

INTRODUCTION

Frontiers of Urbanization

ON THE MORNING OF SEPTEMBER 26, 2009, thousands in Metro Manila woke up to a sudden surge of floodwaters after hours of nonstop rain drenched the city. The tropical disturbance responsible for this record rainfall, Tropical Storm Ondoy (Ketsana), was a minor storm. It lingered several kilometers north of the megacity but drew southwest monsoon rains that dumped a month's worth of rain over a six-hour period. Manila's already overburdened urban streams and waterways failed to contain the excessive stormwater from the hills upstream, which burst their banks and inundated homes with water and mud. The city's inhabitants have long been accustomed to localized urban flooding, but the scale and damage of the Ondoy floods was unprecedented and radically altered subsequent state responses to hazards.

While images and accounts of catastrophe in the city circulated and then dissipated over the next few days—residents stranded on rooftops, motorists trapped inside vehicles, living rooms submerged in muddy water, speedboats cruising on flooded subdivision streets—those who lived along Laguna Lake's shoreline to the city's southeast had to endure flooding for several more weeks. Water that the city could not accommodate had been diverted to the lake, which rose to levels not seen in four decades. The lake's forgotten role in Metro Manila's flood control scheme as a storage space for excess stormwater quickly seeped into the public imagination again. Explanations for both the disaster and the solutions to avert future flash flooding in the city required considering the central place of the lake in making and maintaining the urban flood control infrastructure.

Four years later, in 2013, a lakeside town southeast of Manila celebrated its annual fiesta by hosting an unusual culinary contest. Competing chefs were tasked to create innovative recipes for knifefish, an exotic fish that had

accidentally found and ate its way into Laguna Lake from the aquariums of urban hobbyists. The carnivorous predator posed a serious threat to commercial aquaculture in the lake, an industry introduced four decades earlier to improve fish production and meet urban and regional demands for a cheap, accessible protein source. Aquaculture enclosures eventually took hold in the lake's landscape—a contentious, transformative, and occasionally violent process—and established a lake economy that regularly supplied fish to the urban market. However, the highly invasive and voracious knifefish became a costly pest for many aquaculture producers, wiping out stocked milkfish inside the enclosures and undermining the lake's ability to provide a productive fishery.

The culinary contest was one of several attempts by the government to contain the knifefish invasion and reduce its population by demonstrating its edibility to a skeptical public wary of consuming a strange, unfamiliar fish. The winning dish, knifefish à la cordon bleu, showed that transcending the undesirability of the bland flesh and elevating the edibility of the fish body required practical and imaginative work. Fishers caught the invasive fish as a suboptimal substitute, making do with what was available in a lake ecologically transformed by the boom and bust cycles of aquaculture commodification. But due to lack of demand and limited consumption at the lake, the fish had to be brought to Manila, where its white flesh found use as an ingredient for the processing of urban street food. The exotic knifefish presented an unintended antithesis to farmed fish deliberately introduced to improve the livelihoods of lake dwellers and supply fish for the city. That both types of fish—one considered an invasive pest and the other a valuable commodity—ended up consumed as food forms in Manila shows the close and changing, intended and unexpected socioecological relations between the city and the lake in urban provisioning. It appears difficult to understand one place without the other and the resource flows that connect them.

I draw on these extraordinary and mundane scenes of conveying and provisioning to introduce the book as an urban socioecological story beyond the city. The problem of floods and food exposed urban connections that have been slowly built and maintained over time as cities expand their edges and enroll resources from elsewhere. In this book, I show how environmental trajectories of cities are inextricably tied to their frontiers, a process that simultaneously reconstitutes urban and rural spaces, ecologies, and lives. Manila embodies many of the shifting environmental challenges of the urbanizing Global South. But its proximity to the large, nutrient-rich Laguna

Lake has created particular paradoxes and conjunctures that trouble straightforward chronicles of urban development and environmental management.

