philippine studies: historical and ethnographic viewpoints

Ateneo de Manila University • Loyola Heights, Quezon City • 1108 Philippines

States of Hazard: Aquaculture and Narratives of Typhoons and Floods in Laguna de Bay

Kristian Karlo Saguin

Philippine Studies: Historical and Ethnographic Viewpoints
vol. 64 nos. 3–4 (2016): 527–54

KRISTIAN KARLO SAGUIN

States of Hazard
Aquaculture and Narratives of Typhoons and Floods in Laguna de Bay

Aquaculture, a modern scheme introduced by the Philippine state to improve fish production and livelihoods, has resulted in contradictory outcomes in its four-decade history in Laguna de Bay. This article examines the fate and trajectories of these modern schemes through the lens of hazards. It situates the place of typhoons and floods in the introduction and regulation of pen aquaculture technology, and in the practices of living with hazards among aquaculture producers in the lake. In both cases hazards are considered as intrinsic to their narratives rather than as external forces that occasionally disrupt human plans.

KEYWORDS: LAGUNA DE BAY · LAGUNA LAKE · AQUACULTURE · HAZARDS · DEVELOPMENT · STATE

Hazards have long shaped the configurations of state and society in the disaster-prone Philippines (Bankoff 2003). These historically produced configurations are embedded in the continually evolving relations between state, society, and the natural world. Using the case of aquaculture in Laguna de Bay, this article examines two elements of these relations: the place of hazards in state development schemes and the practices of living with hazards among fish producers. State development schemes in Laguna de Bay carry the modern promise of improvement through the efficient use of lake resources and the control of its processes via technological interventions. These interventions have transformed the landscapes and livelihoods of lake villagers traditionally dependent on capture fisheries. In the trajectory of both narratives, hazards such as typhoons and floods have played a central role. Rather than external forces that disrupt normal proceedings, these hazards, as the article aims to show, are best viewed as intrinsic to the trajectories of state improvement schemes and producer practices.

Laguna de Bay or, as it is now popularly known, Laguna Lake is the largest inland water body in the Philippines, whose basin area covers most of Metro Manila and the two provinces of Laguna and Rizal.[1] Because of the lake's size, importance to fish production, and proximity to Metro Manila, the state initiated a series of interventions to develop its resources beginning in the late 1960s. These interventions were situated within the postwar thrust of Philippine state building through development projects that also intersected with advancements in the green revolution and scientific agriculture. The introduction of aquaculture as one of these development schemes shaped Laguna de Bay's socioecologies that lake dwellers continue to live with forty-six years on. However, despite their constant presence throughout its history, hazards and their role in these schemes have not been considered analytically in accounts of the aquaculture history of Laguna de Bay. In studying these hazards, this article uses as a conceptual guide to examine these improvement schemes James Scott's (1998) model of a high modern state that seeks to make productive a nation's resources. This article also builds on parallel arguments that attempt to amplify or refine the ontology of this abstracting and utilitarian state (Mitchell 2002; Li 2005, 2007).

The succeeding discussion is based primarily on empirical material gathered from ethnographic fieldwork conducted from April to June 2012 in two Laguna de Bay villages: Navotas, Cardona, located at the northernmost tip of Talim Island, and Kalinawan, Binangonan, located on mainland Rizal province. Navotas remains a subsistence fishing village, while Kalinawan relies primarily on small-scale cage aquaculture production (nurseries and grow-out). I interviewed a total of fifty-eight capture fisherfolk, cage aquaculture producers, and fish traders in these two villages, using Tagalog as the medium of conversation.[2] I also interviewed three fish pen operators based in Metro Manila in 2012. In addition, this study draws from a review of project documents, annual reports, scientific papers, and newspaper articles about the lake.[3]

The next section situates aquaculture development within broader state attempts to develop the lake's resources by controlling and harnessing particular socioecological processes, using the example of the debate over the hydraulic control of saltwater intrusion. The subsequent section discusses the place of typhoons and floods in two moments of aquaculture development—the introduction and regulation of fish pens—and considers what this development entails for thinking about the role of hazards in state improvement schemes. The final sections shift attention to how fish producers in the lake—fisherfolk, cage producers, and pen operators—live varyingly with hazards through particular practices and strategies. Although hazards are internal to the functioning of state schemes and producer practices, dissecting the geographies of difference and their structural roots remains an important task.

Developing Laguna de Bay as a Resource: Making Nature Legible

Fish pen and cage aquaculture presents a radically new way of producing fish, one with no precedent in Laguna de Bay or any other place in the Philippines. Whereas pond aquaculture, which first developed in the Visayas in the fifteenth century, evolved slowly over time (Villaluz 1950; Schmittou et al. 1983), pen and cage culture in large water bodies represents late–twentieth-century technologies that very rapidly transformed their host spaces. Aquaculture is the first of several state-improvement efforts designed to gain greater control of lake nature, a discursive framing embedded within postwar state making through development.

The creation of the Laguna Lake Development Authority (LLDA) in 1966 reflected this novel emphasis on development. Its 1966 prospectus argued that "control of the lake is an indispensable element for the proper physical planning and development" (LLDA 1966, 2) and "the rich but untapped resources of the Laguna Lake Area . . . have to be harnessed by a fully organized, long-range development strategy into an effective development event that will yield the best results" (ibid., 6). By 1970 Laguna de Bay had become the pioneer site for pen and cage aquaculture technologies. Experimental efforts to develop them in the lake were always situated within the goal of introducing these technologies to water bodies elsewhere in the country.

The prewar concern for fisheries management (Aldaba 1931a, 1931c; Villadolid 1933, 1934; Mane and Villaluz 1939) was replaced by a broader, holistic development agenda that sought to make use of the lake as a source of fish and water through modern technological interventions. Aquaculture promised efficient and controlled fish production to improve livelihoods and food security, which traditional capture fisheries in the lake were deemed unable to provide. Capture fisheries produced a diverse variety of fish, but these were small in size that fetched low prices in the urban market. Assessments by fishery scientists found that the lake's unique characteristic of producing natural plankton was not fully utilized by existing fisheries and could be more efficiently converted to consumable protein if other species such as milkfish and tilapia were to be introduced (Rabanal et al. 1968; LLDA 1970, 1978; Davies et al. 1986). Thus, quantity and volume of fish according to value and ability to convert natural feeds to protein became a more pressing concern than maintaining a healthy diversity of fish for fisherfolk subsistence. Aquaculture introduction aimed to "meet the current shortage in national fish requirement with particular emphasis on addressing the current fishing catch problems in Laguna Lake" (LLDA 1970, 27). Enabling the growth of aquaculture production required the reworking of fish bodies, techniques of production, and the lake environment. Experimental farms, research stations, and scientists contributed to the first two needs, while infrastructure and governance strategies were necessary in the more complicated third task.

Beginning in 1967 the LLDA commissioned several externally funded studies that assessed the lake's development potentials. These studies included those financed or supported by the United Nations (UN), the Asian Development Bank (ADB), the World Bank (WB), the United States Agency for International Development (USAID), and the World Health Organization (WHO). Foreign experts and consultants collected various limnological data and recommended appropriate interventions based on problems that were identified as constraining development. One of the most contentious issues was whether to allow seasonal saltwater intrusion into the lake. The Société Grenobloise d'Etudes et d'Application Hydrauliques (SOGREAH), a French consultant firm hired by the ADB, undertook limnological studies in 1972–1974 that focused on understanding the unique hydraulic regime of the Laguna de Bay–Manila complex with the purpose of recommending appropriate interventions (ADB 1973). The SOGREAH supported an earlier study's recommendation on the construction of a hydraulic control structure to regulate Pasig River backflow to the lake (UN 1970). The structure was necessary to optimally realize the lake's potential for economic production by controlling saltwater flux that accompanied the seasonal backflow (LLDA 1978b; Rey 1987; SOGREAH 1991; Santos-Borja 1994).

