Catch 'em When the Water is Low : Longue Durée Hypothesis on Floodplains Fishing and its Rhythm in the Palembang and Jambi Region of Sumatra

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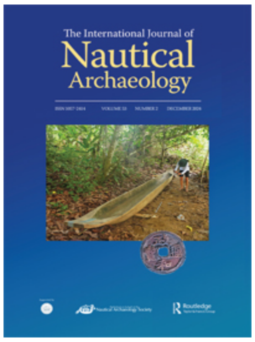

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Catch 'em When the Water is Low: *Longue Durée* Hypothesis on Floodplains Fishing and its Rhythm in the Palembang and Jambi Region of Sumatra

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ABSTRACT
Fishing and wetlands have in many cases been essential facets of life but are often overlooked in archaeological and historical research. In this article, we focus on the floodplains of the Palembang and Jambi region of Sumatra, where both of these aspects are comprehensively entwined. The floodplain fisheries there are highly productive, and function in a rhythm with the hydrological cycle of the rivers. By combining the pre-existing archaeological, historical and ethnographic information with modern environmental data, we propose a *longue durée* hypothesis for their use in the past. We also examine how floodplains fishing may have contributed to the provisioning of Palembang and Jambi, and how it would have fit in with other aspects of Sumatran culture such as floodplain rice cultivation and overseas trade. This is achieved by linking the production schedules with the sailing seasons simulated with qtVlm navigation software.

KEYWORDS
Sumatra; floodplains; fishing; rice; flood extent; sailing models

PALABRAS CLAVE
Sumatra; llanuras aluviales; pesca; arroz; extensión de inundaciones; modelos de navegación

关键词
苏门答腊; 洪泛区; 捕鱼叶; 水稻; 洪水淹没范围; 航行模型

關鍵詞
蘇門答臘; 洪泛區; 捕魚葉; 水稻; 洪水淹沒範圍; 航行模型

الكلمات الدلالية
سومطرة
السهول الفيضية
صيد الأسماك
الأرز
مدى الفيضانات
نماذج الإبحار

Atrápalos mientras el agua está baja: Hipótesis de *longue durée* sobre la pesca en llanuras aluviales y su ritmo en las regiones Palembang y Jambi en Sumatra

RESUMEN
La pesca y los humedales han sido en muchos casos facetas esenciales de la vida pero a menudo no son abordados por la investigación arqueológica e histórica. En este artículo nos enfocamos en las llanuras aluviales de las regiones Palembang y Jambi de Sumatra, donde ambos aspectos están íntimamente relacionados. Las pesquerías de las llanuras aluviales allí son altamente productivas y funcionan al ritmo del ciclo hidrológico de los ríos. A partir de la combinación de información preexistente arqueológica, histórica y etnográfica junto con información ambiental moderna, proponemos una hipótesis de *longue durée* (larga duración) sobre su uso en el pasado. También examinamos cómo la pesca en llanuras aluviales pudo haber contribuido al aprovisionamiento de Palembang y Jambi, y cómo hubiera encajado con otros aspectos de la cultura de Sumatra, como el cultivo de arroz en llanuras aluviales y el comercio de ultramar. Esto es logrado a través de la vinculación de los calendarios de producción con las estaciones de navegación, simulado con el software de navegación qtVlm.

低水位时捕捞: 苏门答腊岛巴伦邦和占碑地区洪泛区捕鱼业及其节奏的"长期性"假设

摘要
在多数情况下，捕渔业和湿地属于人们生活极为重要的方面，但在考古和历史研究中却常常被忽视。我们将在本文中重点关注苏门答腊岛巴伦邦和占碑地区的洪泛区，在这些区域内这两者完全地交织在一起。洪泛区的渔场产量很高，且它的运转同步于河流的水文循环。通过将已有的考古、历史和人种学信息与现代环境数据相结合，我们提出过去洪泛区渔场的使用具有"长期性"的假设。我们还研究了洪泛区渔业是如何为巴伦邦和占碑的供应做出贡献的，以及它是怎样与洪泛区水稻种植及海外贸易等苏门答腊文化的其他方面相融合。通过将生产时间表与导航软件qtVlm模拟的航行季节联系起来即可以实现这一目的。

低水位時捕撈: 蘇門答臘島巴倫邦和占碑地區洪泛區捕魚業及其節奏的「長期性」假設

摘要
在多數情況下，捕漁業和濕地屬於人們生活極為重要的方面，但在考古和歷史研究中卻常常被忽視。我們將在本文中重點關注蘇門答臘島巴倫邦和占碑地區的洪泛區，在這些區域

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內這兩者完全地交織在一起。洪泛區的漁場產量很高，且它的運轉同步於河流的水文循環。通過將已有的考古、歷史和人種學信息與現代環境數據相結合，我們提出過去洪泛區漁場的使用具有「長期性」的假設。我們還研究了洪泛區漁業是如何為巴倫邦和占碑的供應做出貢獻的，以及它是怎樣與洪泛區水稻種植及海外貿易等蘇門答臘文化的其他方面相融合。通過將生產時間表與導航軟件qtVlm模擬的航行季節聯系起來即可以實現這一目的。

قُم بالاصطياد عندما تكون المياه منخفضة: فرضية الفترة الطويلة حول الصيد في السهول الفيضية وإيقاعه في منطقة باليمبانج وجامبي في سومطرة

المُستخلص
لقد كان صيد الأسماك والأراضي الرطبة في كثير من الحالات جوانب أساسية للحياة ولكن غالباً ما يتم تجاهلها في الأبحاث الأثرية والتاريخية. ولهذا تركز هذه المقالة على السهول الفيضية في منطقة باليمبانج وجامبي في سومطرة، حيث يتشابك كلا الجانبين بشكل شامل. ومن الجدير بالذكر أن مصايد الأسماك في السهول الفيضية تتميز بإنتاجية عالية، وتعمل بإيقاع مع الدورة الهيدرولوجية للأنهار. ومن خلال الجمع بين المعلومات الأثرية والتاريخية والإثنوغرافية الموجودة مسبقاً مع البيانات البيئية الحديثة، نقترح فرضية الفترة الطويلة لاستخدامها في الماضي. تفحص هذه المقالة أيضاً كيف يمكن أن يكون صيد الأسماك في السهول الفيضية قد ساهم في إمداد باليمبانج وجامبي، وكيف كان من الممكن أن يتناسب مع جوانب أخرى من ثقافة سومطرة مثل زراعة الأرز في السهول الفيضية والتجارة الخارجية. وتم تحقيق ذلك من خلال ربط جداول الإنتاج بمواسم الإبحار التي تمت محاكاتها باستخدام برنامج الملاحة qtVlm.

Introduction

This work is conducted in the framework of the 'Ports and Harbours of Southeast Asia: Human-environment entanglements in Early Modern maritime trade networks' project (Walker Vadillo, 2020), within which we take a holistic interdisciplinary approach to the study of maritime trade. One of our aims is to understand how ports and their infrastructure functioned in enabling and sustaining trade networks in the highly seasonal environment of Southeast Asia. For a successful *entrepôt*, a key human-environment interaction was ensuring the availability of food – be it by producing it yourself or trading – to feed both your own population and the crews of incoming trading vessels (Charras, 2016, p. 101; Manguin, 2022). Following Walker Vadillo's (2016, pp. 79–84; see also Kallio & Walker Vadillo, 2020) work on the fluvial cultural landscape of Angkor, and Charras's (2016) hypothesis on the early use of floodplains for rice growing in southeast Sumatra, we explore the fishing potential on the floodplains of the Musi and Batang Hari river systems and form a hypothesis for their *longue durée* (e.g. Braudel, 1960) use in the past.

In the overarching project we are mainly interested in the period from late 14th to 17th century CE – i.e., the part of the Early Modern Period before the drastic changes caused by European colonialism – but in this study we extend the discussion also to the previous Srivijayan Period (*ca.* 671–1288 CE) as it laid down the foundations for the later development of the region and its main ports, Palembang and Jambi. Therefore, we will examine how floodplains fishing would fit other aspects of the Palembang-Jambi region (PJR) from the Srivijayan Period onwards and what it would mean to the cities. We recognize that, due to the current gaps in our archaeological knowledge, our highly multidisciplinary approach, and its hypothetical nature, this paper does not fully conform to a traditional archaeological study. Nevertheless, research like this – for example Charras's aforementioned paper – has helped to move the discussion about the means of food production forward and widened our horizons on what to be on the lookout for in future fieldwork.

