The fluvial cultural landscape of Angkor

An integrated study



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Abstract

The development of the medieval city of Angkor (802-1431 CE) in the floodplains of the Tonle Sap Lake has ledresearchers to believe that Angkor made use of its extensive river network; however, little attention has been given to Angkor's relationship with its watery environment. Previous studies have presented a fragmentary view of the subject by analysing different components in a compartmentalize way, placing the focus on nautical technology or neglecting discussions on water transport in academic works on land transport. This work aims to provide a more comprehensive study on Angkor's specific cognitive and functional traits that could be construed as a distinctive form of fluvial cultural landscape. This is done by examining the environment, nautical technology, and the cultural biography of boats within the theoretical framework of the maritime cultural landscape and using a cross-disciplinary approach that integrates data from archaeology, iconography, history, ethnography and environmental studies. A new topological map of Angkor's landscape of communications and transport is presented, as well new insights on the use of boats as liminal agents for economic and political activities.

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Chapter 1

1. Introduction

In the floodplains of the Tonle Sap, in present-day Cambodia, the Angkor civilization thrived from AD 802 to 1431. A vast network of over 1000 km^2 and excellent connections to waterways through the Tonle Sap Lake, the Mekong River and its tributaries indicate that boats must have been very important for the development of Angkor. Although the relevance of water transport is often highlighted by researchers, this aspect of Angkorian life is poorly understood. Previous researches conducted in the first half of the 20^{th} century were limited to the study of the nautical iconography documented in the temples of Angkor, without considering these as part of a larger cultural expression of Angkor's connection to water. As a result, we have a fragmentary view of Angkor's fluvial cultural landscape. Seeking to unpack the complex relations behind the establishment of this aquatic landscape, this thesis takes the environment, the nautical technology, and the iconography as entry points to unravel the main characteristics of Angkor's interactions with its watery environment. Drawing on the concept of "the maritime cultural landscape" and integrating data from archaeology, iconography, history, ethnography, hydrology, and human geography, the thesis deploys a maritime emphasis to a subject that has been dominated by terrestrial concerns in the past.

The three main sections of the thesis correspond to the environment, the development of nautical technology, and the cultural uses of boats in Angkor. The analysis of the environment shows that the Mekong River basin is characterized by strong seasonal flooding cycles marked by the dry and the wet monsoons. The identification of geographical trans-shipment areas corresponds to important archaeological sites, which suggests efforts to manage the river

basin. Furthermore, distribution of archaeological sites suggest a dispersal pattern along waterways, which demonstrates that the Tonle Sap lake and the Mekong river acted as nodes for water transport. Branching off from these nodes were tropical rivers and canals that connected the whole of Angkor's territories. The main characteristic of these tropical rivers is a drastic change in flow, which is low in the dry season and high in the rainy season. The analysis, which also considers the distribution and environmental limitations of Angkor's road system, shows that Angkor's transport network combined water and land transport following weather patterns. From June to December priority would have been given to water transport, while from January to March land transport would have been used. April and May would have been difficult months for transport due to scarcity of water (i.e. not enough for boat transport, and too scarce for humans and animals using land transport). The strong dependence of Angkor's transport network on the cyclical rains made them vulnerable to climate instability, particularly in regards to the tropical rivers whose flow depended exclusively on the monsoon rains. The well documented mega-monsoons of the 14th and 15th century coincide with Angkor's decline, and this study suggests that the impact of the droughts that accompanied these climatic events resulted in the destruction of Angkor's transport network and possibly the fishing stocks.

Dynamic in nature, the influence of the river in the development of hull design is explored in the chapter dedicated to nautical technology. This discussion revolves around the different types of boats that were used in the Mekong river basin looking particularly at the constraints imposed by the environment. The three main types of ships documented in the iconography and the archaeology are planked sea-going ships and coastal vessels used in the sea-river transit zone, and raised dugouts and simple dugouts used in lakes, rivers, and man-made canals and ponds. Although direct contact between the people from Angkor and cultures with planked vessels is attested, dugouts and raised dugouts were prevalent in Angkor and survived until the beginning of the 21st century. This section considers the cultural components found

in boat ethnography that may have prevented a change in technology from dugouts to planked vessels.

The third section of the thesis analyses iconographic data to study the contexts in which boats were used. These are mainly economic activities, warfare, transportation, state progresses by water, and festivals. The study shows that decorations are used only by the elite, and that the central part of the boat is reserved for the most important people on board. This reflects the strong social structure present in Angkor, and the way it translated into boats as an important part of Angkor's complex fluvial landscape.

The thesis rationale is that Angkor was not only the land-oriented polity that it is portrayed as, but instead had a hybrid existence that resulted in the development of a complex fluvial landscape that was expressed through boat design and through cultural activities where boats are central objects of culture, religion, and power. By shifting the focus of study from a land to a river perspective and de-prioritizing land over water it is possible to offer new interpretations to current discussions and observe archaeological data under a new light that emphasizes the environmental context. Consequently, the thesis highlights the deep bias toward land that archaeologists bring into their interpretations, and shows that by selecting a different point of view (in this case rivers) it is possible to open up new lines of inquiry and offer alternative answers to old questions.

The aim of the thesis is to hypothesise on the different ways that Angkor interacted with its watery environment (i.e. lakes, river, and man-made bodies of water such as canals, ponds, and reservoirs). This can be addressed by seeking answers to the following questions:

i) Are there any indicators that suggest that Angkor exploited this river network?

ii) How did Angkor use its river network?

iii) How did the landscape and the geography affect water transport?

iv) How did the landscape and the geography affect hull design and how did it evolve over time?

v) Were there any cultural elements that affected the technology used to make boats? Did this affect hull design?

vi) How do boat creation, modification, usage, and demise relate to the nautical activities?

vii) How do these activities explain Angkor's fluvial cultural landscape?

viii) How do environment, technology, and culture intertwine?

By answering these questions this thesis aims to discover if the people of Angkor developed cognitive and functional traits in relation to the aquatic environment that could be construed as a distinctive form of fluvial cultural landscape.

1.1. Chapter overview

The first four chapters have been designed to provide the reader with the required theoretical, methodological, and historical background of the research. Chapter 2 provides a background for readers who may not be familiar with the evolution of polities that developed in the Mekong River Basin. The summary starts off with the establishment of Funan in the delta region, taking advantage of its geographical location to exploit overseas trade. It then explains how power shifted inland during the Chenla period for reasons that are still a matter of debate, until it was eventually established in the north shore of the Tonle Sap Lake during the Angkor period. This chapter argues that since the distribution pattern of these polities appear to follow the river network, it is possible to explore the idea of a fluvial cultural landscape.

Chapter 3 outlines the most relevant literature for the study of Angkor's fluvial cultural landscape for readers who are experts in maritime trade networks and maritime landscape studies but are not familiar with the archaeology of Angkor. It pays particular attention to the way in which the study of Angkor's fluvial cultural landscape is de-contextualized, with research conducted on the boats and the river networks done separately. It first tackles boat studies, looking at the most influential works on the study of Angkorian boats, that of Pierre Paris, a civil servant of the French empire who made the first in-depth study of nautical iconography from the temples of Angkor, and that of Michel Jacq-Hergoualc'h, a land archaeologist who published a seminal book on the Angkorian armies (including the fleet)

based on iconographic data. Secondly, it looks at the way in which traditional archaeologists and historians have incorporated Angkor's river network into their interpretations and reflects on how the absence of an integrated study has resulted in an incomplete view of Angkor's fluvial culture.

