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Displaced Sand, Displaced People: Examining the Livelihood Impacts of Sand Mining in Cambodia

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**Displaced Sand, Displaced
People: Examining the
Livelihood Impacts of Sand
Mining in Cambodia**

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Résumé

Ce document de travail examine les impacts de l'extraction de sable de rivière au Cambodge sur les moyens de subsistance des populations. Deux études de cas sont élaborées : (a) la première concerne les dragueurs qui extraient le sable du lit de cours d'eau à Phnom Penh et dans ses environs ; (b) la seconde se concentre sur des agriculteurs urbains dont les moyens de subsistance sont affectés par le remblaiement de lacs et marécages dans la capitale. Ces études soulignent combien les moyens de subsistance liés au sable sont de nature temporaire et précaire. Il est démontré que les conséquences sociales,

économiques et écologiques de l'exploitation intensive du sable sont considérables pour plusieurs acteurs de cette filière. Nous arguons que la gouvernance déficiente et l'opacité entourant l'extraction du sable et des remblais va de pair à Phnom Penh et dans sa banlieue avec un modèle de développement qui accroît la précarité des modes de subsistance, et celle de l'environnement. Une gouvernance raisonnée du sable est nécessaire pour l'avènement d'une stratégie de développement urbain plus inclusive à Phnom Penh.

Mots-clés

Moyens de subsistance, précarité, sable, développement urbain, Cambodge

Abstract

This working paper focuses on the livelihood impacts of river sand mining in Cambodia. We draw on two examples: (a) that of sand miners, working directly in riverbed sand mining in and around Phnom Penh; and (b) those of urban farmers, whose livelihoods are impacted by the sand infill of urban wetlands. What is consistent across both our cases is how these livelihoods – both connected to sand – are temporal in nature, with limited longer-term prospects. Our cases highlight more than livelihood losses for households: the social, economic and ecological consequences of unabated sand exploitation are profound.

We argue that the governance vacuum that our sand mining or infill case studies highlight will impact the type of development seen in and around Phnom Penh, the jobs people can access, and the environment in which people live. Serious sand governance is needed, particularly in conjunction with, or as part of, a more inclusive urban development strategy for Phnom Penh.

Keywords

Livelihoods, precarity, sand mining, urban development, Cambodia

JEL Classification

Z (Other special topics)

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Introduction

Sand scarcity is an emerging global crisis (Torres *et al.*, 2017). Sand dredgers, pumpers and miners extract sand found in rivers, oceans, estuaries, and beaches at a pace faster than natural replenishment rates (UNEP, 2019). Much of this demand is linked to skyrocketing urbanisation. Sand is the main ingredient in the concrete used for roads, houses and high rises. China, for example, consumed more sand between 2011 and 2013 than the US did during the entire 20th century (Swanson, 2015). The global urban population is expected to grow from 4.3 billion people today to 5.2 billion in 2030, particularly in Global South cities (World Urbanization Report, 2018). Sand is also used as infill for wetlands or state-territorial expansion – known as ‘land reclamation’ – along with dam building, beach replenishment, and a host of other human-made products (Beiser, 2019; Bendixen *et al.*, 2019). Sand is the world’s third most utilized natural resource after air and water (UNEP, *op. cit.*); even so, the vast social-ecological consequences of sand labour and land infill are widely understudied, including in Cambodia.

Cambodia is one of the countries at the heart of sand exploitation. For example, over 80 million metric tonnes of Cambodian sand have been used as infill for Singapore’s territorial expansion (Comaroff, 2014; Lamb *et al.* 2019). Most of Cambodia’s sand trade is absent from the country’s official trade logs, and this lack of transparency complicates efforts to protest against the negative impacts this sector drives. For nearly a decade, Cambodian fishers opposed sand dredging in their mangrove-estuary fishing grounds, but only with extensive advocacy work and international media attention were coastal

sand exports banned in 2017 (Lamb *et al.* 2019). This unchecked exploitation of coastal sand sits within Cambodia’s longer history of the state using resources such as trees, fish or land to accumulate capital and contribute to a process of elite capture or smuggling by powerful urbanites close to the political regime (Le Billion 2002; Sneddon 2007; Diepart and Schoenberger 2017). The uneven development model that sand exploitation fosters involves ever increasing economic and socio-cultural inequalities between a small urban-based elite and the majority of the population living in rural and urban areas. For most workers, when sand opportunities do emerge, they are short-term, low-paid and transient.