Sutherland (2007, p. 29) has argued that '[…] any understanding of Southeast Asia must begin with the geographic imperatives of location, water and wind'. The same rationale can also be applied in microscale to the interior of the PJR: the winter monsoon brings the rains, the precipitation forms the Musi and Batang Hari river systems including their floodplains, and the major cities of Palembang and Jambi are situated at strategic spots along the rivers (e.g. Manguin et al., 2006, p. 57). However, for example Boomgaard (2007, p. 1) and Hoogervorst (2012, p. 247) have noted that the focus of research in Southeast Asia has nevertheless been mostly terrestrial while aquatic aspects have often been neglected (e.g. Pham et al., 2022). In general, wetlands worldwide have been understudied when compared to their archaeological potential (e.g. Bernick, 2014, p. xi). In a similar fashion, fishing in Southeast Asia has garnered far less attention when compared to the amount of archaeological research on rice cultivation. These two overlooked facets of history come together in floodplain river fisheries. Today, floodplains of Southeast Asia are important fish production areas (e.g. Hoggarth et al., 1999a, 1999b), and they are widely distributed in the region (Figure 1). In contrast to marine fisheries, on floodplains most of the fish are caught with dispersed small-scale gear (Coates, 2002, p. 3), but yet they play a vital economic and nutritional role as fish is the main source of protein in the Southeast Asian diet (e.g. Butcher, 2005, pp. 31–35). This is also the case in our research area in PJR, where many of the modern fishing methods and types of gear used on the floodplains (e.g. Hoggarth & Utomo, 1994, pp. 198–201) – minus the modern materials – would

Figure 1. The distribution of floodplains in Southeast Asia. The map is based on the dataset by Nardi and Annis (2018; see also Nardi et. al, 2019). (Authors)

look familiar to the ancient fishers. The fishing is mostly done by utilising natural landforms and does not leave permanent marks to the landscape that would be readily recognisable by archaeological survey.

Preserved fish was an important internal trade commodity throughout Southeast Asia (Crawfurd, 1820, p. 197), a view shared by Reid (1979, p. 397, 1988a, p. 29, 1988b, p. 2). The main curing methods were salting, drying and fermenting. However, Boomgaard (2005, p. 99) has inferred based on Groeneveldt's (1876) work that Chinese sources from 500–1650 CE on the Malay world only rarely mention fish or other edible products of the sea, instead more durable and luxurious marine commodities such as tortoiseshells, pearls, shells, coral and ambergris are brought up more often. A similar narrative is present in Dutch East India Company (*Vereenigde Oostindische Compagnie*; VOC) sources covering Asia in general, and only when going down to the city government level in Batavia or the Javanese inscriptions does fishing become more visible (Boomgaard, 2005, p. 100; see also Barrett Jones, 1984, pp. 57–58). He concludes that fish and seafood are underrepresented in the sources describing overseas mercantile interests, therefore not accurately describing their importance locally (Boomgaard, 2005, p. 100). The everyday and mundane is often lost in the grander narratives of history (e.g. Robin, 2020, pp. 382–383), and hence must be teased out by other means of research. For this purpose we utilise Maritime Cultural Landscape (MCL; e.g. Westerdahl, 1992) and historical ecology (e.g. Crumley, 1994) as our theoretical framework. Walker Vadillo (2016, 2019) has previously shown the possibilities of this approach – and especially the applicability of its ethnographic component – in the Southeast Asian context. However, as a deep dive into the VOC materials is outside the scope of this study it is possible that they may contain additional information.

Some early accounts from coastal Sumatra do mention fish. Marco Polo (1899, p. 370) stayed in the northern part of the island for five months in wait for fairer winds in the late 13th century and recounted the fish there to be the finest in the world. In the early 15th century, Ma Huan (Ma et al., 1970, pp. 98–102, 123) mentions fish and shrimp to be very cheap in the north but does not mention what the situation was in Palembang on his visit there. Similarly in the early 16th century, Tomé Pires (1944, pp. 136–166) reports on fresh and dried fish in several localities on north-eastern Sumatra, but is again mute on the subject when writing about Palembang and Jambi. In addition, wetlands are often viewed in negative terms especially in Western cultures: they are perceived as sinister and forbidding places of little economic value (e.g. Menotti & O'Sullivan, 2013, p. 2; Mitsch & Gosselink, 2015, pp. 7–9). For example the early European explorers of North America described wetlands as hazardous, barriers to navigation and disease ridden from their etic perspective and later sought to drain the areas, while Native Americans were able to effectively utilise these surroundings (Howarth, 1999, pp. 522–523). This has likely caused biases in the more recent historical data produced by the European arrivals to Southeast Asia as well and may hence have limited our current knowledge of the importance of Sumatran wetlands in the past.

Background

Sumatra was settled by anatomically modern humans *ca.* 73–63 ka ago (Westaway et al., 2017). The hook and pelagic fish bone finds from Jerimalai shelter in East Timor show that already *ca.* 42 ka ago the inhabitants of the region at large possessed advanced fishing skills and methods (O'Connor et al., 2011). Additionally, fish-hooks made out of shells (*ca.* 12000 cal. BP) have been found from Alor Island, East Indonesia (e.g. O'Connor et al., 2017) and stone net sinkers (*ca.* 6000 cal. BP) from Con Co Ngua, Vietnam (Nguyen, 2005). Stone fishing weirs are distributed widely in East and Southeast Asia: they are known from Japan, South Korea, Taiwan, Philippines, Thailand, and Indonesia (Iwabuchi, 2014). However, as they typically contain no organic material, stone weirs are difficult to date directly. Many are probably rather recent, but it has been hypothesised that some may be Neolithic or even older (Nishimura, 1964). For example, the initial construction of the stone weirs at Muldoons Trap Complex, Australia dates to at least 6600 cal. BP based on charcoal found from infill sediments (McNiven et al., 2015). On the other hand, information about dated wooden weirs from the region published in English is rather limited. The geographically closest prehistorical weirs we were able to find from the literature come from Ishikari, Japan and date to *ca.* 4400–4000 cal. BP (Ishikari City, 2003; Matsui, 2005, pp. 53–57), but it is possible that more data are available in other languages. Even though the evidence is quite sparse, it is in our opinion fair to assume that at least from *ca.* 2000 BCE onwards fisherfolk of Southeast Asia had a wide range of fishing methods and gear in their toolkit and were able to operate in multiple ecological settings.

In the inland waters of Southeast Asia, the fishing methods of today vary depending on the circumstances, but their rhythm mostly follows the hydrological pattern set by the monsoons. Fishing efforts typically intensify at the beginning of the rainy season when fish move from rivers to other bodies of water to feed and spawn, and wind down around the mid-dry season as the fish return to the rivers (Muthmainnah et al., 2019, p. 3). These events, however, do not happen concurrently throughout the region, but vary geographically and temporally (Figure 2).

Floodplains are a subcategory of inland waters, where temporary wetlands are formed along rivers that are prone to flooding. The water levels in most wetlands are not constant but vary for example seasonally (Mitsch & Gosselink, 2015, p. 119). In flood rivers the rhythm of this fluctuation is mostly governed by major seasonal variations in rainfall over their basins, sending pulses of increased flow downriver that spills over to the low-lying lateral plains (Welcomme, 1979, p. 1). The flooding brings soil, nutrients, and oxygenated water to the floodplains, making them generally highly productive areas for flora and fauna alike (Welcomme, 1979, pp. 40–81). Tropical floodplain rivers are a home to numerous fish and crustacean species as they provide a wide range of aquatic habitats in addition to the perennial river proper at different stages of their yearly cycle, e.g. inundated floodplains in the rainy season, and pools and marshes in the dry season (Hoggarth & Utomo, 1994, pp. 191–192). These traits make them economically important fisheries: for example, in Indonesia floodplains can be four times as productive as the river itself (Utomo & Ondara, 1987 cited in Husnah et al., 2020, p. 2). Previously, floodplain fisheries have been studied from an archaeological perspective for example in the Amazonian (e.g. Blatrix et al., 2018), Nile Valley (e.g. Van Neer, 2004), Australia (Brockwell & Aplin, 2020), Sri Lanka (Weliange, 2010), Cambodia (Kallio & Walker Vadillo, 2020; Walker Vadillo, 2016, pp. 79–84), and on Sumatra in the Tulang Bawang regency (Saptono, 2010). This non-exhaustive list of studies show that floodplains have been used for fishing worldwide, and in places their utilisation began already in the Palaeolithic and has continued until today. Furthermore, it demonstrates that the subject can be approached from viewpoints ranging from the archaeological remains of the fishing structures and osteological analysis of fish bones to ethnology and social organisation. However, ethnoarchaeological studies related to fishing in Island Southeast Asia have mostly concentrated on fishing at sea (e.g. Engelhardt & Rogers, 1997; Ono, 2010, 2021), suggesting a gap in research pertaining to inland waters.

