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River Sand Mining and Socio-Environmental Impacts: Parallel Case Studies along the Red River in China and the Mekong River in Cambodia

Amélie Lauzon

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School of International Development & Global Studies

Faculty of Social Sciences

University of Ottawa

Abstract

Asian countries are urbanizing at an unprecedented rate, which has led to significant demand for sand. While sand mining fuels infrastructure development, creates livelihoods, and stimulates local economic activity, it also has a number of environmental and socio-economic consequences which cannot be ignored. These include erosion, the destruction of habitats and loss of biodiversity, the deterioration of traditional livelihoods, forced displacement of communities, and damage to homes and infrastructure. On the one hand, this thesis uses mixed methods to study the multifaceted industry of sand mining along the Red River in China, near the Vietnamese border. On the other hand, it explores the same industry using qualitative methods along the Mekong River in Cambodia, near Phnom Penh. Using a political ecology approach, it identifies the actors involved, their motives, and the impacts on the environment and local communities. The extractivism framework is used to describe sand mining activities and practices. In doing so, this thesis contributes to the literature on the understudied sand mining industry and its far-reaching impacts.

Résumé

Les pays asiatiques s'urbanisent à un rythme sans précédent, ce qui entraîne une demande importante en sable. Si l'extraction de sable alimente le développement des infrastructures, crée des emplois et stimule l'activité économique locale, elle engendre également un certain nombre de conséquences environnementales et socio-économiques que l'on ne peut ignorer. Ces conséquences comprennent notamment l'érosion, la destruction des habitats et la perte de biodiversité, la détérioration des moyens de subsistance traditionnels, le déplacement forcé de communautés et les dommages aux habitations et aux infrastructures. D'une part, cette thèse utilise des méthodes mixtes pour étudier l'industrie multiforme de l'extraction de sable le long du fleuve Rouge en Chine, près de la frontière vietnamienne. D'autre part, elle explore cette même industrie à l'aide de méthodes qualitatives le long du Mékong au Cambodge, près de Phnom Penh. En utilisant l'approche de l'écologie politique, elle identifie les acteurs impliqués, leurs motivations et les impacts sur l'environnement et les communautés locales. Le cadre de l'extractivisme est utilisé pour décrire les activités et les pratiques d'extraction du sable. Ce faisant, cette thèse contribue à la littérature sur l'industrie minière du sable, peu étudiée, et sur ses impacts profonds.

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Preliminary Notes

As you read this thesis, keep in mind that all weight-related units of measurement have been converted to tonnes, also known as metric tons, to ensure clarity, consistency and comparability. While the US ton weighs 907.1847 kg, a tonne is equal to 1,000 kg. Although the British also have their own ton (1,016.047 kg), I have assumed that all tonnes cited in the literature were US tons since the British ton is rarely used nowadays. If a source was only available in US tons, I converted the amount to tonnes using Google's unit converter and then rounded the number. Therefore, some units of measurement cited in this thesis may appear differently than in the original source.

Since this is a dual case study with independent fieldwork, I have differentiated the interview numbers as follows. I have referred to interviews from the Chinese case study as i-# (e.g. i-12), and I have referred to interviews from the Cambodian case study as I-0# (e.g. I-012).

Chapter 1 – Introduction

Although most of us think of sand simply as a defining feature of beaches and deserts, this resource is the foundation of modern societies. Without it, the urban landscapes and consumer products that are so familiar to us would look very different – or would not exist at all. Concrete, glass, plastic, sunscreen, toothpaste, paper, semiconductors, photovoltaic panels, paint, mirrors, cosmetics – they all contain sand. In other words, we live in sandcastles. Due to sprawling urbanization, modernization and consumerism all around the globe, the demand for this finite resource is increasing so rapidly that it is outpacing supply, thus leading to overexploitation (United Nations Environment Program [UNEP], 2019).

Deserts cover approximately 20% of the Earth's surface (Nunez, 2020), leading one to believe that there is an unlimited supply of sand. However, desert sand is eroded by wind, and only water-eroded sand is suitable for anthropogenic use (Beiser, 2018; Franke, 2014). The amount of sand extracted is approximately 50 billion tonnes per year, or an average of 18 kilograms per person daily, far exceeding replenishment rates (UNEP, 2019). This accounts for 85% of all mined resources in the world, making sand the most consumed resource on the planet after water (Pearce, 2019). However, this perpetual extraction is not without consequences. This extraction has devastating effects on water quality and fish stocks and increases the risk of erosion and flooding (Beiser, 2018; Levitt, 2010; Marschke & Rousseau, 2022). This affects livelihoods and causes homes to be engulfed by rivers, among other impacts (Pereira, 2020).

Recent literature on sand mining has focused on the Asian context because of the sheer scale of the extraction on that continent (Hass, 2021). While some areas benefit from this industry, others find themselves at a net loss. For example, Singapore’s territorial expansion through land reclamation, a process that requires tremendous amounts of sand, has resulted in the disappearance of at least 24 Indonesian islands since 2005 (New York Times, 2010). In addition, India has been able to sustain its construction boom by mining its own sand, but the industry has also spawned violent "sand mafias" (Mouterde & Depardon, 2022).

Recently, China and Cambodia have become hubs for sand mining – a direct result of unprecedented urbanization rates on the Asian continent (Koehnken, 2018; Naveedh et al., 2020). Notably, China used more sand between 2011 and 2013 than the United States did in the entire 20th century, and it is also home to the largest sand mine in the world: Poyang Lake (Beiser, 2017; 2018). Urbanites are driving this incredible boom—in the early 80s, less than one-fifth of China's population lived in cities, whereas in 2020, more than 60% did. This percentage is expected to reach 80% by 2035. Although this urbanization requires tremendous quantities of sand, rural Chinese areas are also being revitalized. In 2017, the Chinese government launched the "rural vitalization" strategy to improve rural infrastructure (Xinhua, 2022). These major infrastructural projects have made China the world's largest consumer and producer of sand (Zhu, 2022).

One of the goals of this thesis is to understand the implications of sand mining on a segment of the Chinese section of the Red River, near the city of Gejiu and the Vietnamese border (Figure 1.1). Little is known about sand mining in China's Yunnan Province, including on the Red River near the international border, but the prevalence and impacts of sand mining have been documented on the Vietnamese section of the river (Chinh, 2018; Dinh, 2020; Phuong, 2019; Sen, 2020) and elsewhere in China (Wang et al., 2019; Zekun, 2020; Zhu, 2020). All these articles recount stories of unregulated sand exploitation with disastrous consequences for the environment and local residents. The same articles report that illegal sand mining[1] is rampant in the country. This thesis aims to paint a comprehensive picture of the sand mining industry in this section of the Red River.

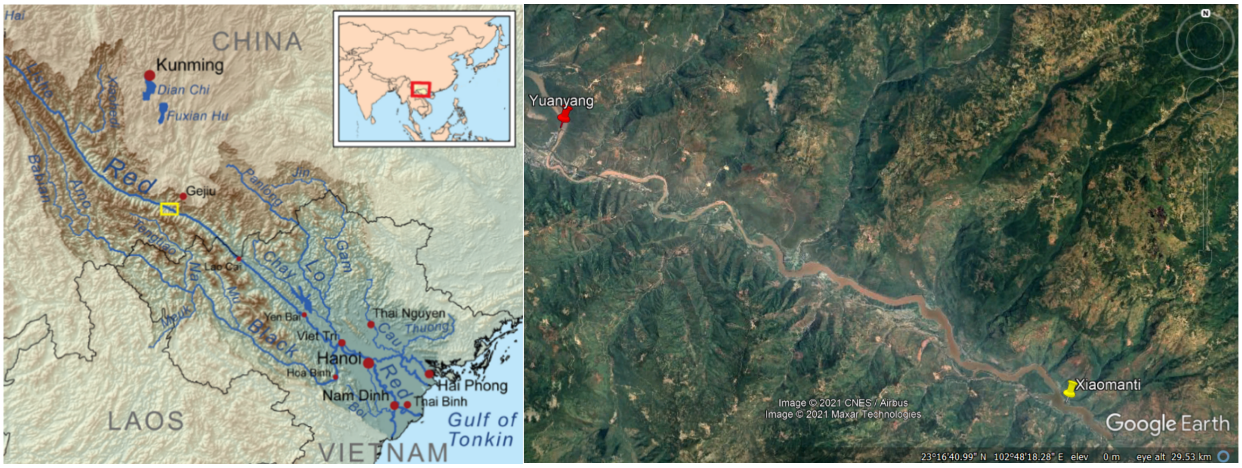

Figure 1.1 Location of the studied segment on China's Red River.

(Sources: Google Earth and Kmusser, 2010)

In Cambodia, the sand industry is also characterized by high levels of extraction and its use to fuel rapid economic growth and infrastructure development, although not as prominent as in China (Hunt, 2017; van Arragon, 2021). Even though Cambodia officially banned sand exports in 2017 at the onset of environmental activist campaigns, the domestic sand industry continues (Economist Intelligence Unit, 2017; NG & Park, 2021). Prior to the ban, Cambodia was one the world's top-ten sand exporters, and since then, many have expressed skepticism about the country's transparency regarding its sand exploitation and exports (Ardhanari, 2021; Beiser, 2019; Workman, 2021). In fact, illegal sand mining is profligate within the country (Mother Nature Cambodia, n.d.; Lowe, 2018). As in other cases, Cambodia's cursory urbanization fuels the country's hunger for this finite resource (Kasztelan & Cristofoletti, 2021).

[1] Illegal sand mining is a form of sand extraction that is done without the required permits or licences and that does not comply with regulations and environmental standards.

Within the sand mining literature, the Mekong River is demonstrably one of the most studied waterbodies (Anthony et al., 2015; Bravard et al., 2013; Hackney et al., 2021; Jordan et al., 2019; van Arragon, 2021). However, when compared with the sheer magnitude of their impact on the region and the lack of reliable data on this industry, regional sand mining activities are still largely understudied.

The Mekong River is considered one of the world's most biodiverse rivers (Ziv et al., 2012). Alarmingly, this once-thriving habitat is being ravaged by excessive sand mining, climate change, overfishing, dams, and other factors (NG & Park, 2021; van Arragon, 2021). Among other things, fish stocks have plummeted and houses have collapsed into the river (Beiser, 2019; Sullivan, 2020). Although the Cambodian government claims to be actively working to solve the excessive sand mining, little has been done to control the situation (Koehnken, 2018).

Another goal of this thesis is to understand the implications of sand mining on a segment of the Cambodian section of the Mekong River, near Phnom Penh (Figure 1.2). Phnom Penh is the capital and most populous city of Cambodia. It has been a hotbed for sand mining over the past decade, with unprecedented impacts on the local population and environment (Kasztelan & Cristofoletti, 2021; Koehnken, 2018; van Arragon, 2021).

Figure 1.2 Location of the studied segment on Cambodia's Mekong River.
(Source: Southerland, 2016)

1.1 Objectives of the Study, Research Questions, and Structure of Thesis

This thesis consists of a dual case study on both China's section of Red River and Cambodia's section of the Mekong River. Through these cases, I aim to understand some of the many implications of the sand mining industry on the environment and riparian populations, as well as to uncover the sand industry, particularly through labourers' accounts. The overarching research question I seek to answer asks: What are the benefits and drawbacks of sand mining in the study sites?

Because this broad question is difficult to operationalize, I approached both case studies with the following sub-questions in mind:

1. What are the environmental and socio-economic impacts of sand mining on communities living along China's Red River and Cambodia's Mekong River?
2. What does the sand mining industry entail in terms of processes, operations, labour, and regulations in China's Red River and Cambodia's Mekong River?

To answer these questions, I begin in Chapter 2 by laying out the conceptual framework I will use to organize and interpret my findings. First, I define political ecology as an approach that frames environmental conflicts as highly politicized processes between human groups, available resources and changing conditions. This approach allows me to critically examine the decisions and worldviews of authorities, sand companies, and villagers regarding changes in local sand resource allocation and their impacts. I then elaborate on the framework of extractivism, which refers to the intensive extraction of resources for external markets and is most prevalent in the Global South. Documented cases of extractivism frame this process as one that degrades local environments and livelihoods, resulting in the long-term impoverishment of communities. I will use this framework to address a broader range of actors and processes than those typically included in political ecology research, particularly with regard to the environmental, socio-economic and political implications of sand mining.

In Chapter 3, I provide a detailed literature review of the sand mining industry. I describe the environmental and socio-economic impacts, sand livelihoods, and the context of each case study—China's Red River and Cambodia's Mekong River. Chapter 4 details the methods used to conduct each case study. In China, the research design emphasized semi-structured interviews that included both closed and open-ended questions. In Cambodia, data were collected through conversational interviews. Snowball sampling was used in both locations. The methodology chapter also addresses ethical considerations, methods of analysis, and the limitations of my study.

Chapter 5 details the findings from the fieldwork in China. Chapter 6 serves the same purpose, but for the Cambodian case study. These chapters provide answers to my research sub-questions. In Chapter 7, I further substantiate these answers by analyzing the relationship between the findings, the literature, and the conceptual framework. I also provide an answer to the overarching question of my thesis. In the final chapter, I conclude by recapitulating the main elements of my thesis and by suggesting avenues for future research.

Chapter 2 – Conceptual Framework

2.1 Introduction

In this chapter, I introduce two concepts that are highly relevant to my findings and allow for a deeper understanding of the case studies: political ecology and extractivism. Other researchers (Martín, 2017; Willow, 2018) have used these concepts conjointly in the past. This allows me to frame the discussion in a way that is geared toward socio-economic, political and environmental dimensions and their interconnectedness. It is important to note that although these are distinct concepts, they sometimes overlap. Nevertheless, I introduce political ecology first because it tends to provide a broader framework than extractivism.

2.2 Political Ecology

The first component of my conceptual framework is political ecology, which is concerned with how power dynamics are manifested in environment-society relations (Blaikie & Brookfield, 1987). Political ecology is more of an interdisciplinary approach rather than a concept per se, as it aims to bridge the social and natural sciences (Benjaminsen & Svarstad, 2020).

More specifically, political ecologists explore how the availability, use, and allocation of resources and changing environmental conditions are directly linked to political processes involving different actors with varying levels of power (Willow, 2018). These actors range from powerful entities, such as governments, corporations, and organizations, to more mundane ones, such as communities and individuals. The former can influence the environment by making decisions that shape the global economy, international relations, national policies and laws, etc., while the latter drives environmental change through local organizations and land use practices

(Benjaminsen & Svarstad, 2020; Blaikie & Brookfield, 1987). Because of its social justice ethos, political ecology addresses issues such as:

> Access to and control over resources; marginality; integration of scales of analysis; the effects of integration into international markets; the centrality of livelihood issues; ambiguities in property rights and the importance of informal claims to resource use and access; the importance of local histories, meanings, culture, and 'micropolitics' in resource use (McCarthy, 2002, p. 1283).

All of these elements form a toolkit that guides the work of political ecologists in analyzing specific case studies. It compels researchers to study nature as a complex system that encompasses social, cultural, and political dimensions (Burchardt & Dietz, 2014).

Political ecology emerged as a research agenda in the 1980s when social scientists realized that wider political and economic structures were directly linked to environmental crises (Dietz & Engels, 2017; Zhu, 2022). Prior to this, researchers mainly attributed these phenomena to neo-Malthusian premises such as "poverty, over-population, bad management, and ignorance" (Walter, 2014, 21). Blaikie and Brookfield (1987) were instrumental in challenging this belief by demonstrating that environmental change in the Global South should instead be viewed through the lens of political economy. Other theoretical frameworks have nurtured the field of political ecology, namely post-colonialism, post-structuralism, environmental justice and sociology, discourse analysis, and gender studies (Dietz & Engels, 2017; Walter, 2014). While this broad scope can sometimes muddle political ecology scholarship, it also allows it to draw from various disciplines when analyzing nature-society relationships (Bridge et al., 2015; Neumann, 2005).

This diversity can be an asset in analyzing the discourses promoted by different actors and how these narratives attest to divergent environmental interests and worldviews (Peet & Watts, 1996).

Amidst political ecology's heterogeneity, Bryant and Bailey (1997) have developed a framework that encompasses three key assumptions applicable to the Global South to guide political ecologists further. First, they explain that the environment is a politicized space, which posits that environmental change generates both positive and negative impacts and that these are unevenly distributed among actors. Although various factors are at play, political power often predominates over other factors. Second, they point out that this unequal distribution of benefits and impacts affects and/or consolidates the political and economic status quo. Third, the unequal distribution of environmental impacts and the disruption of the social status quo leads to altered power relations among actors. As Willow (2018, 4) puts it, "imbalances of power determine who can claim natural resources and how."

Although discourse analysis was not originally tackled in Blaikie and Brookfield's pioneering work, it has since become a fundamental approach within political ecology (Escobar, 1996). Terms such as imaginaries, narratives, agendas, and truths are often used interchangeably to describe how actors give meaning to reality (Peet & Watts, 1996; Scoville-Simonds, 2009). Discourse analysis is a window into power relations because all actors will promote discourses that fit their worldviews, and politically influential actors often do so to the detriment of other actors' worldviews. As Scoville-Simonds (2009) explains in his MA thesis, the relationship between power and discourse can be understood as, one, power over discourse, and two, power through discourse. The first aspect – power over discourse – refers to control over language and ideas. This includes not only the power to define terms and topics of debate but also the power to have them internalized by other actors. The last aspect – power through discourse – refers to the effects this control has on behaviours, including the actions taken as a result and their impact on the status quo. Namely, this can influence the solutions proposed to socio-environmental problems and the perception of actors, in addition to providing further institutional legitimacy to the stakeholders in a position of power. In a nutshell, discourse analysis emphasizes that it is important to reflect on whether and how language is used to construct reality implicitly or explicitly. To answer this question, we should ask, "why the problem is posed in the way that it is, who controls the definition of the problem, and to what extent this control is contested" (Scoville-Simonds, 2009, 31; see also Bacchi, 2012).

One critique of how political ecology scholarship mobilizes discourse analysis is that discourses tend to be understood as emanating solely from the political elite and as facilitating harmful and often ill-intentioned motives (Scoville-Simonds, 2009). Conversely, political ecologists tend to view discourses emanating from vulnerable actors as objective truths. Although researchers have proven this point to be false countless times (Bryant, 1998; Forsyth, 2003; van Arragon, 2021), building on such a framework can lead to unintentional bias.

As sand becomes increasingly sought after, several authors have used the political ecology approach to outline the different actors involved in sand mining, their worldviews, their actions and the various impacts these have on the environment and local communities. For example, Lamb and Fung (2021) and Miller (2022) have used the framework to examine the mobility of sand across Southeast Asian borders. Nnatuanya (2021) mobilized it to investigate the practice of sand mining as a source of livelihood for an impoverished rural population in Nigeria. Van Arragon (2021) has used it as a conceptual framework in his MA thesis to uncover the livelihoods of sand workers in the Phnom Penh region of Cambodia. Finally, Zhu (2022) has used it to analyze river sand mining in rural Zhuang communities around the Maoling River in China.

As Zhu (2022) explains, sand leads to more challenging governance arrangements than other extracted resources because it is a fluid resource that is located both on land and in water. Furthermore, sand governance is a recent phenomenon that has only emerged with the realization that this seemingly endless and expendable resource is finite and valuable.

As Willow (2018, 5) puts it, political ecology "investigates how power arrangements between and within human groups concurrently shape and are shaped by available resources and changing ecological conditions". In this thesis, I will mobilize political ecology scholarship to identify actors and analyze the various benefits and impacts of sand-related decisions and how they testify to unequal power relations. Namely, I will examine the decisions made by government officials, sand miners, local authorities and communities. This framework will be instrumental in examining resource allocation, regulation, and compensation. Furthermore, political ecology will allow me to delve deeper into the political processes and discourses that shape extractivist endeavours. Finally, this concept will serve as a means to examine if and how decisions are made in relation to sand mining, local communities, and environmental change, both in the contexts of China and Cambodia.

2.3 Extractivism

The second component of my conceptual framework is extractivism, which is described as the large-scale exploitation, production and exportation of raw materials through processes that are harmful to local ecosystems and people (Acosta, 2017; Bisht, 2021; Dietz & Engels, 2017). It is closely linked to the concepts of the Anthropocene and the 'resource curse' (Willow, 2018).

Although extractivism as a concept is increasingly used to analyze the implications of extractive industries in the Global South, this concept can be traced back to colonialism in the 16th century, at the dawn of mercantilism (Acosta, 2013). Since the early 2000s, researchers have mostly mobilized this notion in the Latin American context, and definitions vary according to authors and contexts (Burchardt & Dietz, 2014; Martín, 2017).

Extractive companies tend to establish themselves in or near impoverished communities with promises of better living conditions, only to fuel a series of economic, social, environmental, and political problems (Acosta, 2013; Martín, 2017). Extractive industries are financially profitable, but they are also environmentally destructive, disrupting traditional livelihoods and exacerbating local inequalities. They can lead to a range of ecological impacts, including deforestation, soil erosion, water pollution, habitat destruction, and greenhouse gas emissions. This can create tensions within communities and lead to corruption and violence, particularly in countries governed by authoritarian regimes (Acosta, 2013).

According to Acosta (2013; 2017), extractive industries offer few local economic prospects for the following reasons: first, resources tend to be exported as raw materials and processed elsewhere, thus depriving locals of the benefits derived from the added value of processing; second, most inputs, such as machinery, are imported; third, high-paying jobs, such as managerial or skilled positions, are often filled by foreigners, while low-skilled jobs are filled by nationals; fourth, extractive industries tend to solely offer employment to men; fifth, extractive industries often coexist with subsistence economies, resulting in a dual economy. This results in a situation where only a handful of local dwellers benefit from the extractive industry. Local communities often protest when environmental impacts start to manifest, but in most cases, these attempts at change are criminalized or ignored by the authorities. In fact, locals tend to be seen by the latter as obstacles to unfettered extraction, so when they express discontent and concern about the impacts, authorities often side with the extractive industry or offer little compensation for the damage they have suffered, thus exacerbating their vulnerable position (Fabricant & Gustafson, 2014). Martín (2017) further points out that extractivism tends to benefit from the support of urban populations since extracted resources can meet their economic needs. In summary, extractivism has high social costs and generates negligible financial gains for local communities.

