

Work and struggle of fishing livelihoods in the Delta: Development and ‘new’ change along the Ayeyarwady (Irrawaddy) River, Myanmar

Stella Radford  and Vanessa Lamb 

School of Geography, The University of Melbourne, 221 Bouverie Street, Melbourne, Victoria, 3053, Australia.
Email: radfords@student.unimelb.edu.au, vanessa.lamb@unimelb.edu.au.

Abstract: *Fishing constitutes a key source of income and food for rural communities worldwide. This is the case in predominantly rural Myanmar (World Fish, 2019), particularly in the Ayeyarwady (Irrawaddy) River Delta. Fishing has long been a central livelihood strategy and valuable source of food security in the Delta, and now also generates a substantial contribution to the gross domestic product. However, the livelihood practices of the fishers, particularly small-scale fishers, are largely ‘invisible’ in the literature and policy. In this article, we advance understanding of the significant but understudied livelihoods of small-scale fishers through interviews with fishers and a range of other actors in 2018. Taking a careful examination of the challenges, practices and responses of fishers in the Delta, our research underlines that fishers are important actors in the ‘making’ of the Delta as a geographical scale and concept, yet they are being pushed out of the very landscape they have helped co-create and have lived in for generations. At this crucial point in Myanmar’s development and change, we contend that a better understanding of the livelihoods of fishing households, as some of the nation’s most vulnerable, is important for inclusive policy development, economic reforms and research strategy going forward.*

Keywords: *Development, fisheries, livelihoods, Myanmar, political ecology*

Introduction

Fishing constitutes a key source of income and protein for rural communities worldwide. One place where small-scale fishing based livelihoods are becoming a struggle to maintain is along Myanmar’s most prominent river system, the Ayeyarwady (Irrawaddy) River. The river is a national symbol and its ecosystem services are an invaluable asset. It contributes between two to six billion US dollars to the domestic economy annually (WWF, 2018: 4) and supports the livelihoods of one of Myanmar’s most populated (UNDP, 2014: 1) and poorest regions (Central Statistical Organization *et al.*, 2018).

Fishing significantly contributes not only to the economy, accounting for 15.8% of Ayeyarwady Region’s gross domestic product (UNDP, 2014: 14), but also to the livelihood strategies of many households by providing food security and income (Angeles *et al.*, 2019). Fish constitutes approximately 60% of animal protein intake in Myanmar (WWF, 2018).⁷ The Delta’s rapid

development since the country’s political and economic ‘opening’ in 2010–2011 has posed new challenges for fishing villages in the Delta, disrupting and creating new competition for the river-based livelihoods that these villages have relied on for generations. The situation demands that small-scale village fishers adapt to the new challenges, but the reality of their circumstances is one of extreme limitations and a lack of coordinated support from government or other agencies (Tezzo *et al.*, 2018).

Yet, there is a ‘lack of attention paid to Myanmar’s fisheries’ (Belton *et al.*, 2019: 1). There is little in the academic literature about Myanmar’s fishers and fishing (Tezzo *et al.*, 2018), and even less about the lives and livelihoods of small-scale fishers in the Delta (Thein *et al.*, 2019). As a 2019 Myanmar fisheries report explains,

Dramatic changes are shaping the small-scale fishery sector, driven by new investment and diverse government policies oriented towards opening up the country. Amidst all this, the voices and aspirations of those who are among

those being affected by these dynamics – men and women in the small-scale fishery section – are mostly invisible. (Angeles *et al.*, 2019: 1)

As a step forward in addressing this knowledge gap, the data presented here on small-scale fishing livelihoods was generated through interviews with fishers and a range of other actors in 2018. By conducting research on fishers' livelihoods, and generating a better understanding of their most pressing challenges, this paper contributes to the limited literature that exists about some of the most vulnerable communities at a critical time in the region's development. Our research shows a rapid and severe decline in fish catch, a pressing issue that fishers have linked to a range of causes and responded to in multifaceted ways.

We illustrate the range of potential reasons for fish catch decline, and the decline in the livelihoods and participation of fishers more generally. In doing so, we describe the full riverine livelihood portfolio of the fishers in order to show that within the 'fisher' classification people are often conducting a broad range of livelihood activities.

Understanding this complexity also reveals links between broader transformations – such as a two decade long climb in the export of fish (FAO, 2019: 4) and increasing extraction of sand for export – and change in and of the Delta. We argue that attention to these factors is particularly important in Myanmar, as a newly lower-middle income country that is receiving increasing development attention. If policy decisions are going to be made to support fishers going forward, it is imperative that these decisions are informed by the current situation, including how fishers are responding to existing change and policy, or lack thereof.

Key to our arguments and approach is an understanding that these fishing livelihoods are linked to the Delta as a geographical concept (Biggs *et al.*, 2009) in ways that go beyond utility or income to include lived struggles of fishing over generations. Careful attention to the challenges identified by fishers can serve to connect their livelihood struggles to broader debates and contests over resources. Our research underlines that fishers are important actors in the 'making' of the Delta as a place and as geographical scale and concept, yet they are being pushed out of the very landscape

they have helped co-create and have lived in for generations. At this crucial point in Myanmar's development and change, we contend that a better understanding of the livelihoods of fishing households, as some of the nation's most vulnerable, is important for inclusive policy development, economic reforms and research strategy going forward.

Fishing livelihoods and the Delta machine

We approach this research from a political ecology perspective with an understanding that 'landscapes are by definition disturbed – worked, lived on, meddled with, developed' (Wilson, 1992: 17; see also, Braun and Castree, 2001). This is in contrast to, for instance, an understanding of environmental problems that might misunderstand the challenges being faced by fishers in the Ayeyarwady Delta as an impending 'tragedy of the commons', linked only to the rising population and limits of resources (Robbins, 2012: 52). As Marschke notes in her study of fishing livelihoods in Cambodia's coastal communities, key is 'the co-production of livelihoods with nature, something that is often fraught and contested' (Marschke, 2017: 104). This is important because such an approach then positions fishing livelihoods as an integral activity and process of making the so-called 'natural' landscape, rather than an activity, or group of people, to be removed or understood as separate.

Biggs *et al.*'s (2009) introduction of the 'Delta Machine' is illustrative of an approach that understands landscapes as always 'made and meddled with'. They reveal how the Mekong Delta has been 'made' through the work and efforts of a range of actors and technologies over centuries. Taking the Delta as geographical concept that is 'made' rather than as a pre-existing natural artefact (Molle, 2007) means that human activities are not positioned as separate from or as necessarily only posing negative impacts to the Delta. Instead, the governance, technologies and practices of the Delta co-constitute this landscape that we refer to as the Delta. These efforts are ongoing, a 'work without end' (Biggs *et al.*, 2009: 216), underlining that people do not simply 'exist' or 'depend' on the riverine or delta landscape, but they are constitutive of it.