Stitching together diverse accounts of the situated urban transformation of Laguna Lake in relation to Manila, *Urban Ecologies on the Edge* traces the intertwined socioecologies of the city and its urban resource frontier. In what follows, I examine the question of urban provisioning and sustenance and what kinds of work are necessary to make and maintain these relations. I engage with diverse approaches in urban, environmental, and agrarian studies to cast light on multiple accounts of urbanization as a frontier-making process that brings together natures, landscapes, and peoples across space in finding geographic solutions to urban resource challenges. By turning to the ecologies on the edge, I aim to give attention to overlooked, beyond-the-city spaces like Laguna Lake, continually made to work to produce vital resource flows that sustain city life.

Over several chapters, I weave together diverse narratives of work from frontiers to city and back: modern state plans and imaginaries of taming frontier landscapes, crisis and regulation of capitalist enclosures amid transformed lake livelihoods, lively materialities of resource frontier natures that frustrate the best-laid modern plans, access and exclusions surrounding urban commodity flows, practices of sociomaterial transformation of contradictory urban flows, and contested production of risk through flows and infrastructure. These stories have multiple trajectories that rehearse but also refuse predetermined paths of ecological transitions and take situated specificities rooted in place.

The book investigates urbanization as a frontier-making process through the case of Manila and Laguna Lake in the Philippines. Combining empirical accounts drawn from multisite fieldwork and a reading of historical materials, it seeks to provide a picture of urban socioecological transformation by engaging macroscale processes of resource flows and provisioning with the constitutive microscale practices of making a living. Through an in-depth exploration of resource frontier making in Manila, I offer a distinct political ecological approach to urbanization by drawing from a rich body of theoretical work on cities, nature, and livelihoods to describe and explain the empirical accounts across multiple sites within cities and beyond their edges. These accounts in turn are generative in helping redefine, rethink, and revise theoretical formulations of the spaces and ecologies of urbanization.

In particular, the book's framing of urbanization engages with two key concepts: frontier urbanism and urban metabolism. Both suggest that urbanization

requires practical and imaginative work, whether through frontier making as the creative/destructive becoming of spaces made legible for extraction or through the delivery and maintenance of various resource flows to meet the metabolic requirements of cities. As I demonstrate through the historical and contemporary case of Manila and Laguna Lake, urban frontiers may be conceptualized as coproduced in relation to cities, molded by particular conjunctures of state power, capitalist imperatives, and everyday livelihood making. Accounting for the multiple sites of the urban by following resource flows in this case also enables rethinking urban metabolism as fundamentally driven by the work of a constellation of actors, practices, desires, and materialities that continually reshapes such relations.

Manila, with its extended metropolitan population of more than twenty-five million, became plagued with urban environmental problems throughout its rapid growth in the second half of the twentieth century. Two of its most persistent challenges—feeding its burgeoning appetite for food and water and keeping it safe from the threats of recurrent flooding—underscore its intensified dependence on resource flows from beyond its boundaries. Laguna Lake, partly due to its close proximity as a resource frontier, became an important node in state development project designs. It was imagined as a convenient frontier, a ready and pliable source of fish and domestic water and as a sink for wastes and floodwaters. As this frontier developed and resource extraction was legitimized, techniques of simplifying, erasing, and undercounting complex lake socioecologies intersected with lake dwellers' practices of dealing with ecologies and livelihoods transformed by increasing urban connections.

I focus on the political ecologies of two resource flows with particular resonance for Manila's fluid frontier urbanism and urban metabolism: fish and floodwaters. The state introduced aquaculture to spur development in the lake region while supplying steady flows of cheap fish for a growing city framed in the context of crisis in capture fisheries. It revolutionized fisheries in the lake while also changing mechanisms of property rights and initiating decades-long, conflict-ridden agrarian change rooted in deepening capitalist relations. Provisioning fish flows to the city continues to encounter multiple contradictions in both lake production and city consumption. By producing more fish for the city, aquaculture's expansion marginalized fisherfolk, the intended beneficiaries of this development project, and exposed city consumers to cheaper and more abundant but less desirable and more unsafe fish.

During the same period, the state also sought to harness the lake's water for urban domestic consumption and to manage stormwater flows in the linked Metro Manila-Laguna Lake hydrological basin. The constructed flood control network enabled the large-scale control of hydrological flows to prevent flash flooding in Manila's urban core but channeled flood flows and magnified risk for lake dwellers and their fish production. Both fish and water flows further intersect with increased waste loads that have contributed to resource conflicts that the state's various governance mechanisms had long attempted to resolve.