Although sand is the most extracted resource globally, the extractivism framework has rarely been applied to sand mining (Bisht, 2021). According to this author's research, sand mining contains dimensions that fall within and outside of the extractivism framework. The first linkage between sand mining and the extractivism framework is that sand mining companies are politically and economically powerful in the regions where they operate, especially in the Global South. The second linkage is that sand mining sites are often spread out, for example, along a river or in a lake, resulting in cumulative social and environmental impacts. The third linkage regards sand exports beneficiating mostly urban areas. The fourth linkage relates to the deterioration of local livelihoods—such as fishing and agriculture—to the point where the sand mining industry becomes a sought-after livelihood due to the lack of alternatives. The fifth linkage concerns the rampant violence of illegal sand mining in the Global South. Differentially, Bisht (2021) explains that, in comparison to other mineral operations, sand mining requires fewer inputs, and is transported over shorter distances than other mineral operations.

According to Franks (2020), sand can also be considered a 'development mineral' because it is mined to fulfill development processes at the local level. He points out that not all minerals are necessarily exported from the Global South to the Global North, and that more than 84% of all extracted minerals are non-metallic, including sand. The development minerals approach contrasts with extractivism since these resources are mostly used domestically for construction, manufacturing, infrastructure and agriculture. Therefore, development minerals create livelihoods and reduce local poverty. Moreover, even if they do not generate as much fiscal revenue or attract as much foreign investment, development minerals are not particularly prone to the macroeconomic and political challenges that typically plague these types of revenues (Franks, 2020). Despite all of these advantages, development minerals are not exempt from unsustainable extraction or socio-environmental challenges. For example, concerns with health and safety, child labour, and community challenges are common in this sector. Adding the development mineral nuance to the discussion of extractivism allows me to capture a wide range of viewpoints in the data, including those of Chinese villagers who are satisfied with the royalties and the Cambodian sand labourers who see their work as remunerative.

Other critics of extractivism have pointed out that it focuses too much on the nation-state and does not sufficiently consider the "dynamics of global capitalism" (Martin, 2017, p. 25). Furthermore, the extractivism blueprints tend to completely separate rural and urban populations, viewing the former as victims and the latter as oppressors (Martin, 2017). Despite these critiques, I foreground this concept because it allows me to examine sand extractivism through the lens of both communities and industries in economic, social, environmental, and political contexts.

2.4 Conclusion

The political ecology and the extractivism frameworks will allow me to approach the sand mining industry and its impacts comprehensively since these notions feature environmental, socio-economic and political dimensions. These are all areas that the sand mining literature has explored while probing both the positive and negative impacts of sand mining (Beiser, 2018; Graviltea, 2017; Pearce, 2019; Pereira, 2020).

On the one hand, the political ecology framework allows for an in-depth analysis of the different stakeholders involved in river-sand mining, the different discourses they promote, the environmental consequences of their worldviews and actions, and how the power dynamics between them influence the river-sand crisis. On the other hand, the extractivism framework will allow me to examine the inner and outer workings of the sand mining industry, its socio-environmental impacts, and the local development benefits that result from it. Using both political ecology and extractivism conjointly to examine each case study provides me with a powerful conceptual apparatus to contribute to sand mining scholarship.

Chapter 3 – Literature Review

3.1 Introduction

This literature review chapter provides the reader with background information regarding the thesis' case studies. More precisely, it presents relevant information on (a) the sand mining industry and (b) its environmental and socio-economic implications in general, and how they unfold in (c) both China's Red River and Cambodia's Mekong River.

This first section describes the characteristics of sand, how it is used in construction, and why its demand has skyrocketed in recent years, particularly in Asian countries. I also investigate the sand industry's methods of extraction and operational environment. The second section is divided into two parts and focuses exclusively on Asia. The former details the long list of interconnected environmental impacts inflicted upon sand extraction sites. The latter describes the socio-economic impacts the sand mining industry generates on local communities. The third section introduces the broad context of each of the Mekong and Red River case studies. This chapter sets the stage for the rest of the thesis, including highlighting the gaps in the scientific literature.

3.2 General Context: Sand and Sand Mining

3.2.1 Composition of Sand

Sand is one of the most abundant resources on Earth; it is found in deserts, beaches, forests, prairies, waterbodies, and other landscapes around the world. Essentially, sand is not a specific material but rather a particle size ranging from approximately 0.05 millimetres to 2 millimetres in diameter (Çellek, 2019; Daley & al., 1990). Compared to sand, smaller sediments are classified as silt and larger aggregates as gravel. In most cases, these particles form over thousands of years through the weathering and eroding of rocks (National Ocean Service, n.d.).

Sand can also originate, amongst other things, from fragmented shells, corals, volcanic ash, and even organic by-products such as parrotfish excrements (*Ibid*.). Sand's wide array of origins partly explains why its properties and industrial uses vary. For example, construction-grade sand is derived mostly from quartz and contains less than 95% of silicon dioxide (SiO_2)[2] (Shaw Resources, n.d.).

Besides composition, sand's shape is the other main reason why not all sand is created equal (Figure 3.1). Simply put, sand is naturally formed by either wind or water erosion. Wind erosion smooths the edges of the sand grains, giving them a shape that is too round to allow the particles to bind together in their solid form (Beiser, 2018; Zhang et al., 2006). This characteristic makes desert sand unsuitable for most industrial applications, although molten desert sand containing high levels of silicon dioxide can bind together to ultimately form glass (Beiser, 2018; Franke, 2014; Pearce, 2019; Sharafudeen et al., 2015; Zhang et al., 2006). Alternatively, water erosion generally produces angular sand grains, which enables the particles to aggregate and form structures (Beiser 2018; Pereira, 2020). Consequently, it is water-eroded sand that is sought and exploited. This type of sediment can be found in and around waterbodies, such as lakes, rivers, oceans, beaches, dunes, sandpits, floodplains, and so on. Angular sand can also be found in glacial landforms or be quarried in open pits by breaking up sandstone (Beiser, 2018). Unless stated otherwise, all mentions of sand thereafter only refer to water-eroded sand.

[2] Sand containing at least 95% silicon dioxide (SiO_2) and less than 0.6% iron oxide (Fe_2O_3) is considered silica sand. It is used for fracking and to produced glass, semi-conductors, paints, coatings, silicone, and much more (Yunze Mineral, n.d.).

Figure 3.1 Sketches of magnified well-rounded (left) and angular (right) sand grains.
(Source: University of Hawai'i, n.d.)

3.2.2 Sand Usage

After freshwater, sand is the most exploited and consumed natural resource on Earth (Gavriletea, 2017). Despite the many uses of sand – ranging from glass, fiberglass, beach replenishment, sand casting, sports fields, silicone, minerals, semiconductors, etc. – this section will only address its primary uses in the construction industry: infrastructure development and land reclamation. The reason for this focus is that these are the only two uses reported in the case studies.

Sand is a substantial component of concrete[3] and asphalt. Aggregates, which encompass sand and gravel, can constitute up to 80% of concrete's volume (Alqahtani et al., 2021), and up to 95% of asphalt's weight (Jebur & Abedali, 2020). Silica sand also constitutes between 50 to 60% of bricks' weight (Punmia et al., 2003) and is frequently used in cement production, as the latter material requires a silica content ranging between 17 and 25% (Esmaeilzadeh, 2020). These materials form the basis of most of buildings and transportation infrastructure. The construction of a single average-sized house requires 181 tonnes of sand, while one kilometre of highway requires 27,000 tonnes (Goicoechea, 2014). The construction industry therefore drives the largest

[3] People often confound concrete and cement: cement is a powder that acts as a binding substance whereas concrete is the final composite material. According to Sharifi et al. (2020), concrete is generally composed of aggregates (55-80%), water (15-20%) and cement (10-15%). The sand used in construction is referred to as regular sand, feldspathic sand, brown sand, or construction sand.

sand demand for sand globally, with some estimates suggesting that concrete production, which amounts to 27 billion tonnes per year, is responsible for 80% of all sand extraction (Gillis, 2014; Monteiro, 2017; UNEP, 2019).

Land reclamation, also known as infill and land fill, is the process of creating new land over a waterbody by filling the area with sand, gravel, rocks, concrete, and other materials. It is often used to construct or expand ports, airports, luxury islands, military bases, residential and commercial complexes, or simply to expand landmass (International Association of Dredging Companies, n.d.). There are ample examples of these projects around the world. Dubai is famous for its artificial islands 'Palm Jumeirah', 'Palm Jebel Ali' and 'The World', which cumulatively used over 680 million tonnes of sand (Pearce, 2019; Skjerve Dyvesveen, 2020). Over the past two centuries, Singapore increased its landmass by 25% through numerous land reclamation projects (Singapore Land Authority, 2019). In Cambodia's capital Phnom Penh, several lakes have been filled with sand in order to accommodate urban expansion (Beckwith, 2020). With the world's urban population projected to double by 2050, further expansion of land on waterbodies seems inevitable (de Lange, 2014; Van Oord, n.d.).

3.2.3 Sand Mining

With a growing population, rapid urbanization, new technologies and mass consumption around the world, the annual global sand and gravel consumption has reached 50 billion tonnes (Pereira, 2020; UNEP, 2019). Over the last 30 years, the appetite for sand has increased by 360% and is expected to reach 60 billion tonnes yearly, making it the fastest-growing extractive industry (Engineering for Change, 2018; Krausmann et al., 2009; UNEP, 2019, 3). Today, aggregates account for more than 85% by volume of all mined resources extracted worldwide and represent a USD $70 billion per year industry (Mahadevan, 2019; Pearce, 2019; UNEP, 2019).

River sand mining spans three ecosystems: floodplains, riverbanks and river channels, also known as riverbeds (*Ibid.*). Each setting requires different extraction methods, which can be manual or mechanical. Floodplain sand mining usually takes place during the dry season with the use of excavators, shovels, and even bare hands (Hernandez et al., 2021; Mossa & James, 2013). Riverbank sand mining generally involves the same extraction methods as floodplain mining, but seasonality is less of a consideration (Hernandez et al., 2021). Sometimes, miners will dive into the river with a bucket and manually extract sand (Hass, 2021). Most often, extraction is done mechanically with either excavators or dredges (Pearce, 2019).

Extraction capability depends on the method used, and dredges have proven to be the most efficient (Hass, 2021). Several types of dredges are used in sand mining (Figure 3.2). Bucket-Ladder dredges are equipped with an endless chain of buckets with a capacity spanning 30-1200 litres that scoop sand and then deposit it onto a barge (International Association of Dredging Companies, n.d.). Because such mechanical dredges are noisy and have relatively low production rates, sand mining companies usually favour hydraulic dredges, including Trailing Suction Hopper dredgers that act as giant waterbed vacuums (Argawal, 2021). Besides their high production rates, these dredges can store sand, with capacities ranging from a few hundred to 110 700 tonnes (Jan De Nul Group, n.d.). It is estimated that a single dredge can extract up to 555,000 tonnes per day (Habi, 2018).

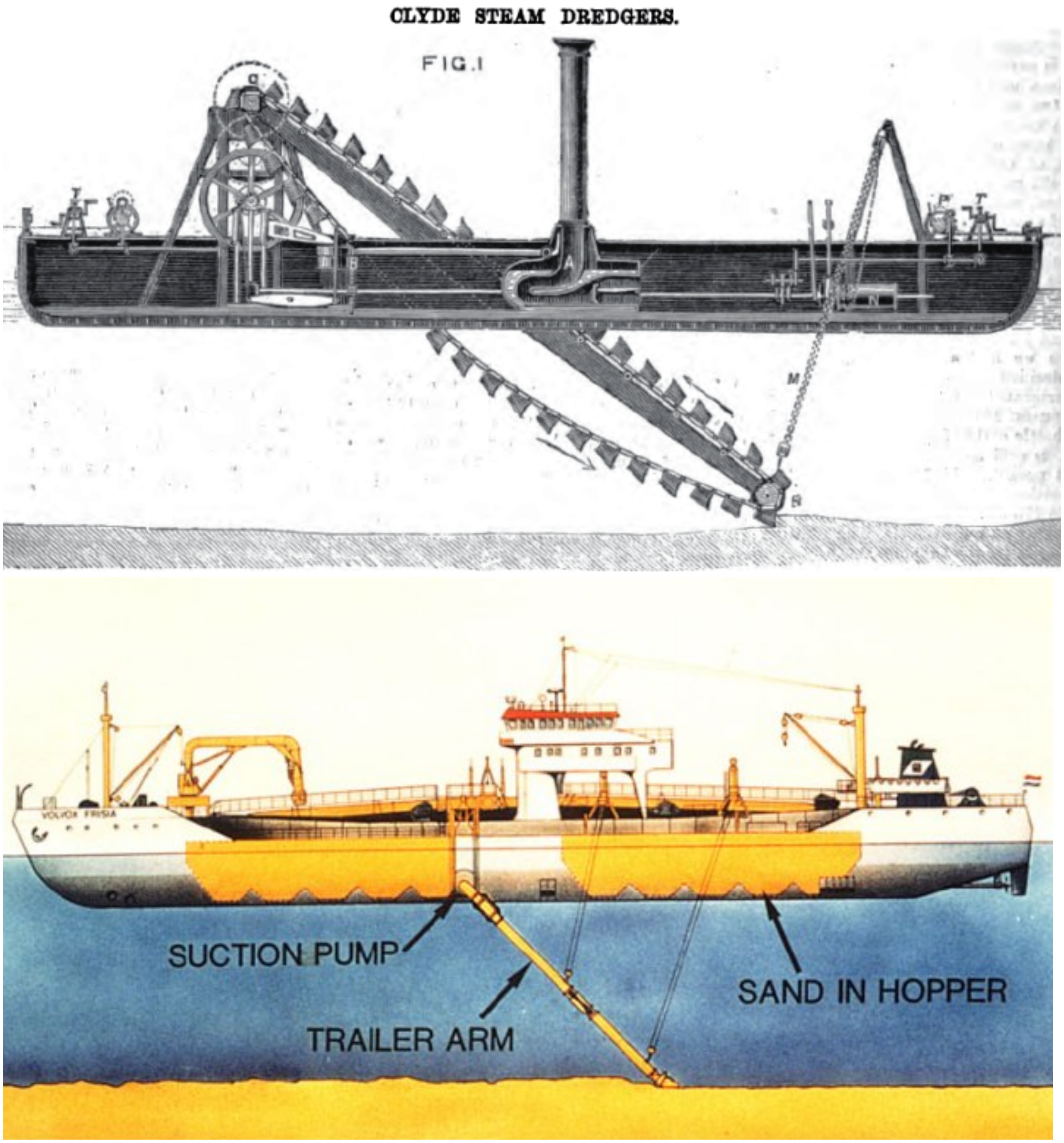

Figure 3.2 Illustration of a Bucket-Ladder dredger (top) and of a hydraulic dredge (bottom).

(Sources: Dredgepoint, 2018; Rajeev, 2013)

Once sand is extracted, it must be transported using barges, dump trucks, and sand pumps (Pearce, 2019; Pereira, 2020; van Arragon, 2021). Sand is most often sourced locally since it is a common material, and this proximity keeps transportation costs and fuel consumption low, and convenience and accessibility high (A.L. Blair Construction, 2018; Raff, 2019). However, sand is increasingly becoming a globalized commodity due to regional shortages and strict sand mining permits and bans (Torres et al., 2017).

Although there are a few large companies within the sand mining industry—Jan De Nul, DEME, Boskalis, China Harbour Engineering, Van Oord, etc.—the vast majority of dredging producers are small and medium-sized (Torres et al., 2021). In fact, the combined production of the top 10 companies accounts for less than 5% of global production (*Ibid.*). As Marschke et al. (2020) explain, working conditions for sand miners vary depending on the degree of mechanization of the labour. However, scholarship on sand labour concurs that sand work is very demanding, dangerous, and pays low wages, which is particularly true for manual sand mining (Hawley, 2017; Mohapatra, 2017; Rege, 2016; Salopek, 2019; Srivastava, 2018). Workers tend to have limited social protection, such as access to occupational safety services and health insurance, and are often unaware of the regulations governing their industry (Hass, 2021; Marschke et al., 2020; van Arragon, 2021). Workers also tend to be poor and uneducated, which limits their livelihood options. To reduce the visibility of illegal operations, some sand companies operate in the shadow of night, which increases the risk of a worker being injured or even killed (Hass, 2021; Mahadeven, 2019). But even under normal working conditions, a study by Mohapatra (2017) found that sand miners experienced a 93 percent prevalence rate of musculoskeletal pain and discomfort, ranging from lower back, shoulder and neck pain. Other studies have noted that continuous exposure to sunlight and glare can damage the skin and eyes (Rajesh and Naik, 2016; Mohapatra, 2017; Farahani and Bayazidi, 2018)

Hass explored sand labour in India and found that workers are not governed by labour regulations and mostly work without contracts, leaving them in a vulnerable position. van Arragon (2021) explored the mechanical sand extraction labour in Phnom Penh and found that the sand mining industry is highly hierarchical, that sand mining is a precarious livelihood and that most business owners and managers are foreigners. He notes that workers have inconsistent work schedules over the seasons, which increases the precariousness of the work. Although they receive an income, free food and accommodation, they spend little time with their families who live in different provinces. Despite these publications, sand livelihoods remain under-researched.

In his thesis, van Arragon (2021) described various occupations within the sand mining industry, including sand pump labourers and dredge operators. He explains how the dredge operators, or rather "dredgers", are tasked with operating dredging machines to fill barges with sand. Once filled, a boat captain and his assistant move the barge to a pumping station where the sand is needed. The sand pump labourers then work as a team of 6 to 10 workers and hose the sand until it is "liquid" enough to be unloaded through a large pipe (van Arragon, 2021). This pipe can either lead to a storage area where the sand is trucked to construction sites by trucks, or it can lead directly to a wetland infill site through long pipes. In the latter case, additional pumps may be required to maintain pressure in the pipe, each operated by one or two sand pump labourers.

The Asia-Pacific region consumes more sand than any other region, being home to more than 60% of the world's population and to an urban population that grew from 375 million in 1970 to 1.84 billion in 2017, then representing 54% of the world's urbanites (The Freedonia Group, 2013; Torres et al., 2017; UNFPA, n.d.). This massive growth requires tremendous quantities of sand and results in a series of consequences. The following section investigates the environmental, economic, social and political implications of river sand mining in Asia.

3.3 Main Implications of River Sand Mining in Asia

3.3.1 Environmental Impacts of Sand Mining

Although sand is renewable in geologic time, it is technically non-renewable, and we are depleting available sand resources faster than ever (Padmalal & Maya, 2014; UNEP, 2019). Torres et al. (2021) estimate that we consume 24 times more sediment each year than rivers deliver to oceans. In the Indian state of Kerala, Pearce found that sand is dug up 40 times faster than it can be replenished (2019). This indiscriminate sand mining offsets the perennial balance within river systems and results in a multitude of important consequences.

Geomorphological changes are among the most common sand mining-induced impacts (Koehnken, 2018). Removing sand from riverbeds leads to their deepening, also known as channel incision (*Ibid.*). Channel incision can disconnect rivers from their floodplains, thus hindering their ecological and social functions (*Ibid.*). Namely, floodplains supply vital nutrients to ecosystems and agriculture through sediment deposition, provide important habitats for a wide array of species and allow groundwater levels to recharge (*Ibid.*). Channel incision degrades groundwater tables as permeable banks dry out, resulting in a loss of aquifer storage and exacerbating water deficits (Koehnken, 2018; Peduzzi, 2014; Pullare, et al., 2014). Channel incision can also create new pools and lakes of stagnant water along the river's path (Koehnken, 2018).

Sand mining also alters river morphology by widening channels, either through direct mining of the riverbanks or through erosion. The latter process occurs when channel mining destabilizes the banks to the point of collapse, ultimately widening the river (Koehnken, 2018; Padmalal & Maya, 2014). Incidentally, channel widening can increase river temperatures by spreading the same volume of water over a larger area (Stohr et al., 2011). Furthermore, sand acts as an efficient filter for various pollutants, so its removal further degrades water quality (Padmadal & Maya, 2014).

Reducing the amount of sediment moving through rivers leads to less sand reaching deltas and beaches, leading to ecosystem degradation (Koehnken, 2018). Affected deltas have lower agricultural productivity, and their ability to protect against extreme weather events and flooding is also reduced (*Ibid.*). Furthermore, deltas serve as a barrier between fresh and salt water, and once they subside, salt water can infiltrate the river's fresh water (Koehnken, 2018; Pitchaiah, 2017).

Changes in sediment volume also alter the riverine hydrology, typically leading to greater bank erosion (Peduzzi, 2014). As sediments are removed, rivers "establish a new equilibrium with the flow and sediment conditions" (Koehnken, 2018, 36), which can ultimately alter the course of the river. Because erosion weakens soil structure, the eroded land becomes even more susceptible to further erosion, creating a positive feedback loop (Ritter, 2018). This suggests that there is a high risk that erosion will continue even after sand mining activities have ceased is high. Furthermore, erosion can exacerbate flooding because degraded land has a lower water absorption capacity (WWF, n.d.).

While sand mining does reduce sediment availability, it also generates a lot of turbidity (Graviltea, 2017). This increase in turbidity has many consequences. First, the suspended sediments darken the colour of the river, which increases temperatures through albedo change-driven heat absorption (EPA, 2007). Second, the creation of sediment-laden plumes can settle on substrates downstream, smothering fish eggs, macroinvertebrates, and algal and aquatic species (Koehnken, 2018; Padmalal & Maya, 2014). Third, the suspended sediments impede light penetration, which reduces the photosynthetic activity of plants, thereby reducing plant biomass and oxygen levels in the water (Graviltea, 2017; Koehnken, 2018; UBC wiki, 2018). Fish populations are particularly affected because turbidity reduces visibility and masks odours, both of which are vital for fish survival (Padmalal & Maya, 2014). Although species can adapt to these types of changes over long periods of time, sudden changes can be detrimental.

The removal of riverbed sand also affects fish populations in other ways. First, sand contains microorganisms that form the base of the food web. When the sand is removed, so are these microorganisms, which then impacts the rest of the food web (Koehnken, 2018). Second, sand dredging directly destroys spawning grounds for fish and macroinvertebrates (Pitchaiah, 2017). Although juvenile and adult fish are rarely caught by dredges, fish embryos are, further reducing their numbers (Koehnken, 2018). A study by Harvey & Lisle (1998) showed that embryonic mortality rates from sand dredging ranges from 18% to 100% in some environments. Third, the noise generated by dredging activities can disrupt nesting and breeding activities (Pitchaiah, 2017). All of these impacts have led to changes in migratory routes and declines in fish stocks (Hass, 2021; Koehnken, 2018).