What we add to such an understanding of the Delta is a focus on fishing livelihoods as a vital, if taken for granted, 'invisible', part of the Delta. Our attention to the struggle of the small-scale fishers to maintain their complex livelihoods reveals that, in the context of the new and rapid development, the Delta is being 'remade' without recognition of small-scale fishers and their intimate river knowledge that has been accumulated over many generations. As Weeratunge *et al.* (2014) have described, marginalisation, as well as economic exclusion and political disempowerment detract from fisher's access to, or here more so command over, resources, further impoverishing them.

To attend to these complex fishing livelihoods key to the Delta, we draw on a livelihoods approach, described as 'a people-centred approach to development research which seeks to improve understanding of the situations of the poor by recognising their assets and capabilities, and by understanding how contextual circumstances constrain their access to resources' (Biddulph and Amberntsson, 2017: 451). Such contemporary livelihoods work builds on earlier approaches developed and actioned by practitioners who sought to understand the totality of assets, activities and capabilities that are necessary for people to make a living (Chambers and Conway, 1991; Scoones, 1998). While some of the earlier work has 'attracted critiques for its perceived rigidity and inability to address embedded power relations' (McLean, 2015: 381), it sets out a useful and important framework for study that we build upon here.

Like the landscapes that are constantly remade, we approach livelihoods not as static but in terms of 'how livelihoods shift, evolve and adapt in villages where numerous actors are vying for access to the same natural resources' (Marschke, 2012: 5). We also underline in this article that livelihoods are dynamic and changing (De Haan and Zoomers, 2003), and that the livelihoods we describe are linked across scales, upstream and downstream (Hirsch and Wyatt, 2004).

A useful intersection across these approaches to livelihoods and landscape, and a key concern across both political ecology and livelihoods approaches, is that the work is people-centred (Biddulph and Amberntsson, 2017: 541) and concerned with social justice (Forsyth, 2008). As Biddulph and Amberntsson note, 'this concern with the lived experience of the poor attempted to

correct expert biases which tended to frame poverty in terms of employment and income' (Biddulph and Amberntsson, 2017: 541).

This is certainly important for research in contemporary Myanmar where, since 2010, many residents, and fishers in particular, are entering a more solidly 'cash' or market economy, either as domestic labourers or abroad, and yet they are struggling (Aung, 2019), even 'invisible'. What we mean is that while it is likely that national or regional metrics may show more people as 'employed' and receiving a cash income, and that this may appear as an improvement, an understanding of their more complex livelihood situation is also required in order to understand the impacts and implications of broader changes for people. Such an understanding requires a framing not solely in terms of employment or income, but in relation to their complex livelihood portfolio. For instance, the increase in day labourers in the Delta means that more people are receiving an income, and at the same time, a greater number of people are *leaving* or not doing other livelihoods, like fishing, which support both their daily food intake and income. There is a need to think about these linked process and concerns, in our research and in terms of what policy might look like to support fishers and fisheries. Presenting fishing livelihoods in this vein, fishing is considered an activity not limited to the use of a boat and net, or as only a way to produce cash income. Drawing a livelihoods approach together with an understanding of human-environment relations, and the larger contexts, also helps us position our work on a 'Delta in the making'.

Fisheries and change in the Ayeyarwady Delta

When looking to provide an overview of fisheries, unfortunately the government fisheries data, such as federal statistics, are in many instances unreliable as they are often compiled and then edited to meet state targets so make for a weak basis for improving policy and planning (Tezzo *et al.*, 2018). There are some indicators of large-scale change, though. For instance, the total of all Myanmar's fisheries exports in 1990–1991 was US\$13 million (Soe, 2008), whereas in 2019, 'Myanmar is hoping to earn at least US\$1 billion from fisheries exports' following the lifting of an EU ban on aquaculture products and strong

growth overall (Lynn, 2019). What has been made clear is that, without proactive governance that is informed by extensive and up-to-date research, the rise in one sector (for instance mining or hydro-power) will cause detrimental impacts on other vital sectors (such as fisheries) in Myanmar (WWF, 2018).

While exports statistics have remained significantly higher than two decades ago (FAO, 2019), evidence of overall decline of inland fish yield is now being seen for most species, particularly fresh water high market value species, at a faster rate in recent years (Baran *et al.*, 2018; Tezzo *et al.*, 2018). It is estimated that 12–15 million people in Myanmar generate income through fisheries in some way (Baran *et al.*, 2018), yet, likely because of a reputation for corrupt practices, all three of the major fisheries subsectors (inland capture, marine capture and aquaculture) hold low political status and have been neglected and underinvested in by the state (Tezzo *et al.*, 2018).

Central to the improvement of fisheries in Myanmar is the Department of Fisheries (DoF). The DoF sits under the Ministry of Agriculture, Livestock and Irrigation. That 'fisheries' is omitted from the title is indicative of the relative weight within the Ministry; the DoF branch receives just 0.8% of the Ministry budget (Tezzo *et al.*, 2018). The DoF Ayeyarwady Region office is located in Patheingyi and is responsible for enforcing fishing restrictions through the waterways used by fishers in this research and for collecting their annual fishing licence fee, which according to interviewees is approximately US\$40.

Other agencies important in shaping the Delta environment include the General Administration Department (GAD), responsible for local government issues, and the Directorate for Water Resources and Improvement of River Systems (DWIR). DWIR's mandate is to 'conserve and protect the water resources and rivers system for beneficial utilisation by the public' as well as to develop the 'State economy' through river resources (<https://www.dwir.gov.mm/index.php/vision>).

As we describe further below, our interviews with fishers (along with research elsewhere, Bush and Marschke 2016; Marschke, 2014) shows that sand mining is impacting fisheries. Sand mining has come under the authority of both the GAD

and the DWIR (DWIR Interview, 29 May 2018; Myanmar Centre for Responsible Business (MCRB) Interview 23 May 2018). Not unlike fisheries, there is not reliable data available on how much sand is being taken or where from (WWF, 2018; Lamb *et al.*, 2019), nor have the impacts of its extraction from the Ayeyarwady Delta been detailed in the literature. What is known about sand mining here is that the volume being extracted has increased significantly since Myanmar's "opening" (Soe and Hammond, 2019; MCRB, 2015). It is occurring at the large-scale by Singaporean companies, as well as at smaller scales by businesses serving the demands of new coastal resorts (Lamb *et al.*, 2019). In Cambodia and along the Mekong (Anthony *et al.*, 2015), sand has led to severe erosion of riverbanks and potential 'sinking' of the Delta, which also impacts fishing-based livelihoods (Marschke, 2014).

