

Embodied Ecologies

How We Sense, Know and Act to Reduce Cumulative Chemical Exposures in Our Everyday Lives

Tait Mandler, Mariana Rios Sandoval, Michael Lim Tan and Anita Hardon

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Abstract

Our worlds and lives are awash with industrially-produced chemicals. This dizzying array of chemicals includes compounds, interactions, and health effects that are poorly, if at all, understood. While the vast majority of both natural and social science research continues to focus on the toxicities of single compound or classes of compounds, we propose a theoretical and methodological framework to attend to cumulative toxicities—known, unknown, interacting and in flux—in everyday life. Our approach builds on the empirical, methodological, and theoretical work of urban political ecology (UPE), anthropology of embodiment, and science and technology studies (STS), and uses radical cartography and ethnographic methods to gain insight into urban pollution's complex and uneven entanglements, which are inseparably chemical, social, and ecological. We are developing this approach in three phases: ethnographically attending to the sensorial experiences and embodied knowledges of those most affected; creatively and cartographically producing representations and evidence; and identifying and supporting existing modes of action and harm reduction practices. Currently transitioning between the first and second phase, here we also share fresh insights from our recently wrapped grand tours of collective explorations.

Keywords

Embodiment, Political Ecology, Environmental Health, Toxicities, Sensorial Mapping.

Introduction

Think of what you did today.

You woke up in the morning and got out of bed.

First things first: you brushed your teeth. You did so conscientiously, moving the brush in thorough tooth-wide strokes, up and down, making sure that the butylparaben, propylparaben, and triclosan—all preservatives put into the toothpaste to make it last longer on supermarket shelves and in bathroom cabinets, and also well-known endocrine disruptors—penetrate well into your gums.

You then jumped in the shower. You probably used soap, shampoo, and perhaps some kind of conditioner or scrub, if you were not in a rush. You rinsed most of this cocktail of parabens, phthalates, artificial scents, and colourants off your body, although some of these molecules, even if you could not feel or see them, had already penetrated your skin.

You stepped out of the shower and dried your body with a towel that still contained some of the pesticides used to grow the cotton of which it is made. After all, 16% of the world's insecticides are sprayed on cotton crops.¹

You then got dressed and applied some kind of deodorant. For a second, you may have worried, like a growing number of people around the world do, about the suggested links between cancer and the aluminium salts contained in most antiperspirants.

Finally, you rubbed on some lotion that contains highly-polluting polyethylene glycol as emulsifier (no wonder it was so silky!) If, on that particular day, you wanted to make a good impression, you may have splashed on a few drops of perfume or cologne, scented with a chemical recipe the manufacturer zealously (and legally) keeps secret.

And then you got dressed.

¹ Even though cotton crops are estimated to represent 2.4% of the world's farmlands, 6% of pesticides and 16% of insecticides are used in this single crop. Data published in 2018 by the Pesticide Action Network UK suggest these proportions have remained fairly stable over the past two decades (PAN UK 2018).

The last thing you did before leaving your house was to eat breakfast. If you live on the American continent, your morning cereal was probably made of genetically modified corn and residues of glyphosate, the herbicide the agrochemical multinational Bayer forcefully promotes to grow their own products. If you live in Europe, there were probably also traces of the herbicide in your food: in the flakes of corn grown in a field cleared with the same product, or in the honey made by bees that forage among crops treated with that and other chemicals.² If you live in Southeast Asia, part of your morning meal might have come from one or several plastic sachets, similar to the ones you can see littered around town, on the streets, and in the water.

After breakfast, you set off for work or school. Wherever your commute took you, you probably spent some time sitting in traffic and breathing. If you belong to the growing mass of people who cannot afford housing close to city centres, you likely had to sit in traffic for quite a while.

Your day, however, has just begun, as has the list of human-made chemicals you will encounter during its course.

A World of Cumulative Toxicities

Chemicals flow into and through our bodies along multiple pathways—the air we breathe, the water we drink, the work we do, the soil on which we live, play, and grow our food, the (pesticide-laced) food that we eat, the building materials of our homes, and the (personal) hygiene products we use—often without knowing what chemicals they contain (Fiske 2020; Solomon 2016). Toxic chemicals interact with each other, with organic material in our environment, and with endogenous molecules in our bodies. They are metabolised by our organs and excreted from our bodies as chemical metabolites that flow into our waterways affecting the quality of our drinking water (Spackman and Burlingame 2018; Shapiro 2015).

Our worlds and lives are awash with industrially produced chemicals. A recent review of the scientific literature revealed a dizzying array of them—the accumulation of 350,000 ‘novel entities’ (human-made chemicals that did not previously exist) in the environment (Wang et al. 2020). These chemicals generate compounds and interactions with health effects that are poorly understood, if at all. There is evidence that we have exceeded the ‘planetary boundary’ for chemical pollution, meaning that pollution disrupts the operation of ecological systems, has

² In June 2018, a group of French beekeepers filed a lawsuit against Monsanto, creator of the herbicide Roundup, and later that year, against the company's new owner, the chemical-pharmaceutical giant Bayer. The suit argued that glyphosate, the herbicide's main component, which the United Nation's International Agency for Research on Cancer (IARC 2015) has classified as a carcinogen molecule, was present in the honey their bees produced. This indicated that the herbicide was a potential, although not the only, cause of the massive die-offs of bee populations in Europe and many other places around the world (ANSES 2014; Laurent et al. 2016).

major impacts on human health, and will continue to do so into the foreseeable future (Steffen et al. 2015). While people undoubtedly experience exposures and resulting health effects unevenly, depending on socioeconomic status and geographical location, mass-produced chemicals dispersed in the environment have led to ‘near universal human exposure’ (Landrigan et al. 2018). Accordingly, we suggest reframing the problem of chemical exposure from a concern with the toxicity of individual chemicals to considering and acting upon cumulative toxicities (see Fig. 1). The vast majority of both natural and social science research, however, continues to focus on the toxicities of single compounds or classes.



Figure 1: In everyday life, industrially-produced chemicals constituting and borne by pollution, consumer goods, construction materials, pharmaceuticals, fertilisers, and insecticides thoroughly permeate the profound metabolic interrelations of bodies and environments through ecological constellations and flows of air, water, food, and soil (see Levins and Lewontin's *The Dialectical Biologist* (1985) on the metabolic and historical profundity of organisms and environments mutually-transformative interrelations). The above diagram is a representation of the dizzying array of chemicals and exposure pathways with which we live. It begins to point to how the histories and practices of technoscience, industrialisation, urbanisation, and racial capitalism are chemically entangled with our bodies, environments, and everyday lives. Diagram developed in dialogue between our team and designer Gamar Markarian in 2021.