By following both fish and floodwaters, the book seeks to make visible the assemblages of flows, landscapes, and infrastructures—the conditions of possibility—that sustain life in the city. These configurations are simultaneously material, biophysical, and quantifiable but are also lived, imagined, and produced through work and practical activity in the everyday acts of making a living. Capital is a world-making driver of urban resource frontier making, joining with state visions and techniques to reconfigure space and nature through deepening commodification and appropriation. Yet it confronts the dynamic urban edge in emergent ways, producing a politicized zone where lives and landscapes fight back, realign, or refuse their frontier making. Through these fluid stories set in Manila and Laguna Lake, the book extends an understanding of how urbanization produces particular, often paradoxical, ecologies in cities, edges, and beyond, and who wins and loses in the process of urban environmental change.

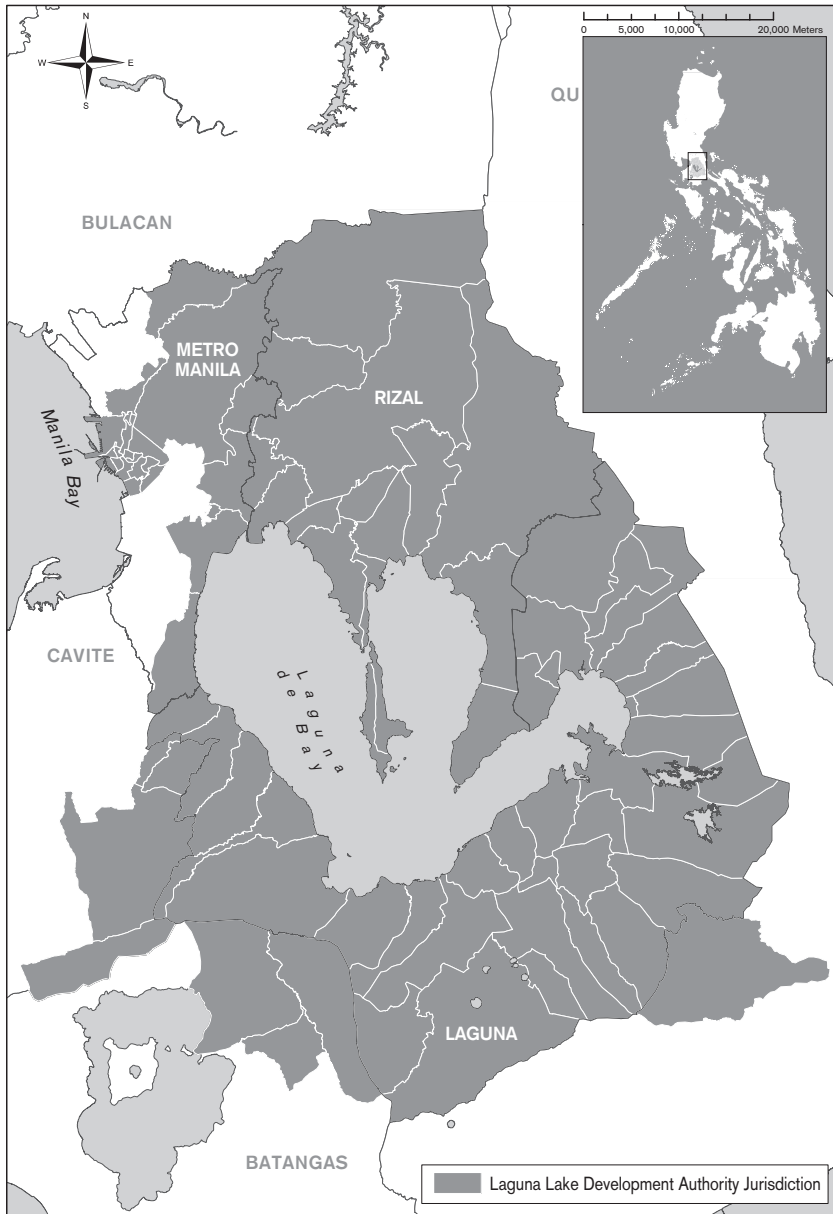
FLUID URBANISMS: MANILA'S FISHBOWL AND TOILET