Available data suggest that the 2017 ban on sand exports resulted in a significant drop in Cambodia’s sand trade, with Singapore, Taiwan and other Asian countries no longer reporting sand imports from Cambodia (DESA/UNSD, 2020). Sand mining however, continues, particularly along Cambodia’s rivers. The sand extracted is used to meet domestic demand as Cambodia’s cities grow. In the capital, Phnom Penh, schemes to create new ground for development through the infilling of local lakes and wetlands are rampant (Brickell 2014; Sahmakum Teang Tnaut 2019). Indeed, sand extraction supports Cambodia’s ongoing real estate boom (Fauveaud, 2016), including the satellite cities mushrooming at the edges of Phnom Penh. In contrast to this visible, overt, everyday use of sand, particularly river sand in and around Phnom Penh, official sand production statistics are difficult to access. There is little sense as to the volume of sand being extracted from riverbeds. Nor is

there a sense of how sand labour livelihoods are being produced, or how peri-urban ones are being impacted by wetland infill. What seems more certain, however, is that sand, as a resource, plays an important role in Phnom Penh's (under)development.

This paper aims to document several livelihood opportunities that have emerged with the growth of the sand industry, and to probe how other livelihoods are in the process of being destroyed by the sand industry. To achieve this dual aim, we examine two cases: (a) that of sand miners, working directly in riverbed sand mining in and around Phnom Penh and along the Mekong River; and (b) that of peri-urban farmers whose livelihoods are impacted by wetland infill. What is consistent across both our cases is how these livelihoods – both connected to sand – are transient. For sand miners and peri-urban farmers, this means that they have no guarantee that they will be able to maintain their livelihoods over the medium or longer term. It also compels them to constantly consider livelihood trade-offs and to scramble to find new livelihood options. Beyond documenting the sand-related livelihood opportunities and insecurities that our research collaborators experienced, our two cases ultimately speak to the consequences of

not managing sand mining or infill and their impacts on the type of development seen in and around Phnom Penh, on the jobs people can access, and on the environment in which people live. In that regard, our findings shed insights into development processes that span beyond our sand mining and infill case-studies.

Our paper builds on data obtained through more than 50 open-ended, qualitative interviews with both men working in sand pumping sites or on sand barges along the Tonle, Mekong and Bassac rivers, and with urban farmers (female and male) working in Phnom Penh's wetlands. These are complementary and cumulative rather than comparative case studies; we use these two examples to illustrate how sand exploitation can both create and destroy livelihoods, and situate these cases within Cambodia's broader development processes and the associated riverine ecologies that are now under strain. We also draw from our long history of working on sand (Marschke 2012; Lamb *et al.* 2019) and urban wetlands (Beckwith 2020) in Cambodia, and from peer-reviewed sand articles, United Nations Environment Program sand reports, the United Nations sand trade data, along with NGO and media reports.

I – Sand infill and river dredging in and around Phnom Penh

Situated on an extensive floodplain at the confluence of three rivers (Mekong, Sap and Bassac) in the lower Mekong River basin, Phnom Penh was originally surrounded by lakes and wetlands. The central districts of the city previously contained 25 lakes, 16 of which are now completely filled in (Sahmakum Teang Tnaut, 2019). Wetland infilling has likewise proceeded apace and led, since 2003, to the drying out of 40% of Phnom Penh's wetland areas (*ibid.*). The city's built-up area increased six-fold between 1990–2005, and land reclamation projects totalling 6,000 ha of natural lakes and wetlands have accommodated this growth (Mialhe *et al.*, 2019). Many of these former lakes and wetlands now host megaprojects, led by private developers – both foreign and domestic – that all rely on nearby river sand. Cambodia's construction sector thus emerged as the largest contributor to Cambodia's economic growth by 2015 (Fauveaud, 2016).

Rapid urbanization in Phnom Penh – including in the Lake Tompoun area we introduce later – and elsewhere along the Mekong has resulted in rates of sand extraction that are higher than natural replenishment levels. Natural replenishment levels in the Mekong watershed have decreased over the last decades due to upstream hydropower expansion in both Laos and China (Bravard *et al.* 2013).¹ Recent estimates posit that 80 million tonnes of sand are withdrawn from the Cambodian section of the Mekong watershed yearly, whereas natural replenishment rates average 5 million tonnes per year (National Public Radio, 2020). This imbalance poses serious sustainability challenges, including habitat disruptions that impact a range of species: macro-invertebrate, plant, aquatic, mammal, bird and, of course, human beings. Some species adapt, others less so (Torres *op. cit.*, 2017).