Paying attention to *cumulative* chemical exposures and toxicities brings into better focus both the near *universality* of exposure and the profound *inequalities* in the quantities, toxicities, and health detriments of those exposures. Environmental justice researchers have highlighted how low-income communities suffer higher exposure rates than others, perpetuating pre-existing inequalities in health and well-being (Mohai and Robin 2015; Blum 2008; Auyero and Swistun 2009; Singer 2011; Roberts 2017; Agard-Jones 2014; Bullard 2007; Madueño et al. 2019). This can be seen in neighbourhoods with more air pollution suffering higher rates of COVID-19-related deaths (Wu et al. 2020). Under-served and marginalised communities, including Indigenous populations and racialised groups, are more likely to be exposed to the environmental and health impacts of cumulative toxicities (Navarrete et al. 2018; Morello-Frosch et al. 2011). Their socioeconomic status means they are more likely to use harmful consumer products, to live near waste dumps or in over-populated poor urban areas, and to lack access to basic sanitation and health care. Their vulnerabilities are multiple, complex, and interlinked, while they have fewer social, economic, and political resources to combat the adverse effects of pollution (European Environment Agency 2018; Huang and London 2012; Morello-Frosch and Shenassa 2006; Agard-Jones 2014). Moving to a cleaner environment is rarely an option (Barba 2020; Tironi 2018). Nor can they easily afford products that promise protection from chemical harm such as organically grown vegetables, eco-friendly cosmetics, or bottled spring water. Despite suffering skin rashes when bathing in the river, persistent coughing, and miscarriages, the residents of Lago Agrio, Ecuador, where Fiske (2020) conducted fieldwork on toxic oil residues, did not want to leave. One of her informants responded, ‘Where would I go?’ This simple question draws attention to the situated vulnerabilities of Fiske’s informant but also overflows their particular bodies and place; in a permanently polluted world of cumulative toxicities, where is there to go?

In this article we introduce our Embodied Ecologies project and approach for studying cumulative toxicities. We use images and vignettes from preliminary fieldwork to illustrate our transdisciplinary methodology that merges ethnography and cartography. We then discuss participation throughout the research process and how we might seek to not only make cumulative toxicities knowable but also actionable. Finally, we conclude with a brief discussion of the politics infusing our embodied ecologies approach.

The Embodied Ecologies Project

To grapple with the issue of cumulative toxicities, we have launched a five-year, multi-sited project using an embodied ecologies approach that foregrounds how exposures and chemicals accumulate in everyday life and how the ‘power-

geometries' (Massey 1993) of social, spatial, economic, and political relations engender and unequally distribute toxic environments and health effects. Our team, composed by senior, postdoctoral and young anthropologists and geographers, carries out research across scales (individual, community, city, nation) and disciplines (anthropology of the body, urban political ecology, science and technological studies, experimental governance, environmental health), drawing on ethnography and creative cartography to study how people sense, know, and act to reduce chemical exposures. By better understanding what people do to avoid or reduce chemical exposures and the concerns that inform their practices, we gain insight into the structural constraints—lack of knowledge, secrecy, poverty—that enable and/or constrain their ability to mitigate toxic exposures.

Our project focuses on the ordinary yet persistent forms of cumulative chemical exposure that threaten human health and well-being in cities, where the majority of humanity now resides. Research sites, five cities in the European Union (Amsterdam and Wageningen in the Netherlands; Paris, Grenoble and Marseille in France) and two cities in the Philippines (Marikina in the Metro Manila Region and Baguio City), have been selected following two criteria. The first is that cities are productive spaces for experimental learning (Alberti 2017; Bulkeley and Castán Broto 2013) from everyday practices of living and surviving under conditions of pervasive but uneven cumulative toxicity. Secondly, we selected cities with an institutional commitment to green policies and consumer protection. Together they allow research on a broad spectrum of measures to reduce chemical harm against the background of varying social, economic, political and regulatory forces that enable/constrain action. The aim here—as in multi-sited ethnography more generally—is not to compare the same measures across urban contexts, but to contrast and learn from strategies employed in diverse ecological contexts.

In what follows we will make the case for an embodied ecologies approach to get an analytical hold of cumulative toxicity, delve into our collaborative and participatory research methods that are particularly tailored to attend to the lived experience of chemical exposure, and share some of the rich ethnographic insights generated so far. To do this, we intersperse ethnographic images and narratives throughout our discussion, offering a diversity of windows into the life-worlds of cumulative toxicities instead of choosing to focus on only one or two more elaborated ethnographic examples.

Why Embodied Ecologies?

An embodied ecologies approach shifts focus from the chemical (isolated compounds and exposures) to the corporeal and ecological (interdependent

processes and relations). After all, as Linda Nash (2008, 651) writes in her history of US pollution regulations, ‘debates over chemicals and their regulation are, at root, debates about the relationship between bodies and their environments.’ Nash demonstrates that it is often the underlying assumptions about what bodies and environments are and how they should be related that prevent chemical scientists and regulators from fully grasping and effectively mitigating chemical harms—all the while ‘calling somewhat blindly for more science’ (657). However, there is no reason to believe that ‘more science’, at least not in and of itself, can address the problem. The pace and variety of industrial chemical production vastly outpaces scientific and regulatory capacities (Boudia and Jas 2014). At the same time, industry profit motives hinder, often intentionally, the production of relevant science and regulation (Murphy 2017). Here, anthropologists and geographers have ethnographic and cartographic tools to offer, not to replace biochemical and health science, but to critically engage and collaborate with them. These tools form the basis of an embodied ecologies approach.

We are not the first to use the term ‘embodied ecologies’. Our inspiration is a series of anthropological ‘fieldsights’ on the *Society for Cultural Anthropology* website in which Andrea Ford (2019a) describes ‘*embodied ecologies* as a conceptual framework for describing a fluidity between bodies and worlds that foregrounds relations instead of bounded entities. In such a framework, humans are inseparable from surrounding environments and also function as environments themselves.’ Thus, Ford explains, embodied ecologies take the materialities of human bodies as a ‘site where environments are manifested in health and well-being.’ The ‘appreciation of embodied ecologies,’ as Margaret Lock (2019) argues in her conclusion to the ‘fieldsights’ series, ‘enables us to usurp biomedical bodies’ and highlight other understandings and models of health. For example, Ford’s (2019a) piece on childbearing casts ‘health’ as an ‘ongoing outcome of the chemical, microbial, and affective ecologies surrounding people and, indeed, composing them.’ Appreciating embodied ecologies draws attention to how ‘explications of health and well-being must be contextualised in time and space, that is, in specific milieux’ (Yates-Doerr 2019). We build upon and develop this approach.

