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Increasing livelihood vulnerabilities to coastal erosion and wastewater intrusion: The political ecology of Thai aquaculture in peri-urban Bangkok

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Abstract

Most livelihood research focuses on micro-level decisions affecting occupations but fails to examine wider scale processes that shape markets, institutions, and thus livelihood choices. A political ecology framework can help address this gap by providing ways to analyse how multi-scalar and extra-local practices, policies, and discourses affect local-level socio-environmental outcomes. In the qualitative research reported here, that framework is applied to Tha Kam, a peri-urban coastal sub-district of Bangkok, where most residents are small-scale aquaculture farmers. These farmers have experienced precipitous drops in incomes because of two major environmental changes: coastal erosion and wastewater intrusion. The causes are multiple and complex, and many originate not from practices within Tha Kham but from challenges present at a larger scale or that start upstream. The political and economic drivers of these problems stem from Thailand's fragmented vertical and horizontal governance structure, unequal class relations in which smallholder farmers and peri-urban residents are marginalised, and lack of accountability and representation. This combination of multi-scalar factors and power imbalances has contributed to evolving injustices of peri-urbanisation, all of which are profoundly geographical in their significance.

KEYWORDS

coastal erosion, livelihood vulnerability, peri-urban Bangkok, Thai aquaculture, wastewater intrusion, water governance

1 | INTRODUCTION

Peri-urban areas in the Global South are receiving greater attention in political ecology literature (Bartels et al., 2020; Karpouzoglou et al., 2018). There is no clear definition of the peri-urban (McGee & Greenberg, 1992). Such areas are often described as dynamic politically and socially contested spaces (Narain et al., 2013; Simon, 2008) and can be characterised by "substantial poverty, inequality and social fragmentation associated with changes in land and natural resource rights and access along with exclusionary service provision" (Karpouzoglou et al., 2018, p. 485). Many primate cities in the Global South aspire to become "world-class" by transforming central urban spaces, usually by marginalising peri-urban areas. As a result, peri-urban residents often lack basic services and resources such as water access and sanitation. Parts of many peri-urban areas have become waste dumping grounds for domestic and international companies and other urban residents, enabling other parts of the city to be transformed into "world-class" urban spaces (Bakker, 2008; Mehta et al., 2014). Those studying political ecology recognise the multi-scalar problems associated with peri-urbanisation; scant scholarship examines wider scale processes shaping

resource and power inequalities and unequal livelihood vulnerabilities to environmental degradation.

This article examines the impact of extra-local political, economic, and environmental changes on the livelihoods of aquaculture farmers in outer peri-urban Bangkok and employs a distinctive political ecology approach. Thailand's capital has experienced enormous but uneven growth, partly the outcome of its quest to be a world-class mega-city. This growth came with enormous environmental consequences ranging from a high-carbon footprint to rapid transformation of agricultural land, green space, and water bodies. Peri-urban residents often bear the environmental consequences (Davivongs et al., 2012; Sajor & Ongsakul, 2007). Our case study of Tha Kham in the Bang Khun Thian (BKT) district on the Gulf of Thailand demonstrates how livelihoods in peri-urban areas are adversely affected by extra-local socio-environmental processes. Tha Kham is primarily inhabited by smallholder aquaculture—especially shrimp—farmers, who are trying to keep pace with Thailand's push to meet global demands for fish and other aquatic products. In 2017, 40% of inland and marine culture derived from farming of marine shrimp; 75% was exported (FAO, 2018). Smallholder farmers struggling to meet global demand were increasingly vulnerable to diverse environmental challenges. In Tha Kham, two extra-local challenges intersected: Thailand's shift towards aquaculture and Bangkok's rapid urbanisation and sprawl. Both processes contribute to increased livelihood vulnerabilities (and opportunities), despite limited efforts by government agencies to remedy them.

We argue that a political ecology lens adapted for a peri-urban deltaic region reveals underlying drivers of Tha Kham's peri-urban farmers' increased livelihood vulnerability and helps explain why vulnerability persists despite efforts to address their vulnerability. By focusing on scale and the politics of place, power relations, and water governance conflict, political ecology offers an approach to the complexities of vulnerability both within and beyond the peri-urban area (Bartels et al., 2020). We begin in Section 2 by considering the role of political ecology in examining peri-urban contexts and outline the study methods in Section 3. In Section 4, we then contextualise aquaculture livelihoods in Tha Kham and focus on coastal erosion and wastewater and the outcomes of the practical and policy responses to the changing situation. Section 5 concludes the article and reflects upon ways forward.

Key insights

Most livelihood research focuses on micro-level decisions affecting occupations but fails to examine wider scale processes that shape markets, institutions, and livelihood choices. A political ecology framework helps address that gap and is applied to Tha Kam, a peri-urban coastal sub-district of Bangkok, where most residents are small-scale aquaculture farmers. They have experienced precipitous drops in income because of two environmental changes: coastal erosion and wastewater intrusion, caused by challenges present at a larger scale or that start upstream and that stem from Thailand's fragmented governance structure, unequal class relations, and lack of accountability and representation.

2 | UNDERSTANDING EXTRA-LOCAL PROCESSES IN A PERI-URBAN CONTEXT

Those promoting sustainable livelihood perspectives have dominated rural—and increasingly peri-urban—development thought and practice, focusing on agroecological systems, place-based practices, and resource management at community and household levels (Bebbington & Batterbury, 2001; Scoones, 2009). We follow Carney (1998, p. 2), for whom a livelihood "comprises the capabilities, assets (including both material and social resources) and activities required for a means of living." While providing insights into local dynamics and household decision-making, livelihood research insufficiently considers wider scale or extra-local processes and power relations that shape markets, institutions, and livelihood strategies (Carr, 2015; De Haan & Zoomers, 2005). These processes drastically transform land—especially in the Global South—by engaging in foreign direct investment, urban expansion, and associated land grabs or serving distant food markets, such as those fostering global demand for cheap aquatic products (Borras et al., 2020; Rigg, 2006; Saguin, 2016; Zoomers et al., 2017).

A political ecology framework links analysis of extra-local processes and their effects on peri-urban livelihood vulnerabilities while focusing on how political dynamics and power relations interact with ecological conditions (Robbins, 2011; Scoones, 2009). Political ecologists denaturalise socio-environmental environments by examining control over access to environments and natural resources (Heynen & Robbins, 2005). They also focus on power dynamics and structures on multiple scalar levels, as practices, policies, and discourses affect local-level socio-environmental outcomes (Eakin et al., 2009). Emphasising power, the political ecology framework we have adopted examines local livelihoods, peri-urbanisation,

and agrarian development "through locally specific materializations of trans-local economic, political, and environmental processes and structures" (Carr, 2015, p. 336).

Building on political ecology scholarship, Taylor (2015) has introduced the concept of lived environments, valuable for understanding agrarian environments, including those of deltaic aquaculture. This notion refers to the "social and biophysical field of relationships that actively bring such landscapes into being" (Taylor, 2015, p. 15) and emphasises the relationships and networks of human and non-human forces that combine across geographical scales to co-produce and continuously reshape socio-ecological agrarian environments (Mustafa, 2005; Swyngedouw, 2006). The relative security or resilience of some groups is attained by producing insecurity or exacerbating others' vulnerability (Taylor, 2013). Relational vulnerability is an idea useful for understanding the drivers behind problems increasingly experienced by aquaculture farmers. Marginal agrarian households depend upon assets controlled by others, such as access to land and water. Thus, they become vulnerable because they lack assets and because they depend upon on wealthier social actors to turn "existing assets into tangible livelihoods" (ibid., 321) They consequently become locked into increasingly established socio-economic relations that enable the transfer of surpluses to these wealthier actors. Here, we use a definition of marginalisation provided by Andriesse et al. (2021, p. 3): a "situation in which households' socio-economic and political position vis-à-vis the national middle class deteriorates as a result of environmental, economic and political pressures."

