An aerial photograph of Manila, Philippines, taken at sunset. The image shows a dense urban landscape with a prominent river winding through the city. The sky is filled with warm, golden light and scattered clouds. In the background, a large body of water is visible with several ships. The overall tone is warm and atmospheric.

# URBAN ECOLOGIES ON THE EDGE

**MAKING MANILA'S RESOURCE FRONTIER**

KRISTIAN KARLO SAGUIN

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*Philip E. Lilienthal*



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# *Urban Ecologies on the Edge*

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MAKING MANILA'S RESOURCE FRONTIER

*Kristian Karlo Saguin*



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## INTRODUCTION

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### *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.

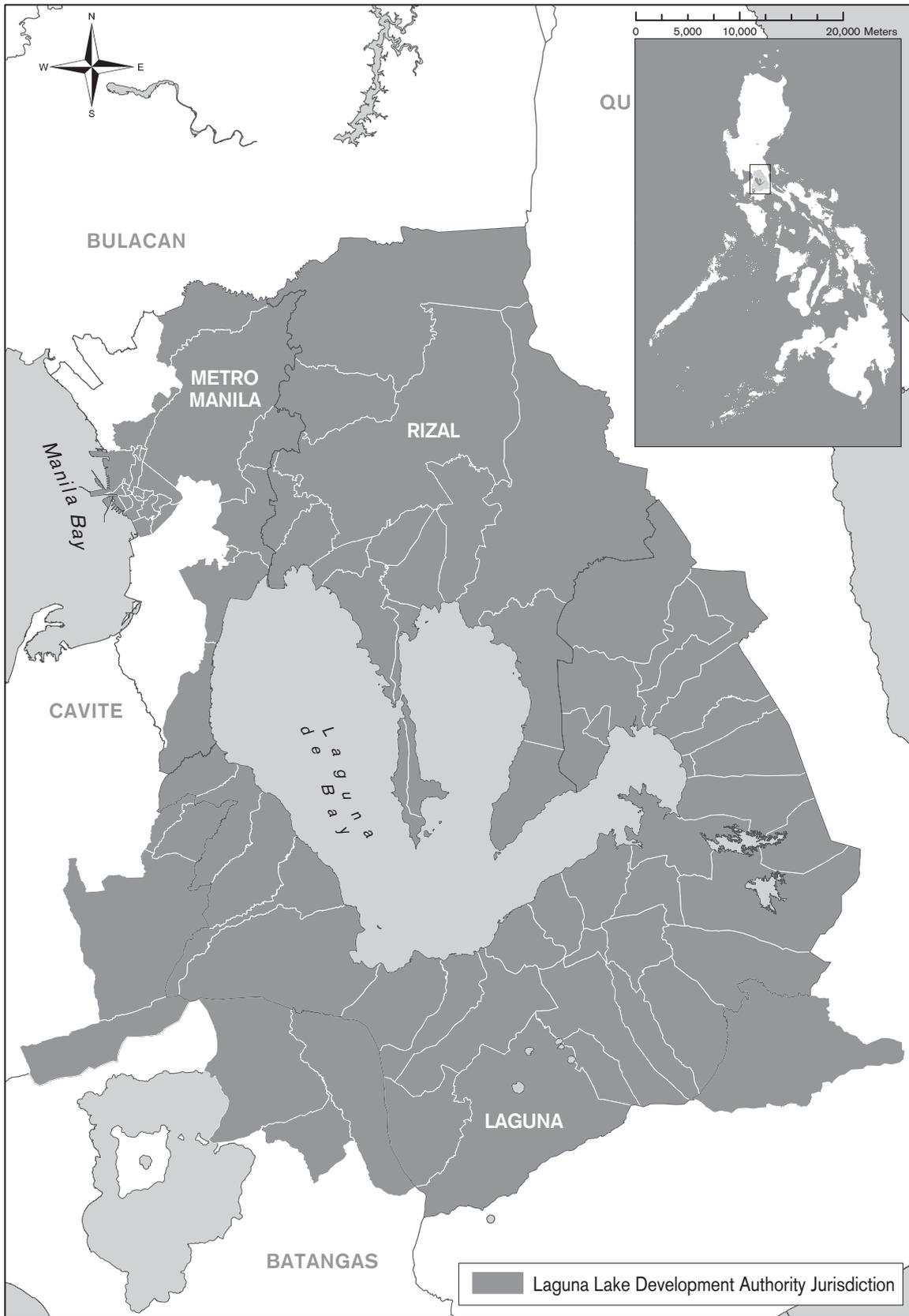
## FLUID URBANISMS: MANILA'S FISHBOWL AND TOILET

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.<sup>1</sup> 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.<sup>2</sup>

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).<sup>3</sup> 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 km<sup>2</sup>), 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.