Chapter 4 presents the theoretical framework and the methodology followed in this research. Westerdahl's concept of the maritime cultural landscape is brought forward as another way of theorizing on Angkor's fluvial cultural landscape in order to offer an integrated approach to these kinds of studies. This chapter introduces the non-maritime archaeologist/historian to the theoretical framework of the maritime cultural landscape, and discusses adaptations of this theory to the context of rivers and the difficulties that doing this entails.

Chapter 5 is the first of the three core chapters of the research; it focuses on the environment and the constraints that it imposes on nautical design and on the organization of transport and communications. Angkor's territory is divided into different transport zones based on the environmental affordability of movement by water and delimiting these areas by trans-shipment points where a change of boat is required and where environmental conditions impose certain conditions to hull design and transport. An anachronic topological map of navigable rivers is presented based on environmental data and the location of 19th and 20th century settlements with the term Kompong (port) attached to their names. A discussion on river ports is also included.

Chapter 6 provides an updated discussion on nautical technology in Angkor after the recent discoveries of two historical boats from the Angkor and post-Angkor periods, as well as the identification of a second plank vessel found the bas-reliefs. The chapter is more comprehensive than previous works, as it discusses not only the dugout techniques, but also current plank-built styles derived from dugout techniques, rafts documented in the bas-reliefs, and two different types of plank vessels depicted in the iconography.

Chapter 7 discusses the technological side of nautical archaeology to look into the activities that took place on board boats. The chapter analyzes iconographic data to discuss the way in which boats were used during the Angkor period from functional objects to symbols of the elite. The iconographic corpus gathered for this research is categorized into the themes of economic activities, leisure, parades, pilgrimages, celebrations, and amphibious warfare, with a small portion of the imagery labelled as uncertain.

Chapter 8 is the final chapter where the three main sections (environment, technology, culture) are brought together to discuss Angkor's fluvial cultural landscape. This integrated approach will provide a multi-faceted interpretation of Angkor's interactions with its watery environment and will emphasize the importance of changing the perspective from land to water in regions where the main mode of transport is by boat. It is expected that by applying the concept of the Maritime Cultural Landscape, the research will yield a better understanding of the complex relationships established between a culture and its watery environment.

Apart from the figures inserted in the text and referenced as (Fig.), there is an appendices volume containing the images referenced in the text, as well as further data from fieldwork and desk-based research that has been used for this thesis. The images referred to in the text as (PL.) can be found In Appendix 1. Appendix 2 contains the tables with individual data from each of the boats depicted in the iconography. Appendix 3 corresponds to the iconographic corpus with details of the surveyed temples. The corpus is organized per temple and includes maps with the location of the images within the temples. Appendix 4 includes descriptions of boat building traditions in Cambodia with accompanying photographs. Appendix 5 describes the archaeological remains of the two dugouts found to date in the area of Angkor. Appendix 6 contains a visual dictionary of boat terminology used in the thesis. Finally, Appendix 7 contains the list of *kompong* villages and their corresponding river networks as well as the references used to elaborate the topological map presented in chapter 5.

Chapter 2

2. From Funan to Angkor

The main archaeological evidence of this thesis is the nautical iconography that emerged in the 12th century CE, a period considered to be the height of the Khmer Empire of Angkor. By the time these activities came to be depicted, the region was (loosely) unified under a temple-based central authority that had developed a keen taste for performance and symbolism (Stark, 2004: 90-91). The representations show sophisticated boats at the centre of what appears to be highly developed activities such as nautical warfare, royal progressions by water, and nautical celebrations. These events, which in some instances appear to be highly formalized, are a response to the complex relationship that Angkor established with the environment over the course of time. Thus even though the scope of this thesis has been set to between the 9th and the 15th centuries CE, this chapter contains a brief overview at the historical progression that ultimately led to the rise of Angkor on the northern shore of the Tonle Sap Lake and the development of cultural expressions Angkor's fluvial cultural landscape.

The polity of Angkor developed in what is currently known as mainland Southeast Asia. This region comprises roughly the modern countries of Myanmar, Laos, Thailand, peninsular Malaysia, Cambodia, and Vietnam (O'Reilly, 2007: 2). The climate of the region is characterized by the Monsoon wind system; the northeast (summer) monsoon occurs from March to October, while the southwest (winter) monsoon runs from November to April (Chuan, 2005: 81-83). These winds are responsible for the rainfall (or lack thereof) in the region: the summer monsoon brings heavy rain, whilst the winter monsoon is characterized by lack of rain. The

geography of Southeast Asia impacts the distribution of this rainfall; for example, the Annamite range experiences a yearly rainfall of 3,000 mm (Pl. 1)[1] while the interior regions of the area like the Khorat plateau or the Tonle Sap Lake basin are drier with an average of 1,500 mm per year (Douglas, 2005: 193-197). The Mekong river basin is affected by this seasonal pattern. The river has high flow from June to October – with a recorded maximum of 67,000 $m^3 s^{-1}$ (cubic metres per second) – and low water from February to April – with a minimum recorded flow of 1250 $m^3 s^{-1}$ as it runs through Kratie in Cambodia (ibid.).

The geography of Southeast Asia has suffered drastic changes in the past related to sea-level changes (Higham, 2002: 8; Bellwood and Glover, 2004: 7). During the last glacial maximum 17,000 yr BP, the sea level in the region fluctuated up to 120 m below the present sea level (PSL), but more than half of the time it was set at or below 30 or 40 m PSL (Voris, 2000: 1165). Though these changes are acknowledged in the literature as factors to be taken into account in prehistoric studies (see for example Higham, 2002: 8), the event is poorly understood and maps usually reflect only the maximum lows (Voris, 2000: 1165). The exposed land was presumably criss-crossed with river systems, the largest of which would have been the Siam or proto-Chao Phraya river (ibid.),[2] which would have received waters from tributaries originating in the Malay peninsula, Thailand, and Cambodia, offering a means of communication between these regions in prehistoric times when the sea level was 75 m and below (PL. 2) but not for epochs when the sea level was 40 m and below (PL. 3).

The fluctuation in the sea level would have affected homo sapiens as it populated Southeast Asia more than 50,000 years ago (Bellwood & Glover, 2004: 12-13). These early humans were hunter-gatherers classified by archaeologists as Hoabinhian, a widely spread culture in mainland Southeast Asia characterized by unifacial or bifacial axe-like tools made using river

[1] Figures labelled as PL. can be found in the appendix.