This approach can be expanded to water usage and access, for example, in relation to dam building in the Mekong, which makes it difficult for powerless aquaculture farmers downstream to maintain their livelihoods (Marks & Zhang, 2019). Relational vulnerability is also applicable to the complex politics of position, interlinked with a politics of place: As economic and political centres, capitals should be protected in the national interest; in practice, this means that environmental risks such as wastewater and floodwater are unevenly distributed to other areas (Lebel & Sinh, 2009).

Several scholars argue that adopting a political ecology approach is useful to understand extra-local challenges in peri-urban residents face, including in agrarian environments (Bartels et al., 2020; Karpouzoglou et al., 2018; Myers, 2008). Scholarship is growing, but there is consensus that more research is needed on the political ecology of peri-urban areas (Bartels et al., 2020), because urban political ecology literature has focused on sites within city limits (Angelo & Wachsmuth, 2015). Looking beyond city limits, political ecologists also call for an examination of the state's role to be central when studying peri-urban areas. Karpouzoglou et al. (2018, p. 427) therefore argued that "peri-urban development has in reality intensified social and income inequalities while the state has become an important mediator not only of land but also of the distribution of environmental risk."

To develop the theoretical focus in this study, we consider the political dimensions of water governance. Scholars argue that water access and rights are linked to contentious politics of struggle (Wilson et al., 2019), and understanding water requires a "hydro-social" systems approach (Hommes et al., 2019). This approach analyses biophysical, climatological, and material linkages and incorporates cultural, ideological, political, and economic dynamics (Shrestha et al., 2020). Shi et al. (2021) have argued that water governance in Asian cities reproduces inequalities and vulnerabilities of the poor, instead of reducing them. For instance, water quality decline in peri-urban areas of Delhi and Yangon is an outcome of politics and power rather than "poor" urban planning (Groot & Bayrak, 2019; Karpouzoglou et al., 2018). Such examples show why the political and power dimensions of water governance, and ideologies such as neoliberalism that underpin them, play a central role in constructing a peri-urban political ecology framework in the context of "lived" hydro-agrarian environments. We apply this framework in relation to smallholder aquaculture farmers in peri-urban Bangkok.

3 | METHODS

Following ethics clearances, this research combined semi-structured interviews with qualitative analysis of documents with the aim of triangulating the data and connecting gaps in the primary and secondary data (Bowen, 2009). Between June and August 2019, the first author conducted 26 semi-structured interviews using purposive (selective) sampling and snowball sampling (targeting participants based on recommendations provided by a select number of them). Two groups were interviewed: (a) 12 key informants and (b) 14 community leaders and aquaculture farmers residing in BKT (Table 1). For the first group, participants were invited to ensure sectoral diversity representation from (sub)national government agencies, private companies, academics, and journalists. They were interviewed to understand the wider socio-environmental processes affecting BKT residents. Those in the second group were interviewed to understand how environmental changes had affected them, their political views, and their responses to these changes. Most interviews were conducted in Thai and, because participants' confidentiality was protected, they spoke freely about the issues discussed below

TABLE 1 Participant information

Interview number	Identity	Gender	Date interviewed in 2019
1	BKT District Assistant Director	M	3 July
2	Saeng To Community Leader	F	5 July
3	Khlong Sao Thong Community Leader	M	15 July
4	Sri Kuman Community Leader	M	15 July
5	BKT Resident 1	F	3 July
6	BKT Resident 2	F	4 July
7	BKT Resident 3	M	4 July
8	BKT Resident 4	M	3 July
9	BKT Resident 5	F	4 July
10	Department of Marine and Coastal Resources senior official	M	11 July
11	Department of Environmental Quality Promotion senior official	F	13 August
12	Pollution Control Department senior official	M	16 August
13	Senior BMA Environmental Officer	M	16 August
14	BKT Resident 6	F	16 July
15	Mahidol University academic and consultant to BMA	M	7 August
16	BKT Resident 7	M	16 July
17	Former *phuyai* (local leader) 1		3 July
18	Rangsit University academic & ex-director of Provincial Waterworks Authority (PWA)	M	10 June
19	BKT District Environmental Officer	M	16 July
20	Former *phuyai* 2	M	5 July
21	BKT Resident 8	F	3 July
22	BKT Resident 9	M	3 July
23	BMA Planning Officer	F	14 August
24	EIA Department Officer	F	23 July
25	Panya Consultants senior manager	M	16 July
26	PBS senior reporter	F	27 June

and shared their political opinions. Therefore, the first author's position as a mixed Thai–American had no evident impact on the findings.

Additionally, we analysed government legislation and reports, academic articles, NGO reports, and media articles. That work is conducive to identifying power asymmetries and political perceptions that do not lend towards quantitative analysis. We selected Tha Kham as a case study for three reasons: It experiences severe coastal erosion; residents are exposed to wastewater; and it is located within Bangkok, which is pushing to be a world-class mega-city.

4 | LIVELIHOOD DYNAMICS AMONG PERI-URBAN SMALLHOLDER AQUACULTURE FARMERS

The coastal sub-district of Tha Kham is in BKT, the only district in Bangkok bordering the Gulf of Thailand (Figure 1 and inset). It is about 33 kilometres from the city centre and can be reached in 90 minutes by car from Bangkok's city centre (Pathum Wan District). Of Tha Kham's population of approximately 61,000, about 70%–80% are aquaculture farmers, and the area's primary source of income is small-scale shrimp and blood cockle farming (Jarungrattanapong & Manasboonphemphool, 2009), and the rest mostly are daily-wage labourers (*khon rap jang)*. According to a provincial officer, 60% of the district is now regarded as urban, largely because of the rapid expansion of housing estates and factories, but Tha Kham remains agricultural because of a lack of access to transportation—there are few sound roads and most people travel by boat—and because Bangkok's land use that stipulates that land there can only be used for agriculture (1). Land prices have sharply increased in other parts of BKT but not in Tha Kham. Thus, Tha Kam might not be considered peri-urban under the well-used "desa-kota" setting of having mixed rural and urban land use and

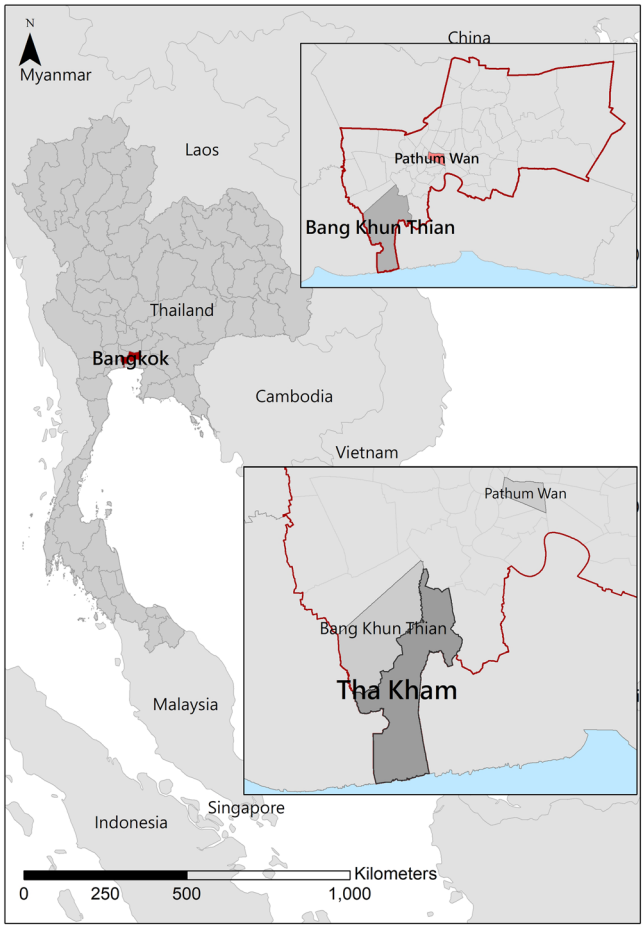

FIGURE 1 Tha Kham, Bang Kung Thian, Bangkok (own source)

increased non-agricultural activities (McGee, 2015); because Tha Kam is governed by a large urban municipal government, Bangkok Metropolitan Administration (BMA), it is peri-urban rather than near-urban. Furthermore, wastewater and coastal erosion originate from proximate, mostly urban spaces. This argument aligns with that provided by Bartels et al. (2020, p. 1242), who argued for an "explicitly plural understanding of peri-urbanisation" despite a lack of consensus on what constitutes the peri-urban. Moreover, as Narain (2022, n. p.) has argued, the peri-urban is a "messy space" that captures "rural-urban transformations led by land use and other changes."