The SOGREAH identified backflow from the Pasig River as the biggest threat to the lake as a source of fish, drinking water supply, and irrigation. This backflow brought excessive nitrogen flux, which they observed was responsible for considerable nitrogen load in the lake and for episodes of *Microcystis* algal blooms that caused massive fish mortality in pens in 1972 and 1973 (LLDA 1978b; SOGREAH 1991; Santiago 1993; NSCB 1999). Thus, the need to control this backflow became a priority program, which the Public Works Ministry realized with the completion of the Napindan Hydraulic Control Structure in 1983.

Technical assistance through feasibility studies and scientific assessments laid the foundation for the production of knowledge about the lake, but such assessments were made within the limnological contexts and experiences of foreign consultants, specifically those of western European lakes (Santiago 1993). Observations by prewar fishery scientists and fisherfolk ecological knowledge about the contradictions of saline backflow as both a blessing and a curse (Cendana and Mane 1937) were overlooked in favor of a simplifying discourse that identified the backflow as an ecological problem—with nitrogen as the limiting factor—that needed to be overcome to promote the lake's resource development. Elimination of the backflow through hydraulic control potentially benefited the lake as a source of public water supply and irrigation, but threatened lake fisheries, whose productivity relied on the saltwater's ability to reduce turbidity, improve photosynthetic activity, and increase plankton production.

Analysis of the issue of saltwater intrusion control adheres to Scott's (1998) model of a utilitarian, high modern state. The hydraulic control of saltwater intrusion is an example of the necessary simplification of the lake's complex socioecologies. In an effort to produce the lake as a multibenefit resource and make it legible for developmental intervention, state and science smoothened and simplified the spatiotemporally uneven processes to make them amenable to technical control. This abstract, narrow, and utilitarian state vision contrasts with and silences what Scott terms as the *mētis* or the practical knowledge of fish producers who live with the complexity of lake nature through everyday practices.

In the case of Laguna de Bay the fish producers asserted this practical knowledge. Because of the importance of saltwater intrusion, aquaculture operators and capture fisherfolk formed an alliance that successfully pressured the state in 1985 to indefinitely open the gates of the hydraulic control structure and allow unrestricted saltwater intrusion (Santos-Borja 1994).

This brief account of the interactions of the LLDA, saltwater intrusion, and hydraulic control in Laguna de Bay points to how the state, science, and the nonhuman world are enmeshed in the politics of modernity (Jasanoff 2004). Telling the story of state development interventions and improvement schemes in Laguna de Bay requires serious engagement with the role of knowledge (scientific and practical), technological objects, and nonhuman elements in shaping outcomes. The following section says more about these dynamics by focusing on the place of typhoon and flood hazards in aquaculture's historical trajectories in the lake.

Hazards in Aquaculture Introduction: Typhoons, Floods, and the Experimental Farm

Following UN recommendations, the LLDA established in 1970 an experimental farm in the lake's Central Bay to determine the feasibility of introducing aquaculture. The 38-hectare Looc Fish Pen Demonstration Project constructed in Cardona, Rizal, stocked milkfish, a species chosen for its high market price and because it fed primarily on the lake's phytoplankton (Delmendo and Gedney 1976).[4] The project used the novel fish pen technology, which entailed the construction of an enclosure with structures made of synthetic mesh nets tied to bamboo poles that were staked to the muddy bottom of the lake. Pen culture methods were first documented outside the Philippines in Japan in the 1920s and China in the 1950s

Fig. 1. Fish corrals and pen structures (background) in Laguna de Bay, 2012

(Beveridge 1984). In Laguna de Bay the LLDA designed the earliest pens as larger versions of the catching chamber of *baklad* or fish corrals (fig. 1), small-scale structures that previously existed in the lake and were used by fisherfolk to trap fish passively (Delmendo and Rabanal 1982).

A typhoon damaged the initial farm in its first year of operation, postponing the first harvest to 1971 after subsequent reconstruction and restocking. As reflection of the project's importance to state development thrusts, Pres. Ferdinand Marcos sent his executive secretary to grace the ceremonial first harvest on 9 July 1971 (LLDA 1971).[5] This harvest demonstrated that pen aquaculture was feasible in the lake despite the setback from typhoon damage and supported earlier assessments of the potential for increased efficiency and yields in fish production. Five months of culturing milkfish without any artificial feeds yielded 700 kilos per hectare and the LLDA estimated the possibility of an annual yield of 1,500 kilos per hectare a figure more than thrice that of capture fisheries (Delmendo and Gedney 1976).

The success of pen technology through higher yields and minimal need for artificial feeds was not the only important factor in the eventual trajectory of aquaculture in the lake over the next few years. Typhoon and flood damages to the Looc experimental farm recurred throughout the 1970s and were regularly documented by the LLDA's annual reports in terms of costs of structural damage and percentage of stocked fish lost. The great flood of July and August 1972 brought the highest water levels in the lake, which nearly doubled its volume, levels matched only by previous records in September 1919 (LLDA 1972; Nilo and Espinueva 2011). It caused extensive damages to both the experimental farm and the other pioneering commercial farms in the lake. The LLDA (1974) scrapped another pen demonstration project in Sta. Cruz, Laguna, on the East Bay because of recurrent strong waves, inundation, and typhoon damage, eventually marking the project as an extraordinary financial loss. In late 1978 a series of typhoons—Weling (international name: Lola), Yaning (international name: Ora), and Kading (international name: Rita)—damaged 65 percent of stocked fingerlings, financially constraining the sustainability of the experimental farm (LLDA 1979).

The 1976 typhoon season also reduced by half the commercial private pen area in the lake and temporarily halted rapid pen expansion, which had developed parallel to but separate from the experimental farm (LLDA 1978a; Palma et al. 2005). However, these private operations were quick to recover and reconstruct despite deriving little technical support from the LLDA and relying primarily on practical knowledge of producers. They continually expanded with new investments by urban entrepreneurs (including celebrities, politicians, and military officials) and fishpond operators and fishing companies from Malabon, Navotas, and Bulacan (Ofreneo 1980; Cruz 1982; Santos-Maranan 1982; Jose 1994b; Santos-Borja and Nepomuceno 2006). From 500 hectares in 1972, private pen area in the lake grew to 4,800 hectares in 1973 and to 7,000 hectares in 1976 (Delmendo and Gedney 1976).

While production of fish increased dramatically, the associated benefits of improved fisherfolk livelihoods did not materialize due to the rapid expansion of fish pen structures owned by nonlake dwellers who displaced the target fisherfolk beneficiaries. To address this concern, the LLDA proposed the Laguna de Bay Fishpen Development Program (LDBFDP) in 1976 to expand access to pen technology among the lake's fisherfolk. Funded mainly by the ADB, the program sought to create 2,500 hectares of fisherfolk-operated 10-hectare pens and to provide the intended beneficiaries with loans (LLDA 1977, 1978a, 1979, 1980, 1981). By the end of its cycle in 1988, only 2 percent of the projected output was met partly because pen sprawl occupied the most productive lake space and partly due to the difficulty encountered by beneficiaries in recovering from typhoon damages.