Out of the Southeast Asian countries, Indonesia currently has by far the largest floodplains totalling *ca.* 333,000 km^2 that cover *ca.* 17.5% of its total area (Muthmainnah et al., 2019, p. 22). Floodplains tend to grow wider the lower the slope of the river is, and on flat coastal alluvial plains of Indonesia the rivers have developed extensive marshy floodplains (Welcomme, 1979, p. 20, 30). The rivers Musi and Batang Hari and many of their tributaries arise from the Barisan mountain range that runs down the full length of Sumatra on its western side. From there, the rivers meander roughly northeast/eastwards through the eastern half of the island and finally run into the South China Sea. The rainfall in Indonesia – and hence also the hydroperiods of its rivers – are largely determined by the Asian-Australian monsoon system (As-syakur et al., 2013, p. 7723). In addition, the

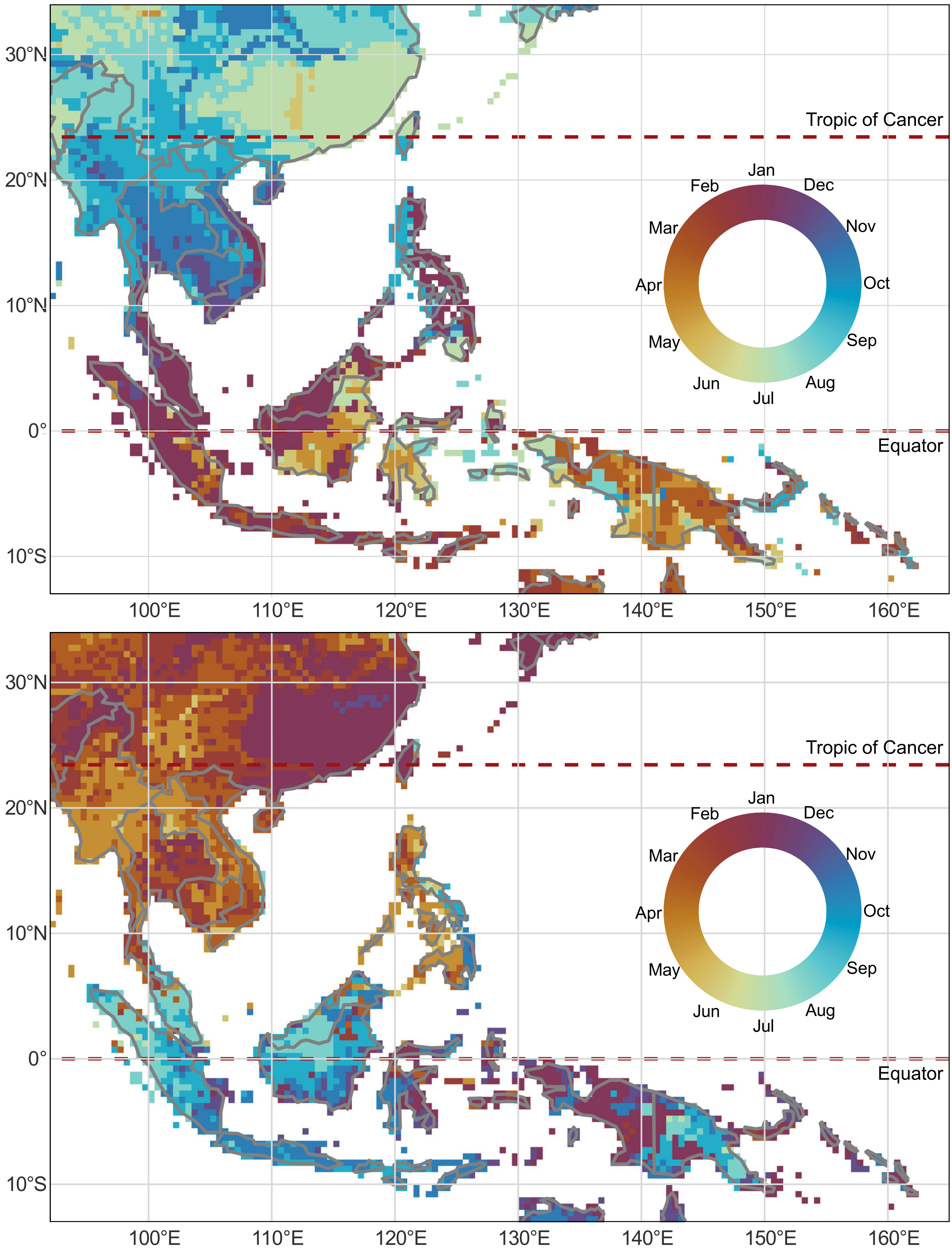

Figure 2. The month when maximum (top) and minimum (bottom) river discharge occurs in Southeast Asia on average. The maps are based on the Community Water Model dataset's (Burek et al., 2020) monthly mean values between 1901–2019. The model run used is available from the ISIMIP3a (2022) archive. (Authors)

rainfall patterns are affected by the variations in the El Niño–Southern Oscillation (ENSO), the Indian Ocean Dipole (IOD), local air-sea interactions, and topography (As-syakur et al., 2013, p. 7724 with references). In south Sumatra the rainy season is typically from October to December, after which the water levels remain high until April and then gradually recede for the dry season lasting from July to September; though the general pattern can vary from year to year (Hoggarth & Utomo, 1994, p. 201).

Palembang and Jambi, the major cities on the Musi and Batang Hari river systems, are set *ca.* 70–80 km inland as the crow flies at spots where the wide low-lying coastal marshes start to give way to firmer, slightly higher ground (see Figure 3). This placement also allowed the construction of monumental architecture such as the 7th to 13th century Muaro Jambi temple compound near Jambi. In addition, Palembang is strategically situated at the confluence of the Musi and two of its major tributaries, Ogan and Komering rivers. Waterways were the main transport routes especially for bulky goods (e.g. Manguin, 2009, pp. 471–472), and due to their position the cities were able to act as middlemen in the trade flowing in and out of the highlands (e.g. Manguin, 2000, p. 412).

Several schematic models have been proposed to explain how this type of social organization might have functioned in Southeast Asian riverine polities. In short, the classic Bronson (1978) exchange model illustrates a scenario where two nearby river systems are separated by a geographic features such as mountains, marshlands, or forests. Their primary centres are situated at the river mouths, followed by lower order centres upstream at river junctions, and finally the producers of export goods at the far reaches of the systems, forming a dendric-like pattern in the landscape. The polities compete against each other for the trade with a superior overseas centre. Manguin (2002, pp. 77–78) extended the model by adding the possibility for a multi-centred polity, in which the river systems co-operate to form a central *entrepôt* capable of participating in large scale trade networks. The river systems could also be connected by footpaths, as was the case for example in the PJR (Andaya, 1993, pp. 163–164, 196; Manguin, 2017, pp. 105–106). Producers of non-bulk goods like gold were able to choose which river system they wanted to use for their exports (cf. Hall, 2011, pp. 22–23), while bulkier low value cargo – e.g. fish – was likely transported mostly along rivers. Miksic (2009, p. 79) further modified the idea to fit specifically with the PJR. In his model, the main centres are no longer on the coast but inland, and there are smaller subservient centres such as Sungsang (e.g. Wolters, 1979) at the river mouths. Additionally, the model includes footpaths through the Barisan mountain range linking the river systems the opposite coast of the island overland.

Ma Huan, who visited Palembang in 1413 as an interpreter on the Ming treasure voyages, described it thusly: 'In this place water abounds, while dry land is scarce' (Ma et al., 1970, p. 99). Interestingly, one of the suggested etymologies for the name Palembang is derived from Malay prefix *pe-* and the word *lembang*, which can be translated as 'a place where water seeps' (Hanafiah, 1995, pp. 15–16 with references). Unlike previously thought (e.g. Chambers & Abdul Sobur, 1978; Obdeijn, 1941, 1944, pp. 40–42; for a more complete listing see Wolters, 1975, p. 11), the archaeological sites found nearer the coast (e.g. Manguin, 2017, pp. 91–94 with references; Manguin et al., 2006; McKinnon, 1984a, pp. 61–64; Rangkuti, 2014; Wolters, 1979; see also Manguin, 1982) show that the coastline in the area has most likely not changed drastically since the Srivijayan times. According to Zaim and Aswan (2018, pp. 95–97), 1500 BP and 500 BP shorelines were situated *ca.* 3–8 km and 1–3 km inland from the current coast.