In the 1930s, Chinese immigrants probably introduced shrimp aquaculture to farmers in coastal areas of Central Thailand, including Tha Kham. The area was mainly devoted to rice farming until the 1970s, when farmers switched to shrimp ponds as water became increasingly saline (Szuster, 2006). During that decade, the Department of Fisheries introduced semi-intensive monoculture techniques, focusing on black tiger shrimp, which had a high export value. Shrimp farming became more profitable compared with irrigation rice (Pongnak, 1999), and favourable biophysical conditions and extension services and tax incentives from the Thai government enabled rapid industry development (Szuster, 2003). From 1988 to 2001, the area used for shrimp farming increased by nearly 50%, productivity per hectare increased more than threefold, and overall production grew fivefold. By 1993, Thailand had become the world's largest shrimp producer. Overall shrimp production exceeded 290,000 tons in 2015, and Thailand remains among the top aquaculture producers globally (Sampantamit et al., 2020).

In contrast to India and Latin America, where large corporations dominate shrimp farming, most Thai operators are small, independent farmers with one or two small ponds on their lands. Most farms are operated by families without much assistance from hired labour, as in Tha Kham. Because of financial risks of disease outbreaks, which can lead to catastrophic failures, Thai and multi-national corporations have focused on other parts of the shrimp supply chains: manufacturing, processing, and marketing (Szuster, 2003). Since the Prayuth military government seized power in 2014, those corporations have harnessed state resources and influenced state agendas to enrich themselves and increased vertical integration along food supply chains have resulted in supermarkets increasing market power by specifying how products are harvested, processed, and distributed. Consequently, large corporations dictate prices and pass economic risks to smaller actors (Chiengkul, 2017), including aquaculture farmers in Tha Kham. Shrimp farming culture provides a livelihood with high risk and high return. Shrimp farmers can achieve returns up to 10 times greater than those among rice farmers, but high operating costs mean that small farms can become bankrupt by one or two harvest failures (Belton & Little, 2008).

Most Tha Kham households continue to work in aquaculture for several reasons. First, the price of shrimp and other aquacultural products steadily increased between 2009 and 2019. Second, many farmers could supplement incomes by selling other products and organising homestays on their properties. Third, those farmers preferred working in Tha Kham, which was more peaceful and less stressful than Bangkok. Fourth, many farmers attached strong cultural values to their land. One mentioned that this land was her family's, inherited from her parents. Fifth, farmers have limited livelihood choices beyond aquaculture. One told us, "I will not sell my land because I do not know how to work in any other occupation" (5). Around 40 years ago, some households had sold their land because prices had then risen (which some later rented back); even so, few land sales have occurred since.

Overall, farming was declining as a livelihood choice, but opinions varied. One farmer stated: "My children still work as farmers, so I see a future for the new generation" (6). Another's comments aligned with that: "Farming is not declining because many of us still work

as farmers, but some have changed the land ownership" (7). In contrast, another said: "The new generation do not want to work as farmers which is very hard, so the number will decrease within 10 years" (8). Likewise, another observed: "Now the average age of farmer is 50 to 60. Our children do not want to be farmers" (9), so that "Many people have moved away … Mostly elderly stay here—younger generation went away to go to school or go to work" (14). Overall, younger people had migrated to find jobs elsewhere, mainly in Bangkok.

By 2019, Tha Kham farmers were experiencing precipitous declines in incomes from aquaculture production. Some had stopped farming and sold their land, retired, switched to become handymen or work in other occupations, or migrated to Bangkok to find new sources of income. Others constructed homestays to host tourists (4). They pointed to two major changes that had increased livelihood vulnerability: coastal erosion and worsening wastewater intrusions, which had caused disease outbreaks. This conjuncture is examined below.

5 | COASTAL EROSION

Farmers and government officials generally agree that the coastline has retreated significantly since the 1950s: "GIS satellite data show that from 1952 to 2009, the land has eroded over one kilometre inland from the original coastline" (18), which is in line with information in Figure 2. In terms of total land lost between 1952 and 2009, both a former local leader and a BMA environmental officer stated the amount to be around 2700 rai (approximately 4.8 km^2) (13, 17). A BKT environmental officer feared that if no actions were taken, "the land will erode 30 metres per year" and "50,000 rai will be gone by 2057" (19). Substantial amounts of land have been lost in half a century, and the remaining coastland is at risk.

Erosion has had significant impacts upon coastal aquaculture farmers, resulting in forced migration, losses in income, and increased pressure to sell land. One farmer stated: "My land has been lost due to erosion. Roughly 10 rai are gone, so the total is now down to 42. I lost 20%. I had to move inland because I cannot afford to farm there anymore" (5). Another farmer observed: "100% of people in this community were affected. Everybody lost about 20% or about 400 to 500 rai in total. Some people moved inland. Half sold their land" (3). Another one said: "Locals here have to spend a lot of money to fight the erosion, about 100,000 Baht per household per year. It's a quite huge issue and locals cannot afford [these measures] (17)." Where land is eroded or erosion imminent, the consequences affect livelihoods, including land loss, or increased spending on protective measures, and, in some cases, forced migration: "My friends and I had to move out because our land disappeared" (8).

FIGURE 2 The inundated and eroded area of Tha Kham in Bang Khun Thian and the change from 2002 to 2019 (Data from Humanitarian Data; Exchange, 2019)

5.1 | Causes of coastal erosion

The relative increase in the sea level of the delta over different periods ranges from 13 to 150 millimetres annually, ranking among the highest in the world (Bidorn et al., 2021). Coastal erosion in Tha Kham has occurred for several reasons. First, climate-induced sea-level rise is a factor, if minor. In the Gulf of Thailand, sea level has been rising a quarter of a centimetre annually, having risen 12 to 22 centimetres during the last century. Concurrently, climate change has increased the number of more severe storm surges, destroying mangroves and coral reefs, which are the coast's natural protective barriers (Marks, 2011). Because of climate change, sea level in the Upper Gulf of Thailand will rise 10 to 100 centimetres in the next 50 years (Jarupongsakul, 2006).

Second, other more local causes in Thailand have been significant. Dams upstream in the Chao Phraya River Basin, particularly the Bhumibol and Sirikit dams constructed in 1965 and 1975 respectively, have reduced sediment supply to the coastal delta area by as much as 75% (Winterwerp et al., 2005). Rama II Road in southern Bangkok also acts as a dam, further withholding sediment; according to a BMA consultant, "the road is the main cause of coastal erosion" but "there was no EIA [environmental impact assessment] of Rama II" (15).

Third, from the 1970s, groundwater pumping has caused all Bangkok land to subside, including in Tha Kham—in some places by more than one metre. Subsidence has followed excessive groundwater pumping, particularly by industries, including factories nearby in neighbouring Samut Prakarn Province. Demand for groundwater surpassed the threshold of the city's aquifer system and over-extraction resulted. The state failed to manage expanding water demand arising from the city's expansion and exacerbated by a lack of proper city planning for land use and infrastructure development (Marks, 2015). During the 1980s and 1990s, most large-scale manufacturers, the heaviest users of groundwater, decided that, rather than locate in the city centre, they would situate five to 20 kilometres away (Dixon, 1999), including in or nearby BKT, where regulatory frameworks and enforcement were laxer (Sajor & Ongsakul, 2007). Although the government curbed the pumping rate during the early 1990s, that rate increased again in the late 1990s because of the city's expansion into new outer areas where no surface water supply was available (Phien-wej et al., 2006). Until the early 2000s, the Federation of Thai Industries succeeded in limiting an increase of well-pumping charges (Molle, 2007). By doing so, federation members could continue to extract groundwater without heavy fees.