Terrestrial animals that lay their eggs in the sand, such as birds and reptiles, are also affected by the diminishing sediment supply and the destruction of riparian vegetation, making them and their offspring more vulnerable (Hass, 2021). Furthermore, since terrestrial and aquatic food webs are connected, reptiles, birds and mammals indirectly experience the repercussions of declining aquatic food sources (Padmadal & Maya, 2014). The same is true for insects. Indeed, sand mining has drastically reduced dragonfly populations in some areas, which is worrisome since they are predators of mosquitoes (*Ibid.*) (see Section 3.2.2).

Although these new conditions devastate some species, others thrive. In fact, generalist and invasive species take over after the loss of native species due to sand mining (Koehnken, 2018). This effect is not only due to perturbations within ecosystems but also because of the barges (Torres et al., 2021). Invasive species can hitch a ride on boats and establish themselves in new areas. The same applies to transported sand, which can contain countless microbial species.

While sand mining undoubtedly causes serious environmental degradation, other factors are often also at play. Indeed, when sand mining occurs in a dammed area, it can be difficult to differentiate the impacts of each factor since they both reduce sediment quantity, increase flood vulnerability and erosion incidence, cause downstream channel incision, and impact biodiversity (Koehnken, 2018). According to the UNEP, most of the world's largest rivers "have lost between half and 95% of their natural sand and gravel delivery to the ocean" (2019, 29) due to damming. Dams also block fish's migration routes, preventing them from returning to their spawning grounds to lay their eggs (Forsyth & Hruby, 2021).

Another environmental issue stemming from sand mining concerns greenhouse gas (GHG) emissions. This refers not only to the emissions generated during the extraction and transportation of sand, but also to the indirect impact of cement production for concrete use (Gavrilitea, 2017; Peduzzi, 2014; Gavrilitea, 2017). The latter is responsible for 10.1% of global GHG emissions and about 5% of CO_2 emissions (Gavrilitea, 2017).

But dredging can also be beneficial. For example, it can: allow navigation along riverbeds, divert river water for use in irrigation, or remove sediment buildup trapped behind dams (Koehnken, 2018; Western Dredging Association, 2021).

This being said, 'developing' countries rarely conduct environmental impact assessments of mining and dredging operations, and "regulations are often established without a scientific understanding of the consequences" (Peduzzi, 2014, 210). Furthermore, studies show that some consequences may not become visible for a decade or more, making it difficult to measure impacts, some of which may be irreversible (Koehnken, 2018; Padmalal & Maya, 2014). This also means that impacts can persist long after sand mining activities have ceased (Padmadal & Maya, 2014). As many citizens of Asian countries rely on rivers for their livelihood or live near them, these environmental impacts translate into socio-economic impacts.

3.3.2 Socio-economic Implications of Sand Mining

Although identifying the socio-economic impacts of river-sand mining is a difficult task, this extraction has changed the livelihoods and lives of many, often negatively. Impacts include wrecked infrastructure, depleted fisheries, loss of land and agricultural productivity, degraded water quality, and increased health risks (Koehnken, 2018).

Channel incision and widening caused by sand mining has led to the deterioration and collapse of infrastructure near riverbanks (Koehnken, 2018; Peduzzi, 2014). Bridges, roads, schools, homes, and other structures have been damaged or destroyed, including bridges in Taiwan and India that collapsed in recent years (Hass, 2021; Weyler, 2018). Rivers have also swallowed people's homes; in Vietnam alone, indiscriminate sand mining will likely force more than 500,000 people to move away from eroding riverbanks (Bendixen et al., 2019). River-sand mining thus causes millions of dollars in infrastructure damage, in addition to reduced tourism revenues due to losses associated with landscape changes to major attractions, such as beaches and historical sites (Beckwith, 2020; Beiser, 2017; Pitchaiah, 2017).

As discussed above, the erosion of deltas can lead to saltwater intrusion, resulting in the contamination of drinking water and leading to the salinization of agricultural land (Koehnken, 2018; Pitchaiah, 2017). Crop productivity and water availability are further reduced by riverbank erosion and the lowering of the water table (Peduzzi, 2014). In some cases, irrigation channels and pumps have been rendered useless by the lowering of river water levels (Koehnken, 2018). In some instances, sand-mining-driven landslides have resulted in farmers losing significant portions of their farmland (Padmadal & Maya, 2014). This not only results in economic losses but also threatens the food supplies.

Fishing communities are particularly affected by river-sand mining as this industry completely destroys fish habitats and spawning grounds. The decline in fish stocks has a strong impact on both traditional and commercial fisheries (Peduzzi, 2014; Pearce, 2019). This, in turn, raises concerns about the availability of protein and the sustainability of fishers' livelihoods (Hass, 2021). Ironically, there have been cases where fishers have joined the sand mining industry because they see no other viable alternatives to make a living (UNEP, 2019; Weyler, 2018).

Sand mining also raises health-related concerns. For instance, the decline in dragonfly populations and the creation of stagnant pools associated with some mining activities contribute to the spread of malaria-carrying mosquitoes and other emerging diseases (Farahani and Bayazidi, 2018; Padmadal & Maya, 2014; Weyler, 2018). Sand mining has also been linked to higher occurrences of drowning due to the changes in river morphology and hydrology

(Koehnken, 2018). Additionally, noisy dredges that can operate up to 24 hours a day have been reported as a nuisance by some villagers (Pitchaiah, 2017).

In response to these impacts, some villagers have signed petitions, protested, taken legal action, and some have even hijacked dredging boats (EJAtlas, 2019a; EJAtlas, 2019b; Hardiansya & Chandra, 2017; Koehnken, 2018). Despite these efforts, authorities rarely listen to the villagers' concerns and reevaluate sand mining operations. To mitigate impacts, some Asian countries have banned all sand exports or exports to Singapore – a top sand importer – and even banned mining in certain areas (Lamb et al., 2019). These measures have sometimes led to the emergence of illegal sand trade and extraction as the demand for the resource continues to grow (Beiser, 2018). In 2017, this underground industry was ranked as the third most lucrative criminal activity globally, just behind drug trafficking and counterfeiting, and it is reported to take place in up to 70 countries, often with complicit governments (Lira, 2020; Koehnken, 2018). Sand mafias are known to be particularly violent and have killed hundreds of people standing in their way over the past decade (Beiser, 2018). Corruption is widespread in the industry, and sand miners who break the law rarely face justice. Therefore, local citizens, journalists and activists can be somewhat reluctant to speak out against the industry.

However, not all of the socio-economic impacts stemming from sand mining are negative. In fact, sand has enabled the development of paved roads, bridges, hospitals, houses and other concrete infrastructure. This has shortened travel time, fostered trade and market development, and led to a reduction in the number of people dying while on the way to obtain medical care (Berg, 2015; UNDP, 2020). Furthermore, replacing all mud floors with concrete floors could reduce parasitic diseases by 80% globally (Watts, 2019).

Moreover, the sand mining industry can benefit residents through royalty payments and taxes (Padmalal & Maya, 2014). It can also generate local economic activity and provide employment. However, management positions are very rarely held by locals. For example, van Arragon (2021) found in Cambodia that those who held the highest positions in the sand business were mostly Vietnamese and that the dredge owners were rarely present. He also documents the precariousness of sand labour, as workers have no protection and work opportunities (and income) fluctuate as much as resource availability and/or demand do.

In summary, the socio-economic impacts of sand mining in the literature are said to outweigh the benefits, by far, and especially in the long run (Padmadal & Maya, 2014). Furthermore, the cost of repairing or replacing infrastructure damaged by sand mining is much higher than the revenue generated by the industry's presence in a given area (*Ibid.*)

3.4 Background Information on the Case Studies

In the following section, I will specifically address what is known about each case study. Since there is little scholarly literature in the areas I focus on, I also refer to media reports to fill in the gaps.

3.3.1 Sand Mining on China's Red River

China is now the largest real estate market in the world, statistically building "a city the size of Rome" every two weeks (Economist Intelligence Unit, 2011, p.1; Slotta, 2021). Since the 1970s, the country has pursued aggressive urbanization. It now has the world's largest urban population, the largest number of dams, and the largest road network in length after the United States (Central Intelligence Agency, n.d.; Statista, 2021; International Commission on Large Dams, n.d.). This colossal development has been made possible by the massive use of sand; China used more sand between 2011 and 2013 than the United States did in the entire 20th century (Beiser, 2018), and it built more houses between 2000 and 2010 than Japan ever did (Economist Intelligence Unit, 2011). The country consumes about 60% of the world's sand supply, extracting 18 billion tonnes of aggregates in 2018 alone, making it the world's largest consumer and producer of aggregates (Pearce, 2019; Zhu, 2022). It is also home to the world's largest sand mine, Lake Poyang, where indiscriminate mining has had a profound impact on wildlife habitats, fish spawning grounds, wetlands, and water quality (Koehnken, 2018; Pearce, 2019). This phenomenal use of sand has allowed the country to modernize and improve the lives of hundreds of millions of people, but it comes with significant environmental and socio-economic implications.

In China, dredging permits are issued by county or provincial authorities and can cost several thousand RMB (Forsyth & Hruby, 2017).[4] These same authorities also have the power to ban sand dredging anywhere within their territory, which many have done on rivers where impacts have become too severe, especially since the 2018 legal reforms (Zhu, 2022). However, inadequate oversight, corruption and an ever-increasing demand for the resource have spurred illegal sand mining operations accross the country (*Ibid.*). Due to the decreasing availability of legally-sourced sand and skyrocketing demand, the price of sand is rising rapidly, sometimes doubling in a single-year span (*Ibid.*).

The Chinese case study I unpack is set in Yunnan Province, along a segment of the Red River approximately 25 kilometres in length between the riparian towns of Yuangyang and Xiaomanti. The Red River (红河 – *honghe*) is also known as the Yuan River (元江 – *yuanjiang*) in this area (Rousseau, 2014) (Figure 3.3). The river originates near Dali in central Yunnan and flows south

[4] As of January 2023, 1 RMB equals CAD 20 cents or USD 15 cents.

to the Red River Delta in Vietnam, south of Hanoi (*Ibid.*). Overall, the river stretches over 1,126 kilometres in length, and its basin covers a total area of 143,700 square kilometres, half of which is in China (CGIAR, n.d.; Le, 2005). In its Chinese section alone, the Red River hosts 83 species of fish (Wang, 1997). The river shrinks and expands over the seasons, peaking during the monsoon months, when 85% of all precipitation occurs (Le, 2005; Rousseau, 2014). This rainfall and associated water level changes, combined with the mountainous topography and low forest cover, result in significant and frequent erosion of the Red River's banks (Rousseau, 2014). Its sediment load is the ninth highest in the world, averaging 160 million tonnes per year much of which is deposited in the Red River Delta, which extends from Hanoi to the South China Sea (Milliman & Meade, 1983; Rousseau, 2014).

Figure 3.3 Red River, near Yuangyang.

(Photograph by Yuqi Deng, September 2021)

The two villages where the study took place are located within Gejiu County and the Madushan Reservoir. The area is dominated by a subset of the Dai nationality minority (Rousseau, 2014).

According to the 2000 Chinese National Census, this officially recognized ethnic minority numbers approximately 1.1 million people in Yunnan (National Bureau of Statistics, 2000). Land is of great importance to the rural Dai, and they tend to prefer not to engage in migrant labor if possible (Rousseau, 2014). Water is also an important identity marker for the Dai, which is necessary for them to grow rice, the main staple food in Dai societies (*Ibid.*).

China's portion of the Red River basin contains 60 dams, including five on the mainstream, while Vietnam's portion contains 37 dams (CGIAR, n.d.; CGIAR, 2016; Rousseau, 2014). As shown in Section 3.2.1, dams have been found to exacerbate certain impacts of sand mining by altering river hydrology and trapping large amounts of sediment (Wang et al., 2019). Downstream, all of these mixed impacts have been documented in the Vietnamese section of the Red River (Pham, 2021; Phuong, 2019). The case study villages are located in a reservoir created in between two mainstream dams (the Nansha and Madushan dams), both of which were developed and completed in the late 2000s-early 2010s (Rousseau, 2014). The resulting flooding and hydrological changes, including changes in sediment discharge, have profoundly altered local, agriculture-centered livelihoods.

Sand mining operations are observable in the Red River's study area through satellite imagery starting in 2013 and are still ongoing (Figure 3.4). In both the Anglophone and Francophone literature, I was unable to find any articles, scholarly or otherwise, on sand mining in the Chinese section of the Red River. I did, however, trace a handful of media articles that document the prevalence of sand mining in the Vietnamese section of the river (Chinh, 2018; Dinh, 2020; Phuong, 2019; Sen, 2020). These articles recount tales of uncontrolled sand exploitation resulting in disastrous consequences for both the environment and local inhabitants.

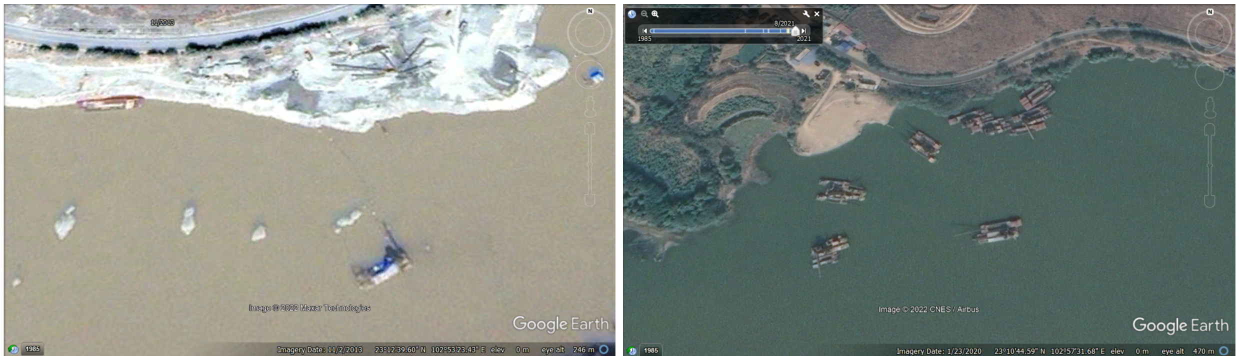

Figure 3.4 Sand mining on the Red River's study area in 2013 (left) and 2021 (right).

(Source: Google Earth)

3.4.2 Sand Mining on Cambodia's Mekong River

Since the 1990s, Cambodia has experienced significant economic growth and infrastructure development, particularly in the capital city of Phnom Penh (World Bank, 2020). Since 1998, the country's paved road network has grown by more than 15,000 kilometres, and a total of 20 bridges have been built across the Mekong, the Bassac and the Tonlé Sap rivers (Cambodia Constructors Association, 2021). Although the country remains largely rural, the urban population grew by 3.7% annually between 2008 and 2014, and it is estimated that by 2030, 5.4 million Cambodians will live in cities, the majority in Phnom Penh (UNFPA Cambodia, 2014). This development is fueled by sand dredged from Cambodia's rivers, lakes, mangroves, estuaries and seabed (Weyler, 2018). van Arragon (2021) estimates that Cambodia may have extracted 22 million metric tonnes of sand in 2015, although he acknowledges that this number could be higher as it does not include sand used to build roads and consumer goods. Conversely, the Cambodian Ministry of Mines and Energy has reported that approximately 9 million cubic metres were dredged in 2020, although the actual figure could be anywhere between 27 and 45 million cubic metres (Haffner, 2020; van Arragon, 2021).

Sand mining for export became so monumental within Cambodia that the government began to ban it in certain hotspots. Sand mining was banned on the Tatai River in Koh Kong province in 2009, and then along the Mekong and Tonle Sap rivers in 2013 (Bravard et al., 2013; Pheap, 2013). Despite these measures, sand dredging permits are still being issued for these rivers by the Ministry of Mines and Energy, which has been responsible for approving and licensing river-sand mining since 2015 (Koehnken, 2018; Radio Free Asia, 2015; van Arragon, 2021). Corruption and patron-client networks are widespread in Cambodia, and the sand industry is no exception (van Arragon, 2021).

Local demand is not the only driver of Cambodia's sand rush, as significant amounts of sand are exported. Although the country first banned sand exports in 2009, it remained one of the world's top ten sand exporters until at least 2017 (Lamb et al. 2019; Rith, 2009). In the wake of a scandal surrounding Cambodia's illegal sand trade, the government imposed an additional ban on all international sand exports in July 2017 (Lamb et al., 2019).[5] However, many have expressed skepticism about the country's transparency regarding its sand exploitation and exports (Ardhanari, 2021; Beiser, 2019; Workman, 2021). In fact, illegal sand mining is said to be roving around the country (Mother Nature Cambodia, n.d.; Lamb et al., 2019; Lowe, 2018).

The Mekong River is a major hotspot for sand mining in Cambodia. With a length of nearly 5,000 kilometres, it is the longest river in Southeast Asia, stretching across China, Myanmar, Laos, Thailand, Cambodia and Vietnam (Mekong River Commission, n.d.). Sometimes referred to as the rice bowl of Asia, the lower Mekong basin alone is the site of 15% of the world's rice production, while its fisheries directly feed more than 60 million people and represent the largest

[5] The export of silica sand, namely used for glass, electronics and silicone production, is still permitted (Roeun, 2017).

inland fishery in the world (Koehnken, 2018; Mekong River Commission, n.d.). Thus, the livelihoods of millions of people depend on the river and its natural resources. The Mekong River is also considered one of the world's most biodiverse rivers, second only to the Amazon River, and it is home to many endangered species (Koehnken, 2018; Ziv et al. 2012).

However, this river is facing significant human-induced changes, including those driven by sand mining (NG & Park, 2021). One study found that a total volume of 34.48 million cubic metres, or 50 million tonnes, of aggregates were extracted from the lower Mekong in 2011 alone. As the Mekong River transports about 30 million tons of sediment per year, sand mining has a serious impact on the amount of sand that reaches the delta and the sea (Bravard et al., 2013). This has had an enormous impact on the river's morphology, ecosystem and riparian communities. Among other things, fish stocks have plummeted and houses have collapsed into the river (Beiser, 2019; Sullivan, 2020). Sand depletion is also causing land subsidence, with some sections now being 1.5 meters deeper than they were 10 years ago (Koehnken, 2018; Weyler, 2018). This facilitates saltwater intrusion, damaging crops and freshwater resources up to 110 kilometres upstream from the coast (ASEAN Today, 2020). In addition, sand mining in Cambodia's mangrove estuaries has muddied the water, disrupted fish migration routes, and erased inlets (Lamb et al., 2019, p. 1521). Although the Cambodian government claims to be actively working to solve this issue, little has been done to control the situation (Koehnken, 2018).

However, sand mining is not the only activity contributing to this socio-environmental crisis (Hackney et al., 2021). In the Lower Mekong Basin, 89 dams are under construction or completed, including 2 on the mainstream, while in the Upper Mekong, there are 12 dams on the mainstream alone (Eyler, 2020; MRC, n.d.). As a result, 77% of the sediment transported by the

Mekong River since 1994 has been lost to dams, further depleting the river (Sullivan, 2020). If all the dam projects currently planned along the Mekong River are built, up to 96% of its sediment could be trapped in reservoirs before it reaches the delta (Hackney et al., 2020). Overfishing and climate change are also contributing to the changes observed in the Mekong River. Each of these causes individual sets of impacts that accumulate for both local populations and ecosystems (Beckwith, 2020; Marschke, 2012; OECD, 2020).

As Cambodia's capital and most populous city, Phnom Penh has been at the center of the country's development (Marschke et al., 2020). Water is central to Phnom Penh's identity as it sits on a low floodplain, contains numerous lakes and wetlands, and is located at the confluence of the Mekong, Bassac and Tonle Sap rivers. Although this water landscape has long provided the capital with important environmental services – natural wastewater treatment, flood control, irrigation, and agricultural productivity – it now stands in the way of urban development (Beckwith, 2020). Of the 25 lakes located in the central districts, 16 are now fully filled, and at least 7 are partially filled (Sahmakum Teang Tnaut, 2015). Likewise, 40% of Phnom Penh's wetlands have been filled (Beckwith, 2020). Together, these land reclamation projects amount to more than 6,000 hectares (Mialhe et al., 2019).

Many infill projects are currently underway, the largest of which is the ING City being developed on Boeung Tompun Lake on the outskirts of Phnom Penh (Marschke et al., 2020; van Arragon, 2021). In fact, 2,572 hectares of this waterbody will be filled with over 90 million tonnes of sand; this amounts to six times the volume officially dredged in Cambodia in 2019 (Knaus, 2020; McFarlane, 2016; van Arragon, 2021) (Figure 3.5). While these projects allow for the urban expansion of Phnom Penh, they tend to only benefit a small elite, while several thousand individuals have been forcibly displaced and have lost their livelihoods as a direct consequence of infills (Gluckman, 2008; Marschke et al., 2021; van Arragon, 2021). Families do not always receive compensation, and when they do, it represents only a fraction of what they have lost (Gluckman, 2008; van Arragon). In the infamous case of the Boeung Kak lake reclamation project north of Phnom Penh, the developers did not consult local residents before the project, and when they protested, the government sent in police and bulldozers to crush the opposition (van Arragon, 2021). It is also an open secret that corruption goes hand in hand with sand mining and land reclamation in Cambodia (Rainsy, 2020; van Arragon, 2021).

Figure 3.5 Sand truck driving on Boeng Tompun's infill, Cambodia Phnom Penh.
(Photograph by Munny, March 2022)

Furthermore, Cambodia's lakes, wetlands and rivers provide critical socio-ecological services to the city (Marschke et al., 2020). Not only are they a source of food, but they also serve to facilitate flood and wastewater management (Beckwith, 2020). For instance, the Boeung Tompun Lake treats 70% of the Phnom Penh wastewater, and no plans have been made to replace the loss of this environmental service (APUR, 2019; Beckwith, 2020). Flooding is expected to increase as the buffering capacity of Phnom Penh's lake system to retain and remove stormwater is reduced (*Ibid.*). Essentially, sand extraction in and around Phnom Penh is being fueled by infill and construction projects (Marschke et al., 2021).