Research sites and methods

The data presented here was generated from 37 semi-structured interviews with a range of actors (fishers, government officials, NGO staff and academics) and from observations in 2018 (February–March and May–June). Interviews were conducted in Yangon, Myanmar's largest city, Patheingyi, the capital city of Ayeyarwady Region with a population of 237 000 (WWF, 2018), and in five rural fishing villages close to Patheingyi. These five villages are located on the banks of the Patheingyi or Pay Pin Rivers, tributaries of the Ayeyarwady (Fig. 1). The five villages were chosen in conversation with Myanmar academic collaborators also working on fisheries; they are noted fishing villages and had established relationships and trust with the research team. Interviewee names are pseudonyms and we have numbered (rather than named) villages to ensure confidentiality.

The research also included naturalistic observations of change, and some participant observation in boats, alongside the interviews. Together, these produced a wide insight into the livelihoods of rural river fishers through meeting, listening to, observing and participating in livelihood activities during interviews and village visits.

At the village level, we started the research with a group interview with members of six fishing households to establish an approximate

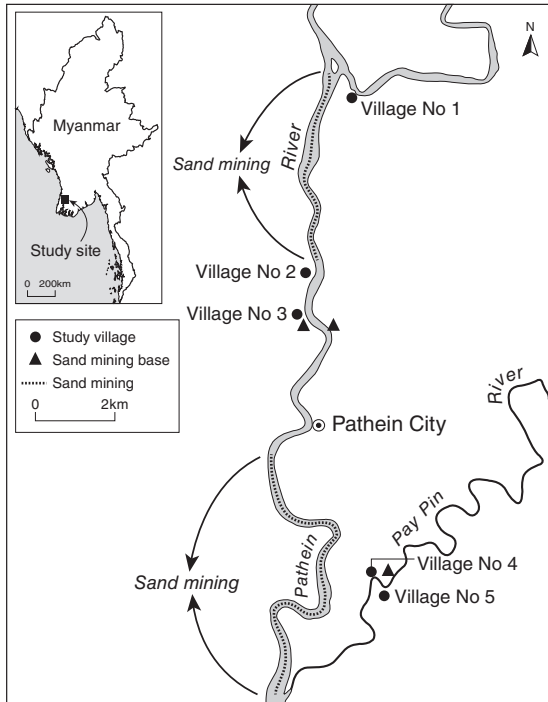


Figure 1. Location of the study site, Patheingyi, Ayeyarwady Region. Cartography by Chandra Jayasuriya, with permission.

livelihoods calendar (Fig. 2). This prepared us for in-depth, semi-structured interviews with 37 individuals living and working in the Delta, and informal interviews with other residents. Twenty-two interviewees were fishers who had lived in their villages for their entire lives. These participants provided detailed personal experiences, insights and perspectives about how their livelihoods change between the seasons and trends in how aspects of this have been changing over their lifetimes. The remaining 15 interviewees included boat-drivers, local researchers, DoF staff, DWIR staff, local sand mining operators and civil society groups. Linked to our conceptual approach, interviewees were encouraged to expand on the reasons they provided to the interview questions by giving explanations for why they held certain views, and to make connections across different aspects of their lives, beyond fishing as an activity limited to the use of a boat and net. Additional interviews were conducted by the second author in February–March 2018 as part of a research project focused on rivers and sand mining.

Interviewee responses were interpreted from Burmese to English by experienced research assistants, audio recorded and transcribed using

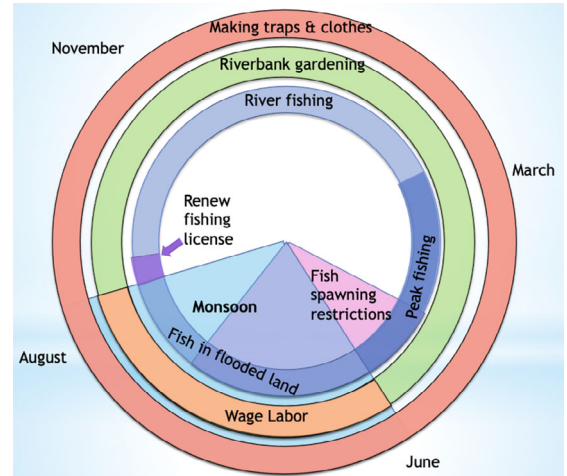


Figure 2. Fishing livelihoods calendar [Colour figure can be viewed at wileyonlinelibrary.com]

pseudonyms. Transcripts were thematically and descriptively coded, the key results of which we present in the following sections. Ethics approval from the University of Melbourne was granted for this research as part of the first author's honours thesis (2018) and as part of the second author's ongoing research project (2017–2019).

The interviews and overall field research was carried out in collaboration with researchers at University of Patheingyi's Marine Science department led by Professor Cherry Aung. As two non-Myanmar, western women studying fishing, a male-dominated occupation in Myanmar, collaboration with a Myanmar university and set of academics and organisations with ties to fishing communities were essential for overcoming barriers in trust and communication.¹

Livelihood and challenges of small-scale fishers

Who are 'fishers' and what constitutes a fishing livelihood?

We highlight two key aspects of fishing livelihoods in this section. First, we outline how fishers and their communities characterised fishing livelihoods and its heterogeneity as well as responses to change. Second, we introduce and discuss key changes and challenges that are part of fishing livelihood struggles at present, and in doing so, reveal some of the associated actors, from local to international, that are also 'remaking' the Delta.

From the start of our research, when we asked and arranged to speak with 'fishers' nearly all the identified individuals were fishermen.² Women largely practiced fish collection by traps in small streams and did not identify fishing as their livelihood; younger men or boys typically acted as assistants or apprentices. This understanding of fishing livelihoods, with men as the fisher and the family supporting them, is not uncommon in mainland Southeast Asia. For instance, in neighbouring Thailand, while many people, men and women, young and old, fish, only a small few will identify as a 'fisher' in terms of a main livelihood. This has had implications for our understanding of fishing livelihoods and for who receives compensation if livelihoods are impacted.³

Second, to be a 'fisher' also had the implication that you would sell the fish caught, even if you also fished for household consumption, and it was both the immediate income and the source of food that was emphasised as key reasons for fishing. The fishers here have access to open fishing grounds which require licences for most fishing gears. The lower entry cost to open access fisheries is important 'particularly [for] the landless for whom fishing requires little investment (as little as US\$10 per net) and is a source of food and possibly income' (Baran *et al.*, 2018: 7). Common catches include hilsa (*Tenulosa ilisha*), prawns and various types of catfish.