As a result, Bangkok's metropolitan area, including BKT, sinks one centimetre annually. Some 69% of subsidence is due to groundwater extraction, 29% to extra weight from construction and landfills, and 2% to natural causes (Na Thalang, 2015). Land is annually subsiding one to two centimetres in the upper Gulf of Thailand's coastline as a result of excessive groundwater withdrawal (Jarupongsakul, 2006), with Tha Kham particularly threatened.

Fourth, felled mangrove forests have hastened erosion; BKT had those forests in abundance half a century ago, and they play a critical role protecting coasts against erosion and storm surges (Thompson, 2018). The total area of mangrove forests in Thailand decreased by more than 50% between 1961 and 1996 (Moriizumi et al., 2010). Two major causes of mangrove clearing are the harvest of trees for export timber, primarily to Japan, and for charcoal production for cooking, and aquaculture development. According to a BMA officer, "all mangrove forests were cut down by local [aquaculture] farmers" (13). However, a former local leader disputed that claim: "The rumour that locals cut the mangrove forests is wrong. It might be outsiders who did this. People here know that we need forests to protect the land" (17). Because the area had been isolated, it was difficult for both BMA and the national government to access this area and prevent mangrove clearing. Although permission is now required from the Ministry of Natural Resources and Environment (MONRE) to clear mangrove forests and alter coastlines, such as by constructing ports and seawalls (1), most mangroves have been destroyed. Regardless of whether local people or outsiders felled them in Tha Kham, clearing contributed to increased erosion.

Although it is impossible to apportion blame for greater erosion, these four causes are not primarily the result of the local communities' actions. Indeed, intensive groundwater extraction, the most significant cause of shoreline retreat (Bidorn et al., 2021), occurred outside the coastal area. Complicating matters, because storm surges are so strong, most newly planted mangroves are washed away (see below). The causes and effects of coastal erosion exemplify Taylor's relational vulnerability: Factories, upstream households, and farmers became more resilient from dams and pumping while those downstream became more vulnerable.

5.2 | Responses to coastal erosion

According to participants, little has been done to address coastal erosion. At household and community levels, farmers in Tha Kham and neighbouring areas have sought to slow down erosion by enacting such measures as constructing small stone breakwaters, soil dykes, bamboo revetments, and planting mangrove forests behind bamboo (Figures 3 and 4). However,

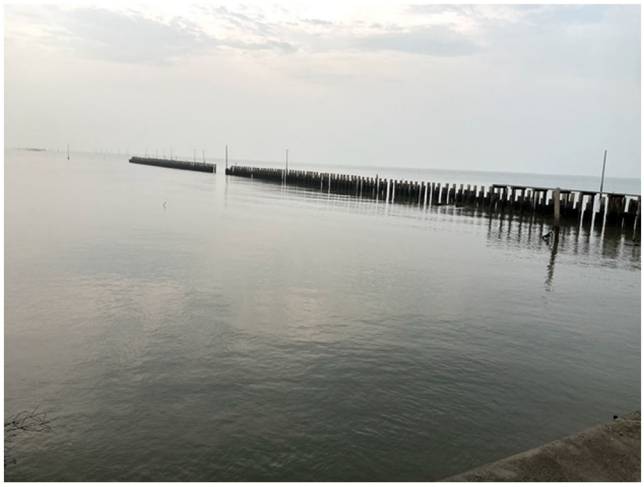

FIGURE 3 Eroded coastline and contemporary protection measures (own source)

FIGURE 4 Bamboo dykes built to protect against erosion (own source)

bamboo dykes are only a temporary solution, because they break every few years, also making it difficult for mangroves planted behind them to grow back. Because farmers feel that outside organisations, such as BMA and the national government, have done little to help them, one farmer stated: "we must help ourselves" (5). Farmers also voiced their concerns to agencies during public hearings and through petitions (5, 21). As one stated, "During every meeting, I say that we need a dyke. If I don't say this, agencies will not know the issues our communities face" (5).

The BMA, responsible for governing all of Bangkok's districts, has done little to slow down or reverse coastal erosion in Tha Kham. In its coastal protection plan, the BMA did not refer to sea-level rise. Nor did the plan address land subsidence and sediment reduction, or propose mangrove restoration as solutions (Marks, 2019). The main solution proposed was to build varying forms of protective barriers along the coast, which either failed or were not built. A few large companies, such as Charoen Pokphand and Mitsubishi, sought to help by replanting mangroves. However, their campaigns were tokenistic and ineffective because they planted mangroves in unprotected areas, such as mudflats. Although they provided good photo opportunities because of the high visibility of "turning brown to green," a form of greenwashing (Thompson, 2018), the new trees were washed away by waves and their survival rate was low.

In 2004, the BMA hired Panya Consultant, an engineering and research firm, to study the problem of coastal erosion. After completing a study in 2005, it proposed sandbag groynes. However, Tha Kham residents argued that sandbags would not prevent erosion and would worsen the ecosystem. However, both Panya and the BMA ignored their opinions and built the project's first phase. The sandbags cracked open, disrupting aquatic life, causing the project to be shelved (Wancharoen, 2014). As one farmer said: "BMA doesn't believe the locals—they always believe the experts' recommendations. BMA wasted a huge amount of money researching the project and still the sandbag project failed" (22).

Subsequently, BMA hired a contractor to build bamboo pole breakwaters that stretch five kilometres off the coast. The Metropolitan Electricity Authority donated old concrete electricity poles, stronger and more durable than bamboo poles, which were placed along the coast. Local people believe the poles slowed erosion but had mixed opinions on that solution's adequacy (3, 5, 17). The BMA thought that a different, larger project could be a long-lasting solution and hired Panya again, which proposed a new project in 2009: a concrete T-groyne project. However, after MONRE expressed concern about the project's possible impacts on neighbouring areas and on aquatic life and pointed to the potential for groynes to block boats, Panya revised it numerous times, delaying implementation for five years (23—25). MONRE's EIA department blamed Panya for providing insufficient information, notably in relation to the project's impacts on neighbouring communities and local ecosystems (24). After numerous delays, MONRE approved the project. BMA estimated that construction would require two and a half years and the project would, at best, be completed by 2024 (23).

Local people were unhappy that the project had still not been built and had to spend their own resources to limit erosion and maintain livelihoods. They were frustrated about being asked to participate in public hearings and research surveys when nothing had been constructed. According to a district officer, "I've worked here for a decade. I've seen a lot of research but not any action" (19). A local community leader added: "Community and locals request a strong structure from the government … Why hasn't any agency come to take care of us?" (5). However, the BMA never explained why the seawall had yet to be constructed.

Local people believed that neither the BMA nor the national government had addressed erosion because of the low priority given to BKT, because the peri-urban area was poorer and more sparsely populated than central Bangkok (Sajor & Ongsakul, 2007). One community leader opined: "Maybe this area lacks attention by politicians. If the government took serious action, there would be no [erosion] problem" (4). Another explained: "BMA always tries to improve the urban areas by building the metro, Skytrain, etc. But look at BKT—it's part of BMA but a rural area. So, BMA doesn't care about it much" (22). A prominent

television reporter stated: "There is not much interest [in BKT]. Ordinary Bangkokians have no idea about this place. They only have seafood at restaurants there" (26). It was too small and distant to be of metropolitan value or significance.

Another problem hampering a national response is Thailand's fragmented decentralisation and budgetary system. BMA is a local government with its own governor and is not under the Ministry of Interior. From 2014 to 2019, Thailand was under a military government that suspended local elections, including for the Bangkok governor. Although the military government was then elected in 2019, a local election for the Bangkok governorship and councillor membership occurred only in May 2022; this adversely affected local representation. In contrast, under the Ministry of Interior are two neighbouring provinces, Samut Prakarn and Samut Songkram, which share the same coastline and also experience coastal erosion. These differing lines of authority have made it difficult to coordinate regional- or national-level responses to erosion in the three provinces. As a BKT district officer explained: "Due to different administration and budgetary issues, we [the three provincial governments] cannot work together in terms of budget sharing" (19). An official at the Department of Marine Coastal Resources expounded: "Provincial governments do not work together. The budgetary system is a problem: projects have to be earmarked for one area and cannot be used for others" (10).