The study took place in a handful of villages in Mukh Kampul district, a few kilometres north of Phnom Penh. This district is located along the Mekong River and in the province of Kandal and is largely made up of rural farming communities (Norén-Nilsson, 2016). Satellite imagery confirms that there are extensive sand mining operations taking place within the area (Figure 3.6).

Figure 3.6 Barges (blue) and dredges (brown) off the shore of Roka Kaong Ti Muoy village, in Mukh Kampul's district, June 2021.

(Source: Google Earth)

3.4 Conclusion

This chapter first described the composition of construction-grade sand, how it is most commonly used in the construction industry – through concrete and land reclamation – how it is extracted from riverbeds and provided an overview of the sand mining industry. It then examined the many environmental and socio-economic impacts of sand mining, with a focus on Asia. It explained how river sand mining disrupts entire ecosystems, and how dams and climate change exacerbate the effects. These environmental damages then affect riparian communities, especially those whose livelihoods depend on agriculture and fisheries.

The chapter then discussed each case study – the Red River in China and the Mekong River in Cambodia –to help understand each context examined in this thesis. Although there is no literature on sand mining in China's Red River, satellite imagery confirms that it is ongoing, and Vietnamese media have documented the industry's impact on their section of the river. For Cambodia's Mekong River in a district north of Phnom Penh, satellite imagery also confirms ongoing sand mining, and a broader literature on the topic provides valuable insights into the case study.

Chapter 4 – Methodology

4.1 Introduction

This chapter describes the methods I used to study the sand mining industry and its environmental and socio-economic impacts on a segment of China's Red River and Cambodia's Mekong River. I first explain how the global COVID-19 pandemic affected my research, both positively and negatively. Following this, I delve into the methods used in the Chinese case study, where structured interviews were conducted by two research assistants (RAs). I then do the same for the Cambodian case study, where another RA conducted conversational interviews. In each section, I detail the preliminary planning, the methods used for data collection and how this process unfolded. I then explain the analytical strategies I employed to delineate my findings. Finally, I discuss the limitations of my study, including those pertaining to translation.

4.2 Doing Remote Fieldwork in the Midst of a Pandemic

As one can imagine, conducting remote fieldwork in the midst of a global pandemic is no walk in the park. My 'co-supervisors'[6] and I had to constantly adjust our goals and strategies to meet the needs of the RAs and the conditions on the ground. Although not being physically present had its limitations, it also allowed me to broaden the scope of my study.

I had originally planned to conduct my thesis research in Makassar, Indonesia, where extensive coastal sand mining operations and two massive land reclamation projects are underway. Due to travel restrictions, lack of contacts in this part of Indonesia, and the unresponsiveness of local organizations, I abandoned this plan. Instead, I decided to follow Jean-François's suggestion: to work on the segment of China's Red River where he had done his Ph.D. thesis and is still doing

[6] Although Dr. Jean-François Rousseau is 'officially' my thesis supervisor, Dr. Melissa Marschke, a member of my thesis committee, acted as *de-facto* co-supervisor.

research. During his last trip in 2018 to study the impacts of the Madushan Reservoir, he noticed numerous dredges and barges collecting sand in the area. Since he had contacts on the ground and understood the local context, we concluded that a remote fieldwork project on sand mining in this location would be feasible.

As I was finishing writing my thesis proposal on China's Red River, Melissa suggested that I hire the RA she had worked with for her own research purposes in Phnom Penh, Cambodia. This would allow me to conduct parallel research on river-sand mining. I gladly accepted and modified my thesis proposal to encompass a dual case study.

There were several advantages to doing fieldwork remotely. I was able to conduct primary research in two countries, which would not have been possible otherwise. This allowed me to get twice as much data and run parallel studies. I saved a lot of time by not having to travel to every site and every person who participated in the study. Supervising the work of three RAs allowed me to gain management experience and build meaningful relationships with people from all over the world. Although none of the RAs were from the case-study areas, they were all from the nearest city (Phnom Penh and Kunming). Their vicinal positionality likely helped participants feel more comfortable than they would have with a complete outsider like myself (Dwyer & Buckle, 2009). Furthermore, it probably helped to keep the interviews discreet, which is highly beneficial for a sensitive topic like sand mining.

Despite the many benefits of remote fieldwork with RAs, it also had its drawbacks. Most importantly, there was a lot of information that I could not gather by not being there. This included body language cues, the ability to ask follow-up questions during interviews, and a first-hand look at impacts. As great as the RAs were, their pictures, videos, and transcripts only tell part of the story. Fortunately, Jean-François and Melissa both have extensive fieldwork experience in these areas and were able to fill in the gaps when needed. Ultimately, I was not able to have the research adventure I was looking for when I enrolled in my master's program.

4.3 Research Methodology for China's Red River

4.3.1 Setting Things Up

The Chinese case study took place on a stretch of the Red River in Yunnan Province, between the villages of Yuanyang and Xiaomanti. Although I knew from Jean-François' account that several sand mining operations were taking place in the area, Google Earth was used to confirm this information. The timelapse tool allowed me to determine the approximate year when sand mining began, to understand the transformation of the sand industry over the past decade, and to observe the infrastructure development and geomorphological changes along the Red River.

It was Jean-François who established the first connections for my thesis. He emailed a fellow professor at a university in Kunming[7] and asked if he knew a student who would be willing to do fieldwork for me. Fortunately, he did, and I received the email of Yuqi Deng, who became the first Chinese RA. A few weeks before going into the field, she admitted that she preferred to do the survey with another student. She suggested her classmate Ruiying, who joined the team. As they had no previous knowledge of sand mining, I provided them with a short document highlighting the main characteristics of the industry and the dominant environmental and socio-economic impacts. Payment for their work was arranged between their university in Kunming and the University of Ottawa. Although both Yuqi and Ruiying worked on this project, most of

[7] The university is unnamed to maintain the fellow professor's anonymity.

my correspondence was with Yuqi. Except for a final virtual meeting in April 2022, we communicated by email.

4.3.2 Producing the Questionnaire

Due to the stringent Chinese context, it was decided that adopting a relatively structured research framework would be preferable. More specifically, by using a structured questionnaire interview to collect data, we would organize the topics discussed and ensure that the personal integrity, safety, and well-being of the research assistants and interviewees were protected (Denscombe, 2007).

However, questionnaires can inhibit the respondents' views and force them to conform to the researcher's biases (*Ibid*.). Given the current pandemic and China's political context, this limitation seemed tolerable.

By the time I wrote my questionnaire in August 2021, I already had a solid understanding of sand mining and knew what kind of data I wanted to collect. I used this blueprint to design the questions and ended up creating eight different sections. The first section consisted of general questions aimed at understanding the interviewee's socio-economic background and the changes their community had experienced over the past five years. The second section was about the Red River itself. I wanted to understand its importance to the local communities and the changes it has undergone due to various factors, including sand mining. The third section was the most important part of the survey because it asked specific questions about local sand mining activities.

The remaining sections were directly related to specific livelihoods. The fourth section related to fishing activities, either commercially or for sustenance, and was designed to determine if and how sand mining activities had affected fish stocks. Out of 12 respondents, only 2 completed this section (Figure 4.1). The fifth section pertained to aquaculture and attempted to comprehend whether sand mining activities had impacted this sector. No respondents completed this section. Sections six through eight were directly related to sand livelihoods. The sixth section targeted sand labourers and sought to understand how the local sand mining industry operates. I also sought sand labourers' opinions about their industry and its impacts. Of the 12 respondents, only 2 completed this section. The seventh and eighth sections, respectively, targeted sand dredge owners and truck drivers, but neither ultimately participated in the research.

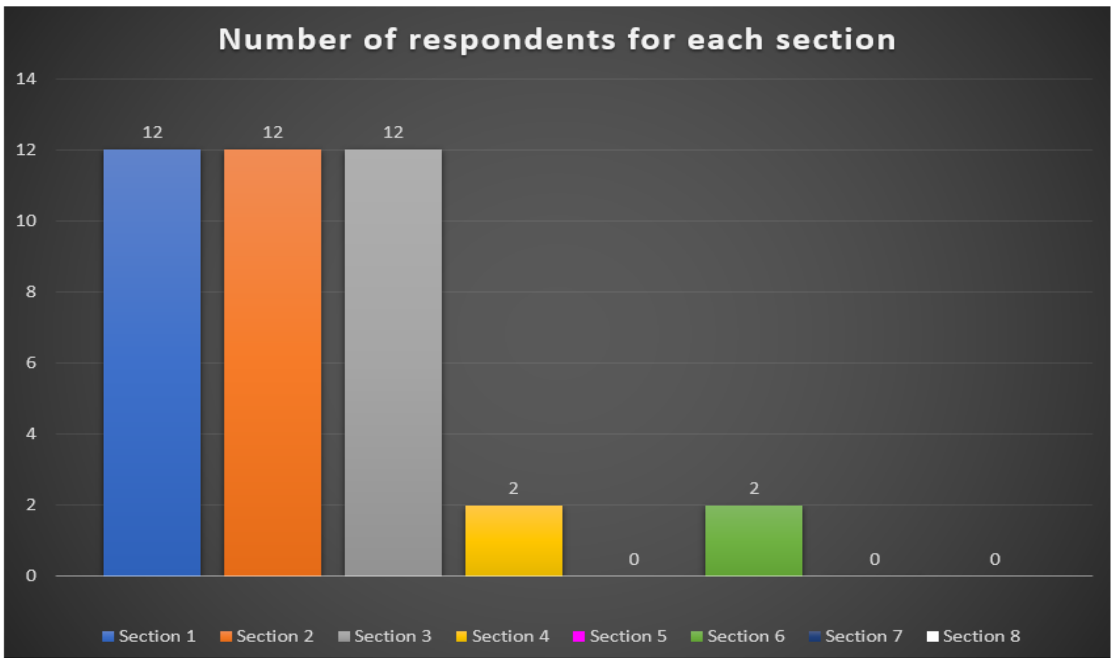

Figure 4.1 Number of respondents for each section of the structured questionnaire in the Chinese case study.

In total, the questionnaire contained 101 questions and many more sub-questions, although the specific length of the questionnaire varied depending on the number of sections completed. I wanted to make sure that none of the questions would endanger the research assistants or respondents. I had to revise my survey about seven times before it was sent to China. Yuqi then proceeded to translate it into the Kunming dialect of Mandarin, and we communicated regularly throughout the process to ensure consistency between the Chinese and English versions.

4.3.3 Collecting Primary Data

Yuqi and Ruiying left Kunming to conduct fieldwork on September 25th, 2021 and returned just before October 1st. They stayed in a hotel in Gejiu, which is roughly three and a half hours away from Kunming and one hour away from the study area. They commuted daily from Gejiu to the study area. During this time, they conducted 12 interviews: six with women in Village A and six with men in Village B. Two of the men had previously worked in the sand mining industry and another was a village chief.

The interviews took approximately an hour to complete. Each participant was informed of the purpose of this study and gave their consent to be interviewed. As compensation for their time, participants received a bottle of cooking oil. Yuqi and Ruiying conducted three interviews per day.

Yuqi and Ruiying used the snowball sampling method, meaning that they asked participants to refer them to other potential respondents (Oregon State University, 2010). This form of non-probabilistic and purposive sampling originated with a local contact, who referred the RAs to individuals he knew would be most likely to be able and willing to complete the questionnaire. These individuals would then refer other people. In fact, individuals who refused to be interviewed did refer the RAs to other potential interviewees. This sampling method permitted the collection of an adequate sample of participants to study sand mining and its implications (Pires, 1997). However, I am aware that purposive sampling can potentially exclude individuals with relevant information on the thesis topic, which may be an unavoidable consequence. Given the sensitive nature of sand mining, this limitation is tolerable.

The interviews were conducted in two different dialects: the Kunming dialect and the Hong dialect, also known as the Red River dialect. Both are mutually intelligible dialects of Mandarin. Yuqi and Ruiying would ask questions in the Kunming dialect, and the respondents would answer in the Hong dialect. According to the RAs, this linguistic difference did not hinder comprehension, and on the rare occasions when it did, they used standard Mandarin to clear up the confusion. Although all interviews went smoothly, the RAs admitted that some individuals became annoyed if they did not understand a question or thought the interview was dragging on.

After each interview, Yuqi and Ruiying would translate the interviews back into English. I received the final transcript in mid-October 2021. Although we had originally planned a second visit to the study area to conduct more interviews after Christmas, China's continuous pandemic-related lockdowns prevented this from happening.

While in the field, Yuqi and Ruiying took a handful of high-resolution photos that helped to visualize the area's landscape, sand mining operations and riverbank erosion. After months of email conversations, we finally met virtually in April 2022 to discuss outstanding questions.

On my end, I also used Google Earth to study the evolution of sand mining in the area, infrastructure development, and environmental change. While the aforementioned satellite imagery provider helped me achieve the first two goals, the limited number of years available, the reservoir[8] and the seasons made it difficult to infer environmental changes such as erosion or island movements.

4.3.4 Analysis

Once I received the completed questionnaires from Yuqi, I went through each question to determine which ones were still relevant. Since several months had elapsed between the time I wrote the questionnaire for China and the time I received and analyzed the data, my research objectives had become more specific and some questions that originally seemed pertinent no longer added significant value to my thesis. Therefore, I identified these questions by highlighting them in red in their respective Word document. I then organized all of the remaining questions and answers into an Excel spreadsheet. I organized all of the questions into the first column and then copy-pasted the answers horizontally to their respective question. This was done with the help of my thesis supervisor. This allowed me to look at all of the questions and answers in a systematic and rapid way. However, since this format was not easy on the eyes, I then took this data and reorganized it in a similar manner into a Word document, where I would have the question as the title and the answers below it. This allowed me to have a centralized view and a better overview of who said what, the Word document was much easier to read and analyze.

I compiled the findings in the Word document, under each question, and in the last column of the Excel spreadsheet. I then applied magnitude coding by categorizing the responses as “Yes”, “No”, and “Other” (Saldaña, 2016). I counted how many of each, and then under each category, I included some long answers that were attached to it, if applicable. For example, if someone said

[8] The water-level in reservoirs artificially fluctuates depending on the dams’ discharge of water.

that riverbank erosion had increased over the past five years, I would include them in the total number of people who said yes, then under that number, I would write their interviewee identification number and write the additional precisions they brought.

Under each dissected question, I used descriptive coding to summarize my findings (Saldaña, 2016). I then proceeded with structural coding by copy-pasting all of these small summaries into another document and sorting them by themes (*Ibid*.). If I found that many answers related to economics, I would move the summary beside summaries that also spoke about economics. I then began to rewrite the findings in a more reader-friendly way.

4.4 Research Methodology for Cambodia's Mekong River

4.4.1 Setting Things Up

The Cambodian case study took place an hour north of Phnom Penh, in a district of Kandal province. The Cambodian research assistant, Munny,[9] had previously worked with other uOttawa students and was regularly hired by Melissa to collect primary data. In November 2021, Melissa asked him if he would be willing to conduct interviews on my behalf, and he promptly agreed. Melissa and the University of Ottawa arranged the payment for his work. On January 30th, 2022, Melissa created a WhatsApp group for the three of us, and this is where most of our communication took place. We all met virtually and discussed the questions I had drafted for Munny.

We decided that conversational interviews would be most appropriate for a few reasons. First, Munny used to be a journalist, has strong investigative skills, and is most comfortable with some flexibility during interviews. Second, we knew he would be able to steer conversations in the

[9] Munny is a pseudonym.

desired direction since he had already worked on sand mining issues. Lastly, we thought that combining data from more and less structured interviews would allow us to paint a more nuanced picture of river-sand mining in Asia.

I wrote the questionnaire template between the months of December 2021 and January 2022. The two-page document contained all the questions I wanted to find answers to. Because of sand mining's sensitivity and Munny's journalistic background, I let him know that he was free to modify the questions as he saw fit. He was also welcomed to ignore the questions he did not feel comfortable asking and improvise questions during the interviews. This inductive approach allowed the participants to shape the results and reduced the likelihood that Munny or the participants would be compromised by partaking in the research (Dépelteau, 2014).

Originally, the questionnaire template contained three different sets of questions: one for local people affected by riverbank erosion, one for sand labourers, and one for Phnom Penh's urbanites. Once the fieldwork began, we decided to abandon the section on Phnom Penh's urbanites and prioritize the two other categories.

4.4.2 Collecting Data

All the interviews with locals took place in a district of Kandal province bordering the Mekong River across several kilometres. Munny chose this area not only because several dredging boats operate there, but also because it is regionally known for rampant riverbank erosion. In other words, he used a purposive case study site sampling method. At times, he also used the snowball sampling method as some interviewees referred him to other locals affected by riverbank erosion. Between February and March 2022, a total of 16 people were interviewed during 14 unstructured interviews; 11 villagers and 5 sand workers. All interviewees were informed of the purpose of the study, and all consented to be interviewed and to have their conversations recorded.

Munny personalized each interview to account for the respondent's situation while also making sure to include most of the questions I had drafted for him. The length of the interviews varied greatly and depended on Munny's judgement. He transcribed and translated each of them into English before sending the interview verbatims to Melissa and me.

In Cambodia, sand is a sensitive topic (van Arragon, 2021). On a few occasions, some individuals refused to be interviewed by Munny, while others even expressed fear of speaking openly about the issue. During a visit to Boeng Tompun lake, an infill site, Munny was interrogated by workers on site. They only left him alone when he stated he was a fisherman, a lie he told to escape the conundrum. One day while in the study area, he noticed that he was being followed by some police officers and decided to take a break for a few days before continuing fieldwork.

In addition to the interviews, Munny took over 100 pictures and videos thatallowed us to see the impacts for ourselves. Most of the videos include explanations and comments by Munny, which helped us understand what he was filming. In the context of a remote qualitative study, these media files played a crucial role in supplementing my knowledge of the field.

Whenever Melissa and I had questions, we would text them to Munny on WhatsApp. I would also ask Melissa - who has worked in Cambodia for over a decade - some of the questions I thought she might be able to answer. Melissa and Munny were kind and patient enough to answer most of my questions.

While Munny was collecting data on the ground, I used Google Earth to study the evolution of sand mining in the area, infrastructure development, and environmental change. This helped me to observe the rise of the sand mining industry over the years, the changes the Mekong River has undergone during those years, and the rate at which wetlands are being filled with sand.

4.4.3 Analysis

Once I received the interview transcripts from Munny, I read through all of them and crossed out any passages that did not align with my research objectives, which focused on sand labour and the environmental, social and economic impacts of sand mining. I then proceeded with structural coding by copy-pasting parts of each interview into a new document with these categories laid out (Saldaña, 2016). Once the research objectives categorized all the relevant data, I went through another round of structural coding by creating sub-categories (*Ibid*.). For example, in the section on environmental impacts, I added the sub-categories of riverbank erosion, biodiversity, water quality, etc. I then used descriptive coding to summarize each sub-category in my own words (*Ibid*.). I then did a final round of structural coding to organize the sub-categories in the most logical order.

4.5 Discussion

I developed the draft of my discussion chapter all throughout the writing of this thesis. Whenever I had an idea, I wrote it down in a document. This form of hypothesis and descriptive coding allowed me to preserve my key observations until I could write them in the appropriate chapter. I then used attribute coding to link the findings to the literature review and the conceptual framework using attribute coding, especially with regard to sand labour and to the environmental and socio-economic impacts of river sand mining.

4.6 Limitations and Challenges

4.6.1 Translation

I recognize that working with RA translators involves certain risks. These include those associated with translating idioms, sentiments, irony, rhetoric, awkward speech, and untranslatable words. Similarly, the choice of literal or contextual translation is crucial and can alter the meaning of the speakers' words, making their translation only approximate (Philips, 1959; Sechrest et al., 1972). Moreover, translators who speak Western languages tend to come from a different social class than the participants with whom they interact, and their translation may be tainted with opinions and judgments (Desai and Potter, 2009). The translator may also filter out information that they consider unimportant, even if it is precisely what the researcher is looking for (Burja, 2006). All of these things could potentially affect the data collected by Yuqi, Ruiying and Munny. Nevertheless, I have great confidence in the translation of the RAs and, whenever I felt that something in the data was not completely clear, I would contact them for clarification.

All quotes provided in this thesis are copied directly from the translated transcripts. I have made a few grammatical changes to correct language errors, but have tried to keep them to a minimum so as to alter the original message.

4.6.2 Environmental Impacts

Neither I, my supervisors, nor the RAs are environmental scientists. Although we documented the environmental impacts of river-sand mining in both case studies, we did so through the accounts of our participants and the use of pictures and satellite imagery. For example, while we have identified instances of riverbank erosion or increased turbidity, we do not have the skills to determine their exact extent or causes. We can only reiterate that such impacts are documented in the literature as consequences of sand mining and suggest that dredging is likely a contributing factor to these processes at the case study sites. Further environmental studies are needed to confirm or refute our environmental findings.

4.6.3 Accountability and Assistance

My study poses two ethical challenges. The first is the lack of accountability I have vis-à-vis the participants. It is unlikely that the RAs will return to the study areas to deliver copies of my thesis' findings and discussion. Even if they did, many of the respondents are illiterate or cannot read English. Therefore, there is a good chance that the respondents who informed the study will not see the final product of their contributions. This is important since member checking helps with accuracy and accountability and is a documented way to level the power relations that manifest during research encounters (Birt et al., 2016).

Currently, the only way I can make up for these challenges is to publish my study. This will contribute to a growing literature on sand mining, which will hopefully lead to better policies regarding the sand crisis.

4.7 Conclusion

Conducting this dual case study during a global pandemic was not a walk in the park. Yet, I was able to collect enough data to make a meaningful analysis and contribution to the sand mining literature. The following chapters detail these findings and their significance.

Chapter 5 – Findings from China's Red River

5.1 Introduction

The Red River case study took place in the riverside villages A and B in Yunnan, China. The goal was to understand the inner and outer workings of the local sand mining industry as well as its environmental and socio-economic impacts. To this end, I designed a structured interview that Yuqi and Ruiying conducted during September and October 2021. They interviewed 12 people of Dai ethnicity: 6 women in village A and 6 men in village B.

The following chapter will describe the results of this study. First, I will depict the local context as portrayed by its inhabitants. Next, I will elaborate on the details of the sand mining industry in this section of the Red River. Finally, I will outline the observed environmental and socio-economic impacts of the industry. These findings will allow me to convey preliminary answers to my research questions.