Moreover, sand mining and upstream damming-driven sediment intakes trigger significant erosional processes, as lowered sediment discharge acts as a sediment sink for riverbed and riverside aggregates (Jordan *et al.* 2019). This explains why photos of houses collapsing into the Mekong River are becoming abundant, with river bank instability being a real issue (Figure 1) (Grundy-Warr & Lin 2020; Hackney *et al.*, 2020). After sand is extracted, its addition elsewhere as infill further alters ecosystems, including squashing the macroinvertebrate species found in sand, along with the aquatic plant species found in urban farms. Other wetland functions are altered or lost in favour of a landscape that can handle the built form.

¹ Dams create obstacle to sediment transport; sand and other aggregates thereby deposit and accumulate behind such infrastructure.

Figure 1. Erosion along the Mekong River, Cambodia (October 16, 2019)



Source: Photo: L. Van Arragon.

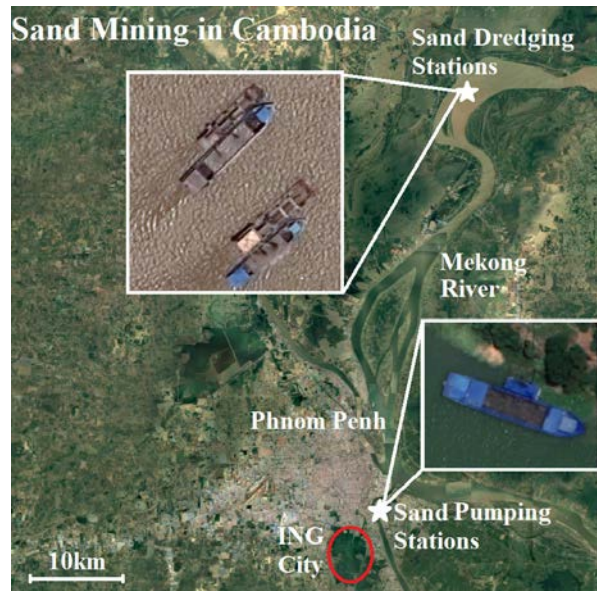
In addition to their ecological impacts, sand mining and infill drive livelihood changes for a wide range of social actors directly or indirectly involved in these activities. However, as of today, very little is known about sand miner livelihoods: sand mining does not appear in Cambodia's socio-economic statistics, and much of this sector operates within the informal economy. Research devoted to the implications of sand mining, particularly in terms of livelihoods, has so far been very limited. Our first case on sand work begins to address this gap.

As for the loss of Phnom Penh's lakes and wetland areas to infill, earlier research has documented how high-end and commercial real estate developments have repeatedly led to the eviction of low-income communities who have been occupying many of these lakes and wetlands for decades. These evictions are poorly compensated, if at all, leaving many former residents without housing, assets or income (McGinn, 2015). In one high profile example, 3,000 households were violently evicted from the 90 ha Boeung Kak lake area in the city centre (Sahmakum Teang Tnaut, 2016). In 2007, the Phnom Penh government transferred this valuable real estate to Shukaku Inc., a private company that belonged to a senator and donor to Cambodia's ruling political party, at a far below market price (Kry, 2014). Until their eviction and resettlement in distant camps, households had relied on the lake for income through fishing or growing aquatic vegetables, meaning the infill resulted in their loss of both homes and livelihoods. The evictions elicited massive protests which gained international attention, led to the imprisonment of many local activists (mostly women) and eventually to the suspension of all World Bank funding to Cambodia (Brickell, 2014). Yet, over a decade later the company had not completed the construction of the planned satellite city (Sahmakum Teang Tnaut, 2019). This case exemplifies both how and why Phnom Penh's history of social exclusion through forced eviction and limited access to housing options for the poor in the urban centre remains a real issue (Brickell *op. cit.*; Kent 2016; Talocci & Boano 2018).

Our second case adds to this scholarship by further detailing the livelihood challenges and trade-offs associated with such infill schemes and probing into the social consequences,

including relating to public health, that span beyond the household scale and impact the population of Phnom Penh as a whole (Figure 2).