Almost all (99 percent) of the project pens were destroyed by typhoons at some point, burdening fisherfolk cooperatives with significant debt that reached P1.2 million per pen (Yap 1999). The inflexible procedures for securing government and bank funding and materials for reconstruction after typhoons meant that cooperatives took several more months to recover than nonproject pens, making it difficult for them to adapt to the quick turnover of the cropping cycle of milkfish culture (ibid.).

With this failure to institute pen technology as a viable or appropriate livelihood strategy for fisherfolk, the LLDA, in partnership with the Southeast Asian Fisheries Development Center, developed another method of aquaculture in the lake. Cage aquaculture became an attractive option for fisherfolk because of their smaller size, financial requirements, and management demands (Tabbu et al. 1986; Garcia and Medina 1987). Beginning in 1980, more fisherfolk invested in tilapia cage polyculture than in milkfish pen monoculture even if the former was more vulnerable to impacts of poor weather conditions (Garcia and Medina 1987).

Hazards such as typhoons and floods were intrinsic to the development and trajectories of Laguna de Bay aquaculture from its early origins in the 1970s and not merely occasional external disruptions to an otherwise stable production system applied from abstract, scientific agricultural knowledge. Feasibility studies and LLDA scientists very quickly recognized, even at the early stages of the experimental pen, the need to integrate typhoons and floods in pen design and operations (LLDA 1978a). Vicente Lavides Jr., LLDA's first general manager, noted that the LLDA staff "have always suffered typhoon damages" and were "in continuous search for materials which could be utilized in the construction of fish pens which have longer economic life and are resistant to wave and wind action" (LLDA 1972, 6).

The ability to incorporate typhoons in pen operations is inherently uneven, with larger-scale pens more successful in investing in technological adjustments, reflecting the disparities in financial and political capacities. Some of these adjustments included the use of stronger but costlier palm trunks (*anahaw*) instead of bamboo poles, and innovations in net design to reduce the threat of fish spillage. The experimental farm and private pens made parallel changes in the pen design and techniques of production through experience, observation, and constant dealing with winds and waves. They developed knowledge about aquaculture and the lake through practice. Private commercial pens, however, expanded dramatically with minimal regulation from the LLDA. In contrast, state aquaculture projects informed by the experimental farm such as the LDBFDP were considered failures.

A combination of three factors—less active typhoon seasons from 1979 to 1984, continued institutional confusion in assigning pen permits, and intensified urban interest in pen investment—culminated in the pen sprawl of 1984 that saw disorganized private pens occupy 51,000 hectares or 56 percent of the total lake surface area (Delmendo and Rabanal 1982; Ruaya 1994; LLDA 1995). Pens encroached on fishing grounds, and operators overfed and overstocked their pens, undermining the lake's productivity (Rivera 1987). Conflicts that became armed and tense arose between pen operators, who acted through their guards, and fisherfolk, who lost access to former fishing grounds (Saguin 2015). The pen operators accused the fisherfolk of poaching and sabotage, while the latter complained of being victims of physical exclusion and extortion. Reports of violence in the lake brought the pen problem to national attention. The state, from the LLDA to the Office of the President, responded with a series of interventions to manage these conflicts and regulate pen aquaculture. In these narratives typhoons and floods were once again intrinsic to the story.

Hazards in Aquaculture Regulation: Typhoons, Floods, and the ZOMAP

Despite its ambitious mandate as the authority on development in Laguna de Bay, the LLDA began as a modest, understaffed organization that encountered problems in exerting its regulatory powers (Delmendo and Rabanal 1982). It had minimal technical expertise and experience when it embarked on the pilot pen project, employing only two technical staff members (ibid.). Its relations with other state and scientific bodies started out on shaky ground, resulting in "conflicting technical opinions and administrative problems" (ibid., 134). The LLDA's spatial jurisdiction also overlapped with those of the local governments of Rizal and Laguna (and eventually Metro Manila). From the beginning of the aquaculture boom in the 1970s, the LLDA clashed with municipal mayors on the issue of granting pen permits and collecting fees from operators. Its lack of enforcement capacity despite well-intentioned rules and jurisdictional conflicts with the local government units enabled the pen sprawl of the early 1980s. By the time the "Rules and Regulations Governing the Construction and Operation of Fishpens or Fish Enclosures in Laguna de Bay" was passed in 1976, the pen sprawl initiated by the nonlake dwellers was well underway (ibid.). Despite its high modernist ambitions of developing the lake by controlling its nature, the state in this regard resembled one that was more diffuse and tentative.

The first regulatory mechanisms that addressed pen conflicts involved national government intervention through the Office of the President. Marcos issued several letters of instruction, including those in 1978 (LOI 769) and 1982 (LOI 1234) that tasked the LLDA to oversee the demolition of illegal pens in order to quell conflicts and violence (LLDA 1978a, 1982, 1983; Cruz 1982). This and subsequent efforts required making an inventory and survey of structures and their areas, further deepening the lake's legibility through tools of statecraft (Scott 1998). In 1983 the LLDA proposed the creation of the Laguna de Bay Fishery Zoning and Management Plan (ZOMAP) as a longer-term solution to the pen sprawl problem, with implementation initially set the following year (LLDA 1983). Based on the estimated carrying capacity of the lake, pen area was set to be reduced to 21,000 hectares and located in the lake's offshore parts. The ZOMAP also delineated cage belts (nearer to the shore), navigational lanes, and fishing grounds.[6]

The ZOMAP provided a fundamentally different way of seeing and managing the lake. Whereas previously the lake was a common property resource where rules and institutions were place- or village-specific (Eleazar 1992), the ZOMAP centralized the lake as a governable resource with distinct spatial zones represented by geometric belts.[7]

Aquaculture as fixed structures in lake space is relatively easier to manage, count, and survey than the fugitive character and more mobile institutions of capture fisheries. The ZOMAP is thus a perfect example of what Scott (1998) calls high modern state planning: creating order and improvement through the modern and efficient language of "rationalization" and "democratization." Because of their displacement and resistance to pen encroachment, the fisherfolk's fishing grounds were spatialized by the ZOMAP, simultaneously legitimizing pen presence in the lake and making their fishing livelihoods more legible to state regulation. The LLDA (1999, 15) believed that "the ZOMAP is still the most effective management system for re-distributing the economic benefits of fishery, and the most acceptable tool to effect equitable allocation of the lake's fishery resources." Making lake production more legible was important in collecting revenue from pen operators, who had to pay annual leases, and in bidding out the spaces formerly occupied by abandoned or demolished pens.

The ZOMAP rendered technical the fundamentally political issue of access to the lake (Li 2007). Through rationalization of lake space and democratization of ownership (LLDA 1999), the zoning presented the solution to a political problem as a matter of spatial ordering of existing access regimes through belts and zones. The need to meet the carrying capacity was also a response to declines in average yields by reducing and rationalizing pen operations within spatial and numerical limits, the end goal being the sustainable improvement of production. The ZOMAP sidestepped contentious issues of access while providing a form of state intervention, accepting that fisherfolk, despite being displaced by the same structures that were supposed to benefit them, needed to coexist with pens. Conflicts between fisherfolk and pen operators could be solved by spatially ordering production and putting their livelihoods in their proper places, which could lead to improved fish production and a win-win solution for all parties concerned (LLDA 1995b). Such a view moved the debate away from political issues of resource access to depoliticized technocratic resource management (Ferguson 1994; Li 2007). Through political connections and institutional means, such as creating dummy or shell corporations, some pens continued to circumvent the limits in size set by ZOMAP regulation in order to operate well past the 50-hectare size limit. Through aquaculture, the state made fish production in the lake more legible and easier to measure and control in part by assigning clearer mechanisms of property rights. The state reworked the contradictions inherent in these new arrangements by increased territorial regulation through zoning when conflicts threatened to undermine production.