5.2 Local Context

The study area is rural and agricultural. In fact, eight respondents indicated that farming was one of their primary livelihoods. The next two most common occupations were salaried employment and retail trade. None of the respondents reported receiving government assistance in the past five years.

Following the loosening of the one-child policy, which was in place from 1980 to 2016, villagers say the local population has increased. In addition, the area has experienced a development boom due to government investment. Notably, the Chinese government has redesigned parts of the villages to turn them into "folk destinations" and promote tourism (Figure 5.1), and has even built a new highway just outside the villages. According to Village B's chief (i-12), the government has invested RMB 17 million (about CAD 3 million)[10] in his village alone. Although locals claim that these investments have helped to boost the economy and tourism, the Covid-19 pandemic has hampered the expected outcomes to the point that four respondents can “barely make ends meet” (i-1, 2, 3, and 5). Moreover, the new highway is a double-edged sword, because while it allows for faster travel and easier market access for the villagers, it is located outside of the villages, reducing the number of people passing through. In sum, the area has seen recent development, but the villagers are not benefiting from it as much as they had hoped.

Figure 5.1 Gate built in village B by the government in the Folk destination remodeling. (Photograph by Yuqi Deng, September 2021)

The Nansha and Madushan dams and reservoirs, respectively completed downstream and upstream from the villages in the early 2010s, also changed the face of the region. The projects

[10] At the time of writing, one RMB equals about CAD 20 cents.

flooded thousands of hectares along the riverbanks, especially agricultural land. Half of the respondents land as a result of the flooding and were not compensated evenly. The quoted compensation amounts ranged from RMB 4000 to 20,000 (CAD 760 to 3,800) per mu and were deemed by far below the official guidelines (Rousseau, 2014).[11]

All of the respondents share a deep attachment to the Red River, saying it is part of their daily lives. They recounted childhood memories of the Red River, such as swimming, playing, and bathing.

5.3 Inner and Outer Workings of the Sand Mining Industry on China's Red River

5.3.1 Outer Workings

It is difficult to determine when river sand mining began in the study area since respondents' answers range from 2001 to 2019. According to available satellite imagery, the first dredge can be seen in 2013 (Figure 5.2). However, respondents unanimously agreed that the Red River's sand was used for construction purposes. Respondent i-7 specified that it is the fine sand that is mined, while respondent i-11 said that it is the one with the least amount of mud. The latter said that the price per metric ton of sand is about RMB 70-80 (CAD 13-15) and has decreased in the last five years.

[11]A Mu is a traditional unit of land measurement used in China. 1 Mu equals 666.67 square metres, or about 1/15 of a hectare.

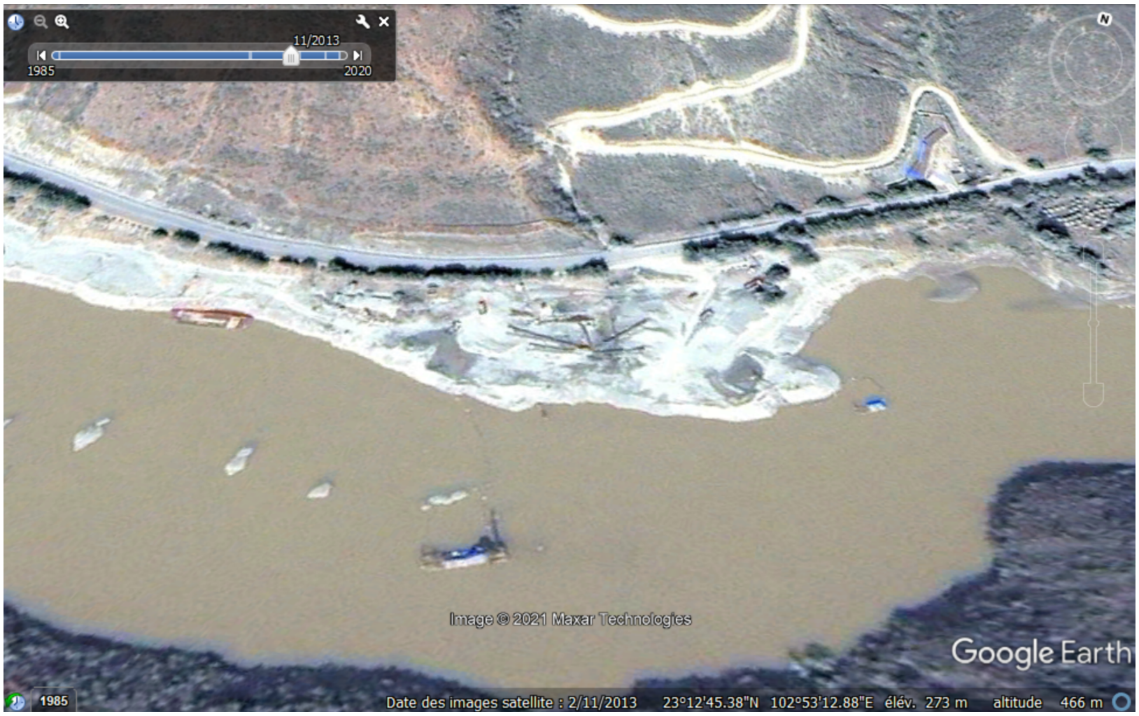

Figure 5.2 A single dredge and barge can be seen northwest of village B by satellite imagery in 2013.

(Source: Google Earth)

Using satellite imagery, we can see that the sand industry has grown rapidly since 2013 and that, several barges and dredges still occupied the study area at the time of the interviews (Figure 5.3).[12] When we asked locals why the area had experienced such a boom in this industry, half of the respondents said they did not know, and the other half said that it was due to construction needs—the area is rich in sand, and the demand is high. It is in January 2020 that we observe the most sand boats along the 25-kilometre stretch between Yuangyang and Xiaomanti on Google Earth: 81. When we asked respondents how many sand mining boats were currently in operation, the answers ranged from zero to fifteen. Village B's chief (i-12) had the most detailed explanation, stating that there were 4 to 5 dredges left in village B and more than 10 between

[12] I reviewed Google Earth imagery along a 25-kilometre section of the river that spans from villages A to B, as well as their surroundings.

Village A and Xiaomanti. It is interesting to note that the residents of Village B tended to give a higher number than those in village A. Satellite imagery from August 2021 indicates that there were 8 dredges and 18 barges between Yuangyang and Xiaomanti, for a total of 26 boats.

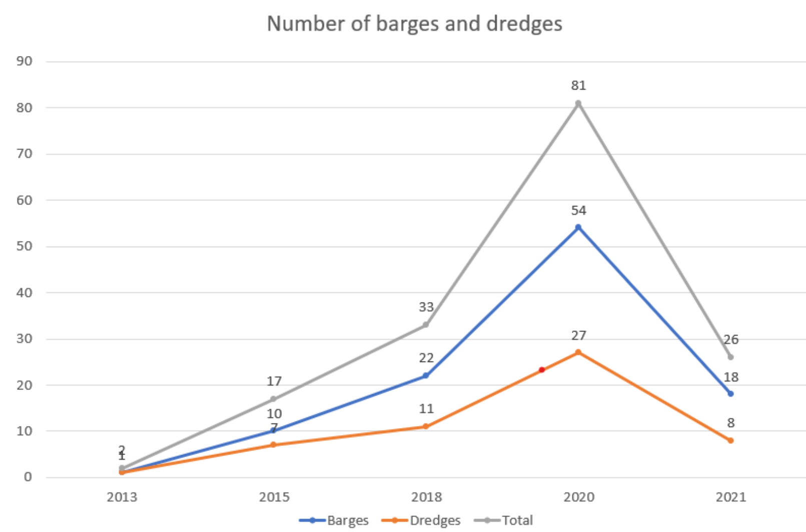

Figure 5.3 The number of dredges and barges on the Red River from 2013 to 2021.
(Source: Google Earth)

We believe that this recent decline is directly related to the ban on sand mining ban on the Red River.[13] This information came out when we asked respondents how long they thought sand mining would continue in the area. At that time, eight respondents told us that the practice had been banned, although seven of them implicitly acknowledged that it was still ongoing. Most said they did not know how long it would continue. Respondent i-6 said that it should not continue for too long because the amount of sand in the river had decreased, and i-12, Village B's chief, said that it would continue for another two years but referred to it as "river cleaning".[14]

[13] A PhD student that visited the area in the summer of 2022 has confirmed this.
[14] River cleaning, also known as sediment management, removes sediment trapped behind dams to avoid damage to the infrastructure, reduction of a reservoir's storage capacity and its subsequent increased risk of flooding (Wang et al., 2005).

Three respondents seemed unaware of the ban, as they said it could go on for years if it was not banned.

The years cited by respondents regarding the implementation of the ban ranged from 2018 to 2020. Respondent i-7 told us that the ban was implemented after businessmen visited the sand pits two or three years ago. Two other respondents, i-11 and i-12 told us that the ban came from the Gejiu government, and the latter specified that it came from the Gejiu Water Bureau. He also said that the ban applied to all of Yunnan Province.

The village chief of Village B told us that the ban still allows one company to continue operations in each settlement. These operations are said to help clear the river of sediments that can allegedly damage dams. Dredging companies must be licensed, and the license must be re-evaluated annually according to the latest requirements.

When Yuqi and Ruiying asked interviewees how they felt about the sand mining ban, most said they did not care, although four respondents expressed positive opinions about the industry. Respondent i-7 said that sand mining was environmentally beneficial, especially for the land along the river, and that the ban left sand workers like him without a livelihood. Respondent i-12 said it was environmentally and economically beneficial to the local area. Respondent i-8 said that he was upset about the ban because he no longer received royalties (see Section 5.3).

When we asked the villagers which government agency oversaw the sand industry in their segment of the Red River, the answers fell into two categories. Seven answered that it was the village committee, and four said it was either Gejiu City or Yuanyang County government. The village chief (i-12) further specified that the Gejiu Water Bureau was in charge.

All interviewees said that there had been a village meeting on sand mining, although they did not provide further details. Albeit two interviewees complained that the officials did not discuss the potential impacts of river-sand mining during this village meeting. Other data collected by a member of the research team in the late 2010s indicate that such a meeting was held in Village A before a mine was implemented on communal land, and that royalties were discussed and the community voted on the project during this meeting (Rousseau and Marschke, forthcoming). Eight respondents told us that the owners and bosses had good relations with the village committee, while only one believed otherwise.

5.3.2 Inner Workings

Four respondents said that they had considered joining the sand industry for a better income, and two of them were hired as sand workers (i-7 and i-11). Another respondent (i-1) said she considered investing in the industry when the owner of a sand company sold his shares, but she put it off because the price was too high. Conversely, two respondents said they had not considered joining the industry, each for different reasons. Respondent i-6 said she could not join the industry because she is a woman and has to sell fruit at the local market. Respondent i-12, the chief of Village B, explained that he did not want to join the sand mining industry because "the government has been strictly investigating illegal sand mining activities. Those mining sand illegally will be fined hundreds of thousands or even millions".

Although a large proportion of sand miners and truck drivers are local, bosses tend to be outsiders. Village B's chief says that he knows bosses from Yuxi City (Yunnan Province), Zhejiang Province and Sichuan Province and that local work permits are required for labourers. Of the 12 respondents, 2 (i-7 and i-11) worked as sand labourers and were able to give us an insight into their livelihood.

Their workday usually starts at 8 a.m. and finishes around 6 or 7 p.m. Five respondents said that the dredges can be in operation for even longer, sometimes up to 24 hours a day when the demand for sand is high. They work eight hours per day, seven days per week, and only have days off during major holidays such as the Spring Festival. However, workers do get an occasional day off if the dredge breaks and needs repair.

Respondent i-7 worked as a labourer in a sand pit along the Red River (see Figure 5.4). He first heard about the job opportunity from relatives, and there were no requirements for it. He feels that his monthly salary of RMB 4,000 (CAD 760) is insufficient and complains that sand mining is only lucrative for his bosses from Zhejiang Province.[15] He also finds the work grueling and says he does not get enough days off. When we asked him about work-related injuries, he replied that they never occurred.

[15] In 2020, the per capita wage income of rural residents in impoverished counties within Yunnan province of southwest China amounted to 3,994 yuan (Xinhua, 2021).

Figure 5.4 Sand pit near the Red River.

(Photograph by Yuqi Deng, September 2021)

The company he worked for had a dredging licence, and the boats it operated tended to stay in a given area, sometimes for several months. Respondent i-7 believes this is either because these areas were abundant with sand or because the boats were damaged. About four to five people work on a dredge, and the size of the dredges can vary considerably. According to i-7, filling the smaller barges takes about one hour to fill, while bigger ones take three hours. He thinks that the Red River is not a good place for sand mining and that the Nansha dam located upstream from the villages further depletes the area of sand by blocking its inflow.

For his part, respondent i-11 worked in a sand pit in Village B that was built on communal land and operated by locals (Figure 5.5). He was responsible for controlling the machine that washes the sand of mud and silt. He explained that one or two people work on washing the sand while two others operate the sand conveyors. He did not specify where the sand was transferred to, but it is likely that he meant the sand was sorted in different piles onsite or put into sand trucks. He, too, first heard about the job by word of mouth. He works seven days a week except on holidays. His specific schedule is from 7:30 to 11:30 a.m. and from 3:30 to 7:30 p.m. He did not explain the reasons for this four-hour midday break. At first, his monthly income was RMB 1,200 (CAD 228), but later it increased to RMB 2,500 (CAD 475). He does not think the pay is good, and he suspects that locals are paid less than outsiders. When asked about work-related injuries, he said that they were rare.

Figure 5.5 Sand pit near village A.

(Photograph by Yuqi Deng, September 2021)

Respondent i-11 said that sand mining companies were required to have a license to operate within the Chinese section of the Red River and that this license came with specific guidelines. Namely, dredges must stay within a certain area, and they are prohibited from mining sand within one or two kilometres of a bridge or a highway, but there does not appear to be a sand allowance in place (Figure 5.6). Regarding the number of workers on a dredge and the time it takes to fill a barge, he gave the same answer as i-7, but he did specify that the dredge he works on has a 962 tonnes per day capacity. This almost concurs with the figure given by i-12, Village B's chief, who mentioned 722 tonnes. However, when we asked the locals the same question, i-9 and i-10's estimates ranged over a thousand cubic metres, whereas the eight other respondents said they did not know. Unlike i-7, respondent i-11 thinks that the Red River is a good area for sand mining because it abounds with sand, and the Madushan Dam also facilitates sand mining by raising the water level and allowing sand boats to work on the water.

Figure 5.6 Two barges and a dredge on the Red River.

(Photograph by Yuqi Deng, September 2021)

Following the sand mining ban on the Red River, both i-7 and i-11 lost their jobs. Respondent i-11 says that there is still one sand mining company operating in the area, but they label its work as “riverway cleaning”.

5.4 Socio-economic Impacts of Sand Mining Along the Red River

Sand mining along the Red River has had a plethora of socio-economic impacts on villages A and B, which I review below. I have organized this section by sub-topic, and some impacts have both positive and negative components. The socio-economic impacts I detail include employment opportunities, local economic benefits, infrastructure development, community engagement, and royalties.

One of the socio-economic impacts reported was local employment. In fact, two of the respondents had been employed in the industry for several years prior to the sand ban. Following the same logic, respondent i-8 said that the ban had reduced employment opportunities.

However, not all respondents felt the same way. Two respondents stated that the sand mining industry has led to an exodus of workers. More precisely, respondent i-6 mentioned that "sand mining occupies villagers' farmlands, which leads to villagers not having farmland to plant, so they go out to work". Similarly, respondent i-2 argued: "Since sand mining takes up the farmland by the rivers, people have to go to the nearby town and city to look for jobs". Although the interviewees did not specify how sand mining occupies farmland, we do know that the sand pits and the dirt roads leading to them have been developed on land that was previously used as farmland.

Eight interviewees said that the sand workers stimulate the local economy by purchasing things in the villages, such as food, water and cigarettes. However, two mentioned that this perception was a hunch since they could not distinguish sand miners from other customers. Furthermore, respondent i-1 argued that sand workers spent less time in the villages than expected since sand mining companies provide them with food and accommodation. She added that the workers mostly come to the village to purchase cigarettes. Also, the sand mining industry fostered local development in two different ways. Firstly, the collected sand is used to build local infrastructure, such as roads, bridges, and shops. Secondly, the villagers can use the sand from the pits for their own needs free of charge. Some have used it to build or renovate their houses. However, since most of the government-sponsored renovation and infrastructure programs have already been completed, the village chief (i-12) says there is currently little local demand for sand.

But the sand mining industry can also deteriorate local infrastructure. Village B's chief said that sand mining could lead to the collapse of riparian infrastructure and that, consequently, "the government has stipulated that sand mining is strictly prohibited within 200 metres of bridges, roads and villages". Furthermore, four respondents think sand trucks impacted the area's road traffic. More specifically, all four mentioned dusty roads, two mentioned air pollution, and one mentioned traffic jams. Although five interviewees were unbothered by the dredges, seven commented on their noisiness. Two respondents living in Village B said that it was mostly bothersome at night. In this context, respondent i-10 said that the dredges do not bother him when he is fishing, but he nonetheless stays at least one kilometre away from them.

When we asked the villagers whether anyone had voiced concerns regarding sand mining activities to the village committee, only one person said yes. This interviewee (i-7) mentioned that he had heard about villagers complaining that the sand mining companies ignored their protests against sand mining about four or five years ago.

All respondents reported receiving royalties from the sand companies, with quoted amounts ranging from RMB 100 to 2,000 (CAD 19 to 380) per household yearly. Respondent i-8 explained that royalties are paid to the village committee and that this amount is then distributed equally amongst all households. The quoted amounts allocated to the villages span RMB 10,000 – 200,000 (CAD 2,000-38,000), and village B's chief specified that the amount indeed varies between regions, but that it is distributed equally to all local households. He added that in order to mine local sand, companies must first bid through an auction process, and the winners then pay compensation to the Gejiu Finance Bureau. According to respondent i-2, sand mining companies also compensate villagers when they use people's land. Furthermore, other data collected by a member of the research team in the late 2010s indicate that in addition to cases where companies paid lump sums, dredge operators were also required to pay annual royalties to local village committees (Rousseau and Marschke, in prep.). These royalties were distributed equally among all households, for a total of 100-200 RMB (15-30 USD) per household yearly. Since the implementation of the ban, the locals no longer receive royalties.

5.5 Environmental impacts of sand mining on the Red River

The sand mining literature most often emphasizes the environmental impacts of this activity (Marschke & Rousseau, 2021). Therefore, I initially believed that locals would give us a good indication of the environmental impacts of sand mining. However, I soon realized that the villagers' opinions varied widely, and many did not perceive any environmental impacts. The questions we asked targeted environmental impacts spanning geomorphological changes, sediment loads, water colour and temperature, waves and currents, flooding, fisheries, biodiversity and usage of the river.

Only a few respondents linked sand mining to geomorphic changes along the Red River. In fact, only three respondents said that sand mining had affected the width of the river. One said the river was getting narrower, whereas another said it was getting wider in some places, and narrower in others. Similarly, only three respondents said that erosion was occurring on the Red River, including one who blamed erosion on the Madushan Dam rather than sand mining (Figure 5.7). Again, only three respondents said that sand mining had affected the islets and banks along the Red River.

Figure 5.7 Erosion on the Red River.

(Photograph by Yuqi Deng, September 2021)

Regarding the amount of sediment in the Red River, five respondents said it had increased, five claimed it had decreased, and one argued it had remained the same. Two of those who said it had increased blamed the Madushan Reservoir and the rain for this perceived trend. The chief of Village B explained that when it rains, the soil from the mountains washes into the river and gets trapped behind the dam, thus leading to an increase in sediments. Four out of the five people who mentioned that the sediment load had increased blamed sand mining operations for this. However, only two respondents thought that the river had become darker, and only one linked this change to sand mining. Furthermore, just one person felt that sand mining had led to an increase in water temperature.

Regarding the waves on the Red River, we again got diverse answers. One person pointed out that there were fewer waves, one that the waves were smaller, and one (i-7) said that the waves were stronger, but only when the dredges were operating. Regarding the current, two persons claimed it had become milder in the last five years, and two others stated the same thing but attributed this outlook to the dam. One person said that the river flow had changed and that flooding had increased over the past five years, especially on farmland. Two others said that, following the construction of the Madushan Dam, the river had become stagnant.

Another commonly reported impact of sand mining in the literature is the decline of some native species and the growing prevalence of opportunistic species (Marschke & Rousseau, 2021). Within our 12 interviews, only 2 people claimed that sand mining had negatively affected local fisheries. They reported not only a decrease in catches but also that the fish did not taste as good as before. However, another interviewee mentioned that sand mining had made it more dangerous to fish on land because of the change in terrain. Conversely, one of the fishermen (i-10) reported an increase in fish species and quantity. Regarding the algae and aquatic vegetation in the Red River, only one respondent thought that sand mining had affected it.

Respondents also reported that sand mining has affected their use of the Red River. Four said that the water quality had deteriorated to the point that it was no longer suitable for bathing and could only be used for irrigation. Two locals also worry that the water is now dangerous for children, whereas they used to play in the river as children.

Overall, only a handful of locals have reported any environmental impacts from the sand mining industry. A similar trend emerged when we asked them whether sand extraction in the area would eventually lead to environmental damage. Village B's chief even claimed that sand mining was good for the Red River since it cleans it.

5.6 Conclusion

This chapter introduced villages A and B, which both border China's Red River in Yunnan Province. It explained how sand mining on the Red River works, notably through the account of two former sand miners. Finally, it detailed sand mining's socio-economic and environmental impacts on the local area as perceived by the inhabitants of villages A and B. The data showed that sand mining has had significant local socio-economic impacts but does not seem to have caused any noticeable environmental changes on the Red River. To conclude, I will answer the two sub-questions on the environmental and socio-economic impacts of sand mining along the Red River in a clear and concise manner.

Insight into the inner workings of the industry reveals that sand dredging, once a booming business, is now banned, and all local employment from it has disappeared. Only one company per village is allowed to dredge the Red River for "river cleaning" to optimize dams and reservoirs. When dredging was allowed, most of the labourers were local, while the managers and owners came from other Chinese provinces. The former labourers confided that their pay was insufficient for the nature of the work. They said it was physically demanding, that they worked long days and that they rarely had time off. They also said that there were some regulations, such as a prohibition on mining sand near bridges, but they were unaware of most sand mining regulations at the time of their employment. There were also some labourers who did not work on the sand boats but at the local sand pits. At least one of these sand pits was locally owned and operated.