In many households, 'fish selling' was a separate activity from 'fishing'. A wife or family member would sell their catch at the Patheingyi Market, to a local fish dealer (who then sold at Patheingyi Market), or directly to others within the village. This was always within the fresh fish supply chain (see also Baran *et al.*, 2018) and fishers would sell their catch on a daily basis, providing regular and immediate income.⁴ The immediate income was described as an important benefit as all households had extremely limited ability to generate income through other assets or to save. As well as selling the fish, the supply would also serve as a central source of protein for the household, providing fishers an element of food security. Maung Lwin, a fisher and father, expressed that 'if we are hungry, I can go in my boat and I can catch some fish' (Interview, June 2018).

Thirdly, fishing livelihoods are diverse. Not only do fishers and their families engage in a range of other activities as part of their overall

livelihoods portfolio, but even within this group of self-identified 'fishers' the fishing practices themselves were heterogeneous and temporally distinct. For instance, while most owned locally made wooden fishing boats (*ngar phan hlay* in Myanmar language) with small, motorised propellers attached, interviewees who identified fishing as their only livelihood generally used both nets and traps, to accommodate different seasonal and river conditions. In contrast, it was common for those who had additional significant livelihood activities to use just nets. This included drift fishing nets, which were often strung between small boats in the river's mainstem; tiger nets (*kyarr phong*); long-lined hook fishing (a baited line dragged behind a boat); small hand-made bamboo traps for catching prawns and crabs in creeks; and larger fish traps also for the mainstem of the river (although these were rare). The tiger net, a gear unique to Myanmar consisting of a bag net underneath a bamboo raft (see also: Nyein and Matthew, 2017) was widely considered to be the most effective for catching large volumes of fish.

Fishing and other livelihood activities were also differentiated seasonally (see Fig. 2). Fishing households would take advantage of the 'high fish season' in the months before and following the monsoon (Interview, May 2018),⁵ then transfer their efforts to other seasonally more productive livelihood activities during the low fish season. Most fishers found the months of the monsoon the hardest time to fish, so if they could, this is when working as a wage or city labourer replaced growing vegetables, and if fishing did continue, it was less productive than other months. Waged work (i.e. garment factory or construction) requires long hours, generally in Patheingyi city, so if a family member was doing this, they were not doing other livelihood activities.

Land was a limiting factor for agriculture, with fishing households cultivating small gardens along the riverbank as most did not own any fields (although some, like a village elder we interviewed, planted chillies in another area). Making prawn, eel and fish traps (done by men and women) and clothes (mainly by women) could be done all year round, but only a minority of households owned a sewing machine. These products would either be used

by the household or sold in the village or at the local market.

In one household of two parents and two adolescent children, both parents fished and made traps as their only livelihood activities. Due to severe riverbank erosion, they did not have land to grow crops or own livestock, and the cost and time of commuting to Patheingyi meant they would not break even with a wage labour job. Despite the almost complete reliance on a diminishing fish catch, the parents insisted that they would remain fishers, as to them, moving would be 'even harder' (Interview, May 2018).

While Myanmar is considered predominantly rural, this move to work in city factories accompanies Myanmar's rapid economic and political transformation, and is part of a broader trend of rural to urban migration within Myanmar (World Bank, 2019). This leaves many fishing villages hollowed out as working age fishers and families move to find better wages in cities, either domestically or abroad (Aung, 2019).

The move to other income-generating activities, and diversification of a fisher's livelihood portfolio, was often described through the activities of the whole household. Identified reasons for diversifying were linked, but not limited to, the following: (i) fluctuation of fish catch through the seasons (location specific) made it difficult to make enough money by only fishing, (ii) the overall decrease in fish catch meant fishing alone was no longer a sufficient income, (iii) seasonal fishing restrictions made it necessary to generate income in other ways at certain times of the year and (iv) there was opportunity to generate money in additional ways that helped the household (e.g. raising pigs).

Each additional activity had its own limitations and risks. For example, growing vegetables in gardens or on riverbanks was always at a very small scale, mostly with only informal land access and could not be done during the wet season due to flooding, so if there was a financial gain, it was always less than fishing. Fishers were not able to save enough money during the high fish season to sustain themselves without working through the low fish season. For fishers in villages 3, 4 and 5, efficient road access allowed them to travel to Patheingyi to work wage labour jobs during the wet season, such as work building roads or driving bicycle taxis, but inefficient road access meant this was

not viable for fishers in villages 1 and 2. Some fishers in these two villages would fish all year round; however, steeply declining catches in recent years had prompted many households to change their livelihoods for work at a garment factory. Unlike fishing, which is a livelihood a whole family can contribute to, often only one family member can work at the garment factory (due to age and long hours), making the family dependent on the single salary (between 80 000–250 000 kyat/month or US\$50–160).

Moreover, while fishers usually lived and fished in the villages they grew up in, learning how to use local stretches of river and creek differently in each season from friends and family, they also described that their livelihoods were dynamic and changing. They reported that 'change' in the Delta is normal based on their long-term experience, and could identify 'new changes' (Interview, May 2018), such as certain sites of riverbank erosion, or the decrease in salt water fish present, that did not change until recently.

In terms of responding to change by altering their specific fishing practices, fishers in these villages discussed three approaches for responding to the challenge of decreasing catch. These included (i) adapting fishing methods, (ii) taking action to address the cause of fishing and erosion challenges or (iii) further diversifying their livelihoods away from reliance on fishing. Many fishers tried more than one of these methods to an extent, or at least knew of the results of others in their village who had tried pathways they had not.

Limited to the use of traditional, laborious, and low impact fishing methods, adapting techniques proved futile for most small-scale fishers. The DoF restricts what equipment fishers can use by making certain gear (such as types of nets) hard to purchase and checking gear on village visits, and also, it is easier to maintain small-scale methods than to apply for permits for larger scale or newer equipment. Additionally, the small size of the fishing boats, which the fishers themselves own, minimal electricity supply in the villages and the cost of fuel are a barrier to larger mechanised equipment.

Options left for fishers included increasing the diversity of their nets to be able to catch fish over a greater size range, or investing in a renowned tiger net. Yet, adapting fishing methods in a substantial way was not an option

for every fisher, and even for those who could, they were still left struggling with decreasing catches of fish. The solution widely considered 'better' was to address the actions that were causing the decreasing fish catches and extreme riverbank erosion. Ideas on what these main causes were varied between the villages. We detail these changes and challenges in the following sections.