Despite these constant efforts to enforce its regulations, the implementation of ZOMAP took thirteen years to materialize. The annual reports from 1983 onward carried promising, if ultimately ineffective, accounts of occasional demolitions of pens. The conflict between the LLDA and the LGUs (the latter citing the Local Government Code or RA 7160) on which entity had the authority to grant licenses to operate a fish pen in the lake was brought to the Supreme Court, which decided to affirm the older 1966 LLDA mandate on regulatory jurisdiction over the lake (LLDA 1995a; Santos-Borja and Nepomuceno 2006). Even then, the pen producers were able to resist demolitions or relocations because of their individual and collective political-economic clout and ties with local government officials (Jose 1994a; Carlos 1995a).

What changes allowed ZOMAP to be finally implemented? An exclusively social account of Laguna de Bay regulation would miss out on the convergence of unintended and nonhuman elements with the state's renewed commitment to manage aquaculture expansion. In this case, a series of typhoons in 1994 and 1995 enabled ZOMAP regulation to take hold on the lake. On 3 November 1995, Category 5 Typhoon Rosing (international name: Angela) hit the Laguna de Bay region. The LLDA had formulated the Laguna de Bay Master Plan, approved by Pres. Fidel Ramos a month prior to the typhoon, which limited total pen area to 10,000 hectares; the LLDA had also intensified demolitions of pen structures despite continued jurisdictional conflict with the LGUs and resistance from pen operators (Carlos 1995a; LLDA 1995; Tribdino 1996). To 90–100 percent of pen structures in the lake the typhoon brought damage that, when combined with the destruction caused by Typhoon Mameng (international name: Sibyl) in 1995 and Typhoon Katring (international name: Teresa) in 1994, severely affected the ability of pen operators to recover (Carlos 1994, 1995b; LLDA 1995; Palma et al. 2002).

Giving credit to Typhoon Rosing for doing the work of clearing pen structures in the lake, Environment Secretary Victor Ramos issued on 8 November a moratorium on pen repair (Carlos 1995c; LLDA 1995).[8] The moratorium gave the LLDA enough time to institute the ZOMAP, which it adjusted and enforced in 1996. The LLDA required what the environment secretary referred to as unplanned acts of Divine Providence and natural forces to finally institute the high modern (and very human) planning project of zoning the lake according to neat belts of differentiated resource use (Carlos 1995b, 1995c).

Three observations need to be emphasized to conclude this discussion on aquaculture development in the lake. First, rather than being driven by a monolithic state vision, aquaculture improvement schemes in Laguna de Bay demonstrate how the state is comprised of various individual or group interests that have multiple discursive formations and possess different capacities for action. The interest of the LLDA to manage and reduce unruly pen expansion through the ZOMAP, for example, clashed with those of local government units and politicians who sought to derive benefits from granting permits or maintaining ties with pen operators. The LLDA, local government, and national government pursued complex relations with pen operators and viewed their future in varying ways. Instead of seeing the regulation of aquaculture as a form of territorialization of monolithic state power or the exercise of preexisting state power in space, the LLDA viewed zoning in this sense as what grants the state the effect of power (Li 2005).

Second, by placing hazards more centrally in state development schemes, typhoons and floods may be viewed as forces that either disrupt or support state visions of improvement. Typhoons, for example, frustrated or reconfigured attempts to establish aquaculture in the lake. Typhoons became factors that state scientists and pen operators needed to overcome in order to institute state schemes and make them successful. The same hazards also presented opportunities for state managers to enforce the LLDA's zoning plan as a solution to the problems the introduction of aquaculture brought to the lake. The LLDA's character as a state institution was strengthened by a confluence of human and nonhuman forces, including stronger national government support, the Supreme Court ruling reaffirming LLDA's jurisdictional mandate, and a series of typhoons that damaged existing aquaculture structures. However, this binary—or perhaps spectrum—of hazards as constraint or resource may be pushed further analytically by considering them as fundamentally intrinsic to these schemes.

Finally, and building on these two points, the existence of multiple—sometimes conflicting—authorities, experts, and interests in aquaculture introduction and regulation suggests a need to also focus beyond improvement schemes driven primarily by state actors and toward other practices, processes, and relations that are enmeshed with these schemes (Li 2005). The forging of alignments and the coming together of various elements into what Tania Li (2007) terms as assemblage call into question how much human agency and intentions drive these modern projects (Mitchell 2002). Thinking through assemblage provides an analytical tool to examine how human and nonhuman elements interweave to produce emergent effects that are neither distinctly social nor natural. This framing challenges the modern tendency to separate nature and society, which views the former as something to be objectified or mastered by the latter. Hazards such as typhoons and floods can therefore become central protagonists not only as external objects that shape social actors or forces that they respond to but also as something internal to how these hybrid development schemes emerge historically. Hazards as part of an assemblage of these schemes highlight the role of the nonhuman without lapsing into crude determinisms or considering their agency independently of relations with other elements.

Timothy Mitchell (2002, 29–30) underscores these points when he argues that nonhumans deserve serious scrutiny in the history of Egyptian modern development:

> No explanation grounded in the universalizing force of human projects and intentions can explore whether the very possibility of the human, of intentionality, of abstraction depends on, at the same time as it overlooks, nonhuman elements . . . [Nonhumans] do not just interact with the activities of human agents. They make possible a world that somehow seems the outcome of human rationality and programming. They shape a variety of social processes, sometimes according to human plans, but just as often not, or at least not quite.

The next section turns to how producers who were enrolled in these state improvement schemes live with hazards as part of the assemblage of aquaculture. Laguna de Bay producers mobilize a wide range of strategies in living, even if unevenly, with floods and typhoons.

Living with Hazards: Producer Practices and Strategies

Aquaculture as a novel production transformed not only agrarian relations in the lake but also how lake villagers experienced and dealt with hazards in their production. Fish corrals were the only precedent to cage and pen structures in the lake. Traditional corrals are cheaper to construct than cage and pen structures and are flexible in that they are moved to another place after they become weak or are damaged by strong waves during typhoons and floods (Aldaba 1931b). This semimobile and spatially flexible character contrasts with cages and pens, which are fixed structures that are significantly capital and labor intensive. Thus, despite promising greater control in the production process, cage and pen aquaculture, once damaged by winds or waves, are costlier and more difficult to reconstruct than fish corrals.

All aquaculture producers have learned to deal with constant typhoons and floods. The impacts of hazards on production and the corresponding responses, however, vary between and among pen and cage producers. Pen structures, with an average size of 28 hectares in 2010, are able to withstand stronger winds than cages. For one wealthier pen producer, typhoons and floods become a problem only to those inexperienced, economical pen operators who use shorter nets that do not adjust to high water levels and

Fig. 2. Tilapia cage aquaculture (nurseries and grow-out) in Laguna de Bay, 2012

second-hand instead of new bamboo poles. Some fishing company-operated pens also use floaters (taken from their marine deep fishing operations) so that the height of the nets adjust relative to the water level and thus avoid the spilling of stocked fish. Pen owners are also able to bounce back and reinvest in production after typhoons more promptly than cage owners. Cage producers (fig. 2) observe this difference between their small-scale operations and large-scale pen operations during the arrival of the typhoon season, as a small-scale cage producer states:

> *Habagat* [southwest monsoon] season is when some producers remove their cages from the lake because of the typhoons. It is costly to lose your stocked fish and your nets. You begin from scratch and invest again. That is why when the typhoon season arrives, producers haul their nets. We are unlike the stronger pens; they just laugh off [Typhoon] Signal Numbers 1 and 2. Unlike them, our cages cannot withstand Signal Number 3 winds. . . . We have weathered several typhoons and we rise again. That is life here. If you have a source of credit, it is easier to recover and pay back your loans. Those producers who cannot get loans tend to be more cautious. (Ramon 2012)

For cage producers (average size: 0.6 hectare) in the two study villages, the arrival of the typhoon season means either reducing the number of cages in production or hauling all of them. Those who are better financed and possess greater ability to recover and reconstruct tend to hold their ground, which is the case also for larger-scale pen producers. Nets are more valuable to cage producers than fish since the latter can be reproduced at very low cost while the former constitutes the bulk of the fixed costs. Therefore, salvaging nets is more important for producers than saving fish. Fish escape when waters rise above overstretched nets or when floating debris, such as poles and clumps of water hyacinths, damage nets.