Our embodied ecologies approach consists of three aspects: (1) ethnographically attending to the sensorial experiences and embodied knowledges of those most affected by chemical exposures; (2) creatively and cartographically producing representations and evidence of these exposures; and (3) identifying and supporting existing modes of action and harm reduction. This approach builds on the empirical, methodological, and theoretical work of urban political ecology, anthropology of embodiment, and science and technology studies (STS) scholars. Like scholars concerned with ‘a permanently polluted world’ (Liboiron, Tironi and

Calvillo 2018), ‘a new age of toxicity’ (Walker 2011), and ‘toxic modernity’ (Grandia 2021), we consider cumulative toxicity an enduring socioecological condition permeating our everyday lives and environments.

The first pillar of our approach is to recognise that industrially produced chemicals are not going anywhere. The ubiquity and temporality of their accumulation and persistence in bodies and environments renders utterly obsolete both the solutions championed by concerned urban planners and reformers, environmentalists, scientists and doctors in the 19th and 20th centuries—developing urban infrastructures of circulation, containment, and sanitisation, and encouraging individual practices of cleaning, avoidance, and immunisation (Gandy 2006; Liboiron, Tironi and Calvillo 2018)—as well as the politics and ideologies of material and natural purity (Chen 2012; Shotwell 2016) underlying these interventions. The second pillar of our approach is to understand that toxic harm emerges not only chemically but socially. ‘Toxicity is not given in advance by nature but is stimulated, constructed, rehearsed and contested through a myriad set of social, epistemological, historical, economic, material, biological and governance systems and structures’ (Liboiron, Tironi and Calvillo 2018, 334). Cumulative toxicity is a matter of social, environmental, and epistemological injustice.

Casting a Wide Net and Attending to the Senses

Instead of entering the field following pre-established hierarchies about which chemicals are dangerous, which direct and indirect exposures are of greatest concern, and what kinds of knowledge are useful or count as evidence, we began with exploratory fieldwork to apprehend the breadth of human-chemical interactions in everyday urban life. One method for this fieldwork is the ‘chemical grand tour’, which was successfully developed and applied in our former ChemicalYouth project. This consists of fine-grained ethnographic analysis of how people use and avoid chemicals in different spheres of their everyday lives, across diverse living and work environments. This panoramic round of fieldwork research was carried out by a team of young researchers (a total of thirty distributed in the three project countries), trained in the embodied ecologies theoretical framework and methods. Researchers were also trained to use the head-to-toe tool (Hardon 2021) to make inventories of chemical exposures in everyday life and spaces, and specifically designed to elicit from interlocutors how they know, experience and act on chemical exposures against the background of local policies, plans, institutions, and interventions that seek to protect people from chemical harm. Research might also address how and when people choose to ignore the health risks of chemical exposures due to more pressing concerns in their everyday lives.

In Fig. 2, one of our informants set all the cleaning and cosmetic products she regularly uses on a table and discusses them with research assistant Martine Wijnstra. How does she know what's in these products? If they work? How might they impact her health? One way is through sensory experience:

Those toilet cleaning things, I don't know exactly what's in it. It has such a strong smell if you breathe that in, I also have it with the bathroom cleaning spray. Last weekend, I had this mould and scale cleaner, it's always there. So, I thought let's spray that over those tiles. But that smell was like inhaling an entire pool of chlorine. I left and left the door open. Then I went back 15 minutes later, because I thought if I stand here in these fumes for 15 minutes, I will faint. Then I think, this can't really be good, what's tucked in here. It smells and looks like an aggressive agent, and you also notice afterwards that your hands are so super dehydrated afterwards. So, I think I don't know.

Throughout Wageningen and Amsterdam, the residents we spoke with tended to share a concern for using the least toxic products and often had the economic capacity to be choosy consumers. However, the kinds of informed choices and everyday trade-offs balancing the healthy and the functional they make rely on iteratively compiling, questioning, and piecing together knowledges from their own embodied experiences, anecdotes and practices circulating through their social networks, scientific and other expert recommendations. For example, a new mother told our researcher Hayley Murray about choosing between diaper creams for her newborn. At first, she used a 'very popular' diaper cream recommended by her sister and maternity nurse but criticised by her friends who recommended a more 'natural' product. She describes how she came to change her choice:

I thought beforehand I'm going to use [the popular cream] because my friends don't use it. They said it's junk and I didn't believe that. I thought, well, whatever. But I did some online research and there is so much in it that shouldn't be in it . . . Some perfume, why is there perfume in it? What's the point of that? So that's why I don't use that. And I don't know exactly all those ingredients, but I do try for him just so. Keep it more to the basics, so to speak. Just what doesn't have to be in it, I don't want that in it . . . And the [alternative cream], it really only has a few ingredients in it and that works just as well, maybe even better. And I also find [the popular cream] quite drying. He gets little dry buttocks from it and [the alternative] is nice and oily.



Figure 2: How to take stock of the everyday chemicals with which we live? Photo by Martine Wijnstra (May 2023).

The strength of an embodied ecologies approach, we argue, is that instead of beginning with a specific chemical, toxicity, or route of exposure, it begins with the bodily experiences of our interlocutors and collaborators. Since this approach begins not with chemicals but with bodies, choosing interlocutors is particularly important. Liza Grandia (2021) argues that bodies with multiple chemical sensitivity can act as ‘canaries in the mineshaft of the Anthropocene’ that offer warnings about the planetary crisis of ‘toxic modernity’. Similarly, polluted communities may perceive toxicity in intuitive and sensorial ways. These canaries have much to teach, both epistemologically and epidemiologically. Grandia proposes ‘canary science’ as a way to take seriously the embodied knowledges of those who are most sensitive to the adverse effects of cumulative toxicities. Canaries are not only (sacrificed) sentinels, but whistleblowers and informants that can sing (even canaries in a cage have agency and voice).

