016. *Metrics: What Counts in Global Health*. Durham, NC: Duke University Press.

Adorno, Theodor W. 1975. *Minima Moralia. Reflexionen aus dem beschädigten Leben*, *Bibliothek Suhrkamp*. Frankfurt: Suhrkamp.

The Asthma Files. n.d. Platform for Experimental, Collaborative Ethnography. http://theasthmafiles.org.

Barocas, Salon, Sophie Hood, and Malte Ziewitz. 2013. 'Governing Algorithms: A Provocation Piece'. Essay written in preparation for the conference Governing Algorithms: A Conference on Computation, Automation, and Control, New York University, 16–17 May. http://governingalgorithms.org/resources/provocation-piece/.

Bataille, Georges. 1991. *The Accursed Share*. New York: Zone.

Beisel, Uli, Sandra Calkins, and Richard Rottenburg. 2018. 'Divining, Testing, and the Problem of Accountability'. *HAU: Journal of Ethnographic Theory* 8 (1/2): 109–113. https://doi.org/10.1086/698360.

Belluck, Pam. 2017. 'First Digital Pill Approved to Worries about Biomedical "Big Brother"'. *New York Times*, 13 November. https://www.nytimes.com/2017/11/13/health/digital-pill-fda.html.

Biehl, João. 2016. 'Theorizing Global Health'. *Medicine Anthropology Theory* 3 (2): 127–42. https://doi.org/10.17157/mat.3.2.434.

Biehl, João, and Adriana Petryna, eds. 2013. *When People Come First: Critical Studies in Global Health*. Princeton, NJ: Princeton University Press.

Brantlinger, Patrick. 2003. *Dark Vanishings: Discourse on the Extinction of Primitive Races, 1800–1930*. Ithaca, NY: Cornell University Press.

Brown, Theodore M., Marcos Cueto, and Elizabeth Fee. 2006. 'The World Health Organization and the Transition from "International" to "Global" Public Health'. *American Journal of Public Health* 96 (1): 62–72. https://doi.org/10.2105/AJPH.2004.050831.

Bryant-Tokalau, Jenny. 2018. *Indigenous Pacific Approaches to Climate Change: Pacific Island Countries*. Cham: Palgrave Macmillan.

Canguilhem, Georges. 1988. *Ideology and Rationality in the History of the Life Sciences*. Cambridge, MA: MIT Press.

Castoriadis, Cornelius. 1988. *The Imaginary Institution of Society*. Cambridge, MA: MIT Press.

Choy, Tim. 2011. *Ecologies of Comparison: An Ethnography of Endangerment in Hong Kong*. Durham, NC: Duke University Press.

Connor, Steven. 2009. 'Michelle Serres: The Hard and the Soft'. Presentation given at the Centre for Modern Studies, University of York, 26 November. http://www.stevenconnor.com/hardsoft/.

Danowski, Déborah, and Eduardo Batalha Viveiros de Castro. 2017. *The Ends of the World*. Translated by Rodrigo Nunes. Cambridge: Polity.

Darwin, Charles, and James T. Costa. 2009. *The Annotated Origin: A Facsimile of the First Edition of On the Origin of Species*. Cambridge, MA: Harvard University Press.

de la Cadena, Marisol. 2010. 'Indigenous Cosmopolitics in the Andes: Conceptual Reflections beyond "Politics"'. *Cultural Anthropology* 25 (2): 334–70. https://doi.org/10.1111/j.1548-1360.2010.01061.x.

Desrosières, Alain. 1998. *The Politics of Large Numbers: A History of Statistical Reasoning*. Cambridge, MA: Harvard University Press.

Dolezal, Luna. 2016. 'Morphological Freedom and Medicine: Constructing the Posthuman Body'. In *The Edinburgh Companion to the Critical Medical Humanities Book*, edited by Sarah Atkinson, Jane Macnaughton, and Jennifer Richards, 310–24. Edinburgh: Edinburgh University Press.

Erikson, Susan. 2016. 'Metrics and Market Logics of Global Health'. In *Metrics: What Counts in Global Health*, edited by Vincanne Adams, 147–62. Durham, NC: Duke University Press.