The environmental findings for the Chinese case study remain vague. Most interviewees did not report environmental changes stemming from sand mining, and those who did seem to disagree on the specific impacts.

The socio-economic findings demonstrate that sand mining has allowed for local infrastructure development, and that riparian residents were given royalties from the sand mining companies up until the ban. The industry provided employment and stimulated the local economy for a short period of time. However, some local residents lost their livelihoods when sand mining took over their farmland and they had to find work elsewhere.

The next chapter describes the findings from the Cambodian case study. The subsequent one is when I dive into the meaning and significance of the findings from both case studies and explain how they relate to the literature and the contextual framework. Namely, I will utilize the concepts of extractivism and political ecology to further interpret the data presented above.

Chapter 6 – Findings from Cambodia's Mekong River

6.1 Introduction

The Cambodian case study took place in riparian villages along the Mekong River, located about 25 kilometres north of downtown Phnom Penh's, in a district of Kandal Province. The Cambodian research assistant, Munny, interviewed a total of 16 people during 14 unstructured interviews; 11 villagers and 5 sand workers. This allowed Munny to be as flexible as needed during interviews, as long as he covered a few key topics that he and I had previously identified. Nine interviews were conducted with local residents, whereas five were conducted with sand workers. The interviews were conducted in February and March 2022.

This chapter describes the findings of this case study. First, I introduce some key points about the interviews and their location. Next, I provide details of the sand mining industry operating along the Mekong River in the Phnom Penh area, as described by local residents and sand workers. Finally, I outline the industry's environmental and socio-economic impacts of the industry as reported by interviewees. These findings will allow me to convey preliminary answers to my research questions.

6.2 Local Context

All of the villagers interviewed were either born in the area or had lived there for more than a decade. In contrast, four out of the five sand workers came from another province within Cambodia, and one did not mention his origins. Three sand workers were from Pursat Province whereas one was from Svay Rieng Province. The ages of the locals ranged from 28 to 84, with only two under 50. The sand workers ranged in age from 23 to 32 years old.

The livelihoods of the locals included retirees, rice mill owners, a grocery store owner, a musician, a motorcycle wash owner, and a river restoration technician. Among the sand workers, three were sand pump operators, one was a dredging engine operator, and the other was a dredging engine assistant. Although there are several dams upstream of the Mekong and its tributaries, the nearest one is several hours away.

6.3 Inner and Outer Workings of the Sand Mining Industry Along Cambodia's Mekong River

6.3.1 Outer Workings

According to the villagers, sand mining activities began along the Mekong River about a decade ago, and in their home region between five and seven years ago. Satellite imagery seems to confirm this, with the first dredges visible in December 2010 (Figure 6.1). According to I-09, sand mining has accelerated greatly over the past three years, while I-04 argues that the greatest increase was seen in 2021. When we asked respondents how many sand mining dredges and barges were currently ply in the 25-kilometre river section between their village and Phnom Penh, answers ranged from a few to 200 hundred sand boats. They also said that the sand was used not only for building infrastructure but also for land reclamation projects and for export out of the country, namely to Vietnam (I-06). Respondents I-03, I-04 and I-06 identified Prek Leap, Kdey Chas, Kampong Chang, Koh Norea, Boeng Tompun, and Phnom Penh as areas where the sand is transported (Figure 6.2 and Figure 6.3).

Figure 6.1 A couple of barges and dredgers can be seen on the Mekong River near Koh Dach Island in 2010.

(Source: Google Earth)

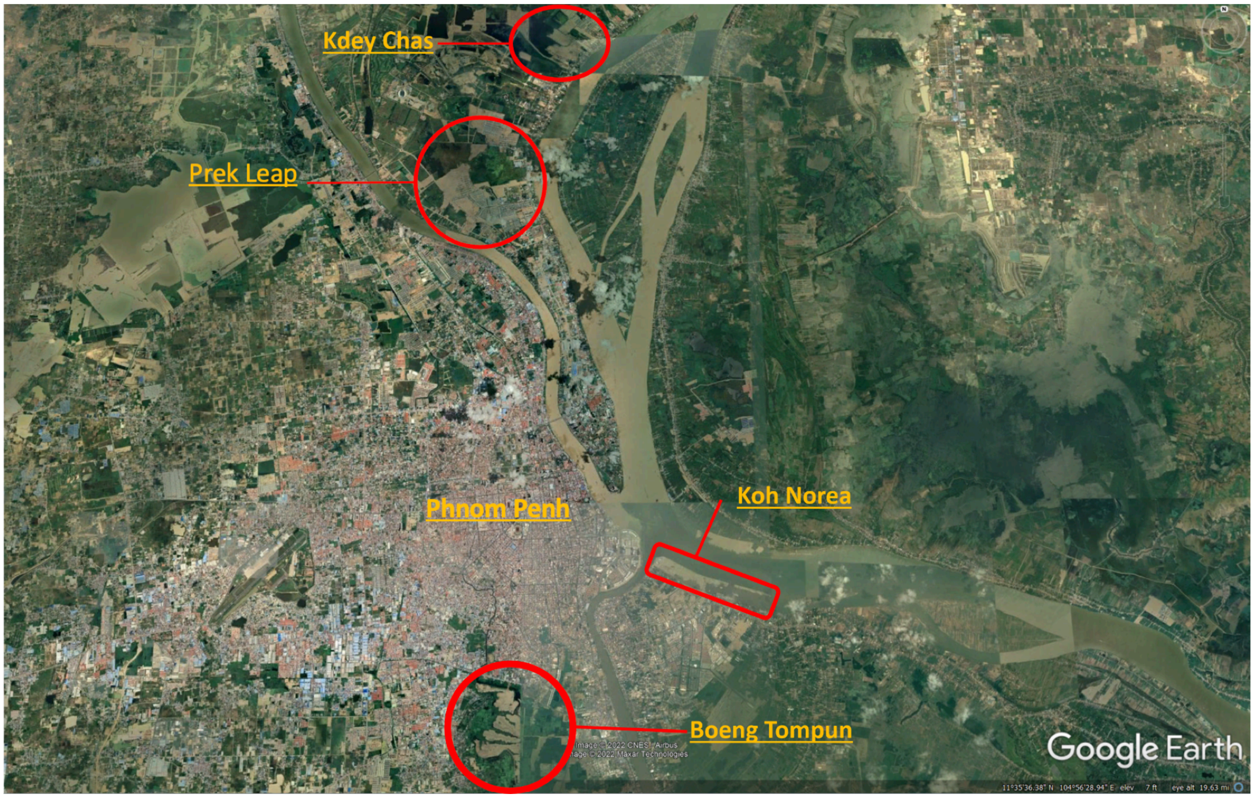

Figure 6.2 Land reclamation sites in and around Phnom Penh.

(Source: Google Earth, created in December 2022)

Figure 6.3 Satellite imagery of Kdey Chas's land reclamation project on December 2015 (left) and on June 2022 (right). Some of the sand dredged in the Mekong is used to fill this wetland to allow for urban expansion.

(Source: Google Earth)

According to respondent I-01, dredging normally starts at 5 a.m. and stops at 5 p.m., whereas respondent I-04 said that most sand mining boats operate day and night. Although sand mining occurs almost everywhere along the Mekong River in the northern part of Kandal Province, there seem to be areas that are more popular than others. Roka Kaong's village and an island off its coast, Koh Sneha, are two such examples. One of the things we have learned through satellite imagery and interviews is that Koh Sneha's Island is being heavily dredged (Figure 6.4). Although the island's size changes throughout the year, the island appears to be inhabited until 2015. Interviewees also reported that the island of Koh Chen, just south of Roka Kaong, was being dredged (I-04 and I-07).

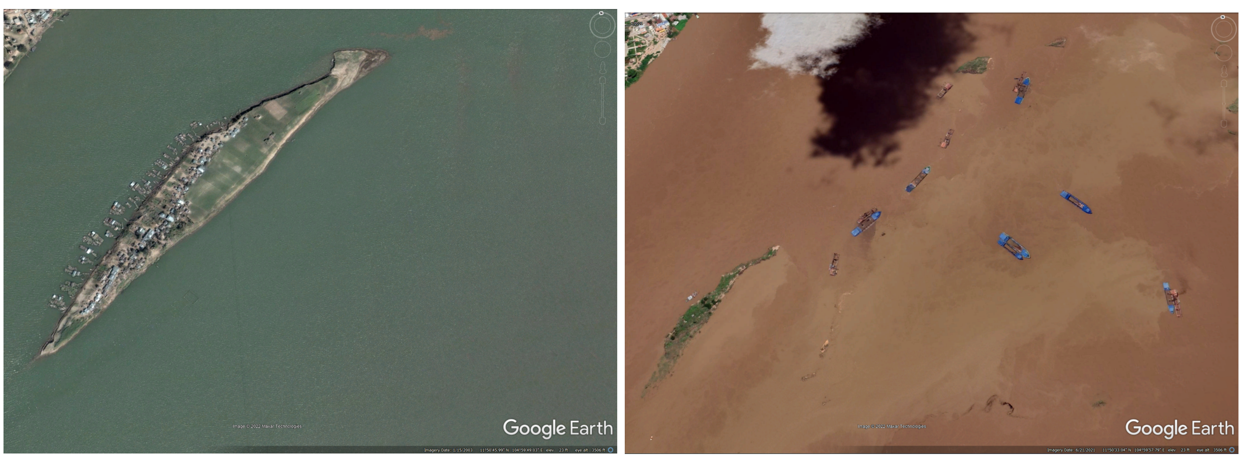

Figure 6.4 Koh Sneha in 2003 (left) and in 2021 (right).
(Source: Google Earth)

I-01 explained that officials do not allow dredging everywhere along the river and that boats can only work where they are permitted to do so. I-04 specified that although the dredging of the islands Koh Sneha and Koh Chen is authorized, the locals have no way of knowing if the boats are dredging outside of their allotted areas since the government does not share any details of dredging zones publicly. Local authorities told the villagers that sand companies would be dredging Koh Sneha and Koh Chen, but they held no public meeting and did not explain the sand regulations. Respondent I-06 gave a similar explanation stating that dredgers are assigned specific plots, but that he never saw the local authorities or sand companies share the zoning map with the villagers. Boats simply place a sign in the middle of the river to indicate where they are dredging and, over time, this sign "glides near people's houses" (I-06). He thinks that this maneuver might be allowed by law, but he is not sure since he does not know the regulations surrounding sand mining. Finally, I-02 said that sand mining boats are not allowed to operate at night, which contradicts I-04's comment about dredges operating day and night.

According to the respondents, sand companies tend to be foreign. Three respondents identified Vietnam and two China as countries of origin, but all were unaware of the owners' nationalities since they had never seen them, and the local authorities do not disclose such information publicly.

When locals were asked if any residents had joined the sand mining industry, respondents I-06 and I-03 said yes, although the latter added that most sand workers came from elsewhere. I-06 added that he knew of local youths working as pump engine operators, sand packers, and sand boat controllers. Conversely, three respondents said locals prefer to work in Phnom Penh and in the garment industry rather than in the sand-mining sector.

6.3.2 Inner Workings

Munny interviewed a total of five sand workers during their break. In this section, I first describe the daily activities of sand pump labourers and dredging workers. I then describe the amount of sand processed by each category of sand worker, as well as their wages and the remittances they send home. Finally, I discuss sexism and physical health within the industry.

6.3.2.1 Sand Pump Labourers

Respondents I-010, I-013 and I-014 all worked as sand pump labourers. Their job is to dilute sand on barges so that it can be sucked into ground-based pipes. The typical scenario consists of a handful of workers holding water hoses near the suction pipe, which is manually controlled by two other workers (Figure 6.5). This process takes place at a pumping station located on a floating platform near the riverbank (Figure 6.6). This pumping station serves as an intermediary between the barges and land transport, namely towards land reclamation sites – in this case, Boeng Tompun (Figure 6.7). The labourers also occasionally repair equipment and perform other general tasks.

Figure 6.5 Sand labourers watering down sand in a barge to allow suction into the pipelines. (Photograph by Munny, February 2022)

Figure 6.6 Sand pump station on the Mekong River, near Phnom Penh. The yellow raft left is the workers' living quarters.

(Photograph by Munny, February 2022)

Figure 6.7 Unassembled sand pipes (left) and sand being pumped into wetlands for land reclamation purposes (right). See section 3.2.3.

(Photograph by Munny, March 2022)

The sand pump labourers then work as a team of 6 to 10 men and hose the sand until it is "liquid" enough to be unloaded through a large pipe (van Arragon, 2021). This pipe can either lead to a storage site where the sand is trucked to construction sites, or it can lead directly to a wetland infill site through long pipes. In the latter case, additional pumps may be required to maintain pressure in the pipe, each operated by one or two sand pump labourers.

Respondents I-010 and I-013 first heard about the sand pumping job opportunity from an acquaintance in their hometown, in Pursat Province, while I-014 heard of it from a relative while living in the same province. At the time of the interviews in February 2022, I-010 had worked in the industry for two months and I-014 for three years, although he does not work year-round. They all chose to join the industry for financial reasons. I-010 and I-013 used to work as construction workers, but they explained that they were not hired for enough hours and were not paid on time. When they heard about the higher wages, hours, and stable pay of sand work, they decided to switch occupations. They also explained that sand work is less physically demanding than construction work and that sand companies provide workers with three meals a day and free sleeping accommodations. I-014 did not specify why he went into sand mining, but he did mention that he is currently in this industry because he could not get a visa to work for a Japanese fishing vessel due to Covid-19 restrictions. Respondents I-013 and I-014 say that most hiring in the sand sector is done by word-of-mouth and that young people, especially teenagers, are not interested in sand work.

All three sand pump labourers said that holding the water hoses was the most difficult part of the job. The hoses are heavy and difficult to maneuver, so workers need to develop techniques to handle them without hurting themselves. For example, I-013 hurt his hand the first few times he held the water hoses, and it took him two weeks to get better at controlling them. New workers are taught not only how to hold the hoses, but also how to operate the machines, maneuver the sand suction pipe and perform other technical tasks. The research assistant, Munny, tried holding a water hose himself to see how it felt. He said that it requires a lot of energy and strenght and that it is quite hard at first because he had not developed a technique yet. Munny added that beginners tend to use strength instead of technique, which makes it much harder. Generally, there are about ten workers and one supervisor per pumping station. There is no hierarchy among the workers; there are just more and less experienced workers.

The reported workday duration at the sand pumping station varied between 5:30 a.m. and 6:30 a.m. as the start time and 5:30 p.m. and 6:00 p.m. as the end time. Sand pump labourers work seven days per week and only have rest days on special holidays such as Phchum Ben and Khmer New Year. They also get time off when they finish emptying a boat, or when a piece of equipment needs repair. Respondent I-014 said that they still get a full day's pay even if the machinery is broken and that they do not work as much overall. A few hammocks are hung up on the ceiling of the sand pump station so that people can relax from time to time, and their living quarters are right next to the sand pump.

6.3.2.2 Dredging Workers

Respondent I-012 has been working as a dredging engine operator for eight years, and his job is to monitor the amount of sand to be dredged and to fill the barges. He also notifies the dredge owner whenever a piece of equipment is broken beyond repair and must be replaced. He is assisted by the dredging engine assistant (see below), and they both work seven days a week, except on national public holidays. I-02 entered the sand industry around 2014 after asking the operator of a dredging boat located in front of his house if he could hire him. He worked as a sand pump labourer for the first three months, then as a barge captain for two months before becoming a dredging engine controller. He can now repair almost any type of sand dredging machine, which has helped him to gain the owner's trust. The company he works for owns eleven barges and three dredges.

Respondent I-011 is a dredging engine assistant. His job is to help the dredge operator and make sure that the machine is working properly. He first heard about this job opportunity from his brother-in-law, respondent I-012. He said that the job was difficult in the beginning, especially when learning how to install the pump in the river. It is also arduous work when the pump gets stuck underwater or when it breaks since they can only rely on themselves to fix this very heavy equipment. He does not know the owner of the dredge.

Although only two people do the dredging work on the boat, it is common for the wife of one of the workers to be on board. In this case, the wife of respondent I-012 lives with them. She is responsible for cooking, and although she stays at the station for free, she does not receive a salary. In fact, a cook's salary is deducted from the captain's salary;[16] with both partners on board, they can save money. In his thesis, van Arragon confirms that the presence of women in the sand mining industry is uncommon, and that they predominantly serve as unpaid cooks on their husbands' work boats (2021). The company provides 50 kilograms of rice per month, and other food items such as salt, fish, and soy sauce.

6.3.2.3 Sand Quantities

On the one hand, the sand pump labourers told us that they can pump the equivalent of three barges per day, which amounts to about 7,000 or 8,000 cubic metres per day. The amount of sand extracted daily is recorded by the supervisor, and the total sum is calculated at the end of each month to determine the sand pump labourers' pay on a pro-rata basis (see below). The price of sand ranges from USD 18$ to 24$ per tonne depending on the demand, the supply, the location, and the grade of sand. Sand pump operators distinguish three types of sand: very coarse, coarse, and medium. The very coarse sand is difficult to pump because it is more prone to

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[16] That is when the wife of one of the workers is not doing it for free.

clogging. Since the pumping stations are stationary and close to the riverbanks, sand pump labourers do not venture out into the dredging areas. From what they have heard from the barge workers, the sand they process at the pumping station comes from Roka Kaong and Kampong Cham.

On the other hand, the two dredgers told us that they could fill up to 12 barges per day, but the dredging engine was broken so often at the time of the interviews that they could only fill 5 to 6 barges per day during that period (Figure 6.8). They told us that each sand company has a river manager who tells the dredgers where to go, as they can only mine sand in their authorized lot and cannot exploit other lots. If they dredge outside of their lot, they first receive a warning, and if the incident is repeated, they are fined. The company they work for currently oversees two lots, which are marked with flags. The manager also informs the dredgers of all the areas where dredging is allowed and where the government prohibits it.

Figure 6.8 Barge filled with sand on the Mekong River, March 2022.

(Photograph by Munny, March 2022)

The sand workers we interviewed did not seem to be aware of the regulations that apply to the sand industry. They only know that all sand companies have to get a permit to extract sand before doing so. Sand pump labourer I-014 also said that their manager only allows them to work from 5:30 a.m. to 6:00 p.m., otherwise the company will be fined.

6.3.2.4 Salary and Remittance

In terms of pay, there are two options for all types of sand work examined in this case study. The first is a fixed amount, and the second is based on productivity.

For the sand pump labourers, the monthly base salary ranges from USD $350 to $360.[17] If they pump over 6,000 cubic metres per day, they get paid per cubic metre, averaging between $400

[17] As of January 2023, minimum salary in Cambodia is at USD 200$ per month, whereas in 2021, the average income was of USD 132$ per month (Cambodian Ministry of Labour, 2023; WorldData, 2021).

and $500 per month. If their pumping station works properly, doing 6,000 cubic metres per day is reportedly feasible. In addition to their wages, sand pump labourers receive free housing and three meals a day.

All three labourers interviewed send a portion of their wages back to their families in their home province. Respondent I-010 sends almost all the money he earns to his parents to support them and only keeps USD $25-50 for his personal monthly needs. I-013 sends $325 per month to his parents when he gets paid on a cubic metre basis, and $250 to $300 when he is paid only his basic salary. I-014 always sends at least $250 per month to his parents.

The dredging engine operator can also choose to receive either a monthly base salary ranging between USD $1,200 and $1,500 or be paid per cubic metre dredged. The second option applies automatically if he dredges more than 150,000 cubic metres in a month, which brings his income to a minimum of $1,800. The motive behind this payment system is to encourage productivity and to retain employees.

6.3.2.5 Sexism and Physical Health

When we asked interviewees why there were so few women working in the sand mining industry, their answers included lesser athletic abilities and a lack of interest in the industry. The only women involved in the sand industry, the informants argued, were the wives of the boat captains and the cooks at the dredging stations.

Although many injuries have been reported in the sand mining literature (Gupta, 2022; Adeyemi et al., 2020), interviewees reported only minor injuries. They stated that the only injuries they had witnessed, experienced or heard about resulted from friction with sand and cuts from sharp objects. In parallel, respondents I-010, I-012 and I-013 all stated they would remain in the sand mining industry until their physical health and abilities no longer allowed them to do so. Respondent I-012 also said that he would quit if working conditions deteriorated, and I-011 said that he is staying in the industry because he lacks the skills to find another job and feels pressured by the understaffed company to continue working in this sector.

6.4 Environmental Impacts

The environmental impact interviewees were most concerned about were geomorphological changes in the Mekong River, particularly with regard to riverbank erosion (Figure 6.9). All local respondents said that erosion was occurring on the banks of the Mekong River, as did the dredging engine controller (I-012) and one of the sand labourers (I-014). They remembered that the erosion began about six or seven years ago and said that it has been getting worse every year since then. Many respondents were personally affected by erosion. Respondent I-04 lost 50 metres in width of his land plot over the past five years. Respondent I-05 said that the river used to be far from his house, and now that his house is practically on the edge of the shore. Respondent I-06 says that his land used to stretch 200 metres wider, ending perhaps where the middle of the Mekong riverbed is nowadays. He also said that one of his neighbours used to live about 100 metres into where the river now flows before erosion sank all his land. Respondent I-07 said that when she was young, her parents' land used to stretch 300 to 400 metres wider than it does today. Respondent I-09 lost 20 metres of land on his property, and now his house stands dangerously close to the edge of the riverbank. Both I-012 and I-014 – the dredging engine controller and a sand labourer – said that the river has become deeper and that the banks are eroding.

Figure 6.9 Erosion under a demolished house, on the riverbanks of the Mekong.
(Photograph by Munny, March 2022)

Residents reported erosion happening not only in their district but also further upstream in Roka Kaong. Respondent I-05 said that until five years ago, most sand mining took place near Phnom Penh. However, after seeing the damage it was causing within the city limits, the government banned sand mining near Phnom Penh, and so the boats moved upstream along the Mekong. The riverbank technician said that his technical team works not only in this area, but also elsewhere along the Mekong River, such as in Steung Treng, Kratie, Kampong Cham, and Kandal. Riverbank erosion has affected riparian infrastructure, such as roads and houses (Figure 6.10), and has threatened farms and caused livestock deaths (see section 6.4).