In addition to studying how people already sense cumulative chemical exposures, research might also seek to make these exposures sensible in new ways. We have, with our University of the Philippines partners in chemistry and electronic engineering, tapped into wearable technologies with anthropology students comparing electronic readings of air quality with people’s descriptive ‘sensing’ of what they feel in different environments. We are now expanding our studies to tap other simple technologies such as lateral flow tests and web-based interactive technologies to complement people’s perceptions of chemical pollution in the air, water and households such as those developed by the US-based Silent Spring Institute. The point is not simply to generate sensor data but to ethnographically

explore how participants employ these techniques and how they value and make sense of the findings, including their assessments of the potential for harm by chemicals whose effects are not immediately perceptible. This exploration will also be pursued through collaborations with artists with a shared interest in experimenting with and expanding our toxic sensorium. One of these partnerships entails co-creating a sub-project that is part ethnographic research, part artistic intervention focusing on people-plant alliances to sense and gauge air pollution.

Creatively Mapping Cumulative Toxicities

Since cumulative toxicities emerge, by definition, through exposures across space and time, the second aspect of our embodied ecologies approach is the cross-fertilisation of sensory ethnography with creative cartography. We offer mapping as a fruitful method for investigating and transforming the dynamics of in/visibility that are central to the epistemological and political problem of cumulative toxicities. Through various practices and forms of participatory, collaborative, and sensorial mapping, the embodied knowledges of our interlocutors can be made visible and tangible. Mapping can also connect sensory experiences with political, economic, social, and regulatory forces that shape uneven exposures but play out over larger histories and geographies that elude everyday perception. It is through these practices of experimental cartography that our embodied ecologies approach fuses the methods and insights of anthropology of the body and political ecology.

Much of the dominant historical practice of cartography has been rightly criticised as relying on a 'God-trick' 'promising vision from everywhere and nowhere' (Haraway 1991, 584), and as 'a form of knowing or seeing which denies its structuring by the gaze of white male bourgeois knowers' (Pile and Rose 1992, 131). However, as our collaborator cartographer Philippe Rekacewicz (2021) has been teaching us, there is also a rich history of critical cartography that has developed practices of counter-mapping to subvert dominant spatial representations, producing situated geonarratives, and constructing alternative sociospatial imaginaries and visions. Critical cartography recognises that 'mapping is necessarily situated, embodied, partial: like all other practices of representation' (Gregory 1993, 7) but instead of rejecting cartographic tools, methods, and representations, engages and transforms them. Critical cartographers insist that maps are potent propaganda tools that can be produced, manipulated, and deployed not only to serve the interests of those in power but equally in the service of building forms of resistance and counter-power (Zwer and Rekacewicz 2021).

Reena Shadaan (2023) has worked with nail technicians in Ontario who report a variety of health concerns. Nail technicians are largely comprised of immigrant women of colour, whose experiences and health concerns are routinely

marginalized and dismissed by medical professionals, policymakers, and the general public. Shadaan engages with occupational health mapping, combining body-mapping and hazard-mapping as a worker-centred method for identifying workplace hazards and health implications. This produces counter-narratives that assert worker-embodied occupational hazards, bringing marginalised knowledge and epistemologies to the fore. The cumulative toxicities nail technicians made visible through mapping exercises included the harms of workplace verbal abuse as much as those of chemical toxins.

Similarly, our collaborator Joseph Palis works with ‘geonarrative mapping’ as ‘a method and approach used in a subaltern setting that allows participants to tell stories in their own terms and in a manner they deem best captures their place-based often-untold narratives’ (2022, 700). Palis encourages interlocutors to use a variety of materials to produce drawings, collages, illustrations, and other visualisations that tell and perform their spatialised stories and are used as prompts for collective discussions. Whereas standard mapmaking relies on and grants authority to technical precision, the production of geonarratives is an embodied practice of countermapping that entangles individuals, images, and stories and ‘brings the emergent, emotional, and performative dimensions to the centre’ (2022, 701). In contrast to the purported universal knowledge presented by standard cartography, what Palis calls the ‘ground-truthed data’ of geonarratives is ‘derived from vernacular vocabularies and lived-in experiences’ such that ‘map stories acknowledge the polyvocalities, relational pluralities and multiplicities of individual narration stemming from their engagements with their diverse environments’ (2022, 701).

The work of Shadaan and Palis exemplifies the potential of critical and creative cartography. As Philippe Rekacewicz (2021, 5) explains:

The map is always an interpretation of how the mapmaker sees, understands, and interprets the way in which the world functions. If a cartographer produces a vision of the world as he or she sees, understands, or interprets it, then the map can allow us to concretely expose (geo)political, social, and economic mechanisms, which are generally invisible to us.

Our embodied ecologies approach seeks to investigate and reveal how uneven exposures and everyday sensory perceptions of cumulative toxicities are embedded in power-laden political-ecologies produced by histories of urban spatial transformation. There is no one right way of mapping cumulative toxicities. In the next two figures we offer examples of how mapping has been used as a tool for researchers to immerse themselves in the field (see Fig. 4), and to co-create ethnographic insights with participants (see Fig. 5).

In the Philippines, one of our student research assistants maps her daily commute through Metropolitan Manila, adding photos of some of the sensorial environments she encounters. Along with many of her fellow students, she identified commuting hubs as among the most unpleasant and toxic places: ‘I consider the terminals very toxic because oftentimes I would wait in line for about 30 to 45 minutes. These public utility vehicles, especially the jeepneys, would not turn off their machine, their engine. So, all the toxic gases we would tend to inhale.’ While waiting, moreover, many people smoke, making the air even more dense. ‘Suffocating’ is the word the assistant used to describe her daily experience.³ In our group discussion afterwards, co-author Mike Tan began to tease out some of the power-laden socioecological relations underlying the toxicity of commuting:

There are class connotations to commuting. If you commute, it means you take public transport—not one ride, but several, as you are likely to live far from your place of work. And then there’s a hierarchy. There are jeepneys, light rail, and all . . . I think it’s one of the reflections of the failure of the state. The inability to provide clean, safe, rapid public transport, and quality of life is so bad because of that commute . . . It’s during the waiting that you have a lot of the embodying we’re investigating. The sweaty bodies, the smells in the environment. They become so much more concentrated because of that horrible commute.

This kind of creative cartography works as a technique for researchers and participants to reflect on their everyday lives, express how their inner emotional world is mediated by and maps onto their urban surroundings, and thus begin considering the trans-scalar entwinements of embodied ecologies.

³ There is no exact equivalent in Filipino for the English word ‘suffocating’, and yet it seems to have entered Filipino English as an important term, describing the malaise felt in unpleasant situations. This same interlocutor explained that in her case of commuting, the unpleasant feeling came about with the COVID pandemic, and is triggered by crowded spaces.