[2] For a recent study of fluvial sequences in the Sunda Shelf see Darmadi, Y., Willis, B.J. & Dorobek, S.L., 2007. Three-Dimensional Seismic Architecture of Fluvial Sequences on the Low-Gradient Sunda Shelf, Offshore Indonesia. *Journal of Sedimentary Research*. Vol. 77, Num. 3, pp. 225-238.

pebbles (Bellwood & Glover, 2004: 16). The Neolithic period in the region has been dated to around 3,000 BCE, when agriculture is estimated to have entered the region (O'Reilly, 2007: 3). According to O'Reilly, it seems that rivers played an important role in the transmission of this new technology which brought about drastic changes in Southeast Asia (ibid.).

There are lacunae in the present understanding of the Bronze Age in the region. The technology was likely introduced from China, which appears in the archaeological record from around 2000 to 1500 BCE. However, interpretations on the social structure that characterized this period differ (O'Reilly, 2007: 5). Higham has suggested that the region had an integrative exchange system that followed the course of rivers or the coast (1989: 187). Access to goods would have been restricted, and status would have been linked to their access to desired commodities. This fluctuation would have led to instability (Higham, 1989: 187). White, on the other hand, sees in mortuary goods evidence of a social differentiation that is not based on an elite class but rather on social subsets, arguing that access to goods was likely less restrictive (White and Piggot, 1996: 157). Whether these communities were peaceful or bellicose is still a matter of debate, but the settlement patterns along the river networks indicate continuous use that would have naturally resulted in accumulation of knowledge of the environment, tradition of boat usage and development of nautical technology, and the establishment of cultural activities on and in the fringes of these rivers.

These were likely autonomous groups with an average size of between 350 and 500 individuals (Higham, 1989: 187-188). The first instances of iron have been dated to 800 to 400 BCE (ibid.: 223). This switch in technology has been identified as a turning point in Southeast Asian history. Archaeological material from this period show an increasing number of weapons being deposited in burials, a feature that has been used as proxy to suggest increasing stress between Iron Age communities (O'Reilly, 2007: 5). Furthermore, beads from India entered into the exchange networks of Southeast Asia (Higham, 1989: 190) and appear in increasingly

stratified burials (O'Reilly, 2007: 6). On the other hand, archaeological excavations in the Mun and Chi river valleys in the Khorat plateau show an increasing population with settlements reaching 1000 and 2000 people (Higham, 1989: 219). This evidence has led researchers to suggest that Iron Age settlements evolved from autonomous groups into increasingly complex chiefdoms toward 500 BCE, creating the setting for the emergence of proto-states at the turn of the first millennium CE (Higham, 1989: 190-192; O'Reilly 2007: 6,). At this time, marine transgressions and delta progradation was still constraining human activities until it stabilized between 2000 and 1500 years ago (Stark, 2006a: 411), so by the time of the establishment of the Angkor empire in the 9th century CE the region was more stable. The landscape of human settlement in the region was characterized by their location close to bodies of water: coastal areas, floodplains along tributaries, or in the vicinity of freshwater lakes, which suggests that water transport played an important role in the development of emerging chiefdoms (Stark, 2006a: 414). Between 500 BCE and 500 CE Southeast Asia is characterized by small urban states characterised by the presence of hydraulic works with moats connected to waterways (Stark, 2004: 77, 79).

2.1. The emergence of complex polities in the Delta (c. 100 – 550 CE)

From the early first millennium CE, following this tradition of sites connected to rivers, the lower reaches of the Mekong River basin served as the backdrop for the establishment of the polities of Funan, Chenla, and finally Angkor. Although early research was keen on seeing a transplantation of Indian civilization in the region, a position heavily influenced by Coedès's *The Indianized States of Southeast Asia* (1968), current scholarship considers that the relationship between Southeast Asian polities and India was more synergetic (O'Reilly, 2007: 91). Though archaeological data from the delta region is scarce, there is enough evidence to postulate that the region has been inhabited since 2000 BCE, with a substantial increase of human occupation from 500 BCE onwards. Stark reckons that the earliest forms of polities in

the Mekong delta were characterized by a concentration of large populations in urban centres where manufacturing processes took place and the development of social stratification influenced by religious ideologies originating from India (Stark, 2003: 80-90). The location of these urban centres in the delta and with access to the sea provided its population with access to long distance trade networks with China, India, and ultimately Rome (Stark, 2006a: 413-417). Current knowledge on the process of state-formation in the Mekong delta is limited. Earlier researchers relied heavily on Chinese historical accounts written centuries after the events happened, but the trend now is to use this information in combination with epigraphic and archaeological data (Vickery, 1998: 95; O'Reilly, 2007: 92; Stark, 2004: 81). The name given to this polity, Funan, was the one used by Chinese historical sources (Higham, 2001: 24-25).

The type of polities that comprised what we call Funan is characterized by their fluid territory, which contracted or extended depending on the ability of the overlord to exert influence and power (Higham, 1989: 240). This kind of dynamic polity has been called *mandala*. Contrary to what the Chinese annals recall, the archaeological evidence suggests that Funan was not a single centralized state, but rather "tribal societies that from time to time produced chiefs who were able to impose their hegemony over neighbouring chiefs by mobilizing military power through family networks, clans of relatives and their allies, and marriage alliances to other chiefs' groups" (Hall, 2011: 51). The form of succession is unclear, but later epigraphic evidence seems to suggest that the form father-to-son was not implemented, and instead the succession was made uncle-to-nephew (the sister's son) (Vickery, 1998). Nonetheless, historical records show the frictions created by the use of this system, for instance the son of the overlord Fan Shih-man took over upon his death but was killed by his cousin who would have been the legitimate heir of the uncle-to-nephew system (O'Reilly, 2007: 98).

The largest Funanese settlement identified to date is Angkor Borei. The site is characterized by the presence of extensive ritual architecture erected on brick foundations and elite residences,

the appearance of non-utilitarian pottery assemblages, and the presence of hydraulic works in the form of a moat surrounding the settlement and a canal that links the site to the settlement of Oc Eo and the coast (Stark, 2004: 88). The morphology of these shallow canals is similar to other earthen works in the region, with a raised embankment on one side and a varying width of between 2 to 4 m, with some sections reaching up to 25 m (O'Reilly, 2007: 101). The current perception is that these canals were used for transport and communication, linking inland sites with the Bassac-Mekong river on the one hand, and with international maritime trade on the other (Miksic, 2003: 16-17; Stark, 2003: 99; O'Reilly, 2007: 101). The site of Oc Eo is also remarkable; archaeological evidence indicate that the site was established in the 1st century CE and was continually occupied until 300 CE when it was briefly abandoned (O'Reilly, 2007: 103).

After the reoccupation of the site in the mid-4th century, a clear Indian influence has been documented in material culture, along with remains of manufacturing areas of pottery, glass and jewellery, as well as bronze and iron smiths (Higham, 2002: 236-239; O'Reilly, 2007: 105). Funan's integration in the trans-Asian maritime trade routes that extended as far as the Mediterranean is documented in the archaeological record: two Roman medallions made from coins minted during the reigns of Antoninus Pius (138-161 CE) and Marcus Aurelius (161-180 CE) have been recovered from the site, along with other jewellery that has been identified as Mediterranean or Mediterranean-inspired (Higham, 2002: 236; Miksic, 2003: 1-34). Funan's connection to China is also attested in the form of a Chinese mirror that has been dated to the same period as the medallions (ibid.). Though Funan is usually perceived as the precursor of Chenla, and ultimately Angkor, it is unclear which language they spoke since there is no epigraphic evidence from this period (Vickery, 2005: 123-125). Based on the similarities of the material culture, it is likely that Oc Eo was connected with some inland settlements found along the riverbanks of the Mekong River up to the Bolovens plateau in Laos, though further work needs to be conducted to confirm this claim (Miksic, 2003: 24).