The Palembang area rose to world prominence in the late 7th century CE as the centre of the expanding Srivijayan polity. Based upon inscriptions, and the writings of the Chinese monk Yijing, Taylor (1999, p. 173) has described Palembang as a prosperous port already at that time. In the 9th to 10th centuries

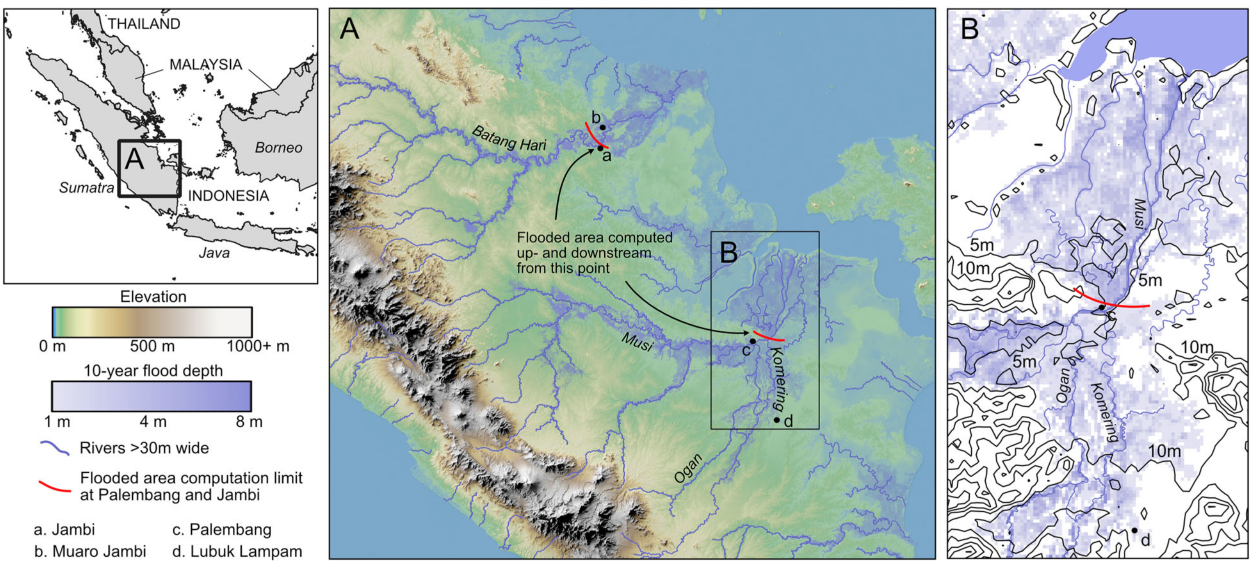

Figure 3. The extent of floodplains in the PJR. The scope and depth information are based on Dottori et al.'s (2016) flood hazard map with a 10-year return period. The cut-off points used to separate up- and downstream in Table 1 are shown in red. (Authors)

Srivijaya had grown into a widely known major power that was able to control the Maritime Silk Route trade flowing through the Malacca and Sunda straits (e.g. Manguin, 2006, pp. 305–308, 2017, p. 90). In the late 11th century, the political centre of Srivijaya moved to Jambi (e.g. Manguin, 2000, p. 410). Even though Srivijaya gradually lost its central role in the 13th century, both cities served as important ports – with their ups and downs – through the Early Modern Period (e.g. Andaya, 1993). This is attested for example by the early 17th century Selden Map of China, which also depicts Southeast Asia and some of the long-distance maritime trade routes of the era: both cities are marked on the map and one of the routes leads to Palembang (Batchelor, 2013, p. 39).

The Extent of Floodplains on the Musi and Batang Hari River Systems

Batang Hari and Musi Rivers have extensive deltas and floodplains; the flooded area in the entire river basins total 9700 km^2 for Musi, and 5100 km^2 for Batang Hari. We estimate the floodplain extent using the flood hazard maps for a flood with 10-year return period, developed by Dottori et al. (2016), and provided with 5-arcmin resolution (approximately 8.3 km at the equator). A map of the floodplain extents is shown in Figure 3. The data are based on the current situation of the river systems and includes modern changes to the landscape; therefore the results only approximate past circumstances. Because the topography of the region is rather flat and much of the floodplains are situated far inland, large floodplain areas would likely exist even if the rivers meander or there are minor changes to the coastline. Table 1 shows a breakdown of the flooded areas into delta and floodplains (i.e. in this case, down- and upstream of Palembang and Jambi) for both rivers. According to the flood maps, upstream freshwater floodplains on the Musi River (including tributaries Ogan and Komering) can cover more than 6000 km^2, and for Batang Hari nearly 2500 km^2. The 10-year return period means that a flood of this magnitude is expected to happen once every 10 years making the typical floods somewhat lower. Therefore, we have included in table 1 how much the flooded area would change if its height were 1, 2, or 3 m lower. Our estimation is more conservative than the floodplain maps in Nardi et al. (2019; see also Nardi & Annis, 2018), which display the maximum extent of the floodplain, rather than an annual extent of the floods. The table also includes an estimate of the extent of permanent (>90% prevalence) water bodies using data from Pekel et al. (2016).

Lebak Lebung

Even though fish is plentiful in the seas surrounding Indonesia and there is a strong tradition of aquaculture, freshwater fishing has still been of importance in certain regions. Van Kampen mentions this to be the case especially for lakes and swamps in Sumatra and Borneo (Van Kampen, 1922, p. 3), i.e. on the islands where the floodplains are the most extensive (see Figure 1). For example, in Palembang, fishing was conducted both at sea and on the floodplains (Van Kampen, 1922, pp. 76–77 with references). In South Sumatra, natural floodplains are called *lebak lebung* (Husnah et al., 2020, p. 2; Utomo et al., 2010, pp. C6-1), *lebak* being the part that is inundated only during the wet season and *lebung*s the deeper pools that hold water throughout the year (e.g. Hoggarth & Utomo, 1994, p. 193; see also Saptono, 2010; Hoggarth et al., 1999b). Similar dichotomy can be also seen in how the fish inhabiting the floodplains are classified: the so called 'whitefish' species return to the river as the water recedes while 'blackfish' have evolved to cope with the deoxygenated conditions and remain in the *lebung*s cut off from the river in the dry season (e.g. Hoggarth et al., 1997, p. 4; Welcomme, 1979, pp. 82–86). The most researched *lebak lebung* area in this region is Lubuk Lampam, which has been used as a study site for the Indonesian Research Institute for Freshwater Fisheries (RIFF) since 1975 (Hoggarth & Utomo, 1994, p. 193). It is situated in the Ogan Komering Ilir Regency (OKI) *ca.* 60 km south from Palembang on the Lempuing river, one of the tributaries of Musi, and consists of the river, *lebak* floodplain, eleven major *lebung*s and *rawang* swamp forest (Hoggarth & Utomo, 1994, p. 193). During the dry season water covers *ca.* 1.2 km^2 of its area growing up to 12 km^2 at the height

Table 1. Approximate flooded areas under a flood with 10-year return period on the rivers Musi and Batang Hari computed for delta (down-) and floodplains (upstream) from Palembang and Jambi, shown in Figure 3. In addition, the table also shows how much the area would decrease if the flood were one, two or three metres lower, and the extent of permanent (>90% prevalence) water bodies.

		Flooded area (km^2)				
River	Area	Total flooded area	Flood depth 1 m lower	Flood depth 2 m lower	Flood depth 3 m lower	Permanent water
Musi	Delta	3450	2524	1583	835	164
	Floodplains	6342	4968	3812	2765	157
Batang Hari	Delta	2671	2177	1613	1072	55
	Floodplains	2431	2107	1882	1645	113

of the inundation (Arifin, 1978; cited in Utomo et al., 2010, pp. C6-1). Its borders stem from the floodplain being divided into auction units, to which the fishing rights are sold in the OKI annually (e.g. Hoggarth & Utomo, 1994, p. 192).

As the water level fluctuates, the fishing methods and gear are adjusted to its rhythm and to the movement of fish in the different parts of the flooded area (see Figure 4). The following simplified description of the fishing cycle in Lubuk Lampam is based on the article by Hoggarth and Utomo (1994, pp. 198–200; see also Utomo et al., 2010, pp. C6-8–9; cf. Saptono, 2010). It pertains specifically to an area with extensive floods, but at the same time follows the general seasonal cycle of fishing on the floodplains (cf. Hoggarth et al., 1999a, fig. 2.4). Elsewhere in the PJR where the floodplains are narrower, different fishing methods and management strategies are in use (MRAG Ltd, 1997; see also Hoggarth et al., 1999a, pp. 13–15). Additionally, the yearly rhythm varies geographically (see Figure 2), and this needs to be taken into account when considering other areas. On the Lubuk Lampam *lebak*, portable traps and hooks are used throughout the year, but during high water in November–March when the fish are widely distributed over the area, the yields are relatively low. The catch becomes more plentiful as water recedes and the fish return from the floodplain in May–July. At this time the fish can be captured for example with filtering barriers built out of tree trunks and split bamboo. When the water is at its lowest in August–September, the now separated *lebung* pools are fished with active seines and barriers. On the river, filtering nets and barriers are effective from March to July. Long lines, cast nets and active seines are used during the dry season. The *rawang* swamp is fished with