Manila, often used to refer to the broader Metropolitan or Metro Manila urban region, sits on a narrow stretch of coastal, alluvial, and hilly volcanic land with water on two sides.¹ To the west lies Manila Bay and its deep harbor, which has played a vital role in Manila's history as one of the first global cities. Manila was a colonial port city that connected Asia and Europe, a central node in the Spanish Empire's territorial and economic expansion from the sixteenth to the nineteenth centuries. Located near the point where the Pasig River meets Manila Bay, the City of Manila is the highly dense, old core of the metropolis, expanding from a precolonial coastal urban settlement to a colonial capital socioracially divided by a fortification.²

To Metro Manila's southeast lies Laguna Lake or Laguna de Bay, a shallow freshwater lake whose significant role in Manila's city making is much less recognized and whose urban connections are less visibly obvious (see map 1).³ Upon gaining independence from formal American colonial rule (1898–1946), the Philippine state embarked on various development projects that were increasingly oriented to the urban needs of an expanding Manila. Laguna Lake served as a proximate source for many vital resource needs, including food, water, and drainage and wastewater management, initiated primarily by the state body Laguna Lake Development Authority (LLDA) (see map 1).

At around 90,000 ha (900 km²), the lake is the largest in the Philippines and the third largest in Southeast Asia. Twenty-one rivers in its watershed drain into the lake, but the Pasig River, which cuts across urban Metro Manila, is its only outlet to the sea. The river brings saline backflow, alongside urban pollution, to the lake from Manila Bay during drier seasons when the lake's water levels fall below sea level. As a result of the prehistoric collapse of a volcanic caldera, the lake's 250 km shoreline follows a hoofprint-like configuration, with two peninsulas dividing the lake into three lobes (East, Central, and West Bays) that have temporally differing levels of salinity. The lake is cut in half by Talim Island, a long, jagged, volcanic land mass separated from the mainland by the Diablo Pass, which at 20 meters is the deepest section of the lake.

The lake is highly eutrophic due to the abundance of nutrients that encourage the growth of phytoplankton. During the transitional period between the dry and wet seasons in May–June, algae blooms temporarily turn the dull water a deep shade of emerald green. This hypereutrophic property served as one of the primary justifications for the state's introduction of extensive aquaculture, enabling the growth of fish even with very minimal external inputs. The lake's shallow depth at 2.5 meters also facilitated construction of aquaculture enclosures, as fences can easily be staked to the muddy bottom. These limnological processes have historically supported capture fisheries in the lake, and since 1970, aquaculture production. As the blue counterpart to the green revolution, aquaculture embodied the parallel aims of improving food production through technological and institutional changes. Laguna Lake pioneered extensive, commercial aquaculture based on a body of water, and its contribution to urban fish diets has become so significant that the lake has been termed Manila's "freshwater fish bowl" (Lasco & Espaldon, 2005, p. 39).



MAP 1. Laguna Lake or Laguna de Bay and administrative jurisdiction of Laguna Lake Development Authority. Map by Patricia Anne Delmendo.

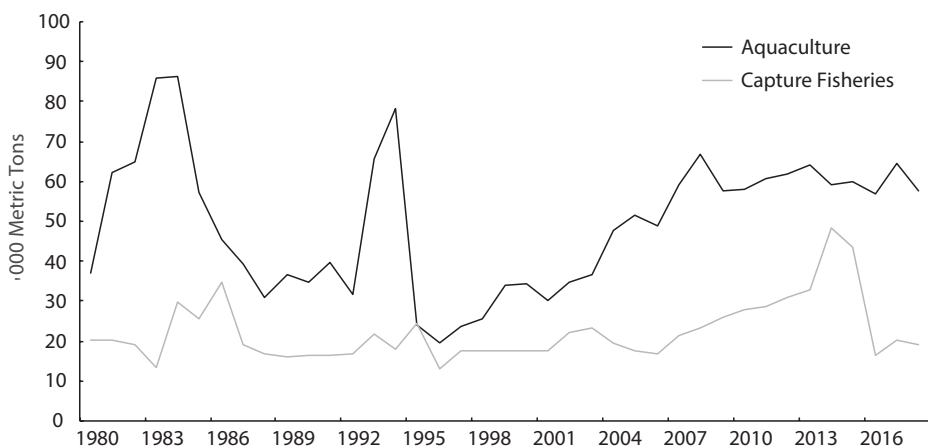


FIGURE 1. Laguna Lake fisheries production, 1980–2018. *Sources:* Laguna Lake Development Authority (1995b); National Statistical Coordinating Board (1999); Philippine Statistics Authority OpenSTAT database. *Note:* Information on capture fisheries production between 1997 and 2001 is unavailable from the database and is presented as the average of preceding and succeeding years.