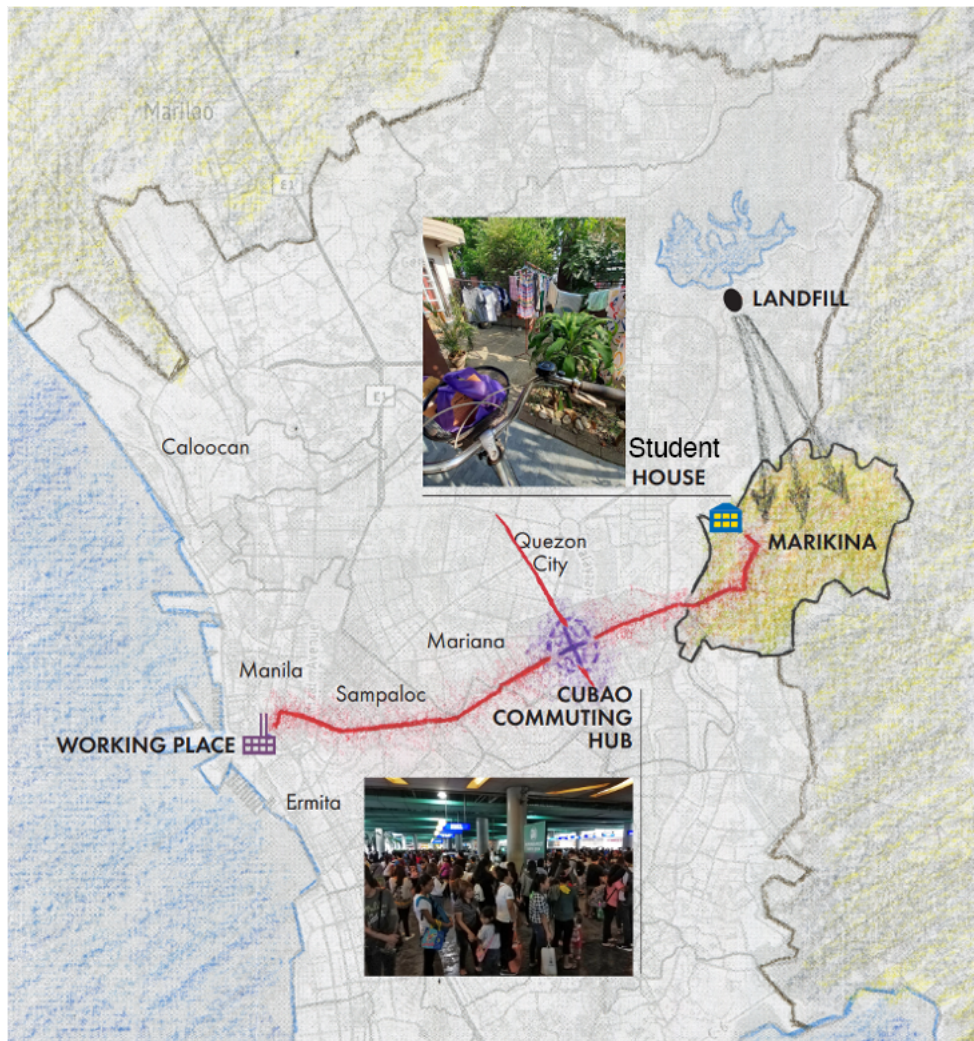


Figure 4: The map above was created by Philippe Rekacewicz as a composite of several student maps, 2021; see also Palago 2025.

In Fig. 5, a map compiles the experiences of 16 informants living in Grenoble, France, gathered through ethnographic interviews and sensorial cartography. The map, produced by research assistant Afroditi Avgerou, superimposes an accumulation of sensory experiences and feelings on a top-down greyscale map of the city. The map combines the technoscientific practice of satellite views and GIS layering with embodied everyday experiences—a collision of a ‘view from nowhere’ (see Donna Haraway’s ‘Situated Knowledge’ (1988)) and an experience of somewhere. It upends our expectations of top-down pollution maps that use sensor and other instrument measurements of specific chemicals to ‘objectively’ show where pollution is and is not present. The colourful organic shapes vividly express the messy subjectivity of everyday cumulative toxicities, creating a

relevant overlay that ultimately causes the underlying map to fade into an almost-inconsequential grey background. Surrounded by mountains, the air polluted by industrial activity remains locked into the city. Air pollution (in thick violet lines) emerges as a pressing issue in the accounts of Afroditi's informants, affecting how they experience, circulate and make use of public space (Avgerou 2023). It contrasts with the green, calm public spaces, that were mentioned by her informants as pleasant spaces in the polluted town.



Figure 5: Map by Afroditi Avgerou (2023).

Participation and collaboration throughout the research process

Our ethnographic approach privileges participatory methodologies through which our interlocutors can co-create representations of how they experience chemical exposures in their own lives, communities, and occupations. Feminist, anti-racist,

and Indigenous scholars have alerted us to the unintended effects that damage-based research can have in amplifying the chemical violence communities experience by rendering certain people and places as pathological (Murphy 2017; 2020; Tuck and Yang 2012; Tuck 2009). Some scholars have also pointed out that discourses with a reductive focus on damage and crisis hamper communities' possibilities and abilities to act (Haraway 2016; Braidotti 2019). Attending to this problem requires privileging collaborative methods in which participants are not considered victims, but rather epistemic partners (Holmes and Marcus 2021; Askins 2018; Hardon 2021) in the co-creation of research insights. It likewise demands exploring how actors we usually treat as hierarchically distinct (i.e., environmental scientists, activists, and exposed communities) manage cumulative toxicity differently and similarly. This coincides with calls from academics and exposed communities to valorise bodily experience and knowledge as evidence and a means of political contestation (Fiske 2018; Fortun 2012).

We approach crafting ethnographic research insights as a collective endeavour that entails co-creating knowledge with partners in the field, but also cultivating and experimenting with more horizontal ways of operating within the research team. Young researchers are encouraged to select interlocutors themselves, based on their ongoing observations, concerns, community-based engagements, past fieldwork experiences and personal relationships. Field instruments were co-developed with the team in an iterative and collaborative process. The teams of young researchers operated organically, articulating in smaller subgroups working around shared interests. After the first phase of exploratory urban ethnography, an analysis workshop was held in each project region. During two full days, young research assistants drew creative/conceptual maps of their research, and in a process facilitated by the senior and postdoctoral researchers, collectively came up with cross-cutting themes and concepts useful to make sense of ethnographic materials.