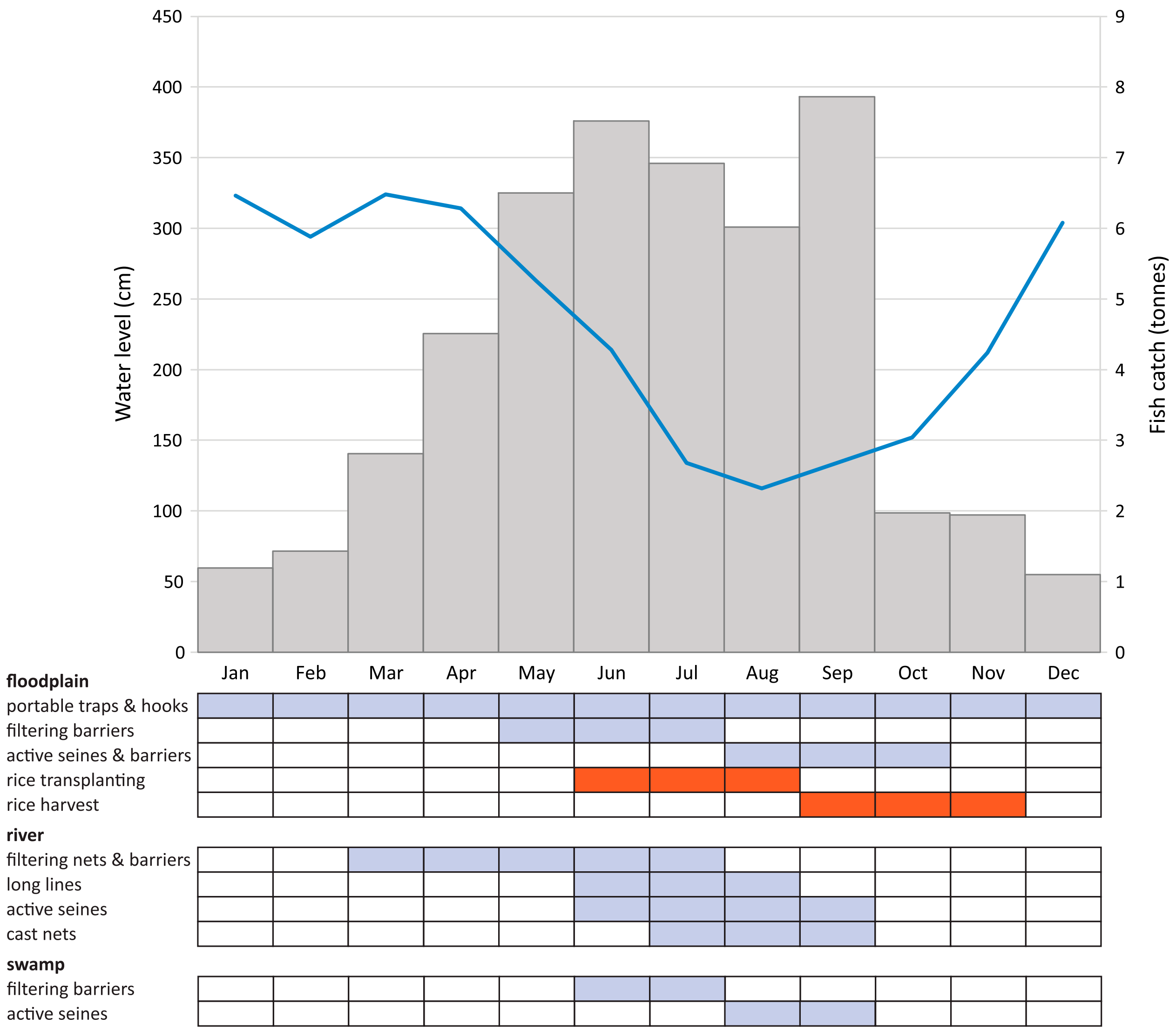

Figure 4. Yearly schedules for fishing at Lubuk Lampam (Hoggarth & Utomo, 1994, pp. 198–200; blue boxes) and floodplain rice farming in South Sumatra (Vonk et al., 1937, pp. 447–449; red boxes) in relation to monthly mean water levels (blue line) and total fish catch (grey bars, sum of the average catches in the *lebak,* river and *rawang*) at Lubuk Lampam between 1984–1991 (Hoggarth & Utomo, 1994, p. 202). The water level and fish catch values have been measured from Hoggarth and Utomo's (1994) fig. 3 and must therefore be considered approximate. (Authors)

filtering barriers in the ebb and active seines in the dry season in a similar fashion to the *lebak*. Hoggarth and Utomo (1994, p. 198) also note that the fishing pattern in this area has largely stayed the same since being first described in the early 1950's (Vaas et al., 1953, pp. 20–21) even though synthetic materials and a new type of river barrier have been added to the arsenal. In comparison, the seasonality of coastal fishing follows not only the monsoons but also the tidal cycle and lunar calendar (e.g. Ono, 2010, pp. 279–282). On inland freshwater floodplains, far from the tidal range, the effects of tides are negligible.

According to Vaas et al. (1953, p. 20) *lebak*s have been fished 'since time immemorial'. We do not claim that the fishing methods of the past were identical to description above, but that there are seasonal rhythms when large amounts of fish can be caught by filtering barriers placed at choke points or from the *lebung*s. Hooks, nets and traps have been in use in Southeast Asia since prehistoric times as discussed earlier in this paper. Additionally, fishing gear also appears in two 9th century reliefs at Borobudur temple in central Java (e.g. Nastiti, 2003, p. 81): relief O 1 shows portable traps and O 109 depicts fishing with nets while standing in shallow water (see Figure 5).

In the early 1990s, there were 63 species of fish found in Lubuk Lampam (Makmur, 2008; cited in Prianto et al., 2013, p. 60; cf. Saptono, 2010), out of which 34 together with giant freshwater prawn and other prawn species were reported to be of commercial importance to the fishers (Hoggarth & Utomo, 1994, pp. 193–194). Based on the monthly average yields between 1984–1992, the yearly catch from Lubuk Lampam was *ca.* 50 tonnes, out of which *ca.* 60% came from the *lebak lebung*, 24% from the river and 16% from the *rawang* swamp (Hoggarth & Utomo, 1994, fig. 3; see also Husnah et al., 2020, pp. 8–9). About 75% of the total catch consisted of species with some degree of ability to breathe air, and especially the *lebak lebung* catches were dominated by blackfish (Hoggarth & Utomo, 1994, p. 198). In the peak year 1997, the catch rose to 93 tonnes (Utomo & Hartoto, 2008; cited in Prianto et al., 2013), but dropped drastically to only 12 tonnes in 2012 (Husnah et al., 2020, pp. 8–9). The reasons behind the fall are deforestation caused by forest fires and the building of oil palm and rubber plantations, dam construction and unsustainable fishing practices (Husnah et al., 2020, pp. 8–9). To put the catch in perspective, just the Lempuing river has *ca.* 200 km^2 of *lebak* floodplain (Hoggarth et al., 1998, p. 26), out of which the Lubuk Lampam area is *ca.* 6%. However, all floodplains are not equal in this regard as much of the catch is tied to *lebung*s. On a larger scale, in 2015 OKI had the fishing rights to altogether 332 *lebak lebung* units up for auction with 260 receiving bids (Muslimin & Suadi, 2018, p. 2). The total yearly catch in the regency in 1990's was

Figure 5. Top left: Borobudur relief O 1. Portable fish traps can be seen on the bottom right of the image. Excerpt from a photo by K. Céphas, 1890–1891 (Collection Nationaal Museum van Wereldculturen, coll.no. TM-10015739, CC0 1.0). Bottom left: Borobudur relief O 109. Fishing with nets is depicted on the mid-right of the image. Excerpt from a photo by K. Céphas, 1890–1891 (Collection Nationaal Museum van Wereldculturen, coll.no. TM-10015846, CC0 1.0). Right: A detail of a photo showing fishing with screens and traps on a river presumably in West Java. Photo: Unknown, *ca.* 1911 (Leiden University, KITLV 159028, CC BY 4.0). This image was chosen, because it depicts fishing on a river, prominently features a wooden fishing barrier, and is as early as possible. We were unable to find such a photo from the PJR region.

ca. 16,000 tonnes (Hoggarth et al., 1997, p. 8; MRAG Ltd, 1997, p. 8). The numbers presented above are naturally not directly transferable to the past, but they are a testament to the high productivity present in the floodplains and can provide us an inkling of their historic potential. It must be also recognised that the modern situation is a product of long-term fishing pressure.

The economic importance of the *lebak lebung*s is also evident by the early formalisation of their administration. Saptono (2010) has argued that in the past fishing on the *lebak* would have been managed by the heads of villages in the Tulang Bawang regency. In the OKI, fishing rights have been sold in public auctions since 1630, and the practice has continued to this day (e.g. Pahlevi, 2002, p. 27). Currently only local villagers can enter bids, and one person is permitted to win only three auction units, but all villagers are still allowed to fish freely for their daily consumption in these areas (Pahlevi, 2002, p. 27, p. 28). There are also ceremonial traditions related to the *lebung*s that have been practised 'since before living memory': in Jambi province some pools are used as traditional fishing reserves, on which fishing is allowed only once per year with discretion on a communal *hari berkarang* day (Hoggarth et al., 1997, pp. 12–17, 1998, p. 28, 1999b, p. 106). Even though there are limitations to the fishing methods that can be used on this occasion, the catches can be as high as ten tonnes (Hoggarth et al., 1998, p. 28). *Hari berkarang* also has some religious connotations due to the fish stocks being regarded as gifts from the ancestors (Hoggarth et al., 1997, p. 14). In addition, communal feasts that included freshwater fish among the consumed foodstuffs are depicted in the inscriptions dating prior to the early 10th century found from Java (Barrett Jones, 1984, pp. 34–36, 47–49, 57–58), where the epigraphical record is much more verbose than on Sumatra (Griffiths, 2011, p. 139). However, it is not specified where the freshwater fish were caught, and there are far less floodplains on Java than on Sumatra.