Figure 2. Map showing ING City boundaries, covering Tompun and Cheung Ek wetlands, sand pumping stations in Phnom Penh, and sand dredging stations further along the Mekong River



Source: Google Maps.

II – Two case examples

Sand work

Sand work involves the movement of workers, boats and sand. Workers travel up and down Phnom Penh's rivers along various sand pumping stations; pumping stations in turn move in response to fluctuating sand resource availability and local demand. Sand, once offloaded, is transported to various infill and construction sites. For the most part, perhaps due to such mobility on the river, the sand industry is a masculine space: men account for the majority of boat drivers, sand pumpers, and boat owners. Sand workers tend to live together in pumping stations, or they congregate on the river at night when sleeping on boats. Women may be involved as cooks, if married or related to a boat captain. Men most often leave their family as they pursue this work, and send remittances back home. Sexism along with rigid conceptualizations of gender norms continue to be barriers for female entry (Lamb *et al.*, 2017).

Men from rural areas are drawn to sand work: poverty, limited educational opportunities, and few livelihood options serve as push factors. It also appears that many workers enter sand work through word of mouth and connections. Although workers know they will work in relatively isolated areas, and that they may sleep on sand barges for long periods of time, this work is seen as a less risky, and a less physically-demanding job than construction work. As one worker explained:

"Sand dredging is better than construction because the pay is about the same, but in construction you do heavy labour eight or more hours a day. Here it's a lot less busy" (Interview, November 26, 2019).

Entry level jobs in the sand industry consist of pumping sand from already filled sand barges onto land. Workers achieving this task earn anywhere between \$ 300–500 USD a month, an amount significantly higher than the monthly minimum wage of \$ 190 USD in Cambodia.² Commenting why this work is the less sought-after in the sand mining industry, another laboured explained:

"The job is really hard at first! You need to hold down a powerful hose with your foot, bend it into the right direction with your hands, and hold it in place for long periods of time." (Interview, October 9, 2019)

Pumpers work in team of eight to ten, equipped with powerful hoses to suspend the sand in water so it can be easily pumped and unloaded from the sand barge through a large rubber tube (Figure 3). A pumping station leader operates the engines of the sand pump: this work is far less physical, and is one of the most wanted jobs in the sand industry. To empty a sand

² In January 2020, Cambodia's minimum wage was \$190 USD. The monthly minimum wage is what garment factory workers earn before overtime. In 2017 urban household income averaged \$700 USD per month in Phnom Penh, in contrast to the rural average household income of \$430 USD.

barge filled with 800 cubic meters of sand takes an hour for a group of eight to ten sand pumpers. On a busy day, sand pump workers can empty six or seven barges. Some teams are paid based on the amount of sand they are able to pump per day, while others receive a fixed salary monthly. Most sand pumpers live and work in and around Phnom Penh to accommodate the huge sand demand from construction and wetland infill.

Figure 3. Labourers blast water at sand in order to dislodge it so it can be pumped out of the barge through large tubes. Up to ten labourers work for an hour to empty one boat. They often live and sleep at the pumping station (October 9, 2019)



Source : Photo L. van Arragon.

Another entry level job is sand dredging. The dredgers we met with worked together in pairs in remote locations along the Mekong River, on small metal platforms far from the shore.

"We sleep in the middle of the Mekong on the dredging station. We can only go to land if we're lucky to catch a fisher sailing by who agrees to take us there." (Interview, November 26, 2019).

If 'lucky', dredgers leave the stations and go onshore to buy supplies every few days. Their daily work, which consists in operating pumps that suck sand from the riverbed, is not generally physically demanding. Yet, they also regularly need to repair pump engines, which can be finicky and time-consuming.

A more lucrative job in the sand industry is that of a sand barge captain, which yields around \$800 USD per month; a quite decent wage compared to Cambodian averages. Boat captains sail barges for hundreds of kilometres along the Bassac, Tonle Sap or Mekong rivers in multi-day voyages between Phnom Penh and sand extraction sites. These workers may sail with their wife – as a household livelihood strategy – or with a young male assistant, whom they pay about \$200 USD per month from their own salary. Captain work is less physical than sand pumping or dredging, but requires navigation skills, management capacity, and involves higher levels of responsibility. The sand barge captains we interviewed were all connected to the boat owners hiring them, most of whom were

Vietnamese business people. Indeed, it appears that Vietnamese actors have invested massively in sand barges and dredgers, and predominantly oversee sand mining operations ongoing in and around Phnom Penh. This also suggests that sand may be partially exported to Vietnam without appearing in official trade logs.