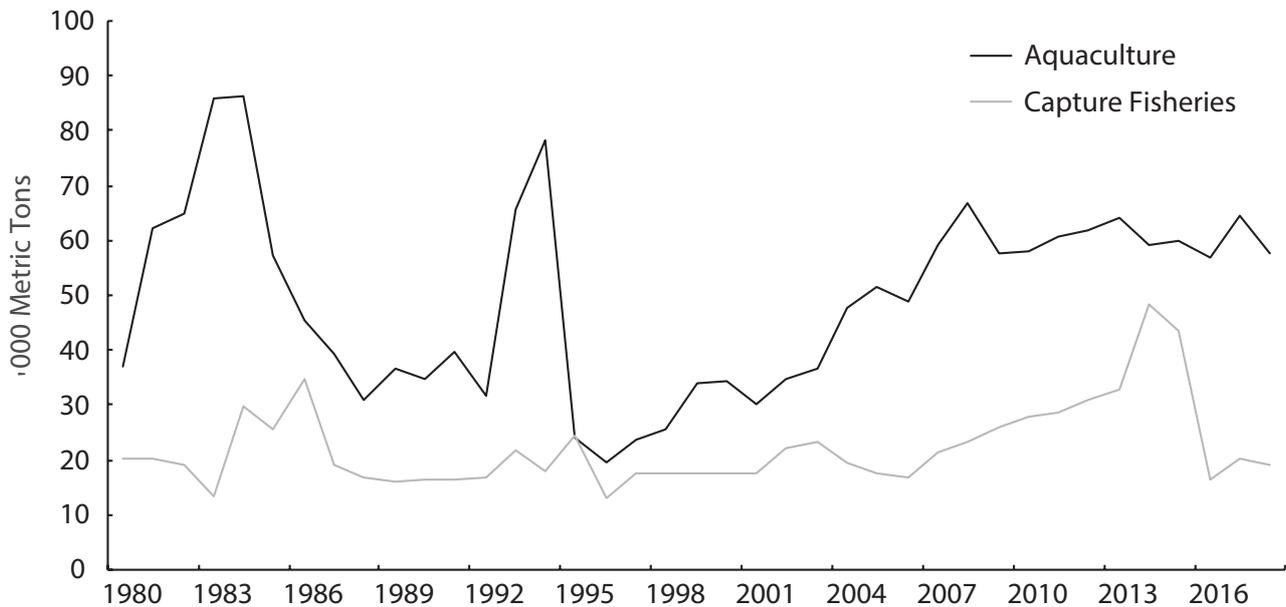


FIGURE 1. Laguna Lake fisheries production, 1980–2018. *Sources:* Laguna Lake Development Authority (1995b); National Statistical Coordinating Board (1999); Philippine Statistics Authority OpenSTAT database. *Note:* Information on capture fisheries production between 1997 and 2001 is unavailable from 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.<sup>4</sup> 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).<sup>5</sup> 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).<sup>6</sup>

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.<sup>7</sup> *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 socational 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).<sup>8</sup> 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.<sup>9</sup>

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).<sup>10</sup>

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).

Connections that make cities and the spaces they transform have been framed as different binaries—urban-rural, city-countryside, city-hinterland, core-periphery, agglomeration-operational landscapes—and emphasize the multiple sites where the urban’s constitutive outside resides (Reddy, 2018; Roy, 2016b). These relations capture the simultaneous marginality and centrality of these spaces in urbanization: spaces that are peripheral yet vital to city making. To understand city-making processes and the geographies of urban metabolism, we need to grasp how these spaces and ecologies also contribute to making the urban. In dominant models of urban and economic geography, and in industrial and ecological economic analyses, the city is a distinct spatial entity from its hinterland or frontier (Gandy, 2004; Golubiewski, 2012; Mehzabeen, 2019). Relational approaches to cities, in contrast, map the multiple spatialities of the city and urbanization in and beyond the bounded agglomerations in which they are often represented (Lepawsky et al., 2015; Massey, 1994; Reddy, 2018).