Over two decades, no policies mitigated these problems. The private sector was tokenistic, the public sector ineffective—with unfulfilled and inadequate plans, largely a function of Tha Kham being on the distant periphery of Bangkok, but also of limited budgets spent elsewhere and scarce human resources—and local people lacked resources to make changes at the scale required and were ignored when they sought to inject local knowledge. Hence, findings suggest that households in Tha Kam have been marginalised because of their location along Bangkok's periphery and because of state fragmentation and limited representation.

6 | WASTEWATER INTRUSION

A second critical influence on aquaculture has been wastewater intrusion, which became a serious problem around 2009: Wastewater began to enter aquaculture farms and aquatic life died. Aquaculture relies upon brackish water, a mixture of fresh and seawater. Farmers trap canal water in their fields by building embankments and turning them into ponds. However, if canal water is degraded by wastewater, productivity and income reduce. In Tha Kam, losses ranged from 30% to 90%. One farmer said: "Wastewater has made the situation bad, and it is getting worse all the time; 50% is lost due to wastewater. In the past, the boat cannot contain all the shrimp" (22). One feared his children would be forced to move because of wastewater intrusion (5). Another sold his land because wastewater has caused shrimp production to steeply decline (8). Since 2011, the frequency of polluted water flowing into the ponds has increased from thrice per year to four to five times per year (3).

Wastewater was universally regarded as a threat to livelihoods greater than coastal erosion because whereas coastal erosion only impacted those living on the coast, water pollution affected all farmers. Farmers elsewhere along the Chao Phraya River have similarly blamed wastewater for several mass mortality incidents (Lebel et al., 2019). Farmers have no option to shift geographically because of increasingly limited land availability. Wastewater intrusion occurs throughout the year so there is no shift seasonally either.

Local people recognised three major upstream sources of wastewater: households, factories, and agriculture and aquaculture farms. The BKT district assistant director told us wastewater in BKT was a national environmental problem emanating from Bangkok and surrounding provinces because five rivers, including the Chao Phraya River running through Bangkok, release water into the Gulf of Thailand. Because wastewater enters the system from many sources, it has been difficult to address (1).

Much wastewater entering BKT's waterways comes from urban households. Some houses in low-income communities lack septic tanks, and in upstream villages, where wastewater treatment is unavailable, waste is released directly into canals and rivers. BMA's sewage system does not cover all households, with coverage rates estimated by the Pollution Control Department (PCD) to be 60% to 70%. In the Bangkok Metropolitan Region (BMR), only about half of wastewater is treated (Mrozik et al., 2019). Several new housing estates, including those in BKT, also lack septic tanks and add wastewater to waterways. MONRE's Department of Environmental Quality Promotion has had promotional campaigns to encourage households to treat wastewater but could not enforce that, and no central system has collected households' wastewater (11). Many upstream households in the BMR have also operated workshops that illicitly discharged high levels of wastewater. Inspections were needed to stop wastewater dumping, but local governments allocated that task had insufficient capacity and budget to do so (12).

Large factories have been another significant source of wastewater, particularly in Bangkok and Samut Prakarn. Industrial estates had sufficient wastewater treatment facilities, whereas small factories lacked them, although Thai law required them to have them (11). Consequently, they "sneakily release wastewater" (2), and lack of enforcement enabled them to continue operating illegally (11, 12). The PCD had limited capacity to enforce standards. After 2010, the

national government reduced the number of inspection officers to save money. Just three such officers operate in each province, a particular problem in Samut Prakarn, where there are over 7,000 factories (12). Much of this wastewater eventually flowed into BKT (OECD, 2018). BKT itself has several factories, some of which also discharge wastewater (12).

Peri-urban agriculture and aquaculture exacerbate the wastewater situation. Swine farms have produced copious amounts of waste into waterways (10). Upstream aquaculture farmers normally do not treat water sufficiently, resulting in downstream pollution, including in BKT (11, 13). Although feeding fish in rivers is illegal because it pollutes rivers, many farmers do so (12). Such a multitude and diversity of wastewater sources has made it difficult to address. Thailand's fractured and underfunded governance of wastewater has thus made a concerted response unduly challenging.

6.1 | The political ecology of wastewater in BKT

Besides increased population and urbanisation in areas upstream of Tha Kham, several underlying political–economic drivers have underpinned the wastewater problem. First, according to a basic politics of position, upstream actors such as households, industries, and local authorities lacked sufficient incentives to reduce wastewater that flowed downstream. Quite simply, as a PCD officer declared, aquaculture farmers downstream always had higher pollution loads (12). A local in Tha Kham declared that those living there must cope unfairly with wastewater flowing downstream from Bangkok and called upon BMA to reduce wastewater levels (5).

The second driver is the fragmented governance of wastewater. Each ministry and department acts as its own fiefdom, seeking to control which issues and projects are under its jurisdiction (Reynolds et al., 2012). The state's fragmentation is especially problematic in the water sector. At least 31 departments in 10 ministries have overlapping roles and responsibilities, which has led to inter- and intra-agency power conflicts (Kovavisarach, 2021). Moreover, the country's 36 primary and 2,000 secondary laws regulating water contradict each other and create confusion (OECD, 2018). This convoluted and conflicting governance structure has led to disputes between agencies over responsibility for managing wastewater. The PCD establishes wastewater standards, but the Department of Industrial Works (DIW) under the Ministry of Industry is responsible for enforcing them. However, DIW's mandate is to expand industrial growth rather than impose regulations that could limit it (12). Similarly, the Ministry of Agriculture has the regulatory power to enforce wastewater standards upon fish farmers, but, to some, this ministry "does not care about the environment" and instead "supports the farmers" (12). A PCD official estimated that only 10% of farmers met the standards (12). A parallel problem is that local governments have not set any household standards for wastewater (11). And the national government has focused policy on improving solid waste management while neglecting wastewater (12). A Tha Kham leader asserted that the problem is beyond the community's scope to solve and that the national government has failed to address it (4). A PCD official added that agencies responsible for wastewater refused to accept responsibility for wastewater in Tha Kam and instead blamed others (12).

Third, Thailand's incomplete decentralisation has damaged wastewater management. Thailand embarked upon decentralisation reforms in the 1990s, giving additional power to local administrative organisations (LAOs), but they did not lead to fundamental changes in central-local power relations because central bureaucrats resisted them and retained control at the local level (Marks & Lebel, 2016). Consequently, LAOs such as that in Tha Kham lack sufficient capacity to manage wastewater (11). A PCD senior official said one reason for their limited capacity is that working on wastewater is too technical for them (12). BMA has limited legal authority to curb wastewater, and, as with air pollution (see Marks & Miller, 2022), it cannot stop factories within its jurisdiction discharging wastewater. Instead, BMA must request DIW to do so but the latter often ignores these requests (1). Within BMA, district officers would like to do more to address wastewater but lack legal and financial tools to do so (4). A BKT district officer complained that the district has to raise issues such as wastewater to BMA and the national government because his office has been unable to solve this issue on its own (1). Moreover, local governments, such as the BKT district office, have used their limited budgets to construct infrastructure and buildings, which constituents could see, rather than focus on less visible issues such as wastewater (11, 12). Thus, the problem of wastewater is a result of scalar politics—no organisation at any level wants responsibility—and the politics of place and position; prioritisation of interests of inner areas' residents means that wastewater flows downstream to those in peripheral areas. Consequently, practices among upstream actors can produce "downstream vulnerability" to wastewater.