One commonality between all the above jobs is that labour in the overall sand mining industry is precarious, similar to many occupations in Cambodia's informal economy. Workers do not sign written contracts, they are not unionized, and are at the mercy of their bosses; sand labourers can indeed be hired and fired at will and they do not always get paid for their work. This is different from manufacturing jobs, including in the garment industry, where Cambodia's labour code affords workers some rights and better protection. As one interviewee noted:

"I used to work for a sand company that often didn't pay our salaries on time. If you work for a smaller sand company, you are at risk of not getting paid if the customers don't pay for their sand. You have to work for a boss who has good connections; he can avoid those situations." (Interview, October 15, 2019).

Sand workers explained that there is little room for professional growth in the sand business as it takes too long for them to gain trust from their superiors, including Vietnamese boat owners that tend to only promote fellow Vietnamese or Vietnamese-speaking men to important positions such as boat captain. Horizontal movement between less well-paid jobs is more frequent, with workers switching jobs and/or sand companies based on their preferences. For example, a sand pumper may decide to work in a more remote location as a sand dredger because this involves less physical labour, while a sand dredger may switch to being a sand pumper in order to live closer to or in Phnom Penh. A captain may also be 'demoted' to being a sand pumper in Phnom Penh because they are not willing to constantly travel up and down the river.

Working at sand pumping stations is a less mobile livelihood, particularly where sand can be poured from the pumping station directly into a wetland area or to a construction site. As this occurs, sand workers must maintain the sand pumps that continuously pump large quantities of sand. One worker we spoke with had been stationed with his family at the same sand pumping station for over two years. He was responsible to maintain the sand pump and ensure a continuous supply of sand was being pumped into the wetland. This worker was further responsible for guarding the sand station when no sand was being pumped. This hints at frequent imbalances between sand supply and demand resulting in week or month-long periods during which workers do not work, nor receive any salary. Sand labourers are nonetheless compelled to live at and guard their sand stations during these periods in order to keep their job.

Thereby, entry level sand mining jobs are more lucrative and less demanding than equivalents in the construction sector, but sand work nonetheless requires that labourers be flexible and available. Workers are often mobile, both geographically and in their occupations, but have few opportunities to attain higher level jobs such as a sand barge captain. Sand mining thus creates transient and relatively marginal sand labour livelihoods.

Sand infill also impacts other kinds of livelihoods. As sand is being pumped through hundreds or thousands of meters of plastic tubing, sometimes for many years (Figure 4), land that is both physically and legally suitable for construction is produced (Doyle 2012), sustaining Phnom Penh's rapid urban expansion. While this happens, thousands of lower-income residents deriving their livelihood from the now disappearing wetlands lose their livelihoods, including those we introduce below (Beckwith, *op. cit.*).

Figure 4. Filling in vast wetland areas like Tompun Lake can take years. Pipes are laid across many kilometres, allowing sand to be continuously fed into the wetland area.



Source: Photo L. Beckwith (June, 2018).

Livelihoods lost with sand infill³

Our second case study highlights the loss of urban farming livelihoods to sand infill, focusing on southern Phnom Penh, where Cambodia's largest satellite city, ING city, is being built on top of two of the few remaining urban wetlands (Atelier Parisien d'Urbanisme, 2019). An immense volume of sand is necessary to complete this infill since the two wetlands – Tompun and Cheung Ek wetlands – expand to over 2,000 hectares in the rainy season (Sovann *et al.*, 2015). In one village on the shore of Lake Tompun farming was the main source of income for 69% of households. Morning glory, a type of aquatic spinach, is grown on the water's surface alongside other aquatic vegetables, which are then sold in local markets, forming an important component of Cambodian diets. Though wetland farming has never been easy, households have generally been able to support their families with this work and in so doing, benefitted from the proximity to the city which offers access to public services often lacking in rural areas. Yet, it is becoming increasingly difficult for them to achieve this as urban farming has become a far less lucrative livelihood activity over time. As a result, farmers now make anywhere between USD 100 to USD 200 per month, far less than what they were able to earn in the past.

³ This section draws on the detailed doctoral research of Beckwith (2020).