Small-cage producers lose a lot more than larger-scale pen producers do when a faulty forecast or an unexpectedly strong typhoon hits the lake, as was the case with Typhoon Basyang (international name: Conson) in July 2010. Basyang was forecasted by the weather bureau to hit further north, but instead it passed through Metro Manila and the Laguna de Bay region, leaving many cage producers unprepared. In such instances better-off producers are able to prepare for typhoons and reconstruct cages more quickly than others in the village. With stronger-engine boats and a bigger labor pool at their disposal, they can haul nets before a typhoon strikes and reassemble them after a typhoon has passed. They also gain some time advantage in the dash for recovering washed out nets when waters have calmed as opposed to those who have slower and smaller boats or those with cages that are further ashore. Better-off producers also tend to have more diversified sources of livelihood and are able to rely on these other sources when cage production is affected by hazards.

Recovering from typhoons involves reinvesting in nets and poles, which requires a significant sum of money, usually the equivalent of at least three quarters of cage construction costs (see table on p. 18). Cage producers use the term "going back to zero" to refer to this situation. Furthermore, the need to pay the annual lease to the LLDA adds to their financial burden particularly because late payments earn penalties on top of leasing fees. Access to credit from kin and through other means such as microfinance is important in this recovery. Producers are forced to downsize production through reduction in number of nets or cages and greater reliance on household rather than wage labor. Other producers also work temporarily as laborers for owners of other cages.

Comparison of costs and revenues of pen and cage aquaculture in Laguna de Bay, 2007, in Philippine pesos

ITEM	PEN AQUACULTURE [a]	CAGE AQUACULTURE [b]
Gross revenues	14,000,000	400,000
Total costs	7,462,595	150,589
Variable costs (fingerlings, feeds, fuel, transportation, hired labor, etc.)	5,375,510	62,895
Fixed costs (depreciation, repair, caretakers, permits, registration)	2,087,085	87,694
Net revenues	6,537,405	249,411
Fixed assets (poles, nets, caretaker huts, etc.)	3,719,500	195,090
Fixed assets as percentage of total costs	49.8%	129.5%

[a] Based on milkfish monoculture in a fifty-hectare fish pen

[b] Based on tilapia culture in a one-hectare fish cage

Source: Israel et al. 2008

Larry (2012), a better-off cage producer, shares his experience with the process of recovery after three years of battling with consecutive typhoons:

> My two huts were destroyed, my boats were submerged. It was one bad luck after another. And every hut had televisions and stoves for my men. These were all destroyed. I was not able to get them back so I invested in new ones. I recovered a few nets, those were what I worked with. Can you imagine that I used to have 10,000 breeders and harvested millions of fingerlings? Sixty nets for breeding and thirty nurseries plus twenty grow-out cages that totaled maybe half a million pesos were destroyed by the typhoon [Basyang]. I tried to recover, I worked with twenty nets and built from there. This is why I was thinking that it is just about going back and forth. The typhoon would spill it out, and you have to put out your remaining savings and start from there. Then another typhoon would wipe it out.

Cage aquaculture producers see recurring flood and typhoon damage as preventing them from expanding production. Mario (2012), a cage producer, noted: "If we did not have typhoons here in Laguna Lake, many people would probably be wealthy." For cage producers, the occurrence of typhoons is something uncontrollable and inevitable, but it is part of and intrinsic to cage aquaculture production in the lake. Nonetheless, these hazards are more predictable and less random than loss, for example, due to poaching by other villagers. Thus, vigilance and preparations for typhoons are possible. The hauling of nets at the beginning of the typhoon season and other similar practices involve being strategic in timing (*madiskarte*). Others harvest or sell their fingerlings or fish early when they hear of an approaching typhoon. Saving enough money from each sale to prepare for the damages of typhoons is also important in recovery. For a pen producer, this ability to budget and save to prepare for typhoon damage is what distinguishes a novice from an experienced producer in the lake.

Fisherfolk, for their part, see floods and typhoons in a different light. To take advantage of fish that escape from damaged or overflowing pens, many fisherfolk (and some cage producers) reinvest in gill nets that catch milkfish and other pen-escaped fish. Some fisherfolk see these events as opportunities to accumulate cash and invest in better gears that will then help improve income from subsistence fishing. Other cage producers invest in gill net gears to take advantage of abundant milkfish and reduce losses and damage incurred in their own cage production. Violy (2012), a village trader-assembler, observes the effect of typhoons on fisherfolk production on which her own livelihood depends: "Business tends to pick up only after typhoons. For example, after Ondoy [Typhoon Ketsana], we had good business for a while and many people had money. As long as the typhoon is not that strong but enough to damage fish pens, people here, the ordinary fisherfolk, have money."

In this case timing is important. On the day after a typhoon, the escaped fish in the lake are plentiful but not enough to produce a glut in the municipal fish market that would depress prices. Milkfish can drop to a tenth of its average nontyphoon price. Village fish traders work quickly to bring the fish to the urban wholesale fish market to capitalize on the temporarily high difference in fish prices between those in the lake and in the city. Producers or traders who have greater storage capacity for fish (usually wealthier ones not based in the villages) are able to buy fish cheaply from the lake and sell them with considerable markup in the urban fish market once the initial glut subsides. However, once the posttyphoon dash for escaped fish has waned, hauling of fish from pens becomes less frequent because it takes time for some pens to stock again and harvest.

Living with Hazards: Difference and Unevenness

Aquaculture producers and lake fisherfolk mobilize a variety of strategies in production and in livelihood diversification that are continually changing in relation to a dynamic socioecological field (Bene and Friend 2011; Goulden et al. 2013). In contrast to the notion of hazards as disruptions to normal life or to an otherwise stable production order (Bankoff 2003), producers continue to live with these hazards, internalizing them as intrinsic in the assemblage of fish production. The notion of living with hazards is different from the modern separation of society and nature, often deployed by experts, technocrats, and state actors who consider hazards as external forces and frame them as problems to be solved or objects to be controlled (Scott 1998; Mitchell 2002; Smith 2008). Rather, hazards such as typhoons and floods are among the set of elements that are part of, and that shape the architecture of, aquaculture production.

Practical knowledge plays a central role in living with typhoons and floods. In contrast to the narrow state or science optic, producers combine various elements that are useful for them, including scientific and other knowledge, through observation, experimentation, and sharing with other producers (Scott 1998). As opposed to state goals of improving livelihoods by increasing their yields through aquaculture, cage producers employ aquaculture as one in a diverse set of options, using these as they benefit them at particular circumstances. Livelihood diversification and access to resources are therefore more important for many rural villagers than narrow concerns solely for increased fish production (Bene and Friend 2011). Hazards are intrinsic to this picture, as they are one of the elements that shape and complicate production and the ability to maintain livelihoods.