The frontier, as I show in this book, opens up possibilities for relationally understanding urban spaces transformed beyond the city. However, the term carries conceptual baggage as an overdetermined category, requiring specificity in its usage and sensitivity to its situated and diverse forms. Frontiers are historically and geographically specific, representing a moment that invokes particular assumptions about center and margins rather than a self-evident concept that manifests uniformly or timelessly. The largely rural-oriented body of work on resource frontiers serves as a starting point to think through the kinds of spatial and ecological forms and processes that urbanization produces as it moves resources between cities and frontiers.

The frontier denotes a dynamic spatiality. Classic works suggest linear movement or a mobile front as frontiers expand into marginal spaces over time, such as Frederick Jackson Turner’s (1920) frontier thesis on the history of the American West and the march of civilization. Frontiers are also often understood as political zones designed in relation to the state, where sovereignty is spatialized and encounters the state’s territorial limit (Saraf, 2020; Watts, 2018). Yet frontiers are more than just a timeless spatial category or place whose boundaries can be demarcated on a map. Rather, they are emergent historical products, produced in relation to the center, as something that *takes place* (Rasmussen & Lund, 2018). While frontiers have historically been understood in terms of particular spatial imaginations such as empty

rural lands at the remote margins, when reframed relationally, they may exist in areas such as Laguna Lake, proximate to the core and populated centers (Barney, 2009; Fold & Hirsch, 2009; McGregor & Chatiza, 2019; Pullan, 2011; Rasmussen & Lund 2018).

Frontiers are mutable and mobile (Cronon, 1996), but their continuous formation is cyclical rather than linear as they emerge and vanish, move and return (Cons & Eilenberg, 2019; Rasmussen & Lund, 2018). *Frontier making* captures this relational dynamism, emphasizing the becoming of frontier as an ongoing process. *Resource* frontiers meanwhile signal the creative/destructive incorporation of margins into the orbit of state and capital, emerging at particular moments when a new resource becomes amenable to extraction and commodification (Cons & Eilenberg, 2019; Rasmussen & Lund, 2018; Tsing, 2005). As sites where the state's territorial power and modern visions of order and capital's logic of accumulation intersect with lives and landscapes, resource frontiers are dynamic spaces of conflict, change, and potentialities. Resources and frontiers are co-constituted in the process of the discovery and release of natural resources, reconfiguring existing livelihood-ecological relations.

In her expansive work on resource frontiers, anthropologist Anna Tsing (2005) identified a few key features of frontiers: imaginative, liminal, unmapped, and lively. First, as an imaginative project, frontiers are discursive constructions produced at specific moments in time, suggesting a particular relationship between core and margins (Cons & Eilenberg, 2019). Frontiers are shaped by contradictory visions of what is and what might be. In this imagination, places are framed as empty, wild, untouched, and underdeveloped but at the same time full of potential and opportunities, primed for exploitation, resource extraction, and state intervention (Bridge, 2001; Cons & Eilenberg, 2019; Eilenberg, 2014). Modern ideologies of the nation, development, and progress clash with other knowledge practices, materially shaping both places and processes (Fold & Hirsch, 2009; Rasmussen & Lund, 2018).

Second, as a contact zone and “an edge of space and time: a zone of not yet” (Tsing, 2003, p. 5100), frontiers are best understood as transitional and liminal. Often conflated with borderlands, suggesting a similar interstitiality in the margins of state power, frontiers are a zone of interface where two worlds meet and confront each other, as spheres of friction where negotiation and collaboration play out (Tsing, 2005). Frontier liminality is both spatial and temporal, as in-between places, emerging amid or beyond state space, in the process of transition into something else in the future (Fold & Hirsch, 2009; Rasmussen & Lund, 2018). But frontiers are indeterminate

and unpredictable, as they emerge through chance and contingency, sometimes veering off from plans and intentions and often without coherence or consistency (Cons & Eilenberg, 2019; Tsing, 2005).