Aquaculture production in the lake surpassed capture fisheries' production only a few years after it was introduced, peaking at 85,000 metric tons in 1985 (see figure 1). Among the low- to mid-value introduced fish species, milkfish (*Chanos chanos*), tilapia (*Oreochromis niloticus*), and bighead carp (*Hypophthalmichthys nobilis*) are the three most commonly produced.⁴ They are grown in large-scale fishpens and small-scale fishcages, aquaculture production systems that together occupy a seventh of the lake's total area.

More than five million people reside along the shores of the lake, with at least three thousand directly engaged in small-scale cage aquaculture and thirty-five thousand fisherfolk still making a living from capture fisheries using various active and passive gear (Israel, 2007).⁵ The resulting livelihood mosaic in the lakeside villages is complex, in which traditional capture fisheries production, aquaculture production, and other activities continue to be shaped by urbanizing processes in Metro Manila and surrounding regions.

The Metro Manila and Calabarzon regions form the country's urban and industrial core, accounting for half of the total gross domestic product and two-thirds of manufacturing employment and output (Shatkin, 2008). Metro Manila's urban landscape and built environment have expanded both vertically and horizontally, driven by a variety of processes including immigration, neoliberal restructuring in governance, and transnational flows,

sprawling over rural, transitional, and mixed land uses (Garrido, 2019; Kelly, 2000; Kleibert & Kippers, 2016; Ortega, 2016; Shatkin, 2005, 2008). The nearby Calabarzon region, which surrounds much of Laguna Lake, has been similarly urbanizing, facilitated by the Calabarzon Project, a regional industrial development plan covering the provinces of Cavite, Laguna, Batangas, Rizal, and Quezon. The project has led to dramatic transformation of areas around Laguna Lake and its watershed, such as agricultural land conversion, displacement, and in-migration, as well as increased pollution emissions, the ecological impacts of which are felt in the lake as a sink for the wastes produced by these activities (Canlas, 1991; Kelly, 2000; Lasco & Espaldon, 2005; Ortega, 2012).

Despite decentralization attempts, Metro Manila's population continues to grow, from two hundred thousand at the turn of the twentieth century to more than ten million by the turn of the twenty-first century. Yet this growth in numbers conceals wide inequality and spatial fragmentation in the city that harkens back to the colonial division represented by the earlier urban wall. Nearly three-quarters of the urban population belongs to the lower and extremely lower socioeconomic classes, with the proportion of urban population residing in poorly served slums ranging from a fifth to half throughout the latter half of the twentieth century (Arcilla, 2018; Arn, 1995; Ortega, 2016; Shatkin, 2005). Manila is highly fragmented, and these inequalities have expanded spatially to the city's edge and temporally toward an uncertain environmental future as a disaster-prone metropolis where earthquakes, typhoons, floods, and pollution hazards pose recurring threats that affect city dwellers unevenly. Its expansion has constantly put a strain on its ability to meet its resource needs, historically addressed by the state by constructing networks of provisioning and sustenance that stretch beyond the borders of the urban region.

URBANIZATION ON THE EDGE

This book traces the resource flows that sustain Manila through its relations with Laguna Lake, its convenient frontier, and lays bare the multiple political ecologies that constitute these flows and the frontier. I turn to the polysemy of the phrase "on the edge" in its multiple meanings to situate these relations. "Urban ecologies on the edge" invokes at least three senses: a location, a relation, and a condition.