Figure 6.10 Snippet of a video taken by Munny showing an eroded road by the Mekong River. (Photograph by Munny, March 2022)

The reason interviewees gave to explain this increasing erosion was almost always sand dredging. Yet, the interviews revealed that the authorities and the riverbank technician blame the erosion on natural phenomena, such as flooding. They would also argue that the river does not even contain that much sand and that the aggregates are mostly composed of gravel and laterite. Respondent I-02 believes this statement since a 500 metres-long section of the riverbank collapsed at a time when there was no sand dredging occurring nearby. He believes that strong currents and changes in water flow cause erosion. Respondents I-03, I-07 and I-08 also believe that erosion can be caused by rising water during the rainy season. Respondent I-08 explained that during the rainy season, “the lakes next to the river bring in mud and sediment to the river, and when the water recedes at the end of the season, the banks of the river absorb all the water and is more prone to landslides." However, respondents I-03, I-05, I-07 and I-09 believe that sand mining plays an important role in local erosion and are afraid of getting into trouble if they say so in public. Respondent I-03 added that about 80 percent of the households in the area blame sand mining for erosion. Both I-012 and I-014 – the dredging engine controller and a sand labourer – said that sand mining is indeed responsible for the erosion.

To combat erosion, the authorities have begun using heavy equipment and concrete to reinforce the riverbanks (Figure 6.11 and Figure 6.12). This work is funded by the Cambodian Ministry of Water Resources and Meteorology. Respondent I-04 is skeptical about the long-term effectiveness of this solution. He explained that erosion tends to occur by large segments falling into the river at once and that, therefore, the added concrete is still at risk of being swallowed by the river. I-09 also said that sandbags had been placed along the riverbanks to prevent rapid erosion, but that this method of protection was only temporary (Figure 6.13).

Figure 6.11 Eroded bank getting prepared for structural reinforcement.

(Photograph by Munny, March 2022)

Figure 6.12 Concrete layer being constructed to reinforce a riverbank on the Mekong River. (Photograph by Munny, March 2022)

Figure 6.13 Sandbags used as structural reinforcement on eroding riverbank.
(Photograph by Munny, March 2022)

Although sand dredging removes sand from the river, not everyone believes that it results in less sand in the water. In fact, respondents I-012 and I-014 both said that sand mining actually increases the amount of sand in the river because the land that collapses and falls into the river replenishes sand quantity regularly. However, they acknowledge that this process is not infinite and suspect that, within the next five years, the amount of sediment in the Mekong River will decrease due to the ever-increasing sand mining in the area. Only one sand worker, I-010, said that sand mining has resulted in an overall reduction of sand in the Mekong River.

Several respondents reported a decline in native fauna and flora, especially in fisheries. More precisely, seven respondents explicitly mentioned that they have noticed a decline in fish species diversity and fish abundance in recent years, which has a direct incidence on the livelihoods of local fishermen (see Section 6.4). Respondent I-01 said that sand mining directly destroys fish spawning grounds by removing sandbars. Respondents I-02, I-06 and I-012 also reported that the water quality has declined in recent years and that this may directly contribute to the decline of fish in the Mekong River, with I-06 and I-012 saying that this is a direct consequence of sand mining. Respondent I-07 said that the erosion resulting from sand mining is also ruining livestock and crops, particularly since 2019. Respondent I-012, the dredging engine controller, said that although he is aware of these impacts, he has no solutions to offer; he is just a worker and wants to earn living to support his family. On the contrary, respondent I-014 said that he does not think sand dredging affects biodiversity in the Mekong because he has never seen fish on the barges he empties.

Akin to what van Arragon (2021) and Beckwith (2020) found, interviews and satellite imagery have highlighted three different land reclamation sites: Boeng Tompun, Kdey Chas, and Koh Norea (see Figure 6.3). According to Munny, all of these areas are being filled with sand to allow for urban expansion. Since wetlands cover most of the area in and around Phnom Penh, filling is necessary to make these areas suitable for real estate development. Munny talked to people living around Boeng Tompun who told him that they grow the following crops on Boeng Tompun Lake: morning glory, neptunia oleracea, and water parsley. However, once the lake is filled, these crops will no longer be able to grow (Figure 6.14). This is an indirect impact of sand mining, as the sand used for the filling is mined from the Mekong River (Figure 6.15).

Figure 6.14 Sand infill on Boeng Tompun Lake encroaching on agricultural land.

(Photograph by Munny, March 2022)

Figure 6.15 Boeng Tompun Lake being filled with sand.

(Photograph by Munny, March 2022)

6.5 Socio-economic Impacts

The sand mining industry has generated both positive and negative socio-economic impacts on Cambodian society, including those living along the banks of the Mekong River or whose livelihoods depend on the river's ecosystem. This section addresses the following subtopics: economic and infrastructure development, infrastructural damage and related socio-economic repercussions, loss of livelihoods, protests, and compensations.

To begin with, the sand mining industry has undoubtedly enabled Cambodia's urbanization and modernization. Several respondents said that the newly paved roads and bridges have made commuting much more efficient. Respondent I-01 said that this infrastructure allows them to get to school or to the market much faster than before, and respondent I-02 said that it reduces fuel costs and allows them to get in and out of the city much faster. Respondent I-02 thinks that the infrastructural modernization of the city also allows for a better economy, which in turn stimulates the job market, tourism, and foreign investment. This development has also increased land value in the area, and locals with land titles can now make a profit from selling their properties.

But despite these benefits, sand mining has also severely damaged infrastructure near the riverbanks. Eight of the respondents explicitly mentioned that houses had recently fallen into the river. Respondent I-04 has had to dismantle his house and rebuild it further away from the bank for the last three consecutive years. This affects the stability of the new house so much that, during the second and third years, typhoons destroyed it, and he had to rebuild it again. He said he is afraid to live where he does, but he stays because he does not have the means to move elsewhere. He added that many of his neighbours are in a similar situation. He estimates the property damage at about $20,000 for the houses and will lose $50,000 when the erosion swallows his rice mill, noting that he has already suffered a loss of income and time. He has reported his situation to the authorities, but the only response he has received so far is that his concerns were “submitted to higher officials”.

Respondent I-05 likewise had to dismantle and rebuild his house farther from the bank twice in the past five years. Nevertheless, his house recently fell into the river. He not only lost his house, but also his land. Respondent I-06 recounted a similar story, saying that he frequently had to dismantle and rebuild a temporary shelter for himself and his wife due to riverbank erosion. Respondent I-09 also reported having lost his home twice to riverbank erosion, as well as part of his land and his rice warehouse. Now he cannot afford to move elsewhere, and he will stay until the river has swallowed all of his property. Meanwhile, the damage inflicted to the warehouse now prevents him from storing large quantities of rice, resulting in a loss of income. He has invested in riverbank erosion protection strategies by installing sandbags and concrete protection along his land (see Figures 6.10 and 6.11) to slow down the process. He is afraid of his warehouse falling into the river without warning. He said that his neighbours are in a similar situation and that many of them will have nowhere to go once the Mekong River has swallowed their homes. He also said that the authorities have not offered any financial help or land to those who have lost their property, but I-07 said that they have helped evacuate some residents before the impending landslides into the river.

Respondents I-01, I-03, I-06, and I-07 explained that people who lose their homes and land often move in with relatives since local real estate has become unaffordable for them. However, since not everyone has relatives willing to take them in, many families are forced to stay on their eroding land until the very last minute and live in a constant state of fear. Respondent I-01 said that if his house collapses, he will have to move in with his mother, who lives in another commune. Fortunately, none of the respondents reported cases of injury or death due to erosion and collapsing houses, but I-07 did report that some animals were killed during such incidents.

Respondents I-01 and I-02 also explained how constant erosion further affects residents living near the riverbanks by making it more difficult to grow crops, raise livestock, run a business, or travel as easily, which in turn leads to increased poverty. Some families have moved not only because of the increasing risk that their house will eventually collapse but also because they can no longer earn a living.

Respondents have also reported that sand mining in the Mekong River has affected the income of fishermen. Respondent I-07 said that they used to easily catch tons of fish and then produce about 24 tonnes of prahok[18] per year. This quantity enabled them to keep large quantities of prahok in stock and thus ensure a year-long income. Nowadays, the number of fish has drastically declined to the point that the locals have difficulty producing prahok themselves and have to buy it at the market.

Respondents I-01 and I-03 said that the locals are very frustrated with the sand mining activities, but no one dares to speak out openly for fear of retaliation from the governmental authorities. Despite this fear, some residents have complained to their village chief, although the latter has not done beyond assuring them that the issue had been reported to higher authorities. As respondent I-04 explained, no resident has attempted to file a complaint with the court because they do not believe they can win against powerful opponents, especially given their lack of education and financial resources. Furthermore, many of the resident's land titles are informal or have been lost and the government refuses to issue any new titles again.

[18] Prahok is a popular Khmer paste/dip made from fermented and salted raw fish.

There is a sense of hopelessness among most of the local residents interviewed, especially since the sand mining industry bosses are powerful individuals sanctioned by the government to operate in this region. Respondent I-06 is also a supporter of a minority political party and thinks this might be one of the reasons why the local officials are ignoring his complaints. Respondent I-06 has heard of only one incident where local residents protesting against sand dredging led to local authorities ordering the sand boats to move away from the banks. This occurred in Svay Romiet Village, just southeast of Roka Kaong, along the Mekong River. In fact, respondent I-09 said that although sufficient complaints to local authorities can sometimes result in the sand boats moving away, this does not solve the problem; it only displaces it. He also mentioned that he attended a meeting on river restoration some time ago and that he did not get an answer when he asked how the river depth could be restored to its original level after extensive sand mining. For his part, respondent I-12, the dredging engine controller, said that locals have told him to dredge away from their homes. On rare occasions, he has also been asked to dredge in the middle of the river to lower the water level during the monsoon season.

Compensation given to local residents for the aforementioned losses is reportedly little to none. Respondent I-04 said he received a 20-kilogram sack of rice from the commune chief, I-05 reported receiving a one-time payment of $250 from the government, and I-07 said that the provincial government gave them some money and food. All of the respondents said that local NGOs, such as Cambodia’s Red Cross, visited them and offered financial and material support. For example, respondent I-04 said he received $125 from the Red Cross, whereas respondents I-05 and I-07 received money, food, and access to certain facilities. Three respondents also reported being interviewed by journalists following landslides, and I-06 said that the journalists used pictures to publish articles about the effects of sand mining. All respondents felt that the compensation they received from the government was grossly insufficient, given the damage they suffered.

6.6 Conclusion

This chapter details how villages north of Phnom Penh are affected by sand mining activities on the Mekong River. It explores how the industry operates from the perspective of both local residents and sand workers. It then delves into the many environmental and socio-economic impacts. To conclude, I will answer the research sub-questions about the environmental and socio-economic impacts of sand mining in a clear and concise manner.

The findings regarding the inner workings of the industry indicate that most sand labourers come from other Cambodian provinces and send most of their income back home in the form of remittances. The more sand they dredge, the better the pay. Moreover, the sand industry offers better income than other unskilled employment, such as construction and factory work. The employer provides free food and lodging. On the downside, sand labouring is not only physically grueling, but it also consists of long workdays with few days off. When asked about regulations, the respondents said that there were some guidelines, such as having to dredge within a defined area, but that they were not aware of them.

The environmental findings for the Cambodian case study mostly relate to erosion, infills, and biodiversity. Geomorphological changes, especially in terms of erosion, were the most widely reported impact by interviewees. The data show that riverbank erosion is rampant in the study area, affecting the homes and livelihoods of local citizens. Answers ranged in the hundreds, with the highest account of erosion stretching to 400 meters in width. Erosion has also affected islands and other parts of the Mekong River, particularly upstream of the study area. Dredging is considered by most respondents to have an impact on fisheries. Most of the dredged sand is used to fill landfills in various parts of Phnom Penh.

The socio-economic findings demonstrate that although sand dredging allows for urban expansion and urbanization, it also results in the loss of riparian infrastructure, such as roads and houses. Loss of livelihood, financial hardship, and displacement accompany these impacts, and in most cases, the government does not offer any form of compensation. The damage ensued by local residents and fishermen is significant. And although sandbags and concrete structures have been added to the riverbanks in an attempt to prevent further erosion, the sand dredging continues unabated to allow for urbanization.

The next chapter delves into the meaning and significance of the findings from both case studies and explains how the data relates to the literature and the contextual framework. Namely, I will utilize the concepts of extractivism and political ecology to further understand the data presented in this chapter.

Chapter 7 – Discussion

7.1 Introduction

The purpose of the previous two chapters was to present the data I collected in order to provide preliminary answers to the research sub-questions guiding this thesis. First, I detailed the environmental and socio-economic impacts of sand mining on communities living along China's section of the Red River and Cambodia's section of the Mekong River. Second, I have outlined the inner workings of the sand mining industry in these two areas. The purpose of this chapter is to further substantiate these answers, namely by addressing how my findings relate to the scholarship I mobilized in my conceptual framework.

This chapter is divided into four sections. In the first two sections, I detail how each case study informs the first research sub-question, emphasizing environmental and socio-economic findings. For the Chinese case study, I analyze discourses related to sand mining to shed light on various perceptions of the environmental impacts of sand extraction, namely by utilizing Scoville-Simonds' (2009) power over discourse and power through discourse to unpack political ecology's discussion as applied to this case. I then utilize the development minerals framework to explain why the local sand mining industry appears to bring more development benefits than setbacks, particularly in terms of infrastructure. For the Cambodian case study, I link the observed environmental impacts to the wider sand mining literature. I then mobilize the sand extractivism approach developed by Bisht (2021) to analyze the reported socio-economic impacts, emphasizing the rural-urban dichotomy.

In the third section, I analyze both case studies simultaneously to answer the second research sub-question probing the inner workings of the sand mining industry. I proceed this way since the findings from each case study overlap significantly and provide more insight when considered as a whole. I first apply Acosta's (2013; 2017) indicators of extractivism to analyze the inner workings of the Cambodian and Chinese sand mining industries. I then examine the political ecology of Cambodia by investigating how the government leverages particular discourses to frame the 'problem' in ways that benefit its interests, as conceptualized by Scoville-Simonds' (2009) notions of power over discourse and power through discourse. Finally, I explain why I suspect that illegal sand mining is taking place along China's section of the Red River and Cambodia's section of the Mekong River.

In the final section, I answer the overarching question of my thesis: What are the benefits and drawbacks of sand mining in the study sites? I address this question last in order to use elements from the findings and discussion as a whole to provide an answer as comprehensible as possible. For the Chinese case study, I summarize some of the findings to demonstrate that the local sand mining industry appears to offer several benefits for riparian communities at first glance. In the Cambodian case study, I reexplore some of the findings to illustrate how the local sand mining industry appears to have brought significant drawbacks for riparian communities.

7.2 Insights on the Environmental and Socio-economic Impacts of River-Sand Mining on China's Section of the Red River

I undertook the case study in China with the expectation that the findings on the local environmental and socio-economic impacts of sand mining be consistent with the literature. That is, I anticipated collecting descriptions of environmental damage and social dissatisfaction with the sand mining industry, with perhaps a fraction of locals economically benefiting from the sector. Instead, the data collected told a different tale; one in which locals did not pay much attention to the industry. Although I was able to gather valuable insights into the socio-economic impacts of sand mining along the Red River, the environmental impacts remain unclear from a local perspective.

In the first part of this section, I use a discourse analysis approach to reflect on the environmental variables of the Chinese case study and the reasons why local residents reported so few impacts. In the second part of this section, I build on the development mineral approach to illustrate how such an industry can prompt modernization.

7.2.1 Environmental Impacts

Most of the questionnaire we prepared for the Chinese case study was centred on environmental issues. In fact, by using satellite imagery, we were able to determine that extensive sand mining was taking place along the Red River until 2020, peaking in 2018 with 81 sand boats in the study area alone. Consequently, we centred much of our questions on environmental aspects and expected the data to reflect the environmental impacts reported in the broader sand mining literature. Therefore, we were somewhat surprised when the data we received did not provide much information regarding environmental dimensions. But one thing that this lack of information suggests is that local residents are either unaware of, or denial about, the actual impacts of the sand mining industry on the Red River.

We suspect that this is in part due to the dams —Nansha and Madushan— that were developed and completed in this area in the late 2000s-early 2010s (Rousseau, 2014). These massive structures visible to everyone in the area, have had a tremendous impact on the agrarian communities living along this stretch of the Red River (Rousseau, 2014). As explained in Chapter 3, the creation of reservoirs has impacted farming-centred livelihoods due to ensuing flooding and hydrological changes. Although households were financially compensated, many have argued that the amount received was insufficient. In the same chapter, I explain that the impacts of sand mining and dams often overlap to the point that they become contributing factors to similar problems, such as erosion. Furthermore, these dams and reservoirs caused immediate and drastic environmental changes that continue to this day, whereas large-scale sand mining emerged more recently and its effects tend to manifest themselves gradually over time.

On another note, the village meetings held to inform locals that sand mining would take place along the Red River did not address any potential environmental impacts that could ensue from such activities. The chief of Village B even proclaims that sand mining is beneficial to the environment. Thus, the message from the authorities regarding sand mining is that the industry is harmless. However, sand mining has recently been banned throughout Yunnan Province. Since cheap sand is necessary for China’s relentless urbanization and modernization agenda, this was probably not a decision taken lightly. The ban was likely enacted to mitigate the environmental issues caused by sand mining, which contradicts the chief’s statement.

Another hypothesis that could explain why locals have not reported significant environmental impacts is that the consequences of sand mining have not become fully visible yet, as they can take more than a decade to become visible (Koehnken, 2018; Padmalal & Maya, 2014). In light of this, it appears that while sand mining does have some environmental impacts, the locals attribute them solely to the dams.

This reasoning echoes Bacchi (2012)’s approach to discourse analysis, which states that when analyzing a situation, we need to ponder why the problem is framed in the way that it is, who controls the definition of the problem, and to what extent that control is contested (see also Scoville-Simonds, 2009, 31). In this case, we think that the locals' worldview is influenced by their belief that the dam is problematic for the environment and that sand mining does not cause any real harm. Yet, it is not only their own beliefs that shape the definition of the problem but also the messages of the authorities, including the village chief. Ultimately, this definition of the problem does not seem to be much contested, with only one interviewee (I-6) seeming to have views aligned with how the literature conveys the impacts of sand mining. This being said, China remains an authoritarian state; therefore, it is possible that more people are covertly contesting the discourse presented by the authorities.

In sum, even if the responses collected through the questionnaire do not indicate a high level of environmental concern related to sand mining, we suspect that there are indeed environmental consequences stemming from this activity. Further environmental studies should be conducted in the area to assess the true impacts.

7.2.2 Socio-economic Impacts

Contrary to what most of the sand mining literature reports, local residents appeared to be content with the industry operating locally. In fact, people spoke positively about infrastructure development, royalties, employment, and economic activity.

This is in many ways related to the 'development minerals' framework (Franks, 2020), which states that non-metallic minerals are mostly used locally and can be a force for positive change within the local community. In the Chinese case study, the extracted sand appears to be mostly used for local infrastructure projects, as there have been important infrastructure development in the area over the past decade, and no interviewees mentioned sand exports (Figure 7.1). The new constructions are made primarily from concrete, a material for which sand is the main ingredient. Therefore, the local extraction of sand has directly served to upbuild the communities in which it was dredged. The development mineral framework also states that non-metallic mineral extraction does not attract as much foreign investment as metallic mineral extraction. Again, this proves to be true, as the interviews revealed that all owners and managers were national citizens, albeit from other Chinese provinces.

Franks (2020) also notes that development minerals generate livelihood opportunities and reduce poverty. In this instance, the sand mining industry employed local people until the ban was implemented. The sand mining companies paid royalties to local residents, who could also use the sand from the pits free of charge to renovate their homes. Lastly, eight interviewees said that the sand workers coming from afar contributed to the local economy by purchasing meals, water and cigarettes in the villages.

In the Chinese context, ownership and control of river sand have an added layer of complexity since rural residents have a customary right to use river sand. As Zhu (2022) explains in her book, this is because rivers have long been considered as a communal property of riverfront communities, and their livelihoods are customarily intertwined with these rivers. Therefore, many residents claim that this is "their sand" and village committees advocate for this to be taken into account in extractive initiatives (Zhu, 2022, p. 19). This may explain why royalties were given out to villages adjacent to the extraction.

Although some negative impacts have been reported, such as loss of farmland, heavier traffic, a diverted highway, and nighttime noise, the socio-economic impacts from the sand mining industry along the Red River in China seem to have been more beneficial than detrimental. The local sand mining industry seems to have directly improved the general well-being of local residents and has been a driver of infrastructure development in the study area.

7.3 Insights on the Environmental and Socio-economic Impacts of River-Sand Mining on Cambodia's Section of the Mekong River

The data from the Cambodian case study are more aligned with the scientific literature on sand mining and, in some instances, the findings are even more significant than anticipated. We already knew from media articles and previous theses in Phnom Penh (Beckwith, 2020; van Arragon, 2021) that there were substantial social impacts stemming from sand mining-driven environmental changes, but the extent of riverbank erosion documented above is striking.

In the first part of this section, I link the reported environmental findings to the sand mining literature. Then, I approach the overall socio-economic impacts by bringing the data into conversation with Martín (2017)'s take on the urban-rural dichotomy and with the sand extractivism framework developed by Bisht (2021).

7.3.1 Environmental Impacts

The responses from the interviewees on the environmental impacts of sand mining covered several aspects, most of which were described as pressing issues that directly affect the respondents' quality of life. The reported impacts concern erosion, landslides, biodiversity, and wetlands.

Prior to the fieldwork, I anticipated the riverbank erosion to average a few meters in width. Instead, questionnaire responses reported erosion that ranged hundreds of meters in width, with the highest report reaching 400 meters. And although these estimates are based on personal accounts rather than scientific measurements, they originate from people long-established in the area and not from hearsay. Furthermore, it is not only local residents who have witnessed erosion; sand workers too stated that the river is becoming both wider and deeper due to sand mining activities (I-012 and I-014), giving these accounts greater credibility.

Even more concerning is the high risk that erosion will worsen exponentially. As erosion weakens soil structure, eroded land becomes more susceptible to further erosion (Ritter, 2018). This suggests that, even if all sand mining activities were to cease immediately, there would still be a high risk of continued erosion.