Third, as a form of unmapping, frontier making requires erasure of existing relations to establish new configurations of rule. Through representational and practical techniques, frontier making simplifies the situated complexities of places and abstracts local knowledge and livelihoods from their past entanglements (Tsing, 2005). Unmapping requires the undoing of established order and expunging all other claims to institute a new regime for the purpose of legitimating and facilitating resource extraction and exploitation (Cons & Eilenberg, 2019; Saraf, 2020). Technologies that territorialize for state legibility are central to this process, such as maps, fences, and titles, codifying new understandings of space and nature (Li, 2014; Peluso & Lund, 2011). The unmapping and effacing of previous orders is often characterized by violent encounters as states attempt to discipline and instill control in frontiers, dispossessing and excluding local people (Cons & Eilenberg, 2019; Rasmussen & Lund, 2018). Frontier making as unmapping is necessarily accompanied by territorialization as a remapping and reordering of space (Peluso & Lund, 2011; Rasmussen & Lund, 2018).

Fourth, frontiers are lively in the sense that they are populated with lives, livelihood, and liveliness. Despite attempts to unmap, abstract, simplify, and efface, this liveliness plays an active role in the making of frontier and haunts as an unexpected surprise that subverts neat plans of control (Cons & Eilenberg, 2019; Mitchell, 2002; Tsing, 2005). The entanglements of human and nonhuman lives and materialities shape frontier trajectories and are reconfigured through new political subjectivities and resistance against frontier making (Saraf, 2020). Frontiers are populated by multiple actors, processes, and configurations and have thus been framed as assemblages and constellations to emphasize their diversity and conjunctures (Cons & Eilenberg, 2019; Eilenberg, 2014; Li, 2014).

Frontiers play a crucial role in sustaining and reproducing capitalist relations and accumulation. Indeed, capitalism is characterized by frontier movements, as capital colonizes the uncolonized in both processes of commodification (expanding capitalist relations to deliver more commodities) and appropriation (bringing the noncommodified realm closer to keep capitalist production costs down) (De Angelis, 2007; Moore, 2015). Frontier sits at the boundary between the commodified and the uncommodified, a boundary that capital seeks to transcend in search of spatial solutions to its internal systemic crises

(Harvey, 2003, 2006; Moore, 2011). Primitive accumulation and accumulation by dispossession, key moments in the development of capitalism, find their spatial manifestations in frontiers, characterized by enclosures that cleave people from their means of production and by multiple processes that destroy and expropriate the commons (De Angelis, 2007; Glassman, 2006; Harvey, 2003; Rasmussen & Lund, 2018). It is in this context that environmental historian Jason Moore (2015) reframes the frontier as a *commodity* frontier vital to capitalism's reproduction not only in expanding spaces of capitalization but in extending zones of appropriation to deliver cheap food, labor, energy, and raw materials to overcome limits of commodification as barriers to capitalism's expansion.

Urbanization is often overlooked in geographical accounts of frontier making, which have largely been interested in examining shifting forms of contestation and extraction in remote, rural lands. A few commentaries, however, have alluded to peri-urban spaces as resembling frontier zones of transition and to how urban processes have blurred frontiers and centers, questioning distance and remoteness as defining features of frontiers (Cons & Eilenberg, 2019; Fold & Hirsch, 2009; Gururani, 2020; McGregor & Chatiza, 2019; Pullan, 2011; Rasmussen & Lund, 2018). But as a flexible concept that describes the relationship between the center and the margins, frontiers and urbanization can be mapped onto each other as relations between cities and hinterlands are co-constituted by resource production and flows. Frontier making tied to (capitalist) urbanization creates stories of spaces reconfigured for urban resource needs. An urban resource frontier promises progress and development for frontiers, achieved through increased integration with the city to solve its urban resource problems, facilitated by state territorialization. As rich and diverse as existing resource frontier accounts are, they often stop short of tracing resource flows beyond the frontier, of what happens to resources as they travel and circulate, and how in turn they (re)constitute the center. This is the frontier story that this book seeks to tell through urbanization, building on a parallel tradition in urban political ecology.

Urban political ecologists have worked within a relational understanding of cities as constituted by a plethora of multilayered flows, suggesting that "there is no longer an outside or limit to the city" (Swyngedouw & Heynen, 2003, p. 899). Urbanization therefore "produces both a new urban and rural socio-nature" and constant "extension of urban socioecological frontiers" (Swyngedouw, 2006, p. 114). Work on planetary urbanization attempts to

challenge UPE on its unfulfilled claims of bringing these frontiers into urban narratives through a critique of its methodological cityism or its primary focus on cities as artifacts of urbanization (Angelo & Wachsmuth, 2015). However, UPE works mapping the urbanization of resources have long demonstrated the material and symbolic coproduction of cities and frontiers through uneven metabolic processes (Connolly, 2019).<sup>11</sup>