The ethnicity of the people of Funan is still a matter of debate. Inscriptions first appear in the 5th century, and they are written in Sanskrit brought into the region by South Indian merchantmen (Higham, 2002: 242). In Vickery's opinion, the use of Khmer in 7th century inscriptions found in Angkor Borei suggests that there was continuity with the previous inhabitants, and thus they must have spoken Khmer (Vickery, 2005: 123-125). Nevertheless, he reckons that Malay, Mon, and Cham speakers would have been present in the cosmopolitan ports of Funan (ibid.), a view supported by Miksic, who reckons that the Khmer of Funan may have relied on Austronesian shipping; though he thinks the population of Funan may have been predominantly Mon (Miksic, 2003: 31).

2.2. The pre-Angkorian period and the move inland (c. 550 – 802 CE)

The reasons that led to the decline of Funan and the rise of Chenla in the mid-6th century CE are poorly understood. Internal and external factors have been suggested. It is thought that overexploitation of resources and/or poor management could have induced the collapse of the urban centres and that these could have been overpowered by competing polities (O'Reilly, 2007: 108-110). Higham is more of the view that Funan's reliance on international maritime trade suffered greatly toward the 5th century CE when trading routes started to by-pass the region favouring the ports of call of island Southeast Asia (2002: 243), a view shared by Hall (2011: 60-65). Funan disappears from Chinese historical accounts in the mid-6th century CE, with a further mention in a 7th-century account that recalls that "Chenla" had taken over the polity (Stark, 2006b: 152). By the mid 7th century the settlement of Oc Eo had been abandoned (Manguin, 2004: 300), although the rest of the delta continued to be populated (Stark, 2006b: 152). Just as was the case of Funan, it is thought that the term Chenla or Zhenla should only be understood as a region in the middle Mekong and the Tonle Sap where competing polities exerted power (Higham, 1989: 255), though O'Reilly thinks that the term may refer to the most powerful of several competing chiefdoms or kingdoms during the 7th and 8th centuries

(O'Reilly, 2007: 111). Stark seems to be of the opinion that Chenla may refer to the polities that settled around the Mekong River, while a different (pre-Angkorian) polity may have occupied the Tonle Sap Lake region (Stark, 2006b: 154).

There is still some debate on whether the Khmer people that comprised the polities of Chenla eventually took over the (possible) Mon polity of Funan (Miksic, 2003: 31) or whether the change from Funan to Chenla represents a continuation of Khmer rule with only a geographic move inland that corresponds to an increasing interest in agriculture (Vickery, 1996: 3; Higham, 2002: 253; O'Reilly, 2007: 110). This assumption however is very land-oriented and does not take into account the role of geo-politics. It is likely that the relocation of the centre of power also corresponded to Khmer aspirations for control over the river networks and protection against waterborne attacks on their capital (the Tonle Sap Lake is a cul-de-sac with a single access from the sea via the Tonle Sap River).

The general agreement is that the region of Chenla occupied central and northern Cambodia from the 6th to the 8th centuries, however, no systematic archaeological work has been done on these sites (Stark, 2004: 89). Epigraphic evidence has been used to theorize about the political organization of the region (see for example Vickery, 1998; Coedès, 1968). The epigraphy suggests an increasing complexity in social organization, with rulers being influenced by Indian culture and using the Indic suffix -*varman* which is translated as shield or protector (O'Reilly, 2007: 115; Higham, 2001: 147). Other hierarchical titles are otherwise in Khmer, like *poñ*, which could have referred to the local authority and was inherited by males through female relatives, or *mratañ*, which came to substitute the former (ibid.: 117-120). The Khmer of Chenla embraced Hinduism and Buddhism, but the former left more traces in the archaeological record (Stark, 2006b: 155). According to Stark, Vaishnavism[3] predominated in

[3] The branch of Hinduism that worships Vishnu.

the south, while Shaivism[4] was practiced north of the delta and in the Tonle Sap area (ibid.). Lavy has proposed that the appearance of the figure of Harihara, a fused deity with attributes from Vishnu and Shiva, in the 7th century suggests the unification of these regions (Lavy, 2003: 39). It is possible that highly mobile riverfaring fishermen groups living in the Mekong River contributed to the dispersal of religious ideas. The role of this nomadic community – attested for later periods as it will be seen in this research – needs to be considered in this context.

The brothers Bhavavarman and Citrasena-Mahendravarman are the first real rulers of Chenla recorded in inscriptions (O'Reilly, 2007: 111). Bhavavarman seems to have died at the beginning of the 7th century, following which his brother succeeded him (Higham, 2002: 250). The inscriptions that Citrasena-Mahendravarman left in the Mun river valley area have been interpreted as incursions from Chenla into the regions above the Dangrek Range (ibid.). However, there is no consensus on whether this region was controlled by Chenla or not.

Coedès (1968) originally proposed that capital of Chenla was located in Wat Phu, favouring the idea of a Khmer population moving southwards (Vickery, 1994: 197). However, Vickery has proposed that the capital need not have been that far north (ibid.: 197-198). Instead, he proposes that the area of Wat Phu, near which a large fluvial settlement was established in the 5th century CE by a king named Devanika and abandoned toward the end of the 7th century (Santoni and Hawixbrock, 1998: 387; Santoni and Hawixbrock, 1999: 400-401), was under possible Cham rule and that the Khmer polities of Chenla pushed northwards during the 6th century CE to expand their territory (Vickery, 1994: 199). This is supported by Hoshino, who believes the polity referred to as Linyi in the Chinese annals, which is interpreted as a precursor of Champa, may have had its seat of power in the area of Wat Phu (Hoshino, 1996: 61).

[4] The branch of Hinduism that worships Shiva.

There are several large sites in central and northern Cambodia that have been associated with different polities within Chenla. South of Wat Phu below the Pha Pheng – Khone Falls, the ruins of Thala Borivat are located in the vicinity of Stung Treng, an area that controls access to the Sekong - Srepok River basin (Higham, 2002: 248). The site has been dated to the 6th century CE on stylistic grounds (Bénisti, 1968: 96), although current research indicates that the area was settled from at least 500 BCE.[5] The location of the site of Thala Borivat suggests an earlier attempt to establish control over the river traffic, though the area eventually fell under the influence of Sambhupura (Vickery, 1998: 379). The seat of power of the latter is located below the Prek Patang rapids, and above the Sambor rapids in the vicinity of the village of Sambor.[6] Sambhupura is considered an important centre of the Chenla sphere of influence that bloomed from the 7th century onwards. The site has been associated to Jayavarman II, founder of the Khmer Empire (Coedès, 1968: 85-86, 97; Higham, 1989: 324). The location of ruins between the rapids suggests that Sambhupura was taking full advantage of the limitations of navigation and managing access up and down the Mekong River. The tight connection between Sambhupura and river trade is reflected in the title of *mahanauvaha*, "great shipper", attested in epigraphic records from this region (Vickery, 1998: 379). According to Vickery the epigraphic records suggest that Sambhupura was an independent *mandala* that had a four-generation royal genealogy dominated by female rulers (1998: 379-380). The region did not lose its independence until the reign of Jayavarman II (c. 770 – 835 CE) when it was incorporated into Angkor (ibid.).