Changes and challenges to fishing livelihoods

It was clear across interviews with fishers, academics, and officials that fish catch is declining, and small-scale fishers are struggling because of it. Every fisher we interviewed reported drops in fish catch from 50% to 92% compared to 5 years ago (see Table 1). For many fishers, such as Mr Arkar, this lower volume of fish amounted to being 'just enough for consumption, not for income' (Interview, May 2018). Many other fishers stated that their income had remained the same because the price of fish had increased roughly in line with their decreased catch. One fisherman from village 4 explained; 'I think if I get even less fish then the price will go up higher' (Interview, June 2018). He had experienced a drop in fish catch from 5 kg/day to 1 kg/day in the rainy season from 2014 to 2018, simultaneously seeing the price of fish increase from 200 kyat/kg to 1000 kyat/kg (between US \$0.83–1.60/kg).

However, when fishers were asked how the price increase of fish compared to the price increase of other items such as rice and fuel, they explained that those things had also become more expensive. The inflation rate in Myanmar averaged 13.95% over the last two decades (Trading Economics, 2018), meaning that in real terms, fishers had been losing purchasing power with their smaller catches of fish even if they were selling at higher prices. As well as catching less fish on an average basis, fishers also reported greater irregularity in their catch. Ms Gawa Chesa, one of only two female fishers interviewed, made the point that 'five years ago I filled the boat with fish, now I get sometimes half a boat and sometimes I don't get any' (Interview, June 2018). For Ms Gawa Chesa catching significantly less fish brought concern for both their family's future, and the future of her village. Thiha, a fisher and father of three from village 5, worried that soon "people will probably

Table 1. Reported fish catch decline

| Village | Number of fishers interviewed | Decline in fish catch 2014–2018 (%) |
|-----------|-------------------------------|-------------------------------------|
| Village 1 | 2 | 70 |
| Village 2 | 4 | 79 |
| Village 3 | 4 | 50 |
| Village 4 | 5 | 85 |
| Village 5 | 6 | 77 |

not get enough fish to make enough money for their family" (Interview, June 2018).

More can be understood from the stresses of poverty these fishing families are increasingly experiencing by considering their access to and command over natural resources, rather than purely only the levels of resources available (Weeratunge *et al.*, 2014). The futures that fishers foresaw for their villages and their own lives was mainly one of increasing struggles and 'big problems' if they persist trying to fish where they are now, while others said they did not like to think about the future. The lack of agency the fishers have to address their severe livelihood struggles pushes them further into vulnerable positions, likely impacting their relational and subjective aspects of wellbeing as well as their material (Weeratunge *et al.*, 2014).

Most fishers believed that recent changes to multiple human activities were to blame for the decreasing catch and expressed strong opinions that the situation should change.⁶ The deep familiarity the fishers have with their local river environment, including its seasonal variation, gave them confidence that they were able to distinguish between natural levels of variation, and 'new' changes that are being induced by human activity. Mr Kan commented, 'I think most changes are because of humans, but I am able to see what the natural changes are too' (Interview, May 2018). Generally, these explanations fell into two categories; either actions that decreased the amount of fish in the river available to be caught, or actions that made the process of catching fish less productive.

The population of each village had grown within the lifetimes of the villagers, and with limited livelihood opportunities, the number of people fishing in each area had also increased. However, there was widespread belief among interviewed fishers that this increase had a

comparatively minor impact on the decreasing catch of fish they were retrieving against other more significant changes in human use of the river. Actions believed to be causing the most harm to the ability to fish include, as discussed next, illegal fishing practices or other illegal activities, sand mining, and the increased commercial fishery operations.

Illegal fishing and sand mining. Illegal fishing was a term used by fishers to describe the actions to obtain fish by using electric shock, poison, or blocking small channels (to quickly kill large numbers of fish, making them easier to collect). Fishers considered these actions harmful to local fish populations, with especially damaging effects on reproduction. One fisher explained that ‘using poison to fish kills every fish that the poison reaches’, rather than discriminating by size, type and season. Fishers spoke about how this has lasting effects on fish populations, well beyond the time of specific incidents. Many noted a significant increase in illegal fishing in recent years, from reports of ‘rarely’ sighting it to now ‘100 times in the past few years’ (Interview, June 2018), correlating somewhat with decreasing catches and leading them to attribute illegal fishing to this decrease.

In interviews, fishers explained that instances of illegal fishing were increasing because of desperation among fishers, in combination with a lack of rule enforcement by the DoF. As Mr Lwin Aye described ‘the law says [illegal fishers] have to be captured with their illegal tools and when they try to catch them, they throw the tools away in the water, so they can’t catch them’ (Interview, June 2018). Fishers expressed deep concerns about the ramifications of illegal fishing, which was consistently said to be carried out by fishers from ‘other places’, but they felt powerless and unsupported by DoF in trying to address it. Among the 22 fishers, only three had complained to the DoF about illegal fishing actions. A reason given by many who did not was that they did not believe it would drive the DoF to action. While fishers desired improved laws and improved law enforcement to address illegal fishing, the director of the Pathein office for the DoF advocated for abidance by the rules already in place (Interview, May 2018).

Fisher Maung Lwin echoed a view held by many fishers: that the DoF was being negligent

in their duty to address issues village fishers were facing and represent their best interests. He stated,

[I] have to pay them for the license to fish, and that is only for being allowed to fish for 8 months of the year... They should address the issue and then find a solution for the fishermen. The thing is, they don’t know what they are doing... and the fishermen don’t want to fight with them. Fishers just tend to change their job if there is no solution. (Interview, June 2018)

In one village, the least connected to Pathein of the five villages, many fishing families had changed their livelihoods in the few years prior to the 2018 fieldwork due to not catching enough fish. The fishers in this village interviewed linked the struggle of catching enough fish to a nearby Chinese fertiliser factory which excreted waste products into the river upstream of the village, effectively causing mass immediate deaths of fish populations. We were told by interviewees that the efforts to complain about the issue were unsuccessful in bringing about change, so fishers had adapted to the situation by changing their fishing methods.

Perspectives on sand mining and its impacts were varied. River sand mining involves the extraction of sand from the bed, alluvial islands and banks of the river, and the authors expected this to be of concern for fishers. However, it was only identified as a problem by fishers when it was occurring within their immediate fishing vicinity.

For instance, in villages 2–3, fishers informed us that sand mining operations had been occurring in the same areas of the river where they fish for many years, with increasing intensity in the last 6 years, and they were witnessing negative impacts. Fishers were certain that both the process of extracting sand and the impact of its depletion were causing riverbank erosion and decreasing fish catches. These fishers expressed concern about the volume of sand mined, as well as the sand boats impacts as they drive through the waterways where they fish. Sand mining boats were described as the largest and fastest boats in operation in stretches of river used by the fishers, and that when they pass by or anchor to extract sand, they cause large

waves and changed water currents (Fig. 3). Additionally, the boats themselves are a physical obstruction to the smaller fishing boats, damaging fishing gear when they collide. Fishers in village 2 explained that the sand mining companies with bases close to village 3 have nine boats and that these each make an average of three trips a day past the river village (Interview, June 2018).