According to the interviews done in 1996 (Hoggarth et al., 1997, p. 6, 8, 1998, p. 26), most of the Lempuing river fishers lived downriver in Pedamaran and had only temporary huts at their fishing grounds: the wide-ranging floods, the lack of roads and yearly auction system had discouraged permanent settlement in the area. Although fishing communities do reside in relatively permanent settlements closer to their fisheries where the floodplains are not as extensive (Hoggarth et al., 1998, p. 26), remote areas may have been fished on a non-permanent basis in the past leaving behind little easily recognisable archaeological evidence. Even though fish are a crucial part of the region's diet, and fisherfolk therefore serve an important role in their societies, they are often poor. On the Barito River in Borneo, fishers' average daily income is below the Indonesian welfare standard (Muthmainnah & Rais, 2020, pp. 37–38). Simple fishing gear like hooks and portable traps are cheap, but capital-intensive larger equipment such as filtering barriers and seines are out of reach to an ordinary fisherman; instead, they are typically owned by wealthier individuals or cooperatives (Hoggarth & Utomo, 1994, p. 200). Historical records from the 17th and early 18th century coastal Indonesia show that in some cases fishing was done by slaves (Boomgaard, 2005, p. 105), suggesting that the social status of the profession was low. Slavery was already common in the region before the arrival of Europeans (Welie, 2008, p. 68), and it was firmly woven into the societal structure. We do not contend that it was slaves who did the fishing on the floodplains, but that manual labour of fishing was likely the purview of the lower rungs of the society also in the past.

Relationship to Rice, Salt & Trade

In Southeast Asia fishing, rice cultivation, salt production and trade are intertwined. Wetlands are transitional areas between aquatic and terrestrial ecosystems (Mitsch & Gosselink, 2015, p. 112), and this duality can be seen in land use as well: parts of the floodplain can serve both fishing and rice cultivation at the same time. Although Chinese and Arabic historical sources describe Palembang as a fertile and self-sufficient rice growing region (e.g. Charras, 2016, p. 109; Charras et al., 2006, p. 78; Manguin et al., 2006, p. 60), the PJR soils and environment are generally thought to be unfavourable for large scale rice cultivation (e.g. Kitchener & Kustiarsih, 2019, p. 4; Manguin et al., 2006, p. 62). However, Charras (2016; Charras et al., 2006, pp. 79–80) has put forward a hypothesis, according to which rice cultivation in suitable *lebak* areas may have started earlier than previously thought and complemented sago as the main staple. Vonk et al. (1937) described *lebak* rice cultivation around Palembang in the 1930's. The transplanting was done from June to August to a depth of 40–45 cm starting from the higher parts and moving downwards following the falling water (Vonk et al., 1937, p. 447). Similarly, the harvest was collected in stages in September to November before the waters started to rise again (Vonk et al., 1937, p. 449). The farming effort coincides with the best fishing season (see Figure 4).

The fishers' interests are also at odds with the farmers' on how the *lebak* is managed: fish fetch a higher price if you can get them to the market before the peak in production, and fishers would like to dry the *lebak* before all the crops have ripened (Vaas et al., 1953, p. 8; Vonk et al., 1937, pp. 448–449). In 1930s the estimated area under this type of cultivation on the Ogan and Komering rivers *ca.* 27000 ha, and on the Lematang and Musi *ca.* 4000 ha with an average yield of *ca.* 3.5 t/ha (Vonk et al., 1937, p. 437, 451). For comparison, a traditional slash-and-burn swidden would produce *ca.* 1.4 t/ha (Charras, 2016, p. 111). More recently, *ca.* 140,000 ha of *lebak* rice has been grown in the Musi River basin (Charras, 2016, p. 112). However, the method has its risks: if water level rises or falls unexpectedly parts of the crop may be destroyed (Charras, 2016, p. 112; Vonk et al., 1937, p. 448).

Especially in cases where the water level rises rapidly after a short dry spell drowning the rice that has been transplanted too low (Charras, 2016, p. 112; Vonk et al., 1937, p. 448), the effects of this on fish yields would likely be far less severe allowing the maritime resources to function as a subsistence reserve (cf. Westerdahl, 2003). As Charras (2016, pp. 111–112) has pointed out, her hypothesis faces a similar obstacle as our own: unlike the irrigated *sawah* rice growing, the *lebak* farming utilises natural landforms and does not require any permanent structures to be built, therefore leaving behind little easily identifiable archaeological evidence. It is difficult to pinpoint when the practice began and more research on the topic is needed, but based on circumstantial evidence it could extend as far back as the 10th century (Charras, 2016, pp. 112–114). If this is the case, there must also have been infrastructure in place to transport the crop to the market. Perhaps some fish and/or fish products were carried along?

Once caught, fish spoil fairly quickly and must be treated if wished to be consumed later. This is especially true if much of the catch is highly seasonal as exemplified above, and still in the 1950's about half of the catch from the *lebak* was reported to be cured (Vaas et al., 1953, p. 21). It is also reported from Palembang that between 1906 and 1910 on average *ca.* 337 tonnes of dried fish was exported per year, with the fish coming from both the sea and freshwater sources (Van Kampen, 1922, p. 76 with references). The main methods for preserving fish in the Sumatran context are drying, fermenting, and salting. The preservation methods have left a lasting mark on South Sumatran and Indonesian cuisine, and for example *bekasam* and *terasi* can be made using freshwater fishery products. *Bekasam* is a traditional fermented fish dish prepared specifically out of freshwater fish mixed with rice (Huda, 2012, pp. 719–720). On the other hand, fermented *terasi* shrimp paste is a condiment manufactured from e.g. *Atya* sp. shrimp (Huda, 2012, p. 732), which are present in nearly all Indonesian freshwater pools including flooded rice fields (Djajadiredja & Sachlan, 1956, p. 367). Its use dates back historically to at least the 15th century (Prihanto & Muyasyaroh, 2021, pp. 378–379 with references). Huda (2012, p. 720) mentions that the *bekasam* used in his study was still edible after 2 months of storage, and in general fish preserved properly by drying or fermenting could last for more than a year (Hall, 2011, p. 8). In other words, curing allowed fish to be transported and traded over long distances, used as food onboard ships, and stored for considerable amounts of time until needed. The widespread consumption of fermented fish originating from the floodplains would likely show up in the cities' archaeological record as high amounts of fragmentary freshwater fish bones – especially from blackfish species – scattered broadly in their cultural layers, and perhaps also as the remains of storage vessels. However, only a few osteological assemblages from Sumatran archaeological sites have been analysed so far (Gruwier, 2017, p. 27). In Island Southeast Asia, fish are in many cases the predominant vertebrates in archaeological find assemblages (Samper Carro et al., 2017, p. 12 with references). Their differentiation into species is challenging due to the region's high biodiversity, therefore the identification is often done on the family-level (Samper Carro et al., 2017, p. 12). For example, Samper Carro et al. (2017) have been able to track the changes in taxonomic diversity from late Pleistocene to late Holocene in the fish bone material of Tron Bon Lei rock shelter, Alor Island, suggesting alterations in the intensity of maritime resource exploitation through time. It is also noteworthy that this type of detailed analysis requires rigorous sieving (Samper Carro et al., 2017, pp. 11–12). On Sumatra, large numbers of fish bones have been found for example from the 12th to 14th century CE site of Kota Cina (McKinnon, 1977, p. 20, 1984b, pp. 121–123).

The use of salt is of special interest in regards to commerce: it is essential for human nutrition and its production capabilities vary considerably geographically, making it an important trade good (e.g. Foo, 2020, p. 271). On Sumatra, salt was traded from the coastal lowlands to the interior (Miksic, 1985, pp. 444–445), and the trade pattern was likely in place at least from the 6th or 7th century onwards (Manguin, 2009, p. 443). The salt trade was politically and economically important, and in the 18th century, the VOC and the local rulers sought to assert their control by monopolising the salt trade in Jambi (Andaya, 1995). Palembang and Jambi are mentioned in 14th and 15th century Chinese sources as locations where salt was produced by boiling saltwater (Foo, 2020, p. 274 with references). During the VOC salt monopoly, established in 1882, Palembang and Sumatra's east coast were included in the areas where production was allowed (Dutch East Indies, 1882). However, Miksic (1985, p. 445) has noted that the environment in coastal southern Sumatra is unfavourable for large-scale salt production due to high precipitation, absence of a pronounced dry season and low salinity of the sea. The modern day Indonesian production areas are situated in Aceh and northeast

Java (Miksic, 1985, p. 445), where salt can be made from seawater in earthen embankments by solar evaporation (Foo, 2020, p. 277). If fish and shrimp were produced and cured on the floodplains in a scale large enough to help provision the cities, there may also be traces of salt transportation present in the archaeological record.