Farman, Abou. 2017. 'Terminality'. *Social Text* 35 (2): 93–118.

Farmer, Paul. 2001. *Infections and Inequalities: The Modern Plagues.* Berkeley: University of California Press.

Fassin, Didier. 2011. *Humanitarian Reason: A Moral History of the Present.* Berkeley: University of California Press.

Feldman, Ilana, and Miriam Ticktin, eds. 2010. *In the Name of Humanity: The Government of Threat and Care.* Durham, NC: Duke University Press.

Foucault, Michel. 2003. *'Society Must be Defended': Lectures at the College de France*. Translated by David Macey. London: Penguin.

Gates Foundation. 2018. 'Simulation: Global Flu Pandemic'. YouTube video. https://www.youtube.com/watch?v=9afTl9z5JHQ.

Geissler, Wenzel, Richard Rottenburg, and Julia Zenker, eds. 2012. *Rethinking Biomedicine and Governance in Africa: Contributions from Anthropology.* Bielefeld: Transcript.

Greco, Monica. 2004. 'The Politics of Indeterminacy and the Right to Health'. *Theory, Culture & Society* 21 (6): 1–22.

Hacking, Ian. 1975. *The Emergence of Probability: A Philosophical Study of Early Ideas about Probability, Induction, and Statistical Inference*. London: Cambridge University Press.

Hacking, Ian. 1990. *The Taming of Chance.* Cambridge: Cambridge University Press.

Halliburton, Murphy. 2009. *Mudpacks and Prozac: Experiencing Ayurvedic, Biomedical, and Religious Healing.* Walnut Creek, CA: Left Coast.

Helmreich, Stefan, and Eben Kirksey. 2010. 'The Emergence of Multispecies Ethnography'. *Cultural Anthropology* 25 (4): 545–76.

Horton Richard, Robert Beaglehole, Ruth Bonita, John Raeburn, Martin McKee, and Stig Wall. 2014. 'From Public to Planetary Health: A Manifesto'. *Lancet* 383: 847.

Jain, S. Lochlann. 2013. *Malignant: How Cancer Becomes Us*. Berkeley: University of California Press.

Jasanoff, Sheila, and Sang-Hyun Kim. 2015. *Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power*. Chicago: University of Chicago Press.

Jerven, Morten. 2013. *Poor Numbers: How We Are Misled by African Development Statistics and What to Do about It*. Ithaca, NY: Cornell University Press

Koselleck, Reinhart. 2004. *Futures Past: On the Semantics of Historical Time*. Translated by Keith Tribe. New York: Columbia University Press.

Lakoff, Andrew. 2010. 'Epidemic Intelligence and the Technopolitics of Global Health'. Paper prepared for the Berkeley Workshop on Environmental Politics, University of Southern California. http://globetrotter.berkeley.edu/bwep/colloquium/papers/lakoff_BWEP.pdf.

Lakoff, Andrew, and Stephen Collier. 2008. *Biosecurity Interventions: Global Health and Security in Question.* New York: Columbia University Press.

Langwick, Stacey. 2018a. 'Healing in the Anthropocene'. In *The World Multiple: Politics of Knowing and Generating Entangled Worlds*, edited by Keiichi Omura, Atsuro Morita, Shiho Satsuka, and Grant Jun Otsuki, 155–72. New York: Routledge.

Langwick, Stacey. 2018b. 'A Politics of Habitability: Plants, Healing, and Sovereignty in a Toxic World'. *Cultural Anthropology* 33 (3): 415–43.

Latour, Bruno. 1993. *We Have Never Been Modern*. Cambridge, MA: Harvard University Press.

Latour, Bruno. 2017. *Facing Gaia: Eight Lectures on the New Climate Regime*. Translated by Catherine Porter. Cambridge: Polity.

Little, Daniel. 2003. *The Paradox of Wealth and Poverty: Mapping the Dilemmas of Global Development*. Boulder, CO: Westview.

Lock, Margaret, and Vinh-Kim Nguyen. 2010. *An Anthropology of Biomedicine*. West Sussex: Wiley.

Lovelock, James. 1991. *Gaia: The Practical Science of Planetary Medicine*. London: Gaia.