Erik Swyngedouw's (2004) account of the urbanization of water in Guayaquil in Ecuador, for example, combines historical and ethnographic approaches to link past colonial processes with contemporary patterns of uneven urbanization, linking agrarian landscapes with the city. Social power permeates control of where water flows, resulting in the highly uneven distribution of access to abundant potable water among urban dwellers. Matthew Gandy's (2003) urban environmental history of New York City similarly examines how resources from the city's hinterland were reworked for the city by tracing their flows, politics, and ideologies. Both accounts have been inspired by William Cronon's (1991) environmental-economic history of Chicago and its hinterlands, which narrates stories of city-frontier coproduction through commodity flows of grain, lumber, and meat. Chicago's urban history is told through its constitution by resource flows from the fields and forests of the Midwest, emphasizing their coconstitution and interdependence: "They created each other, they transformed each other's environments and economies, and they now depend on each other for survival" (Cronon, 1991, p. 384). It seems impossible therefore to discuss urban ecologies without including these metabolic flows and city-frontier relations.

These urban works suggest that capitalist relations embodied by contemporary cities configure the urbanization of nature (Swyngedouw & Heynen, 2003), wherein the city-countryside dynamic becomes a spatial relation of the logics of capital (Moore, 2011) and reflects historical moments in capitalist development that reinforce particular ideologies (Williams, 1973). The city/urban and the noncity/rural are co-constituted in urban metabolism (Harvey, 1996), not in a sense of metabolizing other places but in that various practices and relations constitute this metabolism. The capitalist production of urban space requires a corresponding production of nature, initiated through concrete practices of laboring, a transformative act that brings together the human and the nonhuman (Braun, 2005; Gandy, 2004; Loftus, 2012; Smith, 2008). Yet it needs to be recognized that, as scholars drawing from postcolonial readings argue, capitalist urbanization is a significant but not the only force that shapes the urban frontier (Jazeel, 2018; Reddy, 2018; Roy, 2016b).

Tracking urban transformations beyond the city to the multiple sites of frontier urbanism shows that landscapes, bodies, and communities are shaped by urbanization in radical and banal ways (Arboleda, 2016; Ghosh & Meer, 2021; Gustafson et al., 2014; Hommes & Boelens, 2017; Kanai, 2014; Lepawsky et al., 2015). The urban frontier reveals realms and relations that have been traditionally the subject of agrarian studies and (rural) political ecology, with themes such as access, power, and control surrounding livelihoods, enclosures, and socioecological change similarly applicable to urban formations (Bartels et al., 2020; Cornea et al., 2016; Robbins, 2011). Despite moves to rethink the epistemologies of the urban by challenging the fixity of the city (Brenner & Schmid, 2015), the city remains analytically useful in urban frontier-making explorations, as it enables us to mark historical shifts in metabolic relations tied to decisions made about and for these spaces (Connolly, 2019; Davidson & Iveson, 2015; Rickards et al., 2016). The urban frontier is urban “because of [its] relation to unfolding processes of city-making” (Davidson & Iveson, 2015, p. 655), requiring continuous explanation of the processes through which the urban is made (Roy, 2016a).

The frontier and all its conceptual heft help us think of urbanization’s margins and edges in a relational way as zones of transition that take diverse geographical forms. But it also trains our attention to the specific features in these margins and edges that are shaped by urbanization, including their imaginative, liminal, unmapped, and lively characters. Despite its breadth, frontier is insufficient on its own to understand the socioecological extent of the urbanization of nature, especially as resource flows from the margins reconstitute the city. Thus, there is a need to keep these spaces in a relational tension with the city, turning attention to how resources and metabolic flows co-constitute both city and frontier.

#### URBAN ECOLOGIES: MATERIALITY, INFRASTRUCTURE, AND PRACTICES

The ecological history of cities may be interpreted through their need to continually transform nature and extend frontiers further (Swyngedouw, 2004). Three key concepts that constitute socioecological coproduction in these spaces are vital in frontier making and mediating metabolic flows: materiality, infrastructure, and everyday practices.