The most important site from the Chenla period is Isanapura, now known as Sambor Prei Kuk. The site is located next to the Stung Sen River and close to the town of Kompong Thom. It is

[5] There is ongoing research currently being undertaken on this site by Heng as part of his Ph.D. thesis at University of Hawai'i. Although publications are still to come, preliminary data with dates from the site have been published in a brief report as of 10th April 2016. See further details in Heng, P. (n.d.) *Doctoral Dissertation Research: Political economy and state formation of pre-Angkorian Cambodia: a view form Thala Borivat*. Online resource visited 01/06/2016: http://grantome.com/grant/NSF/BCS-1332761

[6] For a detailed description of the ruins see Leclère, 1904: 739-742.

unclear when the site was first constructed because of its continuous use up to the Angkor period when the site was incorporated into the Khmer road system of Jayavarman VII in the 12th century (Higham, 2002: 248). Following Bénisti's stylistic analysis wherein Isanapura is suggested to postdate Thala Borivat (1968: 95), Higham estimates that the moated enceinte was constructed during the 7th century (Higham, 2002: 248). Jacques is of the opinion that Bhavavarman I ruled the eastern portion of his father's territory from Isanapura, while his brother Citrasena-Mahendravarman governed the western territories from a hitherto unknown location (Jacques, 1986: 69-71). Though this proposition is contested (see O'Reilly, 2007: 112), it clearly departs from Coedès's initial proposal that the Khmer descended from the area of Wat Phu and grants more relevance to the area of central Cambodia (ibid.).

Wolters suggests that in the 7th century Cambodia was still plagued with chieftainships "whose rulers by no means felt that they already normally belonged to a larger and permanent political unity" (Wolters, 1974 383). Jacques seems to agree with Wolters, as he argues that the inscriptions would be better understood if we accepted that there was a plurality of kingdoms or principalities even though there may not be direct references to their names in the epigraphic record (Jacques, 1986: 93). Vickery proposes that nonetheless there was a consolidation of the territory, granted through the support of strong local rulers to the lineage of Bhavavarman I (1998: 124-126). This consolidation, he argues, can be seen in the homogeneity of the region's administrative, cultural, and political practices (ibid.: 132).

Bhavavarman's conquest did not last long and in 638 CE China received several tributary missions from the different polities that were still claiming independence from the area of Chenla (see Wolters, 1974). During the reign of Jayavarman I in the second half of the 7th century some degree of centralization was attained by controlling the foundation of religious monuments (Vickery, 1998: 368) and the suppression of rival overlords by military conquest (Wolters, 1974: 374-375). His domain, according to inscriptions, encompassed part of north-

western Cambodia and reached as far north as Wat Phu, where he appointed a chief of Sresthapura, the fluvial settlement located in the proximity of the temple (Wolters, 1974: 375). The inscription of Kdei Ang[7] indicates that a during the reign of Jayavarman I there was already in place a strong body of royal retainers who traced their ancestry back to the rule of Rudravarman of Funan (Higham, 2001: 41). From another inscription found in Tan Kran we learn that a son from a Brahman from Dharmapura was made governor of Sresthapura, while another son became, among other things, the chief of rowers (ibid.). Wolters reckons that Jayavarman I's prowess was an exception, and that his unification did not survive him (1974: 383-384), while O'Reilly suggests that his daughter, Jayadevi, could have retained during her reign the centralized system imposed by her father (O'Reilly, 2007: 117). Whatever the degree of central power after the death of Jayavarman I towards the end of the 7th century, it seems that the epigraphic records show no sign of re-emergence of the polities subdued under his rule (O'Reilly, 2007: 122). Sambhupura was spared and appears to have remained autonomous throughout the Chenla period.

2.3. The rise of the Angkor *mandala* (802 – 1432 CE)

The king who would finally come to consolidate the territory into a single political unit was Jayavarman II, who rose to power in southern Cambodia toward the second half of the 8th century. His first capital was possibly located in the area of Banteay Prei Nokor (Coedès, 1968: 98), from where he extended his influence over Sambhupura, Vyadhapura (in Kompong Thom), and advanced on the western territories of the Tonle Sap Lake (O'Reilly, 2007: 123-124). Wolters is of the view that Jayavarman II had to reprise the victories of Jayavarman I in the north-western territories if he were to be seen as a powerful leader by his followers. The aspiring overlord launched a military campaign against the polities in this region, including the polity of Malyang, who would retain a strong regional identity up to the 12th century (Wolters, 1974: 358, 384). Vickery has suggested that after pacifying the north-west there were

[7] K. 54, 55 in Coedes, G. (1937) *Incriptions du Cambodge.* Vol.III. Paris: Editions de Boccard. Pp. 157-160.

repopulation efforts in the areas of Battambang, Banteay Meanchey, and Siem Reap province (1998: 316). Jayavarman II established various centres of power in the northern shore of the Tonle Sap Lake before establishing his final capital in Hariharalaya, now known as Roluos (O'Reilly, 2007: 123). Current research in the area indicates that this was the site was inhabited before the arrival of Jayavarman II, so instead of creating a new urban centre he occupied a pre-existing cultural context and established his palace in the site of Prei Monti (Pottier, 2010: 51-52). Before descending into this region, however, he first established a city in the Kulen Mountains called Mahendraparvata.

The most revealing details of the accomplishments of Jayavarman II are found in the Sdok Kak Thom inscription dated to 1052 CE, two centuries after his demise (Wolters, 1973: 21). The text informs of the proclamation of Jayavarman II as chakravartin – universal monarch – in 802 CE while at Mahendraparvata. This date is currently used as the official one for the establishment of the Angkor *mandala*. It also recalls the celebration of the *devaraja* cult (Coedès, 1968: 98). The debate on the interpretation of this cult has produced oceans of ink.[8] The initial interpretation was that it referred to the cult of the God-King, a form of deification of the king, but some interpret the term as a "king of the gods", an indigenous deity that was summoned during the ceremony to ensure the protection of the realm (O'Reilly, 2007: 124). Given the relevance placed on the actions of Jayavarman II in the inscriptions after 877 CE, it is surprising that no contemporary inscriptions praising his actions have been found yet; however, as Stark points out, there are almost no inscriptions in the Khmer language between 791 and 877 CE (Stark, 2006a: 155).9 It is unclear how the polity evolved during the 9th century, but in 868 CE the term *kamvudesa* appears both in Sanskrit and in Khmer to refer to a supraterritorial entity in the region (O'Reilly, 2007: 125).