Mamdani, Mahmood. 1972. *The Myth of Population Control: Family, Caste, and Class in an Indian Village*. New York: Monthly Review Press.

Marcus, George, ed. 1995. *Technoscientific Imaginaries: Conversations, Profiles, and Memoirs*. Chicago: University of Chicago Press.

Margulis, Lynn, and Dorion Sagan. 1995. *What Is Life*? Berkeley: University of California Press.

Mbembe, Achille. 2017. *Critique of Black Reason*. Translated by Laurent Dubois. Durham, NC: Duke University Press.

Million, Dian. 2013. *Therapeutic Nations: Healing in an Age of Indigenous Human Rights*. Tucson: University of Arizona Press.

Murphy, Michelle. 2013. 'Chemical Infrastructures of the St. Clair River'. In *Toxicants, Health, and Regulation since 1945*, edited by Nathalie Jas and Soraya Boudia, 103–115. London: Pickering and Chatto.

Myers, Samuel S., K. Ryan Wessells, Itai Kloog, Antonella Zanobetti, and Joel Schwartz. 2015. 'Effect of Increased Concentrations of Atmospheric Carbon Dioxide on the Global Threat of Zinc Deficiency: A Modelling Study'. *Lancet Global Health* 3 (10): e639–45. https://doi.org/10.1016/S2214-109X(15)00093-5.

Noble, Safiya Umoja. 2018. *Algorithms of Oppression: How Search Engines Reinforce Racism*. New York: NYU Press.

Palladino, Paolo. 2016. *Biopolitics and the Philosophy of Death*. London: Bloomsbury.

Pasquale, Frank. 2016. *The Black Box Society: The Secret Algorithms That Control Money and Information*. Cambridge, MA: Harvard University Press.

Population and Development Program. 2006. '10 Reasons to Rethink "Overpopulation"'. PopDev DifferenTakes Issue Paper 40. Amherst, MA: Hampshire College. https://sites.hampshire.edu/popdev/10-reasons-to-rethink-overpopulation/.

Porter, Theodore M. 1996. *Trust in Numbers: The Pursuit of Objectivity in Science and Public Life*. Princeton, NJ: Princeton University Press.

Power, Michael. 1997. *The Audit Society*. Oxford: Oxford University Press

Puig de la Bellacasa, María. 2017. *Matters of Care: Speculative Ethics in More Than Human Worlds*. Minneapolis: University of Minnesota Press.

Putnam, Hilary. 2002. *The Collapse of the Fact/Value Dichotomy*. Cambridge, MA: Harvard University Press.

Rabinow, Paul. 1999. *French DNA: Trouble in Purgatory*. Chicago: University of Chicago Press.

Redfield, Peter. 2013. *Life in Crisis: The Ethical Journey of Doctors Without Borders*. Berkeley: University of California Press.

Rodin, Judith. 2015. 'Planetary Health: A New Discipline in Global Health'. *The Rockefeller Foundation* (blog). 16 July. https://www.rockefellerfoundation.org/blog/planetary-health-a-new-discipline-in-global-health/.

Romm, Joe. 2012. 'AGU Scientist Asks, "Is Earth F**ked?" Surprising Answer: Resistance Is NOT Futile!' *Think Progress*, 9 December. https://thinkprogress.org/agu-scientist-asks-is-earth-f-ked-surprising-answer-resistance-is-not-futile-eaf54f9cf88f/.

Rose, Nikolas S. 1990. *Governing the Soul: The Shaping of the Private Self*. London: Free Association Books.

Rottenburg, Richard. 2005. 'Code Switching, or Why a Metacode Is Good to Have'. In *Global Ideas: How Ideas, Objects, and Practices Travel in the Global Economy*, edited by Barbara Czarniawska and Guje Sevón, 259–74. Copenhagen: Copenhagen Business School Press.

Rottenburg, Richard. 2009. *Far-Fetched Facts: A Parable of Development Aid*. Cambridge, MA: MIT Press.

Rottenburg, Richard, Sally Engle Merry, Sung-Joon Park, and Johanna Mugler, eds. 2015. *The World of Indicators: The Making of Governmental Knowledge through Quantification*. Cambridge: Cambridge University Press.