First, metabolic processes and circulation of flows encounter nonhuman natures that are neither inert nor passively acted upon by humans as the agent of transformation. Nature's materiality, or the "ontological existence of those entities we term 'natural' and the active role those entities play in making history and geography" (Castree, 1995, p. 13), is central in how we conceptualize urban ecologies within and beyond the city. The matter of nature (FitzSimmons, 1989) and its place in frontiers have been extensively explored in fields such as agrarian political economy, where the role of nature and its recalcitrant materiality in capitalist production focuses on natural obstacles to capitalism in nature-based industries (Banoub et al., 2020; Boyd et al., 2001; Goodman et al., 1987; Henderson, 1999; Kloppenburg, 2005; Mann and Dickinson, 1978). Work in this tradition argues how capital overcomes, circumvents, or takes advantage of the problem that nature poses in agriculture and similar industries, while considering implications for institutions, regulation, scale, and dispossession (Banoub et al., 2020; Bridge, 2000; Huber & Emel, 2009; Sneddon, 2007).

Talk of materiality of nature matters as it shapes social relations of production, including the organization of labor processes, institutions, and relations between producers (Benton, 1989; Mann, 1990; Prudham, 2005). Producing water or through water, for example, encounters material properties distinct from land-based production, such as fluidity, circulation, and the complex biotic/abiotic factors that comprise water quality (Bakker, 2004; Mansfield, 2004; Sneddon, 2007). Perishability and freshness have historically shaped trajectories of food production, distribution, and consumption under capitalism (Freidberg, 2009), as have animals as lively capital (Barua, 2019). Beyond political economy and capitalist natures, materiality has also been deployed through the lenses of cultural studies of commodities, corporeality, actor networks, assemblages, new materialism, and other relational ontologies (Bakker & Bridge, 2006; Bennett, 2010; Miller, 2005; Peters, 2012). Materiality through these lenses yields novel understanding of socionatures at work in resource production, posing ontological challenges to nature/society by emphasizing hybridity, performativity, multiplicity, and relationality of the material in stories of environmental change (Bakker & Bridge, 2006).

In urban political ecology, the materiality of urban nature is understood in terms of the socionatural hybridity—simultaneously social and natural—permeating urban metabolisms. The "hybrid" or "cyborg" metaphor brings together nondualist views of nature and society that claim cities do not just have an ecological dimension but are instead constituted by ongoing

transformations that coproduce both urban and rural socionatures (Gandy, 2005; Swyngedouw, 2006). Combining historical materialist and new materialist approaches to the materiality of nature has inspired an understanding of the urbanization of nature as an ongoing process of bringing together heterogeneous objects with consequences for thinking seriously about the place of more-than-humans in city and frontier making and how materiality makes a difference in urban metabolism (Demaria & Schindler, 2016; Holifield, 2009; McFarlane, 2011; Ranganathan, 2015; Swyngedouw, 2006).

Second, infrastructure as a sociotechnical element of urban metabolic relation facilitates bringing resource flows to the city and connecting the city with the frontiers that sustain them (Loftus & March, 2016; McFarlane & Rutherford, 2008; Monstadt, 2009; Silver, 2015). As networked infrastructures and urban forms coevolve, extending further out with greater spatial reach, they present central nodes within which contestations surrounding access and politics take place both ideologically and materially. Infrastructure facilitates frontier making by integrating adjacent and distant places through resource flows and the complex ecologies that make these possible (Carse, 2012; Furlong & Kooy, 2017; Graham & Marvin, 2001).

Infrastructure serves as the underlying or background mechanism that enables the work of circulation of flows of things, resources, goods, people, and ideas across space (Larkin, 2013; Star, 1999). As hard, rigid structures, they appear as solid, durable, and permanent fixtures of the landscape but simultaneously require repair and retrofitting to continue functioning, meet new demands, and resist being outmoded or obsolete (Howe et al., 2016). Embodying visions of modernity and control of nature, many of these infrastructure networks become vital sites in the struggle for access to flows but whose very political character is often rendered technical and invisible (Graham & Marvin, 2001; Kaika & Swyngedouw, 2000; McFarlane & Rutherford, 2008). They appear utilitarian but are inherently political, reflecting and embodying structures of power (Graham, 2010). Their absence or fragmentation in space is as contentious as their visibility and presence.