Villagers and a sand mining distribution manager described how the boats move as deposits of desirable sand become depleted at each worksite. Villagers here (in village 2–3) had correlated increased rates of riverbank erosion and increased difficulty of catching fish with more regular sightings of sand mining boats. As one fisher, from village 2, explained, 'Ten years ago I saw some river bank erosion but it was insignificant, and after the sand mining boats arrived I noticed more and more river bank erosion' (Interview, June 2018).

Gawa Chesa, like other fishers in village 2, resides in a stilted wooden home very close to the Pathein River where rates of riverbank erosion have become extreme (Fig. 4). As well as having daily trouble working beside sand mining boats, 2 years prior she lost her home and land to riverbank erosion, and anticipated losing her new home to further riverbank erosion. For her family, rebuilding their home as

the riverbank eroded further was the only option they had to adapt to the change. It was only when riverbank erosion started to happen near a local pagoda that she felt there would be a chance that the GAD might listen to her concerns about sand mining. What this shows is that, like the fishers in village 1 dealing with the fertiliser plant, fishers have tried to exercise their agency to have an influence on river governance, but when this is unsuccessful, they are forced to adapt in imperfect ways (rebuilding their house without any support or compensation, or managing fishing practices in response to contamination).

Yet, fishers in village 4 and 5, who are further from sand extraction sites, did not link sand mining to decreasing catches (Fig. 1). They did, strangely, explain how they had been forced to relocate due to severe riverbank erosion, which some fishers did attribute to waves and changed currents caused by sand mining boats. So, they described links between sand mining and erosion, but did not identify direct links to fishing.

Overall, as a relative new addition to the river landscape, the sand mining boats are providing jobs to migrants from cities and serving the demands of Ngwesaung resorts (MCRB, 2015, Frontier Myanmar 2015) as well as shipping outside the area for urban development, such as roads, buildings and houses. In some cases,



Figure 3. Sand mining boat on the Pathein River. Photo by S. Radford, with permission [Colour figure can be viewed at wileyonlinelibrary.com]



Figure 4. Image of riverbank change. Photo by S. Radford, with permission [Colour figure can be viewed at wileyonlinelibrary.com]

sand is exported to Singapore and China where it is used for land reclamation and construction (Soe and Hammond, 2019); these activities extend further upstream along the Ayeyarwady River, near Mandalay. This is one of the ways that the Delta and fishing livelihoods are linked and are being impacted by processes and actors that are simultaneously locally manifest and geographically distant.

Large-scale fishing impacts on livelihoods.

Another explanation for the decreasing fish catch offered by fishers interviewed was that large-scale fishing companies had increased their activity to capitalise on the higher price of fish, and were decreasing fish populations in the process. For instance, fishers from village 3 were concerned about larger companies setting up industrial scale trawling nets at the mouth of the Pathein River as they block ocean species from the upstream waters. These links between the commercialisation of fishing, fish decline and small-scale fishing livelihoods are another point of connection between larger developments in Myanmar and local livelihoods that we draw out here.

The relationship between small-scale fishers, commercial fishing companies and the DoF has a

history tied up with unreliable data collection, corruption and systematic inefficiencies. Despite fishing being an ever-present part of daily life, communication regarding possible reasons for its decline in recent years was severely limited, including the sharing of information by the DoF or GAD. Some fishers would talk to their colleagues in their own village about the challenges, but unless a fisher also worked as a fish trader, communication across villages was minimal. A reason repeatedly provided for lack of communication about these challenges with authorities was that fishers felt it would make no difference to discuss or complain about the problems, and this stemmed from the lack of support they felt from those who held power to improve their situations, namely the GAD and DoF.

The predominate interactions that fishers reported with the DoF was through their infrequent visits (approximately 1/year) when they would check fishing licences or enforce seasonal and locational fishing restrictions (for fish spawning). Practical specifics of the restrictions as reported by fishers were highly inconsistent, but generally restricted net fishing during 3 months of the wet season. Comparatively, sand mining was permitted all year round.

While it seemed clear to many small-scale fishers that commercial fishing was increasingly

having an impact on fish populations, the director of the DoF branch in Patheingyi rejected this notion in our interview (Interview, May 2018). The DoF advocates that the river tendering process manages large-scale fishing to ensure the sustainability of the fish populations, maintain the river landscape and support the fishing industry. This process involves providing a defined segment of river to a fisher or company that puts forward a tender of US \$40 000 or less, with the river segment then being awarded to who made the highest offer. The DoF explained that to 'make sure those with lots of money, lots of financial power, do not control everything, there is a maximum of five tenders that can be awarded to any one fisheries company' (Interview, May 2018). In order to be effective, this regulation assumes that a single fishing company would only be entitled to a maximum of five areas of river within the Delta, and they would therefore be motivated to care for the environmental sustainability of the investment. The director explained that the fisher or fishing company awarded this tender becomes the 'owner [and] will maintain the fish population... the tender process means fishermen can operate systematically by law, such as not fishing during spawning season' (Interview, May 2018). Ironically, this approach primarily focuses on the activity of small-scale fishers and their supposed overexploitation of the commons.

A national NGO working to improve rural livelihoods in the Delta, identified multiple problems with this arrangement. First, staff explained that the tender price put forward by a fisher or fishing company may exceed US \$40 000, opening a path for corruption. Second, the high price of the tender means that fishers must sell a large number of fish in order to make back the money they spend, encouraging overfishing. Third, there exists the ability for fishing companies to register tenders in different names in order to exceed the maximum of five. While the stretches of river where fishers in this study work have not been divided for the tendering process, the Delta's highly connected ecology means that changes in human use can be relevant across far distances (WWF, 2018). Villagers described increases in fishing activity by "investor fishers", or big companies operating in other parts of the Delta (mostly downstream from Patheingyi).

The explanations provided by fishers for fishing decline reveal more than simple 'fish stories' or

narratives of blame. As further underlined in discussion, they reveal the connections of the fishery to the broader transformations that the Delta and Myanmar are undergoing at present. The introduction of sand mining operations along the river is, for instance, linked to demand for sand and to urban construction and development requiring concrete and fill. This is the extraction of the river's resources for an urbanising country. The rise of large-scale commercial fisheries is also linked to broader opportunities and new investments in Myanmar, and at the same time, also shows a capture of the 'commons' for the benefit of particular actors and activities, excluding small-scale resource users, except as labourers on larger fishing boats.