In Fig. 6, an example of the research maps crafted during the analysis workshops, one of our French research assistants, Justine Leret, draws, diagrams, conceptualises, and analyses her research on the construction of the Grand Paris Express subway under the city of Saint-Denis, part of Paris' Olympic urban mega-project. Her map allows us to see how class and race shape ecologies of exposure and distribute them spatially along a vertical, from under, to on, and finally above the ground. Here, toxic dust envelops migrant workers extracting subsoil to dig a new subway tunnel—its toxicity emerges within configurations of geophysical substrates, migratory flows, safety equipment practices and quality, as well as urbanisation. In Paris and its suburbs soil toxicity is a key issue. Much of the pollutants accumulated in the soil comes from industrial activity before the end of the nineteenth century, when factories and workshops were expelled to the city's

peripheries. Deep layers of soil pollution resurface as the city of Paris expands into the suburbs, both in governance and infrastructure, under the label of the Grand Paris project. As Justine's field research captures, construction workers are more directly affected by the materialisation of the Parisian expansion.

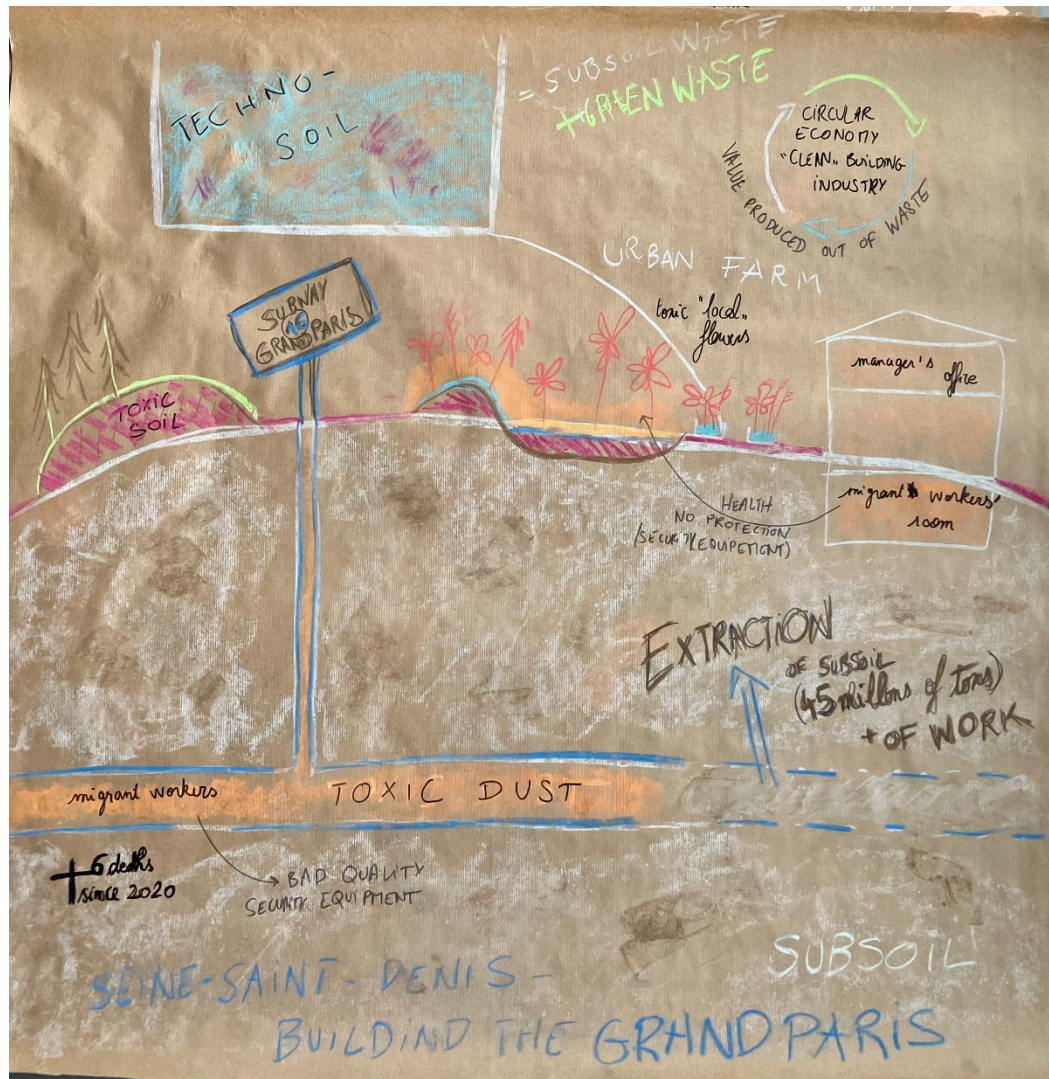


Figure 6: Map by Justine Leret (September 2023).

The writing of articles for academic and non-academic audiences is approached in a similar fashion. At the time of the writing of the present article, young researchers are receiving mentoring and peer support in the form of 'writing care' workshops taking place online and in person. We believe this kind of collaborative knowledge-making across all research stages is key to stay close to the toxicities that matter to the people we do research with.

Acting On and With Cumulative Toxicities

Understanding cumulative toxicities as a socioecological condition means considering their emergence from intimate historical and ongoing entanglements of entities, systems, and processes that are inseparably chemical, social, and ecological. To do so, we mobilise theories, concepts, and methods from the field of political ecology, in which scholars' study and theorise human-environment relations. Urban political ecology scholarship, in particular, excavates the power relations underlying the production of highly uneven urban environments (Heynen, Kaika and Swyngedouw 2006; Tzaninis et al. 2021). Thus, building on the foundational work of Rachel Carson's *Silent Spring* (1962), Paul Robbins' *Lawn People* (2007) explores how the rise of the US lawn chemical industry was entangled with processes of suburbanisation, changing ecosystem compositions, sets of cultural/aesthetic values, and shifting consumer desires and practices. He reframes the suburban lawn as neither a cultural nor biological artefact, but a sociotechnical system that produces 'turfgrass subjects', whose everyday activities are disciplined by the material demands of their lawnsapes. Another example—Dawn Biehler (2009) shows how ideologies and constructions of 'public' and 'private' space that shaped pest control practices gave rise to the use of pesticides in US public housing during the 20th century. Research by Donna Houston and Kristian Ruming (2014, 400) on asbestos in Australia traces how asbestos 'circulates through bodies, homes, infrastructures, working-class histories, and suburban imaginaries.' Arguing against conceptions of asbestos as an inherently hazardous material, they demonstrate how the use, obsolescence, and toxicity of asbestos is intertwined with urban governance structures and urban regeneration processes, situating asbestos as 'complex matter that continues to be lived with and practiced.'