[8] The discussion is out of the scope of this research, but for a lengthy review on the subject see Woodward's review of Jacques's interpretation (2001).
[9] This may change in the near future as work progresses in what is thought to be the remains of Mahendraparvata. See for example Penny *et al.* (2014).

In 21st century scholarship, however, the polity is referred to as Angkor or alternatively, as the Khmer Empire. The term Angkor derives from the Sanskrit word *nagara*, which translates as city or town in a similar sense to the concept of the Greek polis (Soubert, 2002: 73). While Angkor Wat refers exclusively to the famous temple, the use of the term Angkor on its own describes the polity and the archaeological remains associated with it, the majority of which can be found between the north shore of the Tonle Sap Lake and the Kulen Mountains (Stark, 2004a: 101). The four main primary sources for the research of Angkor come from archaeological remains, inscriptions (both in Sanskrit and in Khmer), iconographic representation in bas-reliefs and statuary, and Chinese historical accounts (ibid.). Sanskrit inscriptions provide data on religious affairs, whilst Khmer inscriptions relate to the administration of the temples (Stark, 2004a: 102). The most important historical account was written by the Chinese emissary Zhou Daguan who visited Angkor as part of a diplomatic mission during 1296-1297. This account was first translated into French by Abel-Rémusat in 1819, but it was Pelliot's translation of 1902 (revised and re-published in 1951) that would have further reach as his work was used to translate the text into other modern languages during the 20th century. In 2007 Harris published a new translation from the original Chinese into English (Harris, 2007), and in 2016 Uk and Uk published an annotated translation into English edited by Davis (Uk and Uk, 2016). The wealth of epigraphic and historical data, as well as the difficulty of conducting fieldwork during the second half of the 20th century due to the political instability of Cambodia, ledresearchers to emphasize this kind of data (Stark, 2004: 103). Since the 1990s there have been an increasing number of archaeological projects in the country that aim to provide tangible evidence to the historical data. For example, ongoing archaeological work conducted by the École française d'Extrême-Orient (EFEO) and the Greater Angkor Project (GAP) have resulted in a better understanding on the development of urban sites in Angkor (see for example Evans and Fletcher, 2015). A drawback of the fieldwork projects that have been conducted so far is that the majority has concentrated on the north-

western shore of the Tonle Sap Lake and as a result areas beyond this point are poorly known (Stark, 2006b: 156). Nonetheless, archaeological data from the Mun River basin in Thailand and in southern Laos suggests that there is an overlap between archaeological sites there and in Cambodia, which points to a simultaneous emergence of complex polities in the region (ibid.).

Due to the absence of epigraphic data from the 8th century, the process of state development in Angkor is not fully understood. Vickery points out that there is a clear linguistic or orthographic change in the vocabulary used in the inscriptions from the end of the 8th century (1998: 84-85), something that Stark interprets as a rupture with the past that she feels has not been convincingly explained yet (Stark, 2006b: 155-156). It is likely that more data from this period will be available in the coming years as archaeology catches up with modern technology. The successful use of LiDAR in Angkorian sites[10] demonstrates the complexity of Angkor's cultural landscape and promises to shed more data that may change the way we view the polity as it is applied to understudied areas (Evans and Fletcher, 2015: 1417). Instead of following a historical narrative it is thus best to focus on the processes that characterize the different periods of the Angkor *mandala* until more data comes to light in the forthcoming years. For example, the geo-political component of this research can be used to evaluate the way the fluvial landscape has affected the development of Angkor and help in the selection of further areas to study.

What seems to be clear is that Angkor, like its preceding polities, retained the fluidity of borders that characterizes the Southeast Asian *mandala*. The first three centuries of Angkorian rule are dominated by military campaigns, an aggressive disposition that Stark attributes to the prevalence of Hindu religion – particularly the expansionist ideology that could have been entrenched in Saivism (Stark, 2004: 105). This changed with Jayavarman VII in the late 12th

[10] See for example Evans *et al.*, 2013; Evans and Fletcher, 2015; Hendrickson and Evans, 2015; Stark *et al.*, 2015.

century, as his support of Buddhism putatively shifted Angkor's focus to commercial enterprises (ibid.). After the anointment of Jayavarman II as *chakravartin* and the establishment of the *devaraja* cult, the rulers of Angkor strived to emphasize the connection between them and the divine powers they venerated. As advanced earlier, there is no consensus on the interpretation of this *devaraja* cult. Hall (2011: 160, 168-169) defines this as the god-king and interprets the cult as the process of exaltation but not of deification of the king. It also incorporated the veneration of local spirits. Stark (2004: 106-107), on the other hand, prefers the idea set forth by Kulke (1978) that the *devaraja* was a portable phallic-shaped statue that represented the Hindu god Shiva. While Higham avoids mention of the issue when discussing Jayavarman II as *chakravartin* (2002: 302-303), O'Reilly opts to lay out the different interpretations without taking sides, and includes Jacques's proposition that the *devaraja* was a protective indigenous god (2007: 123-124). Whichever the case, scholars are certain that there were continuous efforts ledby the kings of Angkor to merge religion and monarchy (Stark, 2004b: 90; Higham, 2001: 89). The king was thus identified with a god (Siva, Vishnu, or Buddha depending on the king's affiliations) and was considered as the intermediary between the mortal world and the divinity and also had the ability to intercede with the spiritual world to ensure the fertility of the realm (Hall, 2011: 170). Thus the *devaraja* cult established by Jayavarman II and continued by the successive Angkorian kings had the ability to merge Indian and local cults and strengthen the role of the monarchs (ibid.: 171).

Numerous royal capitals were constructed by Khmer rulers during the Angkor period, all of which include extensive hydraulic features. These capitals had temples that acted as administrative zones (Hall, 2011: 161-163) and it is thought that they contained a suburban perimeter that sprawled over the walls of the cities (Evans *et al.*, 2013; Stark, 2004b: 90). The Khmer design of urban centres during the Angkor period relied on the Hindu idea that there is a parallel between the macrocosm of the gods and the microcosm of humans (Stark 2004b: 90), a line of inquiry that has resulted in numerous studies (see for example Mus, 1936;

Mannikka, 1996; Gaucher, 2004; Stuart-fox and Reeve, 2011). The creation of a capital provided the new ruler with a chance to legitimize power before his subjects through the erection of a temple consecrated to the former royal relative through whom power had been inherited (Stark, 2004b: 90). Temples on the periphery of the polity were used to highlight the power of the central government, while important temples located at the core of the Khmer Empire were used to commemorate victories and narrate stories of Hindu epics in the bas-reliefs of their walls (ibid.). Performance was at the core of Khmer royal authority; public displays of the king's power took the form of public ceremonies, processions and pilgrimages to important sites through imposing avenues open to the populace (Stark, 2004b: 91).