Discussion and conclusion

Overall in this paper, we advance an understanding of small-scale fishing livelihoods, their main challenges and their characteristics, attentive to their heterogeneity as well as their responses to change. In describing the key challenges contributing to fishers' struggles, we also reveal some of the associated actors and processes connected to the Delta, from local to international, and the numerous changes and catch declines described by fishers illustrate a Delta and livelihood 'in the making'.

The range of actors includes, but is not limited to, large- and small-scale fishers, sand mining operators, government officials like the DoF, civil society actors and policy makers. In terms of processes, for instance, the rise in the commercialisation of the Delta's fisheries is noted by interviewees as putting more pressure on small-scale fishers. It also tends to exclude small-scale resource users. Even the increasing use of 'electric shock' and 'poison' as a fishing method is implicated in the ongoing reaction/response dynamic of local fishers and broader changes. Such illegal practices are linked to ongoing problems of fish decline and limited federal regulation, coupled with commercialisation and increasing number of fishers. Despite the severity of the problems the fishers were facing, they were not provided any level of support from the implicated government departments, or even an official explanation as to what had changed to have had the effect of making catching fish so much harder.

Yet, these are not necessarily one-way, direct relationships. For instance, an increase in the number of fishers or amount of 'illegal' methods for fishing was not always equated or directly evidenced to link with a direct fish catch decline. Instead, the relationship and altering of fishing methods and practices was more complicated; in some cases, fish catch decline was a noted reason for deployment of illegal methods, not an effect of it.

Another challenge, sand extraction, was a noted problem by fishers who were witness to the river's associated transformation. This particular form of resource extraction also represents links to urban development and the increasing resource extraction in Myanmar; in this case we see the literal removal of sand and rich fish habitat for sale and shipping outside of the Delta as a resource for others in sites urbanising across the country and abroad. It is also worth restating that this is but one instance where these fisheries in the Delta are also linked to geographical locations upstream, and that those changes, such as increasing sand extraction and other developments as far as the city of Mandalay (Soe and Hammond, 2019), are also likely impacting fisheries downstream in the Delta (Anthony *et al.*, 2015; WWF, 2018).

The changes manifesting in the villages and fishing grounds are also linked the country's broader political and economic transformations and changing regimes of resource governance. At present, the development increasingly surrounding the villages is prompting us (and others, Tezzo *et al.*, 2018; Angeles *et al.*, 2019) to argue that more could be done by those in positions of power and authority to improve the situation for fishers in a more democratic, civilian-led Myanmar.

However, improving the situation also requires understanding the current challenges and responses of fishers. This is essential to be able to understand if, and then how, new policy or regulation would impact their complex livelihood portfolio. One particular concern is that if new fishing policy is introduced or enforced without a clear understanding of the work and struggles of small-scale fishers, they could be worse off. Or, in the case of sand mining, if new fisheries policy or enforcement moves forward without acknowledging the impacts of this extraction (and its lack of regulation), it is likely to continue to impact small-scale fishing livelihoods, further pushing them out of their livelihood and the Delta.

With this, we recommend further research and analysis that puts livelihoods and understanding of the entwined relationships between people and environment at the forefront in Myanmar, and in the Delta in particular. By conducting this and further research on fisher's livelihoods, not simply as fish catch or income, but an understanding of their portfolio and what challenges are most pressing to small-scale fishers as identified in their own words, such work can contribute not only to the limited literature that exists. We also provide an illustration of the impacts of these changes on livelihoods in the Delta particularly focused on some of the most vulnerable communities at a crucial crossroads in Myanmar's development and change.

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Notes

- 1 The Marine Science researchers and one research assistant local to Patheingyi facilitated logistical connections and support. This is not to say that links between academics, NGOs and poor fishing communities are necessarily typical in Myanmar, in fact, most fishing research would be done without fishers input and there generally exists a lack of trust between 'experts' and 'villagers' as we also document in the research. However, knowing this beforehand, we worked collaboratively to produce better relationships and communications as part of this work and with these groups over time.
- 2 This focus on those who self-identified as 'fishers' meant that we mostly spoke with those that seen fishing as a major livelihood activity or 'career', but we recognise that in addition, a range of people also fish. Note we used the gender neutral term 'fisher' intentionally over

- 'fisherman', although in our research those who identified as fishers were largely fishermen.
- 3 This is documented in the infamous Pak Mun dam case in Thailand (Foran and Manorum, 2009). When the Pak Mun project was ultimately built on a tributary of the Mekong River, compensation for lost livelihoods went to households who identified as headed by 'fishermen', but not, for instance, to those who might engage in fishing on a more seasonal basis and not for families who fished in small streams (see also, issues in terms of gender, Lamb, 2018, Angeles *et al.*, 2019).
 - 4 Fish are sold by weight, most species taking a 'standard price', but prawns and hilsa are sold at a premium price.
 - 5 Not shown on the calendar is the year round role that religion plays in everyday life in the fishing villages, including giving donations to monasteries.
 - 6 Government departments did not provide a comprehensive explanation for the rapid and severe decreasing fish catch to fishers or to us as researchers; this has led many fishers we interviewed to develop their own explanations. These ideas were mainly formed from what they saw occurring firsthand, but sometimes also with the influence of information received by word of mouth, radio, or television.
 - 7 Fish is also an important source of micronutrients with average consumption estimated at 30 kg/person/year (World Fish, 2019).