Our research assistant P. A. Echague has explored how the chemical glues and solvents of shoemaking in the Philippines are complex matters that shoemakers live with and practise in various ways. P. A. has explored the intricate enmeshment of people and chemicals across living and working spaces. Expecting to find a clear division between the home and the workplace, P. A. was confronted with a different reality. Living spaces and shoemaking workshops are in close vicinity, often sharing a common alley, street or patio, where her informants use strong chemicals—glue and solvents. To make ends meet, both men and women shoemakers take extra work home, which they carry out in the domestic sphere, while doing other household chores around older family members and children. The toxic fumes are pervasive in the living-working compounds, making it difficult to tolerate for an outsider like P. A.; however, her informants would claim to be

‘sanay’ (already used to) to the strong smell of glue. Across field sites in the Philippines, research participants expressed being sanay to intense exposure to glue, pesticides, air or water pollution. Collectively, the team of young Filipino researchers are critically engaging with the notion of ‘sanay’ as an embodied form of dealing with toxicity under heavy structural constraints and precarious living conditions. To reduce chemical harm, the woman in Fig. 7 works outside so she is in open air.



Figure 7: Photo by P. A. Echague (May 2023).

Understanding cumulative toxicity as a lived reality means considering how people navigate complex, intertwined chemo-socioecological relationships. Here, our embodied ecologies approach builds on recent anthropological scholarship that seeks to reveal the effects of cumulative chemical exposure on everyday life (Ford 2019b; Shapiro 2015; Grandia 2021; Choy 2011; Roberts 2017; Auyero and Swistun 2009). Some of this work shares with political ecology an interest in unearthing the socioecological relations of chemical exposures and toxicity. Michelle Murphy (2008), for instance, casts us as ‘chemically transformed beings’, enmeshed in molecular relations, that are entangled within community, ecological, colonial, racial, gendered, military, and infrastructural histories that have profoundly shaped the susceptibilities and potentials of future life’ (2017, 497). Similarly, Elizabeth Roberts (2017) explores the many forms of ‘chemical kinship’

(Balayannis and Garnett 2020) in a working-class neighbourhood in Mexico City, highlighting overlapping, contested, and power-laden entanglements, porosities, and boundaries of bodies, territories, and histories. Recently, Max Liboiron (2021) has argued that pollution—along with most of the dominant scientific research on pollution—is about more than chemicals, requiring the ongoing enactment of violent colonial land relations. Murphy, Roberts, and Liboiron draw on indigenous, feminist and STS thinking and methods that, more so than in political ecology, concern themselves with embodied experiences and knowledges.⁴

Recent STS scholarship on elemental thinking calls for ‘a shift of attention to the techniques, processes, affects, and intensities that churn soils, airs, waters, and together with organic and synthetic chemicals in order to attend more fully to bodily potentials, relations, toxicities, and harms’ (Papadopoulos, de la Bellacasa and Myers 2021, 3). Amelia Fiske (2018, 391) explores ‘the role of bodily knowledge in witnessing industrial contamination and struggles for environmental justice.’ Similarly, Nick Shapiro (2015) argues that the apprehension of chemicals is both a sensuous and epistemic process that constitutes a form of ‘bodily knowledge’ inscribed with the ramifications of extraction, industry, and inequality.

Mariana Rios Sandoval explores this in her film *Terre toxique, terre fertile (Toxic land, fertile land)* (2022) (see Fig. 8), which follows efforts to repair a brownfield in a Parisian working-class suburb, focussing on peoples’ bodily and sensorial engagements with the heavily polluted soil. In Fig. 8, Ahmed, who was born in the suburb, and speaks fondly of the endless hours spent as a child playing on construction rubble on neighbouring brownfields, smells soil from a patch of land not visibly affected by pollution: ‘It smells the way soil should smell, but I’m sure it’s still toxic.’ While almost the entirety of the soil of greater Paris is polluted, it is unevenly so, as the more recent and dense layers of toxic chemicals concentrate in the belt of brownfields (former sites of industrial activity) surrounding the capital. Community organisers, NGOs, neighbours and scientists, sometimes supported by governmental agencies, are seeking to repurpose sites of former industrial activity, pondering what to do about toxic chemicals in their infrastructures and accumulated in the soil. Pollution accumulated in the soil also stands in the way of urban agriculture initiatives, as residents are increasingly advised not to consume the fresh produce, and even the eggs, that grow in this urban soil.

⁴ See, however, recent calls for embodied political ecology by Doshi (2017) and Tzaninis et al. (2021).



Figure 8: Photo by Claire Jarlan, videographer of *Terre toxique, terre fertile* (2021).

We aim to act on cumulative toxicities by co-creating novel harm reduction tools and strategies based on studying in-depth existing efforts to mitigate chemical toxicities. In this regard, we are inspired by Mormina's (2019) call to rebalance geographies of knowledge by fostering homegrown processes and structures that facilitate the production, and utilisation of tacit, situated forms of knowledge (2019, 676); and Büyüm and colleagues (2020) calls to decolonise global health by attending to the health concerns of the marginalised majority.

In both Marikina and Baguio in the Philippines, our researchers found and were lucky enough to learn from women-run urban and organic farming initiatives seeking to rekindle ancestral knowledges and practices, learn anew from each other and social media networks like YouTube, and generally find ways of collaboratively living good-enough lives rooted in place and history but nonetheless hungry for global connection, sharing, co-learning, and solidarity (see Fig. 9). In the Philippines, the very strict covid lockdowns in 2020–22, in which people were confined to their neighbourhoods, inspired some women living in marginalised urban communities and facing food shortages to take up urban farming. Our researchers Denice Salvacion and Francesca Mauricio have been working with two such groups in Baguio City and Marikina (part of Metropolitan Manila) where women have appropriated land in their communities to grow vegetables. These women are uncertain about the safety of agrochemicals, so they try to avoid them and instead experiment with organic farming methods. Our researchers have helped organise an agroecology workshop connecting them to a nearby urban garden and an agroecology expert. In Marikina the women learn from and experiment with practices that circulate through social media, on sites like YouTube. Meanwhile, in peri-urban Baguio, the women are resuscitating their ancestral knowledge indigenous to the region. The map below, made by Denice, shows the homestead of Claire, a leader in the group. Claire's garden has about thirty herbs, around forty fruits, and hundreds of ornamental plants. For Claire

organic farming has aesthetic value; she encourages Denice to ‘tignan mo’ (look here) or ‘amuyin mo’ (smell it) as she shows her around, and expresses how the plants make her happy. Claire is also a cancer survivor, who believes organic food has not only been beneficial for her health but that collective organic farming helps develop a community sense of care and health. Furthermore, she explained to Denice how her organic practice involves using fermented fruit juice, vermiculture, chicken manure, composting, and trichoderma to improve the quality of the soil. In this way these farming collectives of women are seeking to act on the cumulative toxicities of everyday life to cultivate personal, community, and ecological health and well-being.