In a related vein, sand mining indirectly contributes to the infill of wetlands and sections of the Mekong River. These include land reclamation sites such as Boeng Tompun, Kdey Chas, and Koh Norea (Figure 6.13). Although this allows for urban expansion—as we discuss below—it also destroys important environmental services. As described in Beckwith's Ph.D. thesis (2020), these wetlands provide natural wastewater treatment, flood control, and irrigation, and they are productive agricultural zones. Their flooding is of particular concern since Phnom Penh is "[s]ituated in a floodplain and with no central sewage treatment facilities" (Beckwith, 2020, p. 39).

Interviewees also shared their belief that the sand mining industry is detrimental to fish populations in the Mekong River. Given that sand mining is known to destroy fish feeding and spawning grounds, this belief is tenable (Koehnken, 2018; Pitchaiah, 2017). One of the sand miners (I-014) argues otherwise, stating that he has never seen a fish on the barge he empties. Again, this comment aligns with the literature since it is not adult fish that are sucked up by the dredges, but rather embryos (Koehnken, 2018). Moreover, even if no fish are instantly harmed during the sand collection, their spawning grounds are destroyed since many fish species lay their eggs on sandbars (Koehnken, 2018). The noise generated by dredging activities is also known to disrupt nesting and breeding activities (Pitchaiah, 2017). Whether or not this is already contributing to the decline of fish in the Mekong River, it is bound to do so in the coming years.

Finally, other species rely on fish as a food source, and the decline of fish populations is likely to eventually affect the rest of the food chain.

In sum, the environmental impacts of sand mining witnessed along the Mekong River in Cambodia align perfectly with those described in the literature. Regarding riverbank erosion, the situation appears to be worse than most scholarly accounts describe.

7.3.2 Socio-economic Impacts

All of the aforementioned environmental impacts translate into socio-economic impacts. On the positive side, sand mining has fueled Phnom Penh’s urbanization in terms of concrete infrastructure and land infill. Given that Phnom Penh is surrounded by wetlands, infill is vital for the city’s expansion. Over the past decade, Phnom Penh’s population has neaarly doubled, and the city is in dire need of more housing facilities (Habitat for Humanity, 2019; World Population Review, 2022). Newly built transportation infrastructure has shortened travel times and has even reduced fuel costs for local people. Furthermore, urban expansion means that the city is getting closer to the villages in the study area, and consequently, land values are increasing. This means that those with land titles can yield a high premium when selling their land. Thus, the sand mining industry has generated positive outcomes in the Phnom Penh region.

However, erosion has become so acute in the study area that it is now affecting riparian infrastructure, such as roads and houses (Figure 6.9). In fact, 8 of the 11 residents interviewed reported that erosion had damaged their houses. Furthermore, the decline in fish catches is particularly worrisome, as the Mekong River feeds more than 60 million people altogether. This again threatens not only people's livelihoods but also food security.

The only people here who seem to truly benefit from sand mining in this context are the urbanites, for whom wetlands are being filled and infrastructure is being built. Conversely, people living near the extraction sites tend to suffer. There is a certain irony here, in the sense that some people's homes are being destroyed in order to build homes for others, thus worsening wealth inequalities. More specifically, the sand extracted for land reclamation and construction in the outskirts of Phnom Penh is causing massive erosion along the riverbanks of the study area, resulting in houses falling into the river. The urban-rural dichotomy, as explained by Martín (2017) within the extractivism framework, is thus relevant in this instance, as well as writing on political ecology, as it outlines clear unequal power dynamics unfolding in the context of environment-society relations (Blaikie & Brookfield, 1987).

In the Cambodian context, sand mining rather stands out as a vector of increasing inequalities, enriching the politically well-connected elite while impoverishing the already vulnerable population (van Arragon, 2021). As sand mining damages livelihoods without compensation, rural Cambodians sometimes find themselves forced to join the very business that deprives them of their original source of subsistence: the sand business. Although sand mining may pay better than alternative occupations, such as factory work, sand labourers are at risk of exploitation by their employers because the state provides no legal protection. Additionally, the authoritative regime and businesspeople benefit massively from this exploitation, encouraging its unsustainable continuation and suppressing dissent. In his thesis, van Arragon concludes that although it is the sand labourers who physically exploit the sand, they should not be held responsible for the impacts of the sand industry. Similar observations were made in this thesis.

According to Acosta (2013; 2017), protests often accompany extractivist projects. However, the data collected does not recount such tales of resistance. Instead, interviewees seemed apprehensive when speaking with Munny. In her thesis, Beckwith (2020) explains that this lack of resistance from the Cambodian people can be attributed to the trauma of conflict, particularly from the Khmer Rouge era. She goes on to explain that the government deploys various strategies to minimize political opposition and public protest, namely through threats, violence, and surveillance. Indeed, there are numerous documented cases of Cambodian activists being incarcerated or otherwise punished for their peaceful protests and advocacy against sand extraction activities (Amnesty International, 2021; Cambodian Center for Human Rights, 2015; Radio Free Asia, 2018). This may explain the lack of resistance found in the Cambodian case study, even when people were faced with life-threatening environmental changes.

Moreover, the findings from the Cambodian case study seem to align with Bisht's (2021) sand extractivism framework. Firstly, the sand mining companies are indeed economically and politically powerful in the Phnom Penh region. The Cambodian government is notorious for state patronage, and the sand mining industry is no exception (Schoenberger, 2017). For instance, business tycoon Try Pheap once ran a multi-million-dollar illegal timber operation backed by government officials and now runs one of the sand companies in Phnom Penh (van Arragon, 2022). Natural resource extraction in Cambodia is thus riddled with corruption.

Secondly, the mining of river sand is not confined to one area and tends to be widespread. When the erosion got bad in Phnom Penh, the government banned sand dredging within the city limits and all the boats moved upstream, including to the study area. We also know from the interviews that erosion is not limited to the study area, but also occurs elsewhere along the Mekong River, such as in Steung Treng, Kratie, Kampong Cham, and Kandal. Thirdly, as we explained above, sand mining predominantly benefits urban areas. Fourthly, the evidence shows a deterioration of livelihoods, particularly in agriculture and fisheries. And although there are some documented cases of local residents becoming sand labourers, this occupation is precarious, and the industry is unsustainable in the short term (van Arragon, 2021). Lastly, the sand companies are violent towards people, nature, animals, and traditions. More specifically, the erosion is forcing people to relocate, the dredging is forcibly changing the geomorphology and ecology of the Mekong River, and this destruction is threatening traditional livelihoods.

To recapitulate, the sand mining industry has benefited Phnom Penh's urban population while afflicting rural riparian communities, especially in terms of their livelihoods, housing and food security. The noted lack of resistance despite these impacts can be attributed in part to Cambodia's violent past and authoritative government. Lastly, the socio-economic impacts near Phnom Penh fit perfectly into Bisht's sand extractivism framework (2021).

7.4 Insights on the Inner Workings of the Sand Mining Industry on China's Section of the Red River and Cambodia's Section of the Mekong River

In this section, I will discuss the sand mining industry in terms of processes, operations, labour, and regulations in both China's section of the Red River and Cambodia's section of the Mekong River. The decision to look at both sets of findings simultaneously was made because of the many similarities between the two cases. I will first refer to Acosta's extractivism framework to further explore the data. Then, I will analyze the discourses conveyed by the Cambodian government regarding sand mining. Finally, I will enunciate the reasons why I suspect that illegal sand mining may be occurring on both rivers.

To better understand the findings on the inner workings of the sand mining industry in both case studies, I use Acosta's (2013; 2017) extractivism indicators. These indicators first state that the resources produced through extractivist processes tend to be exported as raw materials and transformed elsewhere. This is true in the Cambodian case study since the sand is extracted in rural areas and transported to Phnom Penh to be transformed into land and concrete. However, in the Chinese case study, the extracted sand appeared to be used primarily for local development.

Secondly, Acosta (*ibid*.) states that most inputs, such as machinery, are imported. Although I do not have specific data on this issue, there is nothing to suggest that the sand dredges and other equipment were manufactured locally. In China, they are manufactured domestically, but not in Yunnan province. In Cambodia, everything suggests that the machines are imported, which supports Acosta's theory.

Thirdly, Acosta notes that high-paying jobs, such as managerial or skilled positions, are often held by foreigners, while low-skilled jobs are held by nationals. In China, the two former sand workers confided that their pay was inadequate and that the industry was only lucrative for people higher up the management ladder. They also revealed that their bosses came from other Chinese provinces, with the exception of one sand pit that was owned and operated by locals. So this statement is true in the Chinese case study. In Cambodia, all the workers interviewed were from another province, which contradicts the statement that locals occupy low-skilled jobs. This is likely not due to a lack of interest, as Cambodian sand workers shared that they preferred to work in the sand industry rather than in factories or construction because the pay was more stable. Relatedly, van Arragon (2021) found in the same area that most sand boat owners were Vietnamese, which would support the idea that only low-skilled jobs, if any, are available to the local population.

Fourthly, Acosta states that extractive industries tend to offer employment solely to men. I found this to be true in both case studies. When we asked for an explanation for this gender segregation in China, one of the women said that she would not consider joining the sand mining industry because “she is a woman and has to sell fruits at the market” (respondent i-6). In Cambodia, lesser athletic abilities and a lack of interest in the industry were cited. Yet, Munny came across the wife of a dredging worker (I-012), who lived on the boat and worked as a cook for free. van Arragon (2021) also highlights this in his thesis, explaining that this is a strategy used by couples, as the captain does not have to pay for a cook out of his own pocket.

Lastly, Acosta notes that extractivism often coexists with subsistence economies, resulting in a dual economy and a situation where only a handful of local residents benefit from the extractive industry. In China, very few residents were employed by the sand mining industry, while most worked in agriculture and retail. Although the industry did not appear to stimulate much economic activity, all locals received royalties. So while the sand mining industry did not interfere much with the subsistence economy, it did directly enrich the residents. It is also thanks to the sand mining industry that villages have been able to develop their local infrastructure. In Cambodia, the sand mining industry did not seem to contribute in any way to the subsistence economy. On the contrary, it has destroyed agricultural land and reduced the number of fish in the Mekong River. Thus, not only did the Cambodian sand mining industry not contribute to the local subsistence economy, it directly damaged it, along with overfishing, dams, and climate change.

In both countries, authorities appear to be somewhat aware of the potential impacts of river sand mining. On the Red River, dredging sand within one kilometre of a bridge or highway is prohibited. In Cambodia, the government has banned river-sand mining within the city limits of Phnom Penh. These policies suggest that the policymakers know that sand mining can cause erosion and damage infrastructure. Yet interestingly, the Cambodian government reports that erosion is not caused by sand mining, but rather by unavoidable natural phenomena. Some sand labourers and even some locals have adopted this worldview as their own, which attests to the potency of government discourses.

This is because actors in power promote discourses that fit their worldview to the detriment of those of other actors. To recapitulate, the relationship between power and discourse can be understood as: one, power over discourse; and two, power through discourse (Scoville-Simonds, 2009). In the Cambodian context, the government agencies promote a worldview in favour of sand mining and construct the problem as a natural phenomenon outside of their realm of control. Here, the Cambodian government exercises power over discourse by controlling the language and ideas of its population (Scoville-Simonds, 2009). Although 80 percent of the households in the area blame sand mining for erosion—according to respondent I-03—most interviewees seemed hesitant to express such views to Munny. Some journalists also have attempted to report on this issue, but often with limited impact, as Cambodia is notorious for cracking down on journalists who publish stories blaming the authorities for environmental and social problems (Corben, 2017).

The Cambodian government also exercises power through discourse by implementing measures and solutions in line with its worldview (Scoville-Simonds, 2009). For instance, instead of banning sand mining in the study area, like in Phnom Penh, to slow down erosion, the authorities implement strategies such as dumping sandbags and concrete layers on the riverbanks. This allows them to continue to extract sand locally without being held accountable for the damages caused by the sanctioned sand mining industry, such as compensating riparian families for their losses.

The data also suggest that illegal sand mining may be occurring in both case studies. For instance, in China, the village chief of Village B told us that he did not want to join the sand mining industry because “the government has been strictly investigating illegal sand mining activities. Those mining sand illegally will be fined hundreds of thousands or even millions RMB”. This is strange, as the questions asked were never about illegal sand mining. His allusion to the consequences of being caught in illegal sand mining activities suggests that he is aware of ongoing illegal sand mining and does not want to get involved. Furthermore, respondent i-11 said that since the ban, only one sand mining company is allowed to operate in the area under the label of "river cleaning". Although reservoir dredging can indeed prevent sediment accumulation on the reservoir flood, this justification could also be used as a way to circumvent the sand mining ban (Ge et al., 2021). In her book, Zhu (2022) documented several cases of illegal sand mining in China, and the above data suggest that such activities may be occurring on the Red River.

In Cambodia, the government does not publicly share any details about the dredging zones. As a result, it is difficult for riparian communities to discern when boats are dredging outside of their designated areas. Locals have confided that the flags that are used to indicate dredging zones tend to “slide” closer to the banks over time. This could be done by the authorities or sand companies when zones are altered, but it could also be a tactic used by the latter companies to dredge outside their designated lot without getting caught. Furthermore, sand boats are not allowed to operate past 6 p.m., yet one respondent claims to have heard them working throughout the night. Again, these circumstances suggest that illegal sand mining activities may also be taking place in the Cambodian study area.

7.5 From a local perspective, what are the benefits and drawbacks of sand mining in the study sites?

The portrait of the local sand mining industry is painted differently in each research area of this thesis. This section of the discussion aims to capture the overall picture of the two case studies by evaluating the pros and cons of sand mining. I will first explore this question through the Chinese case study and then do the same with the Cambodian case study.

The interviews conducted on the Chinese section of the Red River revealed that local residents were not concerned about the potential environmental impacts of the local sand mining industry. As explained in Section 1.2.1, this may simply be a matter of perception, but based solely on the interview transcripts, the sand mining industry does not cause much environmental damage. Rather, residents spoke of infrastructure development, royalties, employment, and economic activity. The few downsides of sand mining on China's Red River that respondents mentioned included loss of farmland, air pollution, traffic, and possibly illegal mining. Although the interviews conducted with local residents suggest that the sand mining industry does not cause much environmental damage, the possibility of negative impacts becoming visible in the future cannot be ruled out, as the literature notes that some impacts take a decade or more to become visible (Koehnken, 2018; Padmalal & Maya, 2014). Furthermore, the ban on sand mining in Yunnan Province does not guarantee the absence of future impacts. While there may appear to be more benefits at first glance, it cannot be concluded that sand mining on China's section of the Red River is clearly more beneficial. Based on the findings of this study, further research is recommended to fully evaluate the long-term impacts of sand mining on the Red River and its surrounding environment.

The interviews conducted along the Cambodian stretch of the Mekong River tell a different story, one in which residents are deeply dismayed by the ongoing sand mining. Even when sand mining allows for infrastructure development, the areas that benefit are urban. Conversely, the areas where sand is mined are experiencing erosion to the point that local infrastructure, especially along the Mekong River, is deteriorating. While the sand industry does provide local employment, the data collected indicates that the people hired for these positions are from other Cambodian provinces. It also affects fishing, an important livelihood in the region, and has led to the disappearance of at least one island. Considering all the pros and cons of the sand mining industry near Phnom Penh, it appears to be doing more harm than good to the communities in the study area. Further studies could help shed light on the potential long-term impacts of sand mining in the region and inform policymakers on possible measures to mitigate any negative effects.

7.6 Conclusion

This chapter delved into the findings presented in chapters 5 and 6. In the first section, I dissected China's findings to further understand the environmental and socio-economic impacts I described earlier. I showed how the lack of reported environmental impacts from sand mining could be due to the nearby dams and the sudden changes they have brought, or because none of the impacts from dredging have yet become visible. The recent ban on sand mining on the Red River is further evidence that there may be more environmental impacts stemming from this industry than what was reported in the findings. I then reviewed the socio-economic impacts using the development mineral framework, which illustrates how an extractive industry can be beneficial to local communities.

In the second section, I reviewed the environmental impacts reported in the Cambodian case study and linked them with the sand mining literature. I then did the same for the socio-economic impacts but instead linked them with Bisht's sand extractivism framework. I also highlighted how Phnom Penh's urban population is predominantly benefiting from sand mining, and how historical trauma and ongoing oppression partly explain why residents do not resist.

In the third section, I delved into the internal dynamics of the sand mining industry for both case studies. I first employed Acosta's extractivism indicators, which allowed me to reflect on certain aspects of the sand mining industry, such as the ratio of male to female workers. I then revisited the Cambodian government's discourse on sand mining and identified some of its discursive strategies. Finally, I highlighted that the sand industry might be ongoing illegal activity in both case studies.

In the fourth and final section, I answered the main research question, which is what are the benefits and drawbacks of the sand mining industry in both China's segment of the Red River and Cambodia's segment of the Mekong River. In the case of China, the answer is positive, and in the case of Cambodia, the answer is negative. The overall answer is therefore nuanced, depending on the context, how impacts are viewed and addressed, other activities, etc.

Overall, this discussion has provided a better understanding of the environmental and socio-economic impacts of river-sand mining on the Red and Mekong Rivers, and the inner workings of the sand mining industry in these two areas. Such an analysis has given further meaning and relevance to the findings within the sand mining literature.

Chapter 8 – Conclusion

This thesis has explored the sand mining industry and its environmental and socio-economic impacts on China's section of the Red River and Cambodia's section of the Mekong River. The objective was to understand the inner workings of the sand industry, particularly sand labour, and how riparian communities are affected by sand mining. I answered three research questions in chapters 5, 6, and 7. To reiterate, the overarching research question of this thesis asked what the pros and cons of the sand mining industry are along China's Red River and Cambodia's Mekong River. Two sub-questions helped guide my inquiry. The first sub-question asked how sand mining translates into environmental and socio-economic impacts on communities living along China's Red River and Cambodia's Mekong River. The second sub-question asked what the sand mining industry entails in terms of processes, operations, labour, and regulations in these rivers.

Regarding the inner workings of the Chinese case study, my research found that while the sand mining industry provided employment opportunities, these were short-lived due to the recent ban on sand mining by the Yunnan authorities. During their employment, workers were dissatisfied with their conditions, stating that they worked too much for too little pay and that their superiors earned far more than casual labourers. Although the industry boosted local economic activity, it also forced some residents out of their land and livelihoods as it occupied farmland along the Red River. The policies and laws surrounding the industry are opaque, and sand workers themselves have a poor understanding of the regulations. This lack of knowledge appears to extend to the legality of current sand mining activities, which are labelled as "river cleaning". To date, no study has focused specifically on sand livelihoods in Yunnan Province, China. As such, this study provides insight into this emerging livelihood in a geographic area generally overlooked by sand researchers.

Regarding the inner workings of the Cambodian case study, my research showed that although the industry seems to generate livelihoods for Cambodians, the sand labourers tended to come from outlying provinces. The data also suggests that the boat owners are foreigners. Furthermore, there was little economic activity generated by the presence of sand labourers since their employer provided them with food and lodging, and most of their wages were sent back home as remittances. Sand labourers' incomes appeared to be higher and more stable than for other unskilled jobs, such as construction or factory work. Despite the fact that they benefit from very few days off, the sand workers interviewed appeared satisfied with their occupation. They acknowledged, however, that they would not be able to do this work indefinitely since it is very physically demanding. The labourers seemed somewhat aware of industry regulations, such as where their company is allowed to dredge. These data allowed me to extend Lukas van Arragon's (2021) findings on sand livelihoods near Phnom Penh, and to contribute to the small but growing literature on sand livelihoods.

The environmental impacts of sand mining in China remain unclear, most likely due to the local population's perceptions of the industry. The findings of the Chinese case study contradict the literature I reviewed in Chapter 3. In Cambodia, the data clearly show massive bank erosion and a decline in the Mekong's fish population, which is much more in line with what the sand mining literature says.

The sand mining industry also prompted a series of socio-economic consequences. In China, locals seemed relatively satisfied, largely because of the infrastructure development, royalties received, and economic activity generated by the industry. In Cambodia, the lived experience of locals with nearby river sand mining can be described as chagrined, with people deeply discouraged by the industry, especially because of eroded land, sunken houses, and lost livelihoods. These contrasting experiences can be explained by the perceptions and magnitude of the environmental impacts and the relationship between the sand industry and local communities.

This dual case study offers different perspectives on the impact of sand mining. On the one hand, the data on the inner workings of the sand industry seemed to align in many respects. There is a growing body of research on the livelihoods of sand miners (Anokye et al., 2022; Lowe, 2018; Marschke & Rousseau, 2022; van Arragon, 2021), and this work provides an additional understanding of this opaque and understudied workforce.

On the other hand, the data on the environmental and socio-economic impacts depicts diverging realities. The general picture that emerges from the case studies is that the severity of the impacts and concurrent environmental stressors within the same environment—such as damming and flooding—are the best indicators of whether a community will perceive the sand mining industry as beneficial or detrimental. In China, nearby dams have caused major socio-environmental changes in a short period of time, and local residents have never been adequately compensated for their losses. As a result, many negative changes potentially associated with the dredging of the Red River have been dismissed and blamed on the dam. In Cambodia, however, the dams along the Mekong River are several hours away from Phnom Penh, while the sand boats are visible from the riverbanks. So when the banks began to erode at a rate villagers had never seen before, they attributed the change to the ongoing sand dredging.

As a social scientist, I am unequipped to assess the exact causes or extent of these environmental changes. However, I can state from a cluster of strong, accurate and consistent data, both from this thesis and the literature, that sand mining is most likely causing serious environmental damage along the Mekong River. Further environmental studies would need to be conducted in the area to confirm these findings. In the Chinese case study, the evidence is too inconclusive to reach such a conclusion. Future environmental studies on the Chinese section of the Red River will need to further explore this area to understand the extent of local sand dredging, especially in an area where many dams have been built in the last decade.

Although sand has allowed our cities to expand and our buildings to rise, this development has come at a cost that is most often borne by the communities where sand is mined. If we are to continue to build modern worlds of sandcastles, we must consider the fragile balance of river ecosystems and the well-being of riparian communities. It is not by burying our heads in the sand that China, Cambodia, or any other country will solve unsustainable sand mining. In fact, it is by burying our heads in the sand that we risk destroying the sandcastles we have built.

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