References

- Angeles, M. Barbesgaard, M. Franco, J. (2019) Trends in small-scale fishery in Myanmar. *TNI Working Paper*. Retrieved 30 May 2019, from Website: <https://www.tni.org/en/publication/trends-in-small-scale-fishery-in-myanmar>
- Anthony, E.J., G. Brunier, M. Besset, M. Goichot, P. Dussouillez and V.L. Nguyen (2015) Linking rapid erosion of the Mekong River delta to human activities, *Scientific Reports* 5(1): 14745.
- Aung, C. (2019) Fisheries and socio-economic change in the Thanlwin River estuary in Mon and Kayin State, Myanmar, in C. Middleton and V. Lamb (eds.), *Knowing the Salween*. Springer. Retrieved 7 January 2020. https://link.springer.com/chapter/10.1007/978-3-319-77440-4_13
- Baran, E., W. Ko Ko, Z.Z. Wah, K. Myat New G. Ghataure and K. Maung Soe (2018) *Fisheries in the Ayeyarwady Basin: Ayeyarwady State of the Basin Report*. National Water Resources Committee. Retrieved 3 February 2019, from Website: <https://www.airbm.org/the-ayeyarwady-state-of-the-basin-assessment-soba/>
- Belton, B., M. Marschke and P. Vandergeest (2019) Fisheries development, labour and working conditions on Myanmar's marine resource frontier, *Journal of Rural Studies* 69: 204–213.
- Biddulph, R. and P. Amberntsson (2017) Whose reality counts? Critical junctures in livelihood trajectories under deforestation, *Tijdschrift voor Economische en Sociale Geografie* 108(5): 540–553.
- Biggs, D., F. Miller, C.T. Hoanh and F. Molle (2009) The delta machine: Water management in the Vietnamese Mekong Delta in historical and contemporary perspectives, in F. Molle, T. Foran and M. Kakonen (eds.), *Contested waterscapes in the Mekong region*. London: Earthscan.
- Braun, B., and N. Castree (eds.) (2001) *Social Nature: Theory, Practice, Politics*. Oxford: Blackwell.
- Bush, S. and M. Marschke (2016) Social and political ecology of fisheries and aquaculture in SE Asia, in P. Hirsch (ed.), *Routledge handbook of the environment in Southeast Asia*. London: Routledge.
- Central Statistical Organization, UNDP and WB (2018) *Myanmar living conditions survey 2017*. Myanmar: Ministry of Planning and Finance, UNDP and WB. Retrieved 20 February 2019, from Website: https://themimu.info/sites/themimu.info/files/documents/Report_Myanmar_Living_Conditions_Survey_2017_Jun2018.pdf.
- Chambers, R. and G. Conway (1991) Sustainable rural livelihoods: Practical concepts for the 21st century. *IDS Discussion Paper 296*. Retrieved 15 May 2019, from Website: <https://www.ids.ac.uk/publications/sustainable-rural-livelihoods-practical-concepts-for-the-21st-century/>
- De Haan, L. and A. Zoomers (2003) Development geography at the crossroads of livelihood and globalisation, *Tijdschrift voor Economische en Sociale Geografie* 94 (3): 350–362.
- FAO (2019) *Fishery and aquaculture country profile*. Myanmar: Fisheries and Aquaculture Department. Retrieved 18 November 2019, from Website: <http://www.fao.org/fishery/facp/MMR/en>.
- Foran, T. and K. Manorum (2009) Pak Mun dam: Perpetually contested? in F. Molle, T. Foran and M. Kakonen (eds.), *Contested waterscapes in the Mekong Region*. London: Earthscan.
- Forsyth, T. (2008) Political ecology and the epistemology of social justice, *Geoforum* 39(2): 756–764.
- Hirsch, P. and A. Wyatt (2004) Negotiating local livelihoods: Scales of conflict in the Se San River Basin, *Asia Pacific Viewpoint* 45(1): 51–68.
- Lamb, V. (2018) Who knows the river? Gender, expertise, and the politics of local ecological knowledge production of the Salween River, Thai-Myanmar border, *Gender, Place & Culture* 25(12): 1703–1718.
- Lamb, V., M. Marschke and J. Rigg (2019) Trading sand, undermining lives: Omitted livelihoods in the global trade in sand, *Annals of the American Association of Geographers* 109(5): 1511–1528. <https://doi.org/10.1080/24694452.2018.1541401>
- Lynn, K.Y. (2019) Fisheries sector upgrades as exports set records. *Frontier Myanmar*, 16 January.
- Marschke, M. (2012) *Life, fish and mangroves*. Ottawa: University of Ottawa Press.
- Marschke, M. (2014) Sand mining returns—dredging for every last grain within Cambodia's coastal protected area. Retrieved 11 October 2018, from Website: <http://melissamarschke.wordpress.com/2014/06/12/sand-mining-returns-dredging-for-every-last-grain-within-a-coastal-protected-area/>
- Marschke, M. (2017) Exploring rural livelihoods through the lens of coastal fishers, in K. Brickell and S. Springer (eds.), *Handbook of contemporary Cambodia*. London: Routledge.
- McLean, J.E. (2015) Beyond the pentagon prison of sustainable livelihood approaches and towards livelihood

- trajectories approaches, *Asia Pacific Viewpoint* 56(3): 380–391.
- Molle, F. (2007) Scales and power in river basin management, *Geographical Journal* 173(4): 358–373.
- Myanmar Centre for Responsible Business. 2015 Letter to HE Vice President U Nyan Tun, Chair of the Tourism Development Central Committee, 30 April 2015. Retrieved 7 November 2019, from Website: <https://www.myanmar-responsiblebusiness.org/news/ngapali-beach-sand-mining.html>
- Nyein, Y. and S. Matthew (2017) Myanmar *kyarr phong* fishery: The tiger's mouth, *Samudra Report* 75: 20–24.
- Robbins, P. (2012) *Political ecology*. Malden, Massachusetts: Wiley-Blackwell.
- Scoones, I. (1998) Sustainable rural livelihoods: A framework for analysis, *IDS Working Paper* 72: 1–22.
- Soe, K.M. (2008) *Trends of development of Myanmar fisheries*, VRF Series No. 433. Chiba: Institute of Developing Economies, Japan External Trade Organisation.
- Soe, H.K. and C. Hammond (2019) Our land is collapsing around us. *Frontier Myanmar*, 13 February. Retrieved 22 March, from Website: <https://frontiermyanmar.net/en/our-land-is-collapsing-around-us-ayeyarwady-at-risk-from-rampant-sand-mining>
- Tezzo, X., B. Belton, G. Johnstone and M. Callow (2018) Myanmar's fisheries in transition: Current status and opportunities for policy reform, *Marine Policy* 97: 91–100.
- Thein, A.K., R. Gregory, M. Akester, F. Poulain and R. Langeard (2019) *Participatory rural appraisal: Vulnerability study of Ayeyarwady Delta fishing communities in Myanmar and social protection opportunities*. *FAO Circular No.1177*. Rome: FAO.
- Trading Economics. (2018) *Myanmar data, inflation rate 1998–2018*. Retrieved 27 August 2019, from Website: <https://tradingeconomics.com/myanmar/inflation-cpi>
- UNDP. (2014) *The state of local governance: Trends on Ayeyarwaddy*. Retrieved 5 May 2018, from Website: https://themimu.info/sites/themimu.info/files/documents/Report_Local_Governance_Mapping_Ayeyarwady_UNDP_Nov2014.pdf
- Weeratunge, N., C. Béné, R. Siriwardane et al. (2014) Small-scale fisheries through the wellbeing lens, *Fish and Fisheries* 15(2): 255–279.
- Wilson, A. (1992) *The culture of nature*. Oxford: Basil Blackwell.
- World Bank (2019) *Myanmar's urbanisation*. Myanmar: World Bank.
- World Fish. (2019). *Myanmar*. Retrieved 18 August 2019, from Website: <https://www.worldfishcenter.org/country-pages/myanmar>
- WWF (2018) *The Ayeyarwaddy River and the economy of Myanmar*, Vol. 1. Myanmar: WWF.