Seaver, Nick. 2017. 'Algorithms as Culture: Some Tactics for the Ethnography of Algorithmic Systems'. *Big Data & Society* (December): 1–12. https://doi.org/10.1177/2053951717738104.

Seth, Suman. 2018. *Difference and Disease: Medicine, Race, and the Eighteenth-Century British Empire*. Cambridge: Cambridge University Press.

Shapin, Steven, and Simon Schaffer. 1985. *Leviathan and the Air-pump: Hobbes, Boyle and the Experimental Life*. Princeton, NJ: Princeton University Press.

Shore, Cris, and Susan Wright. 2015. 'Audit Culture Revisited: Rankings, Ratings, and the Reassembling of Society'. *Current Anthropology* 56 (3): 421–44. https://doi.org/10.1086/681534.

Smith, Matthew R., Gitanjali M. Singh, Dariush Mozaffarian, and Samuel S. Myers. 2015. 'Effects of Decreases of Animal Pollinators on Human Nutrition and Global Health: A Modelling Analysis'. *Lancet* 386 (10007): 1964–72. https://doi.org/10.1016/S0140-6736(15)61085-6.

Strathern, Marilyn, ed. 2000. *Audit Cultures: Anthropological Studies in Audit, Ethics, and the Academy*. London: Routledge.

Sun, Lena. 2018. 'Bill Gates Calls on US to Lead Fight against a Pandemic That Could Kill 33 Million'. *Washington Post*, 27 April. https://www.washingtonpost.com/news/to-your-health/wp/2018/04/27/bill-gates-calls-on-u-s-to-lead-fight-against-a-pandemic-that-could-kill-millions/?utm_term=.b2554ac79c1c.

Szreter, Simon. 2005. *Health and Wealth: Studies in History and Policy*. Rochester, NY: University of Rochester Press.

Taylor, Charles. 2003. *Modern Social Imaginaries*. Durham, NC: Duke University Press.

Ticktin, Miriam I. 2011. *Casualties of Care: Immigration and the Politics of Humanitarianism in France*. Berkeley: University of California Press.

Tilley, Helen. 2011. *Africa as a Living Laboratory: Empire, Development, and the Problem of Scientific Knowledge, 1870–1950*. Chicago: University of Chicago Press.

Timmermans, Stefan, and Aaron Mauck. 2005. 'The Promises and Pitfalls of Evidence-Based Medicine'. *Health Affairs* 24 (1): 18–28. https://doi.org/10.1377/hlthaff.24.1.18.

Umair, Irfan. 2015. 'Planetary Medicine Needed to Deal with Global Warming'. *Scientific American*, 17 July. https://www.scientificamerican.com/article/planetary-medicine-needed-to-deal-with-global-warming/.

Union of Concerned Scientists. 2014. 'The US and Military Oil'. https://www.ucsusa.org/clean_vehicles/smart-transportation-solutions/us-military-oil-use.html#.Wt0ftsgh1Bw.

Whitmee, Sarah, Andy Haynes, Chris Beyrer, Frederick Boltz, Anthony G. Capon, Braulio Ferrereira de Souza Dias, Alex Ezeh, et al. 2015. 'Safeguarding Human Health in the Anthropocene Epoch: Report of the Rockefeller Foundation–*Lancet* Commission on Planetary Health'. *Lancet* 386 (10007): 1973–2028. https://doi.org/10.1016/S0140-6736(15)60901-1.

WHO (World Health Organization). 2017. *WHO 2018–2019 Program Budget*. http://www.who.int/about/finances-accountability/budget/PB2018-2019_en_web.pdf?ua=1.

Whyte, Susan Reynolds, Michael Whyte, and David Kyaddondo. 2018. 'Technologies of Inquiry: HIV Tests and Divination'. *HAU: Journal of Ethnographic Theory* 8 (1/2): 97–108. https://doi.org/10.1086/698359.

Youatt, Rafi. 2014. 'Interspecies Relations, International Relations: Rethinking Anthropocentric Politics'. *Millennium* 43 (1): 207–223. https://doi.org/10.1177/0305829814536946.

Zhan, Mei. 2009. *Other-Worldly: Making Chinese Medicine through Transnational Frames*. Durham, NC: Duke University Press.