Angkor's economy depended largely on wet-rice agriculture, fishing, trade, tribute, taxation, and corvée labour (Stark, 2004a: 107). The Khmer polity inherited from Chenla a temple-based economic infrastructure wherein produce was stored and redistributed through a network of temples linked to the central power (Hall, 2011: 161). Hall reckons that the increasing political complexity of Angkor eventually led to a more sophisticated system that involved a higher level of centralized control, and that temples ultimately became the means to redistribute economic and symbolic capital (ibid.: 161-162). Provincial elites appointed by the ruler ensured that the goods were channelled to support temple construction and specialized work (Stark, 2004a: 108). Efficient water control system appears to have increase the productivity of Angkor's agriculture, but it is unclear how this was attained (Higham, 2001: 154). Though the northern shore of the Tonle Sap was good for agriculture (Higham, 2001: 80), the reasons that led to the relocation of the centre of power there are unknown, as the southern lands were better suited for agriculture (O'Reilly, 2007: 122-123).

It is acknowledged that markets played an important role in the Khmer Empire and yet Angkor had no apparent coinage system (Stark, 2004a: 108-109). The epigraphy suggests that barter was the common exchange method (see Jacob, 1979: 414-415), something that appears

mentioned in Zhou Daguan's account (Uk and Uk, 2016: 87). In terms of overseas trade, the role of Angkor as an international hub is reflected by the presence of a permanent community of Chinese traders in the capital during the 13th century (Uk and Uk, 2016: 124).

It is not the aim of this chapter to relate in detail the accomplishments and shortcomings of all the kings of Angkor, however, especial attention must be given to Suryavarman II (1113 – c. 1150) and Jayavarman VII (1181 – c. 1218) since the majority of the nautical iconography comes from their reigns. Suryavarman II came to the throne after killing his great uncle, Dharanindravarman I, during times of political fragmentation (Higham, 2001: 112). The text of the stele of Ban That (found in southern Laos and dated to the reigns of Jayavarman VI and Suryavarman II) describes how Suryavarman fought against the enemy king, and jumping on his elephant he killed his enemy like the Garuda takes down the snake on the mountain (Finot, 1912: 27). It also mentions how boats were sent to bring a priest (*hotar*) to the king, and then celebrations ensued (Finot, 1912: 6, 22; Sharan, 1974: 119-120). The greatest accomplishment of Suryavarman II was without a doubt the construction of Angkor Wat, a Hindu temple consecrated to Vishnu where one of the most elaborate nautical scenes can be found. He also ordered the construction of the temples of Banteay Samré, Chau Sey Tevoda, and Thommamon and contributed to the temples of Wat Phu, Preah Vihear, and Preah Khan of Kompong Svay (Boisselier, 1952: 222-223). Suryavarman II engaged in warfare[11] with the Cham on the east and the Dai Viet on the northeast to extend his territories, which eventually led to a period of instability after his death (Higham, 2001: 120).

During the political turmoil that reigned between the 1160s and 1170s there were raids by the Cham on Khmer territory. There is some confusion about what happened during these decades; a prevalent but dated assumption is that the Cham launched a naval invasion in 1177,

[11] Wolters has proposed that Suryavarman II had a fleet (Wolters 1958: 598), this will be discussed in the section pertaining to nautical warfare.

shortly after which Jayavarman VII, who was in Vijaya – one of the Cham capitals – at the time, came to power. However, these events have been contested by Vickery, who indicates that the epigraphic evidence points to a land invasion (see Vickery, 2005). In Vickery's opinion, the reality may have been that Cham raids of varying degrees of success took place while Jayavarman VII was in Cham territory (ibid.). In 1181 he took over the throne, and shortly after had to face a Malyang rebellion on the western shore of the Tonle Sap Lake (Coedès, 1968: 170; Wolters, 1974: 358). His military accomplishments granted him recognition as a great warrior, but his greatest contribution to Cambodian history was his patronage of Buddhism and the construction frenzy that characterised his reign (Briggs, 1951: 215; Higham, 2001: 121-132).

The creation and maintenance of transport infrastructure is akin to constructing empire, as it improved communications that grants any ruler the ability to control his territory. The improvement of the road network that linked the central sites of Angkor with the periphery have been attributed to Jayavarman VII (see for example Im, 1998; Hendrickson, 2007). He promoted the construction of 102 hospitals, 121 rest-houses , stone bridges (Hendrickson, 2007: 100), and commissioned the temples of Preah Khan, Ta Prohm, Bayon, the enclosures of Angkor Thom, Ta Nei, Ta Som, Banteay Kdei, Prei Nokor, and the Jayatataka baray with its island temple of Neak Pean. He also had further works done on Banteay Chmar and Phimai (see Cunin, 2004; Jacques and Freeman, 2006). Many of his temples shed light on Angkor's life on water, as many were decorated with bas-reliefs depicting nautical scenes.

After the death of Jayavarman VII the Khmer Empire waned until finally disappearing in 1432 when the court moved to the area of Phnom Penh. Research conducted in the last 16 years suggests that even though epigraphic evidence is scarce, the Angkorian kings of the 13th century finished Jayavarman VII's ambitious construction program (see Cunin, 2004). Though earlier scholarship assumed that the ultimate demise of Angkor was due to attacks from the

neighbouring western polity of Ayutthaya, environmental research has demonstrated that during the 14th and 15th centuries two mega-monsoons affected the region, the first between 1345 and 1374, and the second between 1401 and 1425 (Buckley et al. 2014: 17). This phenomenon is characterized by a long period of drought followed by unusual levels of high rainfall (ibid.). Current scholarship argues that these mega monsoons gravely affected Angkor's hydraulic infrastructures and significantly contributed to the collapse of the Khmer Empire (see (Buckley *et al.*, 2010). The relocation of the political centre from the Tonle Sap to the Chaktomuk area has thus been ascribed to an increasing importance of maritime trade and the destruction of Angkor's infrastructures (ibid.: 6750).

The relationship between landscape exploitation and social development is apparent in the evolution of societies in the lower reaches of the Mekong River basin from prehistory to the Khmer Empire. The ability of Funan to engage in overseas trade was likely supported by agricultural surplus and its strategic position as intermediary between foreign merchants and produce from the Mekong River basin. For reasons yet unclear the centre of power moved inland, settling during the Chenla period on the riverbanks of the Mekong River, the Stung Sen River, and possibly on the north-western area of the Tonle Sap Lake. Military expansion led to the establishment of the Khmer Empire centred on the north shore of the Tonle Sap Lake and encompassing the territories first occupied by the polities of the Chenla *mandala*. Archaeological evidence thus indicates that there is a trend in settlement patterns from Funan to the establishment of Angkor. The majority of the sites are located in the vicinity of rivers or streams, which suggests that waterways were used as their primary means of transportation (Parmentier, 1927: 374). It therefore seems reasonable to explore the affordances and constraints imposed by the geography and how these became entrenched in Angkor's fluvial cultural landscape. Although the role of rivers in the development of these polities is acknowledged, they are usually described as formless conduits of communication and transport. Consequently, the affordances and constraints imposed by the aquatic landscape on

human action, technology and culture remain unclear. This research aims to explore the ways this entanglement contributed to the development of a fluvial culture in Angkor in order to bring a balance to the narratives of the past in a region with amphibious landscapes.