Urban infrastructures reflect ideals of modernity and create the grounds for the operation of resource frontiers. Consequently, they also become sites and objects that are the visible target of resistance when they convey harmful or disrupted flows as socioecological burdens for people. Thinking about infrastructures requires recognizing their paradoxical character (Howe et al., 2016) but also the ways that they are lived, experienced, and seen (Graham & McFarlane, 2014; Simone, 2004), locating them beyond the Global North

ideal of functioning centralized networks and within the realm of everyday practices (Furlong & Kooy, 2017; Lawhon et al., 2014; Monstadt & Schramm, 2017). Infrastructure becomes an important site for urban metabolism materially, ideologically, and politically.

Finally, the ecologies of urbanization are also situated within practices and experiences of inhabitants in both cities and beyond their edges. The urban is lived, inhabited, and experienced—within and beyond processes of capital accumulation—and situated within particular conjunctures (Roy, 2016a). The everyday becomes a key site of socioecological transformation and is a product of local contingencies that vary across contexts (Connolly, 2019; Doshi, 2017; Lawhon et al., 2014; Simone, 2019). Situating and grounding urban metabolism through accounts of the everyday in Global South cities produces an alternative or counterpoint to how we understand the urban (Lawhon et al., 2014). It involves rethinking how resources are constituted, diversifying narratives of which flows and transformations matter in particular places. The metaphor of flow that defines the fluidity of resource movement may similarly be reframed as constituted by ordinary practices of doing that produce and reproduce social power, urban difference, and space (Doshi, 2017; Lawhon et al., 2014; Zimmer, 2015).

Accounting for practices surrounding transformation of resource flows at various sites in frontier urbanism demonstrates the generative acts of gaining or restricting access, positioning, meaning making, and material change as people reshape ecologies of connection. These extend to diverse, mundane acts of doing that rework the urban environment and sustain obdurate relations in minute and mighty ways. Metabolism of food, for example, is not just a question of urban-rural exchange of nitrogen or phosphorus but is also the situated relations surrounding its production, circulation, and consumption. Materiality, infrastructure, and situated everyday practices all point to the labor necessary to build and maintain socioecologies. They present opportunities to engage various readings of the city and the frontier linked by urban metabolic relations.

## FOLLOWING THE FLOWS AND ORGANIZING THE NARRATIVE

The urban ecologies on the edge encompass multiple sites between Manila and Laguna Lake and extended time frames from the past to the contempo-

rary. I have sought to capture these stories through accounts from multisite fieldwork research complemented by a reading of documents from state and scientific reports and news articles published from 1905 to 2017. The multisite methodological strategy enabled me to follow metabolic flows of fish and the geographical lives of a commodity along various nodes (Cook et al., 2006; Freidberg, 2004; Ribot, 1998), as well as to map the flows of floodwater mediated by infrastructure networks. This strategy allowed placing a geographically extensive process involving various agents in specific sites, paying attention to macro processes that constitute the context while allowing for a flexible engagement with theory through empirical cases. Multisite approaches identify the diverse sites of the urban and the diffuse practices that constitute them (Lepawsky et al., 2015), linking together places shaped by similar processes (Freidberg, 2001b).

Through the multisite research strategy, I have covered a wide range of livelihood engagements within and beyond the fish value chains and infrastructure networks that connect Laguna Lake and Metro Manila. Anchored on a “follow-the-thing” approach focused on fish flows (Cook et al., 2006), I conducted semistructured interviews with a total of 115 fish producers, traders, consumers, and lake residents, as well as state officials and key actors in Manila and in Laguna Lake. The bulk of the interviews, participant observations, and field research in the lake took place in the first half of 2012 in two Rizal villages (*barangays*): Navotas in Cardona municipality and Kalinawan in Binangonan municipality. These villages, located within the primary fisheries municipalities of the lake, were selected because they represented differing engagements with fisheries and aquaculture. Navotas hosted a diverse set of fishing-based livelihoods, while Kalinawan is almost exclusively dependent on cage nursery aquaculture, allowing for comparison of diverging agrarian trajectories of urban-oriented aquaculture.

In Manila, I conducted interviews and observations at the Navotas Fish Port Complex and other fish markets in the latter half of 2012, employing a method similar to Bestor’s (2004) inquisitive observation. I also talked to representatives of fishpen and fisherfolk associations based at the lake and in Manila, as well as state engineers and officials in agencies involved in urban flood control and the lake’s environmental management. I returned to the lake villages in 2015 for follow-up interviews and also conducted additional fieldwork from 2015 to 2017 along the lakeshore sites of Muntinlupa and Taguig in southern Metro Manila and Calamba in Laguna.