The transformation of the Tompun and Cheung Ek wetlands into ING city is a process of both ecological and social change. Sand infill is dramatically altering the wetland landscape (Figure 3), as one interviewee explains:

"It is very hard. I don't even know what to say. In the past, I loved the scenery. As I got up in the morning and came out of the house, I saw the pasture and morning glory fields. It was beautiful. It was so green. Now, it is full of white sand. In the past, as we opened our eyes, we felt the clean breeze and now, when we open our eyes, a cloud of dust flies in our eyes." (Interview, June 2018).

Farming livelihoods have become less viable since work on the ING city and sand infill began in 2011. Phnom Penh, a city of 1.5 million people, is not equipped with a central sewage treatment facility and these wetlands remain the "lynchpin in the management and treatment of the majority of Phnom Penh's waste water" (AtPUR, *op. cit.*, p. 38). The slow creep of sand infill has resulted in less water exchange throughout the wetland areas, preventing the intake of fresh water that would normally help to flush wastewater out. Interviewees observe that they now rely on greater quantities of chemical inputs to produce aquatic vegetables, and have experienced severe skin rashes in recent years.

These health impacts may be further compounded by the wastewater entering the wetland, as it contains multiple contaminants including nitrogen, phosphorous, *E. coli*, and detergents (Sovann *op. cit.*, 2015). Whereas the aquatic plants grown by farmers serve as filters to clean urban wastewater, rising contamination levels and shrinking wetland areas reduce the capacity of the morning glory fields to serve as filters. As a resident commented:

"Wastewater from Phnom Penh has always come in but the lake used to be bigger so it didn't make such an impact. But now that the lake is filling the amount of water is less so and the amount of wastewater coming in makes an impact. [I] think the amount of wastewater is the same but the lake is smaller – as cited in Beckwith (2020)". (Interview, March 2018).

In a few more years, most urban farmers will no longer be able to farm as wetlands will be completely swept away by the ongoing construction – luxury commercial and residential ventures are already beginning to dominate the landscape as ING city develops (Figure 5). While some of these urban farmers will be able to remain in their homes, a win given the rate of eviction and land grabbing in Cambodia (Brickell 2014), their wetland farming area will no longer exist. Families will therefore need to find another livelihood.

Figure 5. A pile of sand grows behind morning glory fields. The sand will be levelled and used as new land, likely in the construction of gated communities for the city's wealthy residents.



Source : Photo L. Beckwith, September 17, 2018.

This livelihood transition will not be easy, particularly for older farmers, many of whom are migrants who have turned to urban farming after trying other options such as construction and found working conditions to be poor and wages low. Nevertheless, urban farmers do not want to return to the countryside to farm rice, as successive years of drought have made this untenable. For example, since 1960 temperatures in Cambodia have risen by 0.8 Celsius with a projected increase of up to 4.3 Celsius by 2090, along with an increased likelihood of heatwaves which will impact households in rural and urban areas alike (Thoeun, 2015). Urban farmers would unanimously prefer to continue farming here, but there are few wetland areas left around Phnom Penh, and what is left, is already occupied. Still, urban farmers are committed to remaining in Phnom Penh as they greatly value the access to higher quality services, such as health centres and schools, that is afforded by living in the city.

As one older resident explains:

"If they fill in the wetland and don't allow us to live here anymore, we will look for a new place. I don't know where to go yet. If we had money, we would have ideas about where to buy here and there, but we don't have money. If we move back to our hometown, we will have nothing to do to earn a living. I wouldn't move, because living here allows my grandchildren to go to school". (Interview, March, 2018).

In sum, people recognize that sand infill will destroy urban farming, and that other livelihood strategies need to be in place by the time the Tompun and Cheung Ek wetlands are completely gone. With so few options available, hope is pinned on the next generation, with children and grandchildren encouraged to focus on their education in order to strive for 'better' jobs. Cambodia's development pathway makes it unlikely that such 'better' jobs will be accessible to all residents though (Horlings & Marschke, 2020).