As a location, the edge refers to the urban fringe, the zone where the city dissolves into the beyond-the-city. This urban periphery is more of a continuum or gradient than a geographical area with an abrupt or static boundary. It is more gradual, patchwork, hybrid, or ambiguous than delineated, often shaped by a mix of multiple urban and rural processes and logics, characterized by situated transformations and unpredictable juxtapositions. The political ecologies of these dynamic and transitional spaces on the urban edge have been framed in distinct but related, sometimes overlapping, and contradictory terms: the peri-urban (Bartels et al., 2020; Myers, 2008; Simon, 2008), suburban (Keil & Macdonald, 2016; Ortega, 2012; Pares et al., 2013), exurban (McKinnon et al., 2019; Walker & Fortmann, 2003), and megapolitan (Gustafson et al., 2014). Yet edges take diverse historical-geographical forms, extend beyond the usual hinterland borders, and are situated in differing contexts, necessitating attention to their dynamic interplay. Laguna Lake is a particular example, as it sits on Manila's expanding edge, the built environment of the city literally stopping at the lakeshore, even as its urban connections, flows, and impacts extend far beyond.

As a relation, the edge denotes limits, transitions, and liminality, being wedged between two worlds: in between the core and its margins, the city and its frontiers. The edge reflects a spatiotemporal relation manifested in particular times and places, suggesting that the history and fate of places like Laguna Lake and Manila are imbricated relationally through urban processes. The in-betweenness creates unique and novel ecological relations that require a focus on both city and frontier and their liminal edges. Ecologies describe the multiple relations between individuals and their physical environment, relations that are more accurately referred to as socioecological. On the edge, the socioecological is more visibly constitutive of the production of both city and frontier.

Finally, being on the edge alludes to a condition of uncertainty, precarity, and being unsettled. Talking about ecologies on the edge suggests socioecological relations and transformations are marked by dynamic shifts and surprises, with the looming sense of being on the precipice of transforming into a different state. There is a degree of undecidability and provisionality in the kinds of arrangements emerging as diverse spaces, peoples, and ecologies are juxtaposed (Massey, 2005; Roy, 2016a; Simone, 2020). The term is an appropriate description of certain processes of urban frontier making in Laguna Lake and other edges, where visions of space and material transformations

reconfigure precarious lives and landscapes, which in turn redefine trajectories in unexpected and never complete or predetermined ways.

Urban edges are relational and may occur in various formations, from the proximate peri-urban frontier such as Laguna Lake to further resource hinterlands connected by extending capital flows and globalized infrastructure networks. They are characterized by a type of “edginess,” whose diverse emergent politics and ecologies require further exploration as they are situated in place. In this book, I explore one of these formations rooted in a particular place at a particular moment, but I aim to keep the relational tension between city and frontier in focus to think about other cities and frontiers elsewhere. Framing the ecologies of edginess engages with two concepts with rich histories: urban metabolism and the frontier.

URBAN METABOLISM AND THE POLITICS OF FLOWS

Urban metabolism—a boundary concept mobilized in multiple ways in both the natural and social sciences—anchors the socioecological exploration of urbanization on and beyond the edge. In its organicist sense, as understood in industrial ecology, it presents an idea of the city as supplied by flows of materials and energy from the outside necessary for the city’s continued functioning. Employing a systems approach, scholars in this field argue that quantifying and measuring resource flows, stocks, inputs, and outputs is a necessary precondition for planning toward urban sustainability (Kennedy et al., 2007; Pincetl et al., 2012).⁶

But as critical urban scholars have pointed out, flows and their infrastructure also bear deep-rooted histories, situated practices, and contested politics that require casting attention to constituted social relations and lived experiences. Scholarship in the field of urban political ecology (UPE) has deployed a historical and political understanding of urban metabolism drawing from Marx’s original use of the term.⁷ *Metabolism* becomes a metaphor for the material and symbolic production of nature in cities through circulation, exchange, and transformation, as well as the co-constitution of social labor and material processes in capitalist urbanization (Heynen et al., 2006; Heynen, 2014). Urban political ecologists emphasize socionatural relations through a historical and political approach to the production of urban natures, wherein both cities and nature are understood as coproduced

or as hybrids that bring together heterogeneous actors and objects (Gandy, 2004; Swyngedouw, 2006).