Fourth, lack of political representation contributed to problems. BKT farmers complained about wastewater from upstream entering their ponds and requested assistance from BMA but, as one local community representative lamented: "BMA has done nothing. People here are not happy with them" (2). According to a BMA consultant, inaction was because the BKT coastal zone is sparsely populated with lower-income groups so BMA prioritises the needs of wealthier inner-city voters

(15). Similarly, the national government did little "about addressing the problem of wastewater, only campaigning and seeking to raise awareness" because wastewater management was a low priority for national leaders (1). It is likely that a politics of visibility is a reason behind the lack of prioritisation: Because wastewater is less visible, the public and the press pay less attention to it (Colven, 2020) and so do political leaders. The national government has failed to introduce wastewater tariffs, resulting in polluters lacking financial disincentives to stop dumping (OECD, 2018). Once again, being on the periphery has proved disadvantageous.

Farmer livelihoods vulnerable to wastewater involve relational challenges. Industry owners, households, and upstream farmers profit from not having to pay wastewater costs. In contrast, aquaculture farmers' livelihoods in BKT and elsewhere at the bottom of delta suffer. Political ecology studies thus usefully show interconnections across and divisions between urban and rural spaces (Baird, 2022) and resulting problems and complexities where there exist overlapping and competing governance structures.

7 | CONCLUSION

Different factors have contributed to increased wastewater and coastal erosion in Tha Kham and their impacts on aquaculture. The former was primarily a function of increased and unregulated upstream and local runoff, the latter an outcome of upstream dam construction, groundwater pumping, and climate change. Ironically, valuable silt flowing downstream had been replaced by harmful wastewater. Although Tha Kham residents were disadvantaged, others, including factory owners, central Bangkok residents, and upstream farmers, benefitted from environmental changes, such as by being able to dump wastewater without cost: an illustration of adverse inclusion where "the relative security of some social groups is achieved through the production of insecurity among others" (Taylor, 2013, p. 318). Tha Kham residents have been able to retain their land, but it has become increasingly economically worthless, above all for aquaculture. That is scarcely unusual in peri-urban areas, where rural areas have come under pressure from expanding cities leading to marginalisation, dispossession, and worsening inequality between urban and rural populations.

Although underlying problems differed, responses to them were remarkably similar, reflecting a politics of position downstream and on urban margins. Tha Kham was unrepresented, often out of sight and mind of the centralised BMA, whereas government departments at different scales, charged with development and environmental management, were unusually fragmented, hampered by scarce financial and human resources, and sometimes in conflict. At the outskirts of Bangkok, Tha Kham residents were excluded from political and urban development processes, which have often prioritised Bangkok's inner-city and wealthier residents (see Marks & Elinoff, 2020). Farmers have received limited assistance from urban and national governments, and policymakers and planners neglected peri-urban fringes such as Tha Kham, both intentionally and inadvertently. Although Tha Kham residents should receive government support and representation commensurate with others residing in the city, because of the politics of position, the national elite and bureaucrats have deemed them less important than inner city residents, whose interests significantly differ from theirs. Their vulnerability to risk has been accentuated and produced at scales beyond their traditional sphere of influence and risk-mediation strategies (Miller, 2014). Coincidentally, it is increasingly evident that the future of sustainable aquaculture lies at scales beyond the farm (Bottema et al., 2019).

Other peri-urban residents in the Global South face similar bleak prospects. Wider-scale, extra-local processes at multiple scales have increasingly and profoundly shaped resource and power inequalities as well as unequal livelihood vulnerabilities, as the lived environment of smallholder aquaculture in Tha Kham and elsewhere become less productive. Tha Kham exemplifies problems caused by poor and absent governance of peri-urban space. The high degree of bureaucratic vertical and horizontal fragmentation, legal ambiguity, and incomplete decentralisation have created governance gaps in wastewater and coastal erosion. Poor governance and limited accountability and representation favour the better-off and disadvantage smaller places on the peri-urban fringes. Tha Kam residents consequently suffer what Allen (2010, p. 40) labelled a "peri-urbanisation of injustice" that, here, is accentuated by their being downstream. Reversing such circumstances is implausible without more effective governance in representation and resource allocation. Consequently, as Rigg argued (2020) more generally, such vulnerabilities and unfair governance structures further accelerate the risks of smallholder's abandonment of the countryside.

What is needed is for the state to address the two major sources of vulnerability: erosion and wastewater. To address erosion, BMA could enact an immediate moratorium on groundwater pumping; significantly invest in a mix of soft and hard structures along the coast, including mangrove forests; and collaborate more with other sectors within and beyond aquaculture Andriesse et al. (2021). To reduce wastewater intrusion, national and local organisations need to fine those who illegally dump wastewater, enact wastewater fees for all households, and ensure that low-income households can access sewage facilities. Beyond these solutions, needed are the institutionalisation of risk management between farmers and state actors (Bottema et al., 2021)

and a revitalisation of peripheral areas, improving transportation linkages, quality of education, and creating effective social safety nets and subsidisation of inputs. Such solutions would help smallholder farmers in BKT and beyond escape marginalisation.

The political ecology of peri-urban areas ultimately revolves around transcending the rural–urban binary (Baird, 2022). It focuses on how vulnerabilities in peri-urban areas are relational, linked to power and socio-economic inequalities (Savelli et al., 2021) and to how peri-urban residents lack representation to improve their livelihoods and property. Many peri-urban residents, who are often marginalised, employ livelihood strategies to mitigate and adapt to environmental change but are hampered by extra-local factors that compound local challenges. Livelihood research is insufficient for understanding how these factors shape the material and social environments that constitute the peri-urban lived environment. A peri-urban political ecology approach analyses not only local livelihood dynamics but also convoluted and conflicting governance systems in which government agencies are shifting responsibilities away from the locals without working with and listening to local constituents. Such a political ecology aims to understand how peri-urban injustices and the "peri-urbanisation of injustice" (Allen, 2010) are ultimately linked to other urbanisation and capitalist processes that have contributed to the emerging "post-justice city" here and elsewhere (Mitchell, 2001). Environmental risks are shifted to peripheral areas to enable "world-class" urbanisation to take place elsewhere. Prioritising interests among those residing in the inner city has detrimental effects on those living in the periphery as smallholder farmers are increasingly incorporated into new capitalist frontiers (Saguin, 2016), creating new socio-ecological conflicts, aggravated, but not necessarily caused, by climate change.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to disclose.

ETHICS STATEMENT

The research was conducted in accordance with the principles embodied in the Declaration of Helsinki and in accordance with local statutory requirements. All participants gave verbal informed consent to participate in the study.

DATA AVAILABILITY STATEMENT

The data are available from the corresponding author upon reasonable request.

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REFERENCES

Allen, A. (2010). Neither rural nor urban: Service delivery options that work for the peri-urban poor. In M. Kurian & P. McCarney (Eds.). *Peri-urban water and sanitation services: Policy, planning and method* (pp. 27–61). Springer Netherlands. https://doi.org/10.1007/978-90-481-9425-4_2

Andriesse, E., Kittitornkool, J., Saguin, K., & Kongkaew, C. (2021). Can fishing communities escape marginalisation? Comparing overfishing, environmental pressures and adaptation in Thailand and the Philippines. *Asia Pacific Viewpoint*, *62*(1), 72–85. https://doi.org/10.1111/apv.12270

Angelo, H., & Wachsmuth, D. (2015). Urbanizing urban political ecology: A critique of methodological cityism. *International Journal of Urban and Regional Research*, *39*(1), 16–27. https://doi.org/10.1111/1468-2427.12105

Baird, I. G. (2022). The problem of the urban-rural binary in geography and political ecology. *Dialogues in Human Geography*, 20438206221102950.

Bakker, K. (2008). The ambiguity of community: Debating alternatives to private-sector provision of urban water supply. *Water Alternatives*, *1*(2), 236–252.