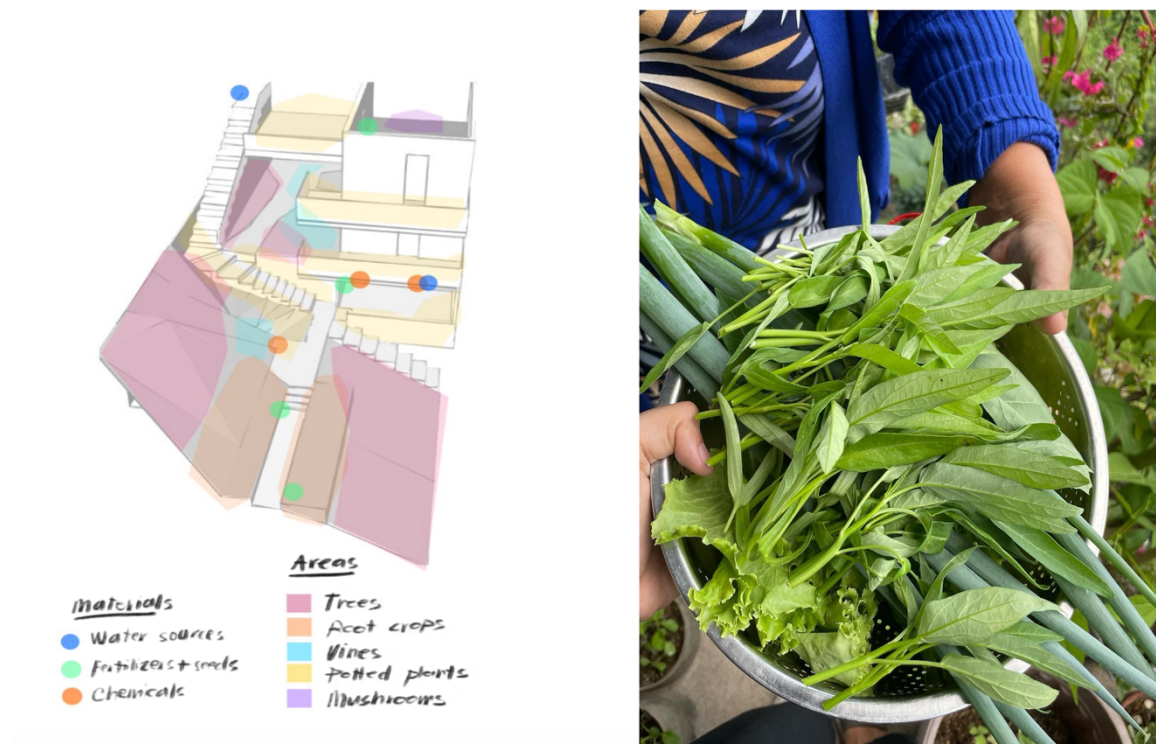


Figure 9: Map and photo by Denice Salvacion (July 2023).

Conclusion

In the next phase of our five-year research project, we will experiment with the ways our research can support efforts to live a good-enough life in a permanently polluted world. This means being attentive to what people living in the various affected sites aspire to, and working with them to make connections, and trying out (new) harm reduction practices (see Fig. 10).



Figure 10: Cumulative exposures are not simply the result of industry activity—insidious or otherwise—on passive consumers—informed or otherwise. Cumulative toxicities are lived; people navigate and respond to exposures in everyday life, scientific research, environmental and health policy, social and environmental justice movements, and beyond. This expanded diagram indicates the variety of harm reduction practices through which people—both individually and collectively—seek to act on cumulative toxicities. Paying attention to these practices means working with our informants and collaborators as epistemic partners who already have situated knowledges and repertoires of response. Diagram developed through conversations between our team and designer Gamar Markarian in 2021.

Yes, our world is awash with industrially produced chemicals. Yes, at least for the authors of this article, our hope for a better future cannot rely on returning to an imagined unpolluted past. Yet, we, like our informants and collaborators, and perhaps like you, reader, continue to strive for a good-enough life amongst the polluted ‘ruins’ of industrial capitalism (see Tsing 2015). Our bodies are in and of toxic ecologies, but—and this is the fundamental political assertion of an embodied ecologies approach—these ecologies themselves emerge through our and others’ bodily activities—through the practices and structures of our labour and leisure. Neither ecologies nor bodies are finished products; both might be remade anew. In this way, an embodied ecologies approach looks for what Ernst Bloch would call ‘concrete utopias’, which have their base in ‘social life with an immanent referential in the reality of the present, in the here and now, in the perspective of building

another society, where the utopian future glimpsed never materializes but is in permanent re-elaboration' (Monte-Mór and Limonad 2023, 67). It must also be recognised that our bodies, labours, leisure, and ecologies are not the same. The power geometries that unevenly distribute the persistence and health effects of cumulative toxicities likewise shape the specific knowledges, harm reduction practices, and political demands of different people in different places.

Authorship statement

Tait Mandler conceptualised the study, led the primary research in the Netherlands, led the literature review process, contributed to data analysis and interpretation in the three project countries, and drafted significant portions of the manuscript. Mariana Rios Sandoval conceptualised the study, led the primary research in France, contributed to data analysis and interpretation, as well as drafting significant portions of the manuscript. Anita Hardon conceptualised the study, secured funds to carry out the project, led the overall research team, led the primary research in the Philippines, contributed to data analysis and interpretation in the three project countries, and provided critical feedback during the writing process and assisted with literature review and revisions. Michael Lim Tan contributed to data analysis and interpretation in the Philippines, provided critical feedback during the writing process and assisted with literature review and revisions. All authors reviewed and approved the final manuscript for submission to *Medical Anthropology Theory*.

Ethics statement

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About the authors

Tait Mandler is a postdoctoral researcher with the Embodied Ecologies project at the Knowledge, Technology and Innovation Group at Wageningen University.

Mariana Rios Sandoval is a postdoctoral researcher with the Embodied Ecologies project at the Knowledge, Technology and Innovation Group at Wageningen University.

Michael Lim Tan is co-PI of the Embodied Ecologies project in the Philippines and Professor Emeritus and former chancellor of the University of the Philippines Diliman.

Anita Hardon is the PI of the Embodied Ecologies project and Department Chair of Knowledge, Technology and Innovation at Wageningen University.

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