Aquaculture producers distinguish among various types of hazards, ranging from localized strong waves (*seguada*) that accompany thunderstorms, typhoons, and floods to seasonal fish kills associated with the circulation of "bad water" (*masamang tubig)* that often coincide with the saline intrusion of water from the Pasig River. Villagers consider these as inevitable events, and escaping damages from them as a matter of luck and chance. Because of state weather forecasts, cage producers are able to prepare for typhoons, while the relatively slow rise in water levels associated with floods can give them time to secure their cages.[9]

Production is a balance between strategy (diskarte) and pushing one's luck similar to gambling (*pakikipagsapalaran* and *pagsusugal*). The impacts of typhoons and floods on lake ecologies are not given. The ecological effects on lake water conditions and productivity are variable and complex. Villagers note that Typhoon Ondoy in 2009 brought good productive conditions for the next several months after it hit the lake, whereas Typhoon Basyang achieved the opposite effect the following year. Producing in the lake therefore involves constant adjustment that becomes the basis and opportunity of deepening their practical knowledge. In the face of hazards, producers deploy practical knowledge to avert, mitigate, or prepare for damages, thereby stabilizing aquaculture production as an assemblage of varying human and nonhuman elements. These assemblages break down with disruptions in particular elements, such as an error in the weather forecast, the spread of an invasive species, or specific changes in producer ability to prepare or recover.

One way of framing hazards is by considering them as either a problem or an opportunity. There is a thin and flexible line, however, that separates typhoons and floods as hazard/risk or as resource/benefit for agricultural producers (Bankoff 2003; Eakin and Appendini 2008). In Laguna de Bay, cage and pen producers perceive typhoons and floods as hazards/risk (given that aquaculture fixity exposes their production to the possibility of damage) while capture fisherfolk see them as resource/benefit (in view of the opportunities these events present in improving incomes). A further step in this framing would be to understand how typhoons and floods come to be considered as a hazard or a resource for specific groups of people. This task entails identifying the historic role of the state in producing particular socioecological relations and the role of social differences in structuring perceptions, practices, and knowledge about their environments (Nazarea-Sandoval 1995).

The emphasis on practical knowledge and living with hazards does not imply that all practices are successfully adaptive or that focusing on adaptation should occlude political-economic or political-ecological processes that shape these relations (Oliver-Smith 1999; Bassett and Fogelman 2013). People live with and create their socioecologies but not necessarily in conditions of their own choosing (Eakin and Appendini 2008; Smith 2008). Two examples of these dynamics deserve further discussion in the context of modern state interventions that produce new configurations of people's relations with the lake environment.

First, aquaculture is a fundamentally different kind of production from capture fisheries. Capture fisheries production, given its mobile character, has not been significantly affected or damaged by floods and typhoons in a manner similar to aquaculture. Risks from hazards became amplified with the introduction of aquaculture, a type of production fixed in lake space. Aquaculture created new types of exposure to hazards for lake dwellers who attempt to live with and incorporate these hazards in their production. In this sense floods and typhoons only came to be environmental phenomena directly important to village production with the increasing reliance on aquaculture livelihoods promoted by state development projects.

Second, the ability to adapt to or internalize typhoons and floods is uneven. In this regard, the notion of vulnerability in its critical realist sense (Wisner et al. 2004) presents a lens in understanding the process and roots of unevenness and their consequences. In Laguna de Bay vulnerability to floods and typhoons is differentially distributed according to producer groups, with the least capitalized producers hardest hit and slowest to recover.

Conclusion

In probing relations between state, society, and nature, this article has placed typhoon and flood hazards at the center of the narrative of aquaculture development in Laguna de Bay. Introduced as part of broader goals of state-initiated development, aquaculture presented a modern way of harnessing and controlling the lake's resources that sought to improve fish yields and lake livelihoods. The process of its introduction and expansion in the lake, however, has been far from straightforward as conflicts between and among state actors and fish producers led to failures in achieving project goals and to contradictory socioecological outcomes. Typhoons and floods were significant in shaping the introduction of the novel technology and the development and feasibility of both the experimental farm and commercial private pens. They were also important actors in enabling state regulation of pen sprawl and expansion.

Aquaculture transformed the relations among lake dwellers dependent on capture fisheries. For producers, aquaculture introduced greater risks to fish production even as it provided greater control in production, more profits per transaction, and greater volumes of fish than capture fisheries. Its internal characteristics as a production system and its linkages to household and village dynamics have made it a comparatively higher risk venture that becomes problematic during instances of exposure to hazards. Lake dwellers and fish producers continue to live with their socioecological conditions, wherein hazards are constant features, through experimentation, direct observation, and everyday practices. This living with hazards, however, is never a politically neutral process, as capacity, knowledge, vulnerability, and particular socioecological configurations always have structural roots.

In the stories of both state improvement projects and producer practices, typhoon and flood hazards are intrinsic to their development. This observation underscores one paradox of high modern schemes of improvement: in attempts to separate nature and society to objectify the former for the use and control of the latter, nonhuman elements continue to subvert and shape human visions of simplifications, legibility, and ordering of nature.

Abbreviations Used

ADB	Asian Development Bank
LDBFDP	Laguna de Bay Fishpen Development Program
LLDA	Laguna Lake Development Authority
SOGREAH	Société Grenobloise d'Etudes et d'Application Hydrauliques
USAID	United States Agency for International Development
WHO	World Health Organization
ZOMAP	Laguna de Bay Fishery Zoning and Management Plan

Notes

This article is a revised version of a paper originally presented at the conference, "Disasters in History: The Philippines in Comparative Perspective," held at the Ateneo de Manila University, Quezon City, and organized by this journal, the Ateneo's Department of History, and Kyoto University's Center for Southeast Asian Studies, 24–25 Oct. 2014.

1 "Laguna Lake" is an erroneous English translation of Laguna de Bay, which drops the name of the town, Bay (*Ba-e*), after which the lake has been named. In effect, the English name means "Lake Lake." However, "Laguna Lake" is the official English language name of the lake. – EDS.

2 Further discussion of agrarian change associated with aquaculture introduction in these two villages can be found in Saguin 2015.

3 For this article, the author reviewed available project documents and annual reports from the LLDA published between 1966 and 2009, taking into account how hazards are reported or discussed. Newspaper articles about the lake were also collected, specifically from 1994 to 1995, to gain a sense of the impacts of typhoons on aquaculture management at a time when the Laguna de Bay Development Plan was being formulated and fish pen demolitions had become once more a concern of the national government. Scientific papers from the late 1920s and early 1930s, and from the 1970s onward, also guided some of the arguments in this article about fisheries and water management.

4 Fisheries in the lake prior to aquaculture introduction was dominated by snails, shrimps, and freshwater finfish, including mudfish, silver perch, and white goby (Mercene 1987; Aldaba 1931a, 1931c; Palma et al. 2002). These were low-value fish that were caught for local consumption. Snails were used as feeds for the duck industry along the shores of the lake and in Pateros and Pasig (Arriola and Villaluz 1939).

5 Aquaculture as part of Laguna de Bay development schemes fits well with at least two of the three technocratic foci of the Marcos regime: green revolution through scientific agriculture and foreign borrowing (Boyce 1993; Ofreneo 1980; Tadem 2013). Several of the subsequent development programs in the lake were funded through loans from the Asian Development Bank, World Bank, and other institutions.

6 The 2003 map of the revised ZOMAP may be accessed online through the LLDA website, http://www.llda.gov.ph/index.php?option=com_content&view=article&id=113. The map of the 1999 ZOMAP may be found in Israel et al. (2008, 16) or in Santos-Borja and Nepomuceno (2006, 263).