The urban metabolic and socionatural transformations of city and beyond-the-city spaces are inherently political questions. Urban political ecological work is thus explicitly concerned with transforming unjust urban relations by revealing what is hidden or made invisible in the capitalist urbanization of nature (Heynen et al., 2006). It brings empirical attention to control and access to metabolic flows, which benefit a group of people or particular places at the expense of others, showing how urban socionatures are constituted by social power as a result of attempts by various groups to mobilize their interests and access resources (Swyngedouw, 2004).

This book focuses on the material and imaginative politics inseparable from the production of socionatural transformations, tracking material flows as in industrial ecology to show how the ecological connections between the city and its frontier matter (Demaria & Schindler, 2016; Newell & Cousins, 2015). It also explores the materiality of nature in urban metabolism in its multiplicity and grounds metabolism by illustrating the various ways that ecologies are urbanized through practical acts of work and labor. It seeks to maintain the tension between a microscale focus on individual and collective practices and ways of seeing and a macroscale transformation and control of flows.

Flow is an important metaphor to describe metabolism's spatial dynamics. It implies fluid movement and circulation, which are not simply material but are constituted through various relations in the process of flows maintenance (Kaika, 2004; Swyngedouw, 2006). Urban metabolic transformations involve circulation of commodities as "forms of metabolized hybrid socio-natures" (Swyngedouw, 2006, p. 109) that are produced under exchange value relations. Water has been the subject of many UPE urban metabolism narratives in various cities (and similar framings have been applied to other urban flows such as alcohol, fat, and wastes).⁸ Yet apart from Susanne Freidberg's (2001a) notable work in Burkina Faso, the circulation of food supplied from beyond the city has largely been overlooked by urban political ecologists. Unlike water channeled to the city, food produced elsewhere often requires particular material and symbolic transformations of landscapes and flows and brings together a host of actors, places, and relations before being consumed.⁹

Because the city sources most of its food from outside, city dwellers consume food primarily as commodities via market exchange mediated by increasingly global supply or value chains. Food is metabolized through various

practices and work at different sites as it moves toward and around the city, as commodification fundamentally transforms people's relationship with nature. Exploring the displacement and geographical lives of food commodities through metaphors such as chains or networks presents a point of productive engagement with urban metabolism, examining how commodity flows constitute urban natures through everyday practices of provisioning and securing livelihoods (Castree, 2004; Cook et al., 2006; Hughes & Reimer, 2004).¹⁰

Other types of flows, on the other hand, are managed because they present harm and risk to urban populations. In the modern Western world, "bad" water, considered harmful and hazardous, is expelled from private domestic spaces and hidden in public city spaces (Kaika, 2004; Karvonen, 2011; Walker et al., 2011). Wastewater and stormwater flows are the noncommodified and unwanted opposite of municipal water (good water) or of the vital inflow of food and energy. As an undesirable hazard, bad water in cities is often rationalized, displaced, and efficiently conveyed elsewhere through modern infrastructure networks (Karvonen, 2011). The sanitary city and the networked city emerged as twentieth-century visions of the modern city that sought to expel and control metabolic flows through integrated infrastructural services and initiating changes in the built environment (Gandy, 2004; Graham & Marvin, 2001; Melosi, 2008). Yet in many Global South cities, these flows often frustrate or overcome technocratic managerial attempts at control through engineering solutions, resulting in spatial fragmentation manifested in uneven exposure to destructive hazards (Collins, 2009; Mustafa, 2005; Schramm, 2016).

A metabolic lens applied to multiple resource flows that sustain and constitute urban life suggests that urbanization assembles diverse things, relations, and politics in making and maintaining particular socioecological arrangements across space. Cities are places always in the making (Lepawsky et al., 2015; Simone, 2010), and city-making processes are also located in the everyday material and symbolic practices surrounding resource flows and transformations. This situated everyday urbanism (Lawhon et al., 2014) stretches across space from cities to their frontier, as material transformations of flows intersect with inhabitants' understanding and experience of urbanization, including their acts of doing and making a living situated in place. An emphasis on metabolism beyond the city is also politically generative, as it extends "the potential sites of interventions" and widens "the objects of analysis and the epistemology of social change" (McFarlane, 2013, p. 500) within both visibly politicized landscapes and hidden ecologies embedded in the broader geographies of power (Huber, 2017).