For the interviews, I employed purposive and theoretical sampling, which combined snowballing and stratified purposeful techniques that targeted

individuals from specific subgroups referred to me by other participants (Miles & Huberman, 1994). This strategy was adopted because of the large number of potential participants located at multiple sites and to ensure that all major fish-related livelihoods between lake and city were included in the interviews. It also facilitated access to various sites, including places that might otherwise have been difficult to enter, such as certain aquaculture production sites and the very restrictive urban fish port.

The semistructured interview schedules were composed of several questions that were subsequently adapted to fit the livelihood and initial responses of participants, inquiring about production and trading practices, access to means of production, relations with other producers, marketing and distribution of fish, place histories, and socioecological changes in the lake, among other topics. Interviews were conducted mostly in Tagalog/Filipino, the local language, coded for analytical themes and translated into English. Where appropriate in the discussion, I have included the Tagalog terms for various local names and their closest, locally used English translations.

I also spent time talking to and engaging in participant observation of everyday events at various sites at the lake to understand livelihood practices—for example, maintaining aquaculture cages, seining a fishpen, harvesting fish in a corral and cages, assembling fish for trade, strip spawning of fish in hatcheries, unloading fish—and at the city markets, fish ports, and neighborhoods where fish is consumed. Multisite research on an expansive topic such as the geographies of urban resource flows requires making analytical choices about which people, relations, or places are included in the narrative. These choices are of course a product of a partial, selective, and situated understanding of places that cannot be divorced from research positionalities. Navigating my insider/outsider position as a Filipino researcher who spoke the local language but remained an outsider to many of these communities has been shaped by particular theoretical and political commitments to understanding spatial injustices and uneven development resulting from urban metabolic relations. These orientations are embedded throughout the subsequent discussion of the various visions and practices of people as they rely on, make do with, or transform the particular socioecological configurations they continue to inhabit.

The book is divided into two parts and contains six chapters, four of which present empirical narratives that tease out urban metabolic relations between the city and the frontier. In part 1, I examine how Laguna Lake was socioecologically produced as an urban resource frontier by the intersections of state, capital, and livelihoods, generating contradictions that reconfigure

resource governance and production. This half of the book narrates a history of the spatial expansion of urban resource frontiers in the lake (chapter 1), complemented by accounts of socioecological transformation in these frontiers (chapters 2 and 3). In part 2, I follow resource flows from frontier to city and back to investigate questions of access, practices, and imaginaries. I use stories of provisioning of fish and movements from spaces of production to consumption (chapters 4 and 5), and of floodwaters and infrastructure (chapter 6) to illustrate how resource flows from frontiers are encountered and transformed by everyday practices.

In chapter 1 I investigate the history of the frontier-making relations between Metro Manila and Laguna Lake throughout the second half of the twentieth century. This chapter traces imaginaries and visions of the lake as a frontier through state and scientific projects, bodies, and infrastructure that initiated, controlled, or managed fish, water, wastes, and other vital flows between the city and the lake. The modern ideology of progress and taming nature permeated the postcolonial state and underpinned visions of the subsequent developmental, authoritarian, and neoliberal modes of lake governance. I demonstrate how Laguna Lake was dreamed of and designed as a multi-use resource that would promote agrarian development while providing resource flows for Manila. Aquaculture became central to this project as a technology to produce fish more efficiently amid framings of an overexploited yet underutilized lake that rendered the lake extractable. Efforts to improve the fish, the production techniques, and the lake were necessary to realize the modern goals of development, and knowledge of the lake's nature became a significant prerequisite to control. Using the controversy over hydraulic control of saltwater flux to the lake, I also contrast the state's modern/scientific and fisherfolk's lived/practical knowledge of the lake as a form of frontier unmapping of complex lake socioecologies. The chapter shows how the lake became a modern laboratory for socioecological experimentation and new modes of production and resource governance that aimed for state managerialism of conflicting urban metabolic flows.

Chapter 2 adopts the lens of the commodity frontier to narrate the expansion and crisis of aquaculture in Laguna Lake. The emergence and entrenchment of capitalist aquaculture in the lake are rooted in changing political economies of a fishing industry that took advantage of routine failures of lake management and reshaped state regulation. The intrusion of large-scale urban investments on aquaculture and expansion of enclosures produced conflicts with small-scale fisherfolk, leading to a contentious history of accumulation,