Large cities were unable to produce enough food within their limits, and had therefore to import food at least locally from their hinter- or *umlands* (e.g. Manguin, 2002, pp. 76–78; Reid, 1988b, p. 53, 67). In some cases this had to be supplemented by long distance trade: for example, Jambi was heavily dependent on imported Javanese rice in the mid-17th century due to the focus on growing pepper instead of rice in its interior (Andaya, 1993, p. 66), and late 17th and early 18th century Batavia bought dried fish from Pekalongan and Madura as it was struggling to feed its growing population (Boomgaard, 2005, p. 103 with references). Reid (1988b, pp. 75–76) has estimated that the urban populations of both Palembang and Jambi would likely have exceeded 10,000 inhabitants at their height in the 16th to 17th centuries. In addition to feeding their own populace, surplus food had to be at hand to provision incoming ships and their crews who might stay in harbour for considerable amounts of time in wait for favourable winds in order to continue on their voyage (Charras, 2016, p. 101; Manguin, 2022). This could have been a make or break for a successful *entrepôt*: if no food was available, the trading ships might take their business to competing ports elsewhere (Charras, 2016, p. 101). Provisions were also needed for the voyages themselves. For example, according to the Selden Map of China sailing from Quanzhou, China to Palembang took *ca*. 19 days in favourable winds not including the time needed to sail up the Musi River (Perttola, 2022, p. 710). For comparison, it took *ca*. 8 days for an early 17th century VOC flyboat to sail up the Batang Hari to Jambi in the best of conditions (Wellan, 1926, p. 346). Additionally, the population levels in the highlands were likely relatively high (Reid, 1998, pp. 69–72) and fish may have also been traded upstream from the floodplains to satisfy their demand.

All of the above begs the question: how does the rhythm of maritime trade dictated by the monsoons fit into this? To investigate the matter, we modelled the weekly sailing durations between Palembang and selected ports present on the Selden Map of China using qtVlm navigation and weather routing software version 5.10-9 (Meltemus, 2022). Previously qtVlm has been used to model ancient seafaring by Gal et al. (2021). The ERA5 (Hersbach et al., 2018) three-hourly wind data (10 m above ground u- and v-components of wind speed, i.e. the east-west and north-south vectors, out of which wind speed and direction can be calculated) of 1979–1980 (see Perttola, 2022, pp. 704–705 for the rationale behind this choice) with 0.25° spatial resolution was downloaded from Copernicus Climate Change Service (C3S) Climate Data Store (CDS), and the ship performance was set as in Perttola's (2022) previous article. The calculated routes and their durations represent unrestricted and optimal fastest paths between the ports in the prevailing winds. The analysis covers only seaborne travel (see Figure 6), the sailing times up and downriver to riverside ports situated further inland are not included. The schematic results, which can be applied to Jambi as well, are shown in figure 6 as the months when the simulated ships with short voyage durations would arrive or depart Palembang. The results somewhat vary from year to year, but the general picture seems clear: there are two distinct spurts of activity in December–March and June–September. Ships from ports northwest, north, and northeast from Palembang would arrive in the former time window with the winter monsoon and set sail in the latter along the summer monsoon, while for the ships coming in from the east and southeast the periodicity is the opposite. When compared to the fishing and rice farming schedule on the PJR floodplains, the ships from northern ports sail in outside the busiest production season and depart at the height of the fish catch when most of the floodplain rice is yet to ripen. On the other hand, ships coming from the east – and especially the ones carrying rice and salt from Java to PJR – would arrive in time to replenish the stocks before the new harvest and perhaps help to provision the outbound vessels.

Discussion

The PJR floodplains have offered ample fishing potential in the *longue durée*. The concept of *longue durée* stems from Annales school and especially the works of Braudel (e.g. 1960), where he used it to describe long duration historical phenomena that span hundreds or even thousands of years in contrast to shorter-term events. In the *longue durée*, certain elements – be they natural or manmade – that permit the systems to develop and flourish also provide limitations for human actors. In our case, the Barisan mountain range and the monsoonal winds, both millions of years old, form the large-scale environmental backdrop that perpetuates the PJR rivers, floodplains and their fishing potential in the long-term. This however does not mean that the rivers and floodplains have been static for the past several thousands of years. The meandering and the yearly fluctuations in the water levels create an ever-changing and dynamic landscape for fish and man to perform in, and in the last two millennia there have been several periods of intense drought in Southeast Asia

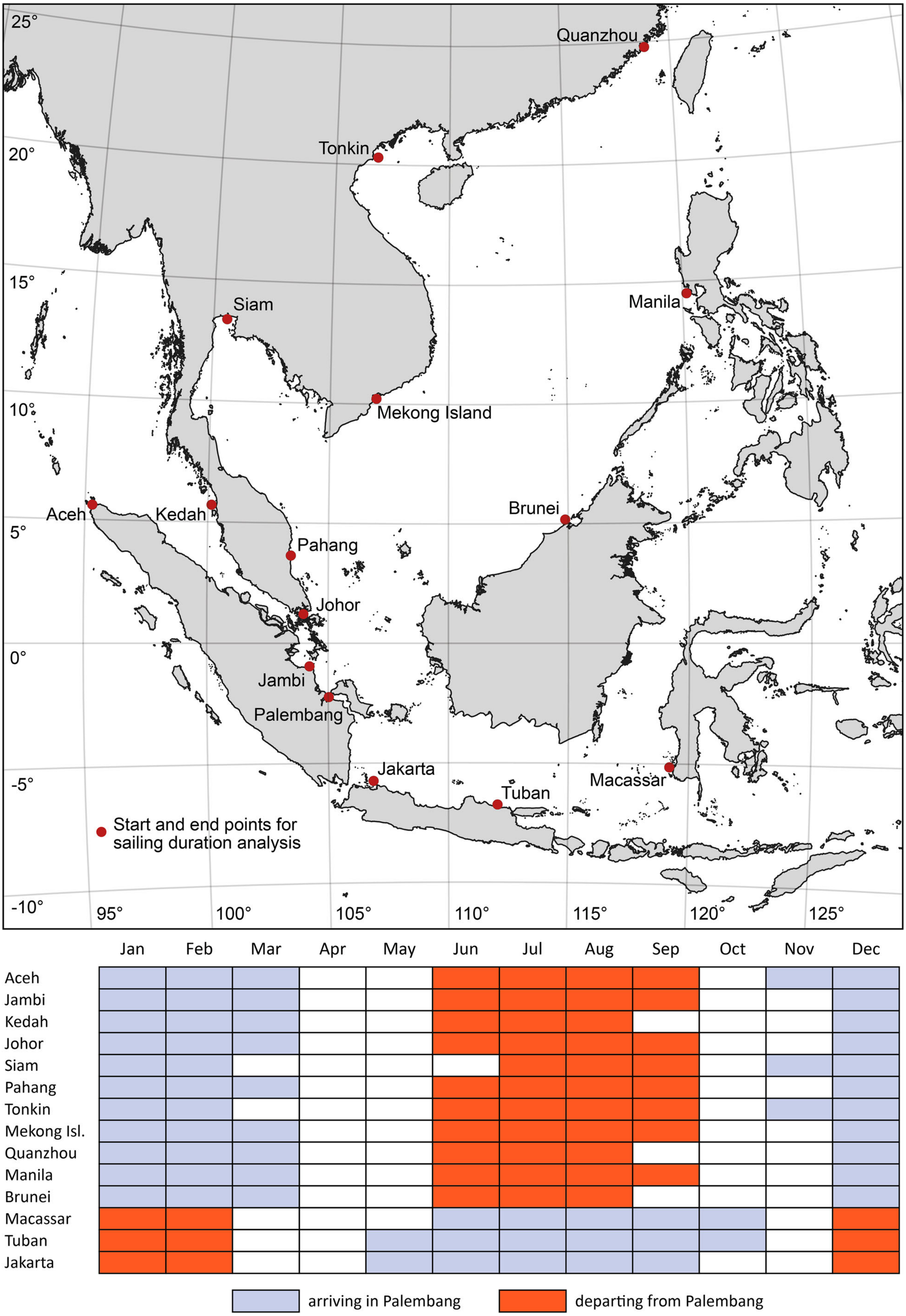

Figure 6. Top: The start and end points used in the sailing duration analysis. Their positions are approximated from the route lines on the Selden Map of China (see Perttola, 2022, p. 695 for the rationale behind this choice). Bottom: The schematic optimal arrival and departure months to and from Palembang based on the wind patterns of 1979. The ports are organised from the viewpoint of Palembang starting from northwest and going clockwise towards southeast. Naming convention of the ports follows Batchelor (2013, p. 39). (Authors)

caused by the fluctuations of the monsoons (e.g. Clift & Plumb, 2008, p. 199). More recently the term *longue durée* has also been adopted into the discussion of continuity of indigenous cultures under the pressures of colonialism (e.g. Silliman, 2012). To juxtapose the *longue durée* and cultural continuity, Silliman coined the term *short purée* to describe the opposite where the cultures would have lost much of their integrity and morphed into something new due to the outside influences. Even though cash cropping black pepper did become much more prevalent in the PJR in the 17th century due to European influence (e.g. Andaya, 1993, pp. 43–73) reshaping the economic landscape in the process, we find it unlikely that fishing would have been notably affected as it is so intimately linked with rice consumption. Therefore we contend in this article that fishing practises on PJR floodplains fall on the *long durée* side of this argument, and that the early colonisation efforts nor the introduction of Islam (cf. Boomgaard, 1998, pp. 198–199 on hunting wild boar) would not have caused a major break in the traditions.