Discussion and conclusion

Although significant attention has been paid to land grabbing, forestry loss and overfishing in Cambodia (Diepart *et al.*, 2019; Le Billon, 2000; Loughlin & Milne, 2020; Marschke, 2012; Schoenberger, 2017), illustrating how resulting commodity reallocations impact local livelihoods, this has not been the case for sand. Sand extraction is a serious issue given the scale at which it is taking place on Cambodia's rivers, and Phnom Penh's reliance on sand as infill for urban expansion. Phnom Penh's prioritization of luxury real estate and commercial development indicates that the local vision of urban expansion comes at the expense of the urban poor, as evidenced by the case of morning glory farmers (Fauvaud 2016; Beckwith, *op. cit.*). Sand is a vital ingredient for Phnom Penh's urban development process: as infill, to enclose wetlands or lakes to help build up the cities' land mass, and again in the concrete used for building the infrastructure that fuel urban expansion. This also creates livelihoods, even if transient in nature.

As our two examples show, sand plays an important role in Phnom Penh's development. The livelihoods linked to – or impacted by – sand are temporary in nature, and how they evolve is linked to Phnom Penh's broader development processes. Experiences are uneven at best for sand workers who often remain in entry level jobs, and for urban farmers, who were able to sustain urban farming livelihoods at one point in time, but now cope with diminishing returns. The other consequences of unabated sand mining and infill in general, and those linked with erosion, habitat destruction and biodiversity loss in particular, may not be immediately felt, but will have significant impacts nonetheless. In sum, sustained sand exploitation drives major social-ecological repercussions, and those are set to aggravate in the future (Kothari & Arnall, 2020). Below we further reflect on the livelihood, environmental and development challenges associated with sand mining.

Firstly, sand exploitation can disrupt and upend livelihoods. Sand dredging and pumping does offer livelihood opportunities for a few young men, namely those willing to work on barges or at remote sand pumping stations. Even though such livelihoods are limited in terms of advancement, and temporary in nature, they are seen as more appealing than alternatives such as construction work. Sand work may also be easier for younger men to access than factory work where women are favoured for employment (Horlings & Marschke, 2020), but this work is not without its burdens. Contracts are non-existent, workers are only paid when sand is dredged or off-loaded, and this work compels men to live far from home and families as sand dredging increasingly occurs further away from towns. Workers acknowledge that there will be a limit to this work: sand is a finite resource.

The consequences of sand exploitation unfold differently for urban wetland farmers. Here, the steady rhythm of sand being pumped into wetland spaces takes time, resulting in a gradual change to the ecosystem and landscape. Urban farmers observe how sand infill steadily degrades their environment, and they mourn the green wetland spaces as they slowly recede. Sand infill further impedes natural flood cycles that made farming in wastewater viable, and crops now need more pesticides to grow. Farmers take on greater financial risk even as the contribution that their farming makes to municipal wastewater

treatment goes unrecognized and, in fact, is slowly coming to an end. Farmers know that urban farming cannot last, but it is less clear what their alternative options may be, other than the hope that the next generations will be better prepared to secure jobs in the city.

Secondly, sand exploitation and infill disrupt ecological systems. Wetland infill has proceeded almost without interruption, perhaps linked to the 'light touch' seen in Phnom Penh's urban planning processes. Little information about the government's plans for urban expansion or wetland conservation (if at all) is available publicly. From a public health perspective, if no wastewater treatment solution is found for Phnom Penh, the loss of wetlands as a natural wastewater treatment system will trigger serious health consequences. Yet, any alternative solution will be costly to build and maintain; an irony given that the current system of relying on natural wetlands achieved such treatment for free while further providing nourishing food for the city and sustaining urban farmer livelihoods (Beckwith, *op. cit.*). Although our two cases did not shed detailed insights into how sand exploitation contributes to erosion processes, interviewees all agree that biodiversity loss will emerge with wetland infill. This is another area that warrants careful attention.

Thirdly, while the urbanization of Phnom Penh has created diverse economic opportunities, the sand industry likely contributes to growing inequalities rather than broader development goals. Instead of addressing the needs of the majority of Phnom Penh's residents, the pattern of urban expansion has been focused on wealth creation for a minority. Lakes and wetlands have been filled in for elite residents, shopping malls and gated communities, yielding profits for developers and foreign investors first and foremost. Space that formerly housed low income residents has been lost and those that have been allowed to remain will need to shift livelihood strategies. Although a citywide Master Plan was approved for Phnom Penh in 2015, its details remain undisclosed and were not open to public consultation or scrutiny. This lack of transparency compromises efforts to challenge existing patterns of urban expansion (Beckwith, *op. cit.*). While we agree that sand, in the form of concrete, is key to ensuring people's right to housing and safe living spaces, Phnom Penh requires a more environmentally sustainable and socially inclusive urban growth process.

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