7 Prior to the creation of the LLDA and the establishment of the ZOMAP, the Bureau of Fisheries as part of the national government had primary, centralized jurisdiction over fisheries management in the lake. Administrative orders regarding fisheries dating back to the 1930s were poorly enforced and remained unheeded in the lake during this period (Delmendo and Rabanal 1982).

8 Victor Ramos is the third Department of Environment and Natural Resources Secretary (1995–1998) under the Fidel Ramos administration. This administration prioritized the formulation of the Laguna de Bay Development Plan and the demolition of unregistered pen structures in the lake, which was framed as an environmental protection, sustainability, and pollution management issue (Tribdino 1995; Carlos 1995b) in the context of Ramos's vision of the Philippines as an emerging "green tiger" (Goldoftas 2006). The emphasis on pollution management is also associated with a shift in lake governance toward experimenting with market-based mechanisms, such as the Environmental User Fee System, to address industrial pollution issues in the lake (Oledan 2001).

9 Saline intrusion occurs during the dry months when lake water levels fall below sea level. However, there are other factors that contribute to the intrusion, making it difficult to predict if a certain year will see an intrusion.

References

Aldaba, Vicente C. 1931a. The dalag fishery of Laguna de Bay. *Philippine Journal of Science* 45(1): 41–60.

———. 1931b. Fishing methods in Laguna de Bay. *Philippine Journal of Science* 45(1): 1–28.

———. 1931c. The kanduli fishery of Laguna de Bay. *Philippine Journal of Science* 45(1): 29–40.

Arriola, Felix J. and Domiciano K. Villaluz. 1939. Snail fishing and duck raising in Laguna de Bay, Luzon. *Philippine Journal of Science* 69(2): 178–90.

Asian Development Bank (ADB). 1973. *Laguna de Bay water resources development study*. Manila: SOGREAH.

Bankoff, Greg. 2003. *Cultures of disaster: Society and natural hazard in the Philippines*. London: Routledge.

Bassett, Thomas and Charles Fogelman. 2013. Deja vu or something new? The adaptation concept in the climate change literature. *Geoforum* 48:42–53.

Bene, Christophe and Richard M. Friend. 2011. Poverty in small-scale fisheries: Old issues, new analysis. *Progress in Development Studies* 11(2): 119–44.

Beveridge, Malcolm C. M. 1984. *Cage and pen fish farming: Carrying capacity models and environmental impact*. Rome: Food and Agriculture Organization.

Boyce, James K. 1993. *The political economy of growth and impoverishment in the Marcos era*. Quezon City: Ateneo de Manila University Press.

Carlos, Maricris C. 1994. "Katring" damage to Laguna Lake at P655.41 million, reports lake dev't authority. *BusinessWorld*, 23 Nov.: 12.

———. 1995a. LLDA conflict with LGUs derails phaseout plan for lake's fish pens. *BusinessWorld*, 6 Sept.: 11.

———. 1995b. LLDA, LGUs finally agree to lower Laguna Lake fishing area bounds. *BusinessWorld*, 16 Nov.: 10.

———. 1995c. *Rosing* helps DENR in Laguna Lake. *BusinessWorld*, 9 Nov.: 9.

Cendana, S. M. and Andres M. Mane. 1937. Recent physical changes in the water of Laguna de Bay and their effect on the lake fauna. *Philippine Agriculturist* 26:327–37.

Cruz, Jo-Ann B. 1982. A dying lake. In *The troubled waters of Laguna Lake*, ed. B. A. R. Foundation, 1–9. Metro Manila: BINHI Agricultural Resource Foundation.

Davies, Jonathan, Flor Lacanilao, and Andy Santiago. 1986. *Laguna de Bay: Problems and options*. Manila: Haribon Foundation for the Conservation of Natural Resources.

Delmendo, Medina N. and Robert H. Gedney. 1976. Laguna de Bay fish pen aquaculture development—Philippines. *Proceedings of the Annual Meeting– World Mariculture Society* 7(1–4): 257–65.

Delmendo, Medina N. and Herminio R. Rabanal. 1982. The organisation and administration of aquaculture development in Asian countries–part 2. *Agricultural Administration* 9(2): 131–37.

Eakin, Hallie and Kirsten Appendini. 2008. Livelihood change, farming, and managing flood risk in the Lerma Valley, Mexico. *Agriculture and Human Values* 25:555–66.

Eleazar, Floradema C. 1992. Managing common property resources: A case study of Laguna Lake. Master's thesis, School of Urban and Regional Planning, University of the Philippines Diliman.

Ferguson, James. 1994. *The anti-politics machine: Development, depoliticization and bureaucratic power in Lesotho*. Minneapolis: University of Minnesota Press.

Garcia, Angel M. and Ruben T. Medina. 1987. The state of development program of cage culture in Laguna Lake. In *State of development of the Laguna de Bay area*, ed. L. C. Darvain, M. A. Mangaser and Z. C. Gibe, 17–24. Los Baños: PCARRD.

Goldoftas, Barbara. 2006. *The green tiger: The costs of ecological decline in the Philippines*. Oxford: Oxford University Press.

Goulden, Marisa C., W. Neil Adger, Edward H. Allison, and Declan Conway. 2013. Limits to resilience from livelihood diversification: Social capital in lake social-ecological systems. *Annals of the Association of American Geographers* 103(4): 906–24.

Israel, Danilo C., Melanie C. Boni-Cortez, and Maria Ellaine Patambang. 2008. *Aquaculture development in Laguna de Bay: An economic analysis*. Makati City: SEAFDEC-AD and PIDS.

Jasanoff, Sheila. 2004. The idiom of co-production. In *States of knowledge: The co-production of science and social order*, ed. Sheila Jasanoff, 1–12. London: Routledge.

Jose, Doreen. 1994a. Demolition of illegal fishpens halted: Part 1. *Philippine Daily Inquirer*, 6 Mar.: A1, A12.

———. 1994b. Demolition of illegal fishpens halted: Part 2. *Philippine Daily Inquirer*, 7 Mar.: A1, A11.

Laguna Lake Development Authority (LLDA). 1966. *The Laguna Lake Development Authority prospectus*. Manila: LLDA.

———. 1970. *Profile of fishery development with a concise project study on Looc Pilot Lake Fishing*. Pasig: LLDA.

———. 1971. General manager's second annual report 1971. Pasig: LLDA.

———. 1972. General manager's third annual report 1972. Pasig: LLDA.

———. 1974. LLDA annual financial report calendar year 1974. Pasig: LLDA.

———. 1977. Annual report 1977. Pasig: LLDA.

———. 1978a. Annual report 1978. Pasig: LLDA.

———. 1978b. *Final report–Comprehensive water quality management program, Laguna de Bay*. Pasig: LLDA.

———. 1979. Annual report 1979. Pasig: LLDA.

———. 1980. Annual report 1980. Pasig: LLDA.

———. 1981. Annual report 1981. Pasig: LLDA.

———. 1982. Annual report 1982. Pasig: LLDA.

———. 1983. Annual report 1983. Pasig: LLDA.

———. 1995a. Annual report 1995. Pasig: LLDA.

———. 1995b. *The Laguna de Bay master plan final report*. Pasig: LLDA.

———. 1999. *Celebrating 30 years of lake management*. Taytay, Rizal: LLDA/DENR.

Larry. 2012. Interview by the author, Binangonan, 15 June.

Li, Tania Murray. 2005. Beyond "the state" and failed schemes. *American Anthropologist* 107(3): 383–94.