The link between *long durée* and MCL is a strong and natural one. Braudel mentions parts of maritime culture as an example of a persistent system (Braudel & Wallerstein, 2009, p. 179). According to Westerdahl (2003) *long durée* is a prerequisite for maritime cultures as they are not just temporary short-term phenomena. Hence Rönnby (2007; see also Staniforth, 1997) has used the term *maritime durées* when discussing coastal landscapes, but his idea is also applicable to our setting and MCL in the wider sense. The overarching theme of MCL, developed by Westerdahl since the 1970's and brought to wider knowledge two decades later in his landmark paper (Westerdahl, 1992), is a holistic view over maritime heritage. In it, maritimity is understood in a wide sense: it includes not only the seas and oceans, but also other bodies of water – lakes, rivers and even floodplains – and extends on land to sites, structures and resources connected to humankind's aquatic endeavours. In addition to physical remains created by people operating in the maritime sphere, high emphasis must be placed on its immaterial aspects: for example toponyms, folklore and ethnography are considered to be crucial sources on this otherwise elusive facet of the past as maritime culture is often underrepresented in historical sources. In regard to fishing on the PJR floodplains the problem goes one level deeper as the fishing practices are largely invisible archaeologically. Therefore, we argue that using recent ethnographic data to build our hypothesis is warranted. We must also rely on modern measurements when reconstructing the floodplain extents and modelling seafaring because historical high-resolution datasets do not exist.

In order to discuss how well the floodplains fishing corresponds to the MCL framework, we can compare it to MCL's subcategories. According to Westerdahl (e.g. 2014, p. 746) MCL can be subdivided into the following aspects: 1) economic, 2) transport and communications, 3) power, 4) outer resource, 5) inner resource, 6) cognitive and 7) recreative landscapes. In our view, the fishing on the PJR floodplains clearly fits into categories 1–2 and 5–6 and may have contributed to category 3. Fishing was an integral part of the 'economic landscape', i.e. the landscape of sustenance, and – if performed on a large scale – would have acted as an 'inner resource landscape' that provided surplus to the ports and facilitated trade. In the 'transport and communications landscape' the river forms a crucial artery, along which the fisherfolk move, their supplies, gear and catch are carried, and news and orders transmitted upon. The 'cognitive landscape' is the mental map of the fishers that includes things like preferred fishing spots, best practices, and understanding the rhythm of the river and the fish, which are conveyed through generations for example by oral traditions or teaching by example. In addition, rituals such as the *hari berkarang* and communal feasts described earlier in this paper fall under this category. The act of fishing itself can also be highly communal as seen in Figure 5. Altogether, the social lives in the communities on floodplains can be highly seasonal as well in conjunction with the rhythm of the river as Harris (1998, 2000, pp. 125–141) has poignantly shown with his work on the Amazon. However, when compared to the Tonle Sap Lake where fishermen of Chinese, Vietnamese and Khmer ethnicities are known to have congregated for the fishing season from the tributary rivers in the early 20th century (Walker Vadillo, 2016, pp. 81–82 with references), fishing on the south Sumatran floodplains was likely a more local affair. Floodplains fishing may also contribute to the 'power landscape' through security of supply as it has the strategic advantage of the resource being inland and available even if invaders would blockade the river downstream. This would also keep the workforce out of sea raiders' reach; people were one of the main forms of plunder in conflicts because Southeast Asia was underpopulated (Reid, 1980, pp. 243–245). Left out are the 'outer resource' and 'recreative landscapes'. The former pertains to providing materials to ship- and boatbuilding, which floodplains may also have done but is outside the scope of this article. The latter is the tourist landscape of today and therefore not applicable to our case, although it needs to be noted that people of the past may have fished for the fun of it as well.

By bringing MCL, *longue durée,* and modern cartographic methods and data together, we arrive at historical ecology with a maritime emphasis, i.e. marine historical ecology (e.g. Crumley, 2021; Engelhard et al., 2016) that also includes other bodies of water than just the sea. Historical ecology is a research programme that began to take its shape in the 1960's (e.g. Deevey, 1964), and it is a highly interdisciplinary approach that combines a wide range of natural sciences and humanities – including e.g. archaeology and ethnography – in order to reconstruct the past environment and to study the historical relationship between humans and nature (e.g. Balée & Erickson, 2006). As Crumley (1994, p. 9) has pointed out, this relationship is seen as interactive and non-deterministic:

> Historical ecology traces the ongoing dialectical relations between human acts and acts of nature, made manifest in the landscape. Practices are maintained or modified, decisions are made, and ideas are given shape; a landscape retains the physical evidence of these mental activities.

The changes – or the lack thereof – in the landscape and people's mindsets towards it, and the intricate interplay between them, can be traced through time and space based on these clues. It is necessary to stress that in our view fishing on riverine floodplains is not an environmentally deterministic phenomenon: the environment only offers the potential, which people may or may not have chosen to utilise. Also, the intensity of fishing may have fluctuated throughout history.

Therefore, to verify our hypothesis more archaeological field research is needed to find the possible remains of fisherfolk dwellings, fish processing sites and/or fishing gear on or near the floodplains. In the spirit of historical ecology, the human interactions with nature in the form of fishing may have been written into the landscape but in this case the small print makes it challenging to decipher. For example Walker Vadillo (2016, pp. 57–59, 85–94; see also Kallio & Walker Vadillo, 2020) has shown the potential of toponyms in her research on the Mekong, and this is a prospect that should be considered in PJR as well. If suitable toponyms related to fishing do exist, combining them with floodplains extent maps and interviews with local fisherfolk – plus perhaps even airborne laser scanning data when it becomes available – it might be possible to create a predictive model and identify hotspots for further study: for example, areas in the vicinity of suitable *lebung*s are of special interest. There, with the help of locals and their intimate knowledge of landscape and biocultural heritage, the remains of abandoned fishing gear and poles for stilted houses revealed for example by river erosion could hopefully be pinpointed. The findings should be vigorously radiocarbon dated *en masse* to hone in on the older traces of floodplains fishing. Even though recognising them may be difficult, the enhanced preservation of organic matter in wetlands might offer a very detailed record of human activities there (e.g. O'Sullivan & Van de Noort, 2007).

Conclusion

Our main objective in this article was to show the historic fishing potential of the floodplains in the Musi and Batang Hari river systems and to build a *longue durée* hypothesis for their use. This was accomplished by combining the meagre archaeological and historical information available on the subject to modern ethnographic and environmental data using the theoretical frameworks of maritime cultural landscape and historical ecology. We were able to show that the floodplains in question cover extensive areas at the height of their yearly flood cycle and are highly productive fisheries. The fishing gear and methods needed on the floodplain are rather straightforward and would likely have been available to the fisherfolk already pre-Srivijaya. The fishing productivity follows the rhythms of the rivers, and the highest catches are connected to descending and low water levels. Floodplains are also used for rice cultivation, and the practice may have already begun in the 10th century CE (Charras, 2016, pp. 112–114). The same areas could also be utilised for fishing. The best fishing season partly coincides with the rice transplanting and harvesting activities leading to competition over workforce. Fish from the floodplains may have contributed to feeding the cities of Palembang and Jambi, and in their part enabled them to function as successful *entrepôts* throughout the Srivijayan and Early Modern Periods. Inversely, this would also connect the floodplains to overseas trade and its rhythm dictated by the monsoons. On a grander scale, fishing and wetlands remain understudied aspects of history in comparison to their importance in the lives of many people. Further archaeological fieldwork is needed to validate our hypothesis, but it is possible that similar cases for floodplains fishing could be made for other suitable Southeast Asian rivers. Studying them further would reveal a fuller spectrum of human-environment entanglements and deepen our knowledge on how the societies of the past functioned.

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Author Contributions

Marko Kallio wrote the section 'The Extent of Floodplains on the Musi and Batang Hari River Systems' and made the maps, otherwise the article is by Wesa Perttola. The final touches to the paper were done together.

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The authors report there are no competing interests to declare.

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