Bartels, L. E., Bruns, A., & Simon, D. (2020). Towards situated analyses of uneven peri-urbanisation: An (urban) political ecology perspective. *Antipode*, *52*(5), 1237–1258. https://doi.org/10.1111/anti.12632

Bebbington, A. J., & Batterbury, S. P. J. (2001). Transnational livelihoods and landscapes: Political ecologies of globalization. *Ecumene*, *8*(4), 369–380. https://doi.org/10.1177/096746080100800401

Belton, B., & Little, D. (2008). The development of aquaculture in Central Thailand: Domestic demand versus export-led production. *Journal of Agrarian Change*, *8*(1), 123–143. https://doi.org/10.1111/j.1471-0366.2007.00165.x

Bidorn, B., Sok, K., Bidorn, K., & Burnett, W. C. (2021). An analysis of the factors responsible for the shoreline retreat of the Chao Phraya Delta (Thailand). *Science of the Total Environment*, *769*, 145253. https://doi.org/10.1016/j.scitotenv.2021.145253

Borras, S. M., Franco, J. C., & Nam, Z. (2020). Climate change and land: Insights from Myanmar. *World Development*, *129*(May), 104864. https://doi.org/10.1016/j.worlddev.2019.104864

Bottema, M. J. M., Bush, S. R., & Oosterveer, P. (2019). Moving beyond the shrimp farm: Spaces of shared environmental risk? *The Geographical Journal*, *185*(2), 168–179. https://doi.org/10.1111/geoj.12280

Bottema, M. J. M., Bush, S. R., & Oosterveer, P. (2021). Territories of state-led aquaculture risk management: Thailand's Plang Yai program. *Environment and Planning C: Politics and Space*, *39*(6), 1231–1251. https://doi.org/10.1177/2399654420965241

Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal*, *9*, 27–40. https://doi.org/10.3316/QRJ0902027

Carney, D. (1998). *Sustainable rural livelihoods: What contribution can we make?* Department for International Development London.

Carr, E. R. (2015). Political ecology and livelihoods. In T. Perreault, G. Bridge, & J. McCarthy (Eds.). *The Routledge handbook of political ecology* (pp. 332–342). Routledge.

Chiengkul, P. (2017). *The political economy of the agri-food system in Thailand: Hegemony, counter-hegemony, and co-optation of oppositions*. Routledge. https://doi.org/10.4324/9781315267920

Colven, E. (2020). Subterranean infrastructures in a sinking city: The politics of visibility in Jakarta. *Critical Asian Studies*, *52*(3), 311–331. https://doi.org/10.1080/14672715.2020.1793210

Davivongs, V., Yokohari, M., & Hara, Y. (2012). Neglected canals: Deterioration of indigenous irrigation system by urbanization in the west peri-urban area of Bangkok Metropolitan Region. *Water*, *4*(1), 12–27. https://doi.org/10.3390/w4010012

De Haan, L., & Zoomers, A. (2005). Exploring the frontier of livelihoods research. *Development and Change*, *36*(1), 27–47. https://doi.org/10.1111/j.0012-155X.2005.00401.x

Dixon, C. J. (1999). *The Thai economy: Uneven development and internationalisation*. Growth Economies of Asia Series. Routledge. http://lcweb.loc.gov/catdir/toc/98-4882.html

Eakin, H., Winkels, A., & Sendzimir, J. (2009). Nested vulnerability: Exploring cross-scale linkages and vulnerability teleconnections in Mexican and Vietnamese coffee systems. *Environmental Science & Policy*, *12*(4), 398–412. https://doi.org/10.1016/j.envsci.2008.09.003

FAO. (2018). The State of World Fisheries and Aquaculture 2018-Meeting the sustainable development goals. Fisheries and Aquaculture Department, Food and Agriculture Organization of the United Nations, Rome.

Groot, R., & Bayrak, M. M. (2019). Achieving water security in peri-urban Yangon: Exploring the local governance processes. *Water Policy*, *21*(5), 980–998. https://doi.org/10.2166/wp.2019.058

Heynen, N., & Robbins, P. (2005). The neoliberalization of nature: Governance, privatization, enclosure and valuation. *Capitalism Nature Socialism*, *16*(1), 5–8. https://doi.org/10.1080/1045575052000335339

Hommes, L., Boelens, R., Harris, L. M., & Veldwisch, G. J. (2019). Rural–urban water struggles: Urbanizing hydrosocial territories and evolving connections, discourses and identities. *Water International*, *44*(2), 81–94. https://doi.org/10.1080/02508060.2019.1583311

Humanitarian Data Exchange. (2019). Thailand—Subnational administrative boundaries. 2019. https://data.humdata.org/dataset/thailand-administrative-boundaries

Jarungrattanapong, R., & Manasboonphemphool, A. (2009). Adaptation strategies to address coastal erosion/flooding: A case study of the communities in Bang Khun Thian District, Bangkok, Thailand. EEPSEA Special and Technical Paper. Economy and Environment Program for Southeast Asia (EEPSEA). https://ideas.repec.org/p/eep/tpaper/tp200911t1.html

Jarupongsakul, T. (2006). Coastal erosion in Thailand: Causes and management. Research Paper, Department of Geology, Chulalongkorn University (in Thai).

Karpouzoglou, T., Marshall, F., & Mehta, L. (2018). Towards a peri-urban political ecology of water quality decline. *Land Use Policy*, *70*(January), 485–493. https://doi.org/10.1016/j.landusepol.2017.11.004

Kovavisarach, C. (2021). The pervasiveness of political polarisation in Thailand's water policy gridlock. MA Thesis, The University of Tokyo.

Lebel, L., Lebel, P., & Joon Chuah, C. (2019). Water use by inland aquaculture in Thailand: Stakeholder perceptions, scientific evidence, and public policy. *Environmental Management*, *63*(4), 554–563. https://doi.org/10.1007/s00267-019-01143-0

Lebel, L., & Sinh, B. T. (2009). Risk reduction or redistribution? Flood management in the Mekong Region. *Asian Journal of Environment and Disaster Management*, *1*(1), 1–25. https://doi.org/10.3850/S179392402009000040

Marks, D. (2011). Climate change and Thailand: Impact and response. *Contemporary Southeast Asia: A Journal of International and Strategic Affairs*, *33*(2), 229–258. https://doi.org/10.1355/cs33-2d

Marks, D. (2015). The urban political ecology of the 2011 floods in Bangkok: The creation of uneven vulnerabilities. *Pacific Affairs*, *88*(3), 623–651. https://doi.org/10.5509/2015883623

Marks, D. (2019). The political ecology of climate injustice in Bangkok. In G. Bracken, R. Paul Rabé, N. S. Parthasarathy, & B. Zhang (Eds.). *Future challenges of cities in Asia* (pp. 155–182). Amsterdam University Press. https://doi.org/10.2307/j.ctvs32qp6.9

Marks, D., & Elinoff, E. (2020). Splintering disaster: Relocating harm and remaking nature after the 2011 floods in Bangkok. *International Development Planning Review*, *42*(3), 273–294. https://doi.org/10.3828/idpr.2019.7

Marks, D., & Lebel, L. (2016). Disaster governance and the scalar politics of incomplete decentralization: Fragmented and contested responses to the 2011 floods in Central Thailand. *Habitat International*, *52*(March), 57–66. https://doi.org/10.1016/j.habitatint.2015.08.024

Marks, D., & Miller, M. A. (2022). A transboundary political ecology of air pollution: Slow violence on Thailand's margins. *Environmental Policy and Governance*, *32*(4), 305–319. https://doi.org/10.1002/eet.1976

Marks, D., & Zhang, J. (2019). Circuits of power: Environmental injustice from Bangkok's shopping malls to Laos' hydropower dams. *Asia Pacific Viewpoint*, *60*(3), 296–309. https://doi.org/10.1111/apv.12242

McGee, T. G. (2015). The emergence of Desakota Regions in Asia: Expanding a hypothesis. In N. Brenner (Ed.). *Implosions/Explosions* (pp. 121–137). JOVIS Verlag.

McGee, T. G., & Greenberg, C. (1992). The emergence of extended metropolitan regions in ASEAN: Towards the year 2000. *ASEAN Economic Bulletin*, *9*(1), 22–44. https://doi.org/10.1355/AE9-1B

Mehta, L., Allouche, J., Nicol, A., & Walnycki, A. (2014). Global environmental justice and the right to water: The case of peri-urban Cochabamba and Delhi. *Geoforum*, *54*(July), 158–166. https://doi.org/10.1016/j.geoforum.2013.05.014

Miller, F. (2014). Constructing risk: multi-scale change, livelihoods and vulnerability in the Mekong Delta, Vietnam. *Australian Geographer*, *45*(3), 309–324. https://doi.org/10.1080/00049182.2014.930000

Mitchell, D. (2001). Postmodern geographical praxis? The postmodern impulse and the war against homeless people in the 'post-justice' city. In C. Mincia (Ed.). *Postmodern geography* (pp. 57–92). Blackwell Publishers.