———. 2007. *The will to improve: Governmentality, development, and the practice of politics*. Durham: Duke University Press.

Mane, Andres M. and Domiciano K. Villaluz. 1939. The pukot fisheries of Laguna de Bay. *Philippine Journal of Science* 69(4): 397–414.

Mario. 2012. Interview by the author, Binangonan, 13 June.

Mercene, Eliadora C. 1987. Assessment of capture fisheries and biology of some commercially important fish species. In *State of development of the Laguna de Bay area*, ed. L. C. Darvain, M. A. Mangaser and Z. C. Gibe, 10–16. Los Baños: PCARRD.

Mitchell, Timothy. 2002. *Rule of experts: Egypt, techno-politics, modernity*. Berkeley: University of California Press.

National Statistical Coordination Board (NSCB). 1999. Estimation of fish biomass in Laguna de Bay based on primary productivity. Makati: NSCB.

Nazarea-Sandoval, Virginia D. 1995. *Local knowledge and agricultural decision making in the Philippines: Class, gender, and resistance*. Ithaca, NY: Cornell University Press.

Nilo, Prisco and Susan Espinueva. 2011. Metro Manila flash flood of 26 September 2009: Causes, impacts and lessons learned. In *Large-scale floods report*, ed. Ali Chavosian and Kuniyoshi Takeuchi, 170–91. Tsukuba: PWRI.

Ofreneo, Rene E. 1980. *Capitalism in Philippine agriculture*. Quezon City: Foundation for Nationalist Studies.

Oledan, M. T. T. 2001. Challenges and opportunities in watershed management for Laguna de Bay (Philippines). *Lakes & Reservoirs: Research and Management* 6:243–46.

Oliver-Smith, Anthony. 1999. "What is a disaster?" Anthropological perspectives on a persistent question. In *The angry earth: Disaster in anthropological perspective*, ed. Anthony Oliver-Smith and Susanna M. Hoffman, 18–34. London: Routledge.

Palma, Adelaida L., Adan S. Diamante, and Romualdo M. Pol. 2002. An assessment of fishery resources of Laguna de Bay. *Aquatic Ecosystem Health and Management* 5(2): 139–46.

Palma, Adelaida L., Eliadora C. Mercene, and Milagrosa R. Goss. 2005. Fish. In *Ecosystems and people: The Philippine millenium ecosystem assessment (MA) sub-global assessment*, ed. Rodel D. Lasco and Ma. Victoria O. Espaldon, 115–32. College, Laguna: Environmental Forestry Programme, College of Forestry and Natural Resources, University of the Philippines Los Baños.

Rabanal, Herminio R., Pedro A. Acosta, and Medina N. Delmendo. 1968. Limnological survey of Laguna de Bay—A pilot study on aquatic productivity. *Philippine Journal of Fisheries* 8(1): 101–11.

Ramon. 2012. Interview by the author, Binangonan, 13 June.

Rey, Teodoro Jr. 1987. Overview of Laguna de Bay area development and management plan. In *State of development of the Laguna de Bay area*, ed. L. C. Darvain, M. A. Mangaser and Z. C. Gibe, 2–5. Los Baños, Laguna: PCARRD.

Rivera, F. T. 1987. Socio-cultural aspects of the fish industry around Laguna de Bay. In *State of development of the Laguna de Bay area*, ed. L. C. Darvain, M. A. Mangaser and Z. C. Gibe, 63–78. Los Baños: PCARRD.

Ruaya, Pat. 1994. Nursing lake Laguna back to its natural balance. *Today*, 18 June: 8.

Saguin, Kristian. 2015. Blue revolution in a commodity frontier: Ecologies of aquaculture and agrarian change in Laguna Lake, Philippines. *Journal of Agrarian Change* DOI 10.1111/joac.12114.

Santiago, Alejandro E. 1993. Limnological behavior of Laguna de Bay: Review and evaluation of ecological status. In *Laguna Lake basin, Philippines: Problems and opportunities*, ed. P. Sly, 100–105. Halifax and College: Environment and Resource Management Project.

Santos-Borja, Adelina C. 1994. The control of saltwater intrusion into Laguna de Bay: Socioeconomic and ecological significance. *Lake and Reservoir Management* 10(2): 213–19.

Santos-Borja, Adelina C. and Dolora N. Nepomuceno. 2006. Laguna de Bay: Institutional development and change for lake basin management. *Lakes & Reservoirs: Research and Management* 11:257–69.

Santos-Maranan, Aida. 1982. A dying people. In *The troubled waters of Laguna Lake*, ed. B. A. R. Foundation, 10–18. Metro Manila: BINHI Agricultural Resource Foundation.

Schmittou, Homer Rudolph, John H. Grover, Susan Peterson, Aida R. Librero, Herminio R. Rabanal, A. A. Portugal, and M. Adriano. 1983. *Development of aquaculture in the Philippines*. Woods Hole, MA: Woods Hole Oceanographic Institution.

Scott, James. 1998. *Seeing like a state: How certain schemes to improve the human condition have failed*. New Haven: Yale University Press.

Smith, Neil. 2008. *Uneven development: Nature, capital, and the production of space*. 3d ed. Athens, GA: University of Georgia Press.

SOGREAH. 1991. Environmental assessment of Laguna de Bay: Final report. Paris: Ministère Des Affaires Estrangères Direction Du Développement et de la Coopération Scientifique, Technique et Educative.

Tabbu, Marlo, Melchor Lijauco, Ruel Eguia, and Corazon Espegadera. 1986. Polyculture of bighead carp, common carp and Nile tilapia in cages in Laguna Lake. *Fisheries Research Journal of the Philippines* 11(1–2): 13–20.

Tadem, Teresa Encarnacion. 2013. Philippine technocracy and the politics of economic decision making during the martial law period (1972–1986). *Social Science Diliman* 9(2): 1–25.

Tribdino, Raymond B. 1995. As over 100 pens seen to be affected by dismantling. *BusinessWorld*, 21 Sept.: 11.

———. 1996. Laguna Lake fishermen want first crack in issuance of fishing permit (With inevitable competition from big business). *BusinessWorld*, 19 Jan.: 6.

United Nations (UN). 1970. Feasibility survey for the hydraulic control of the Laguna de Bay complex and related development activities: Investment opportunity analyses of Laguna de Bay hydraulic control. Vancouver: T. Ingledow and Associates.

Villadolid, Deogracias. 1933. Some causes of depletion of certain fishery resources of Laguna de Bay. *Natural and Applied Science Bulletin* 3:251–55.

———. 1934. Kanduli fisheries of Laguna de Bay, Philippine Islands: Remedial and regulatory measures for their rehabilitation. *Philippine Journal of Science* 54(4): 545–52.

Villaluz, Domiciano K. 1950. *Fish farming in the Philippines*. Manila: Bookman.

Violy. 2012. Interview by the author, Cardona, 8 May.

Wisner, Ben, Piers Blaikie, Terry Cannon, and Ian Davis. 2004. *At risk: Natural hazards, people's vulnerability and disasters*. 2d ed. London: Routledge.

Yap, Wilfredo G. 1999. *Rural aquaculture in the Philippines*. Bangkok: Food and Agriculture Organization.

Kristian Karlo Saguin is assistant professor, Department of Geography, 4/F Bulwagang Silangang Palma, Africa St., University of the Philippines, Diliman, Quezon City 1101, Philippines. His research lies at the intersection of political ecology, urban studies, agrarian studies, and development geographies. He has published papers on the political ecologies of aquaculture in Laguna de Bay in journals such as *Geoforum* and *Journal of Agrarian Change.* <kcsaguin@up.edu.ph>