Molle, F. (2007). Scales and power in river basin management: The Chao Phraya River in Thailand. *The Geographical Journal*, *173*(4), 358–373. https://doi.org/10.1111/j.1475-4959.2007.00255.x

Moriizumi, Y., Matsui, N., & Hondo, H. (2010). Simplified life cycle sustainability assessment of mangrove management: A case of plantation on wastelands in Thailand. *Journal of Cleaner Production*, *18*(16), 1629–1638. https://doi.org/10.1016/j.jclepro.2010.07.017

Mrozik, W., Vinitnantharat, S., Thongsamer, T., Pansuk, N., Pattanachan, P., Thayanukul, P., Acharya, K., Baluja, M. Q., Hazlerigg, C., Robson, A. F., Davenport, R. J., & Werner, D. (2019). The food-water quality nexus in periurban aquacultures downstream of Bangkok, Thailand. *Science of the Total Environment*, *695*, 133923. https://doi.org/10.1016/j.scitotenv.2019.133923

Mustafa, D. (2005). The production of an urban hazardscape in Pakistan: Modernity, vulnerability, and the range of choice. *Annals of the Association of American Geographers*, *95*(3), 566–586. https://doi.org/10.1111/j.1467-8306.2005.00475.x

Myers, G. A. (2008). Peri-urban land reform, political-economic reform, and urban political ecology in Zanzibar. *Urban Geography*, *29*(3), 264–288. https://doi.org/10.2747/0272-3638.29.3.264

Na Thalang, J. (2015). City goes down the sink. *Bangkok Post*, August 2, 2015. http://www.bangkokpost.com/news/special-reports/640784/city-goes-down-the-sink

Narain, V. (2022). Wading across the frontiers: A new paradigm for peri-urban water security? *Water Dissensus* (blog). April 15, 2022. https://www.water-alternatives.org/index.php/blog/wading

Narain, V., Khan, M. S., Sada, R., Singh, S., & Prakash, A. (2013). Urbanization, peri-urban water (in)security and human well-being: A perspective from four south Asian cities. *Water International*, *38*(7), 930–940. https://doi.org/10.1080/02508060.2013.851930

OECD. (2018). Multi-dimensional review of Thailand: Volume 1. Initial assessment. OECD Development Pathways. Paris. https://www.oecd.org/publications/multi-dimensional-review-of-thailand-volume-1-9789264293311-en.htm

Phien-wej, N., Giao, P. H., & Nutalaya, P. (2006). Land subsidence in Bangkok, Thailand. *Engineering Geology*, *82*(4), 187–201. https://doi.org/10.1016/j.enggeo.2005.10.004

Pongnak, W. (1999). Case study on the impact and conflict in using the nation's freshwater land resources for farming penaeid shrimp. *Greenline*, *4*, 6–15.

Reynolds, C., Nishizaki, Y., Glassman, J., Farrelly, N., Busbarat, P., Lim, S., Haberkorn, T., & Chachavalpongpun, P. (2012). *Time's arrow and the burden of the past: A primer on the Thai un-state*. Sensate.

Rigg, J. (2006). Land, farming, livelihoods, and poverty: Rethinking the links in the rural south. *World Development*, *34*(1), 180–202. https://doi.org/10.1016/j.worlddev.2005.07.015

Rigg, J. (2020). *Rural development in Southeast Asia: Dispossession, accumulation and persistence*. Cambridge University Press. https://doi.org/10.1017/9781108750622

Robbins, P. (2011). *Political ecology: A critical introduction* (2nd ed.). John Wiley & Sons.

Saguin, K. (2016). Blue revolution in a commodity frontier: Ecologies of aquaculture and agrarian change in Laguna Lake, Philippines. *Journal of Agrarian Change*, *16*(4), 571–593. https://doi.org/10.1111/joac.12114

Sajor, E., & Ongsakul, R. (2007). Mixed land use and equity in water governance in peri-urban Bangkok. *International Journal of Urban and Regional Research*, *31*(4), 782–801. https://doi.org/10.1111/j.1468-2427.2007.00752.x

Sampantamit, T., Ho, L., Lachat, C., Sutummawong, N., Sorgeloos, P., & Goethals, P. (2020). Aquaculture production and its environmental sustainability in Thailand: Challenges and potential solutions. *Sustainability*, *12*(5), 2010. https://doi.org/10.3390/su12052010

Savelli, E., Rusca, M., Cloke, H., & Di Baldassarre, G. (2021). Don't blame the rain: Social power and the 2015–2017 drought in Cape Town. *Journal of Hydrology*, *594*, 125953. https://doi.org/10.1016/j.jhydrol.2020.125953

Scoones, I. (2009). Livelihoods perspectives and rural development. *The Journal of Peasant Studies*, *36*(1), 171–196. https://doi.org/10.1080/03066150902820503

Shi, L., Ahmad, S., Shukla, P., & Yupho, S. (2021). Shared injustice, splintered solidarity: Water governance across urban-rural divides. *Global Environmental Change*, *70*, 102354.

Shrestha, A., Joshi, D., & Roth, D. (2020). The hydro-social dynamics of exclusion and water insecurity of Dalits in peri-urban Kathmandu Valley, Nepal: Fluid yet unchanging. *Contemporary South Asia*, *28*(3), 320–335. https://doi.org/10.1080/09584935.2020.1770200

Simon, D. (2008). Urban environments: Issues on the peri-urban fringe. *Annual Review of Environment and Resources*, *33*(1), 167–185.

Swyngedouw, E. (2006). Circulations and metabolisms: (hybrid) natures and (cyborg) cities. *Science as Culture*, *15*(2), 105–121. https://doi.org/10.1080/09505430600707970

Szuster, B. (2003). *Shrimp farming in Thailand's Chao Phrya River Delta*. International Water Management Institute.

Szuster, B. (2006). A review of shrimp farming in Central Thailand and its environmental implications. In P. S. Leung & C. Engle (Eds.). *Shrimp culture: Economics, market, and trade* (pp. 155–166). John Wiley & Sons, Ltd. https://doi.org/10.1002/9780470277850.ch11

Taylor, M. (2013). Climate change, relational vulnerability and human security: Rethinking sustainable adaptation in agrarian environments. *Climate and Development*, *5*(4), 318–327. https://doi.org/10.1080/17565529.2013.830954

Taylor, M. (2015). *The political ecology of climate change adaptation: Livelihoods, agrarian change and the conflicts of development*. Routledge.

Thompson, B. S. (2018). The political ecology of mangrove forest restoration in Thailand: Institutional arrangements and power dynamics. *Land Use Policy*, *78*(November), 503–514. https://doi.org/10.1016/j.landusepol.2018.07.016

Wancharoen, S. (2014). Saving the Bang Khunthian Coast will cost B1.5bn. Bangkok Post, May 4, 2014. https://www.bangkokpost.com/print/403518/

Wilson, N. J., Harris, L. M., Nelson, J., & Shah, S. H. (2019). Re-theorizing politics in water governance. *Water*, *11*(7), 1470. https://doi.org/10.3390/w11071470

Winterwerp, J. C., Borst, W. G., & de Vries, M. B. (2005). Pilot study on the erosion and rehabilitation of a mangrove mud coast. *Journal of Coastal Research*, *21*(2), 223–230.

Zoomers, A., van Noorloos, F., Otsuki, K., Steel, G., & van Westen, G. (2017). The rush for land in an urbanizing world: From land grabbing toward developing safe, resilient, and sustainable cities and landscapes. *World Development*, *92*(April), 242–252. https://doi.org/10.1016/j.worlddev.2016.11.016

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