Chapter 3

3. Previous studies of river trade and boats in Angkor

From the early stages of Angkorian studies, it became apparent that the distribution of archaeological sites was linked to river networks (Parmentier 1927: 374). This chapter is an overview of the work that has been conducted so far on river usage and nautical technology.

One of the earliest mentions of the nautical scenes of the Bayon temple appeared in *Voyage au Cambodge* published by Louis Delaporte in 1880. The descriptions are simple, more aimed at explaining the images than to provide an academic interpretation; nonetheless, he was probably the first to describe the boats of Angkor as pirogues. The term originally describes a boat with a shallow draft made from a single log, with no decking and a single mast used for coastal travel in the Caribbean (Marley, 2010: 319), however, the term has now evolved to describe a long and narrow boat made from a single tree trunk. Although Delaporte does not provide a description of the boats, it is possible to deduce from his work – and that of Garnier – that the term refers to the construction technique (dugout). The term is picked up by Parmentier in his description of the naval battles of Banteay Chmar (Parmentier, 1910: 209-211), who furthers the confusion of specialized terminology by using the terms paddler and rower interchangeably. Parmentier's article also aims to be descriptive and not a reflection of scholarly thought, but the confusion generated by the imprecision of the wording limits its contribution.

The first article to take on the task of analysing the fleet of Angkor was *La Batellerie Cambodgienne* (Groslier, 1917). The text sets out to discuss Angkor's fleet as represented in

the reliefs, drawing comparative information from historical and ethnographic data. Like Parmentier, Groslier had a tendency to use a variety of boat terminology without providing any reflection on the reasons that led him to use those terms. He indiscriminately called the boats of Angkor pirogues, junks, and sampans without acknowledging that these terms refer to specific kinds of boats with very different characteristics. There are controversies surrounding the use of the term *junk*, which are often identified as Chinese-built ships. The French often used the word *jonque* to refer to any traditional Vietnamese sailing vessel, but in some instances also used the term to refer to boats propelled by poles or sweeps (Brooks and Bui Quang Trach, 1962: IV). However, the term *junk* originates from the Malay term *jong* and it refers to Southeast Asian-built ships of considerable tonnage (see Brooks and Bui Quang Trach, 1962: IV; Manguin, 1980). Hence the use of the term in early publications may be misleading.

Groslier used rower/rowing and paddler/paddling interchangeably without recognizing the different technology employed in each case. For his initial analysis Groslier benefitted from the work of Paul Pelliot, who translated two crucial texts from the study of boats in Angkor. The first translation, published in 1902, was of the historical account *A Record of Cambodia: the land and its people* written by Zhou Daguan, a Chinese emissary who travelled to Angkor in 1296-1297. The text contains a chapter on boat construction describing general features of the boats, where small boats are described as dugouts, and larger boats are said to be made with planks (Uk and Uk, 2016: 113). This reference usually appears in any scholarly work discussing the boats of Angkor. The second text, a translation of the *Book of Southern Qi* (479-501 CE) that appeared in Pelliot's seminal paper *Le Fou-Nan*, has a short reference to the boats of Funan: "*On fait des bateaux qui ont de 8 à 9 tchang. On les taille en largeur à 6 ou 7 pieds. L'avant et l'arrière sont comme la tête et la queue d'un poisson"* (Pelliot, 1903: 261). Based on this evidence, Groslier advanced the discussion on the boats of Angkor by establishing their main characteristics, which were: 1) made from a single log, 2) had central cabins, 3) had no anchors, and 4) had no rudders (Groslier, 1917: 199). His greatest contribution was the

identification of two types of hull shapes among the Cambodian boats: one with curved ends, and another one with hard angles (1917: 198). Unfortunately he did not pursue this line of inquiry and in his following publication *Recherches sur les Cambodgiennes* (1921) this observation was scrapped from his analysis. Instead, Groslier provided a more in-depth analysis of the large planked ship depicted in the Bayon,[12] which he initially identified as a Chinese junk (1917: 202-204). In the 1921 discussion he concluded that the ship had to be either Chinese, or of Khmer construction following a Chinese design (1921: 114). Groslier also expanded his research on Angkorian boats, adding more details in terms of construction techniques and technology (ibid.: 109-114). He advanced that the dugouts were likely up to 24-25 m long and 1.5-1.8 m wide, made from local hardwood, and identified the section amidships as the space destined for the most important character on board.

Groslier acknowledged the relevance of boats in the environment in which Angkor developed, noticing that a substantial part of the land was covered in water during the rainy season (1921: 109). Parmentier also picked up this reflection and in his seminal work *L'art Khmér Primitif* he emphasized that waterways were the preferred means of transport based on the distribution of the archaeological sites located by French archaeologists up to the 1920s (Parmentier 1927: 374). The maps elaborated by Parmentier recorded in detail the waterways of the region, including the small rivers that are often left out in more recent publications. The map elaborated by Lunet de Lajonquière (1901) is more often referred to, but in both cases it is apparent that there is a correlation between the location of archaeological sites and the river system. A recent reappraisal of Angkor's road and river network and its relation to archaeological sites shows that many were not connected to roads but were near rivers (Hendrickson, 2007: 134).

[12] Scene BY-SG.III in corpus, see iconographic corpus in the Appendix.

Angkor's nautical iconography corpus kept increasing as temples were being cleared by the EFEO. An excavation of a pond located north of the Phimeanakas temple in Angkor Thom ledby Marchal brought to light another nautical bas-relief (Marchal, 1924: 303-328, Pl. XXIX). The presence of lavishly decorated barges with bows and sterns depicting fantastic animals did not go unnoticed by Quaritch-Wales, who tangentially discussed nautical events in Angkor on his book *Siamese State Ceremonies* (1931: 111-115). His main focus was the State Progress by Water of the kings of Thailand, looking particularly at the event that took place on the 3rd of March of 1926 as part of the celebrations of the coronation of king Prajadhipok (ibid.: 111). In his analysis he drew attention to the description of similar events witnessed by European travellers in the 17th century and referred to Groslier's 1921 publication. In Quaritch-Wales's opinion, the Thai State Progress by Water evolved from similar events staged by the Angkorian kings, making the same connection to the *Book of Southern Qi* and agreeing with Groslier that the reference to the boat decorated with "the head and the tail of a fish" demonstrated an early example of decorated royal barges that could be traced as far back as Funan (Quaritch-Wales, 1931: 113-114).

An updated study of the boats of Angkor – aptly titled *Les Bateaux des bas-reliefs Khmérs* – was published in 1941 by Pierre Paris, a cartographer and EFEO correspondent who made great contributions to the study of traditional boats of French Indochina (see Pham, Blue and Palmer, 2010: 262-263). Paris's intention was to review the subject of boat representations in the light of the new discoveries. Paris's work picked up where Parmentier (1910) and Groslier (1921) had left off, adding to this corpus the description of the boats depicted in Angkor Wat, Tanei, Preah Khan, and the ones found by Marchal north of Phimeanakas. He used Parmentier's description of the boats in Banteay Chmar and expanded the description of the boats found in Bayon. His work seems to have been based on the photographs taken by the EFEO (Paris, 1941: 335 f.n. 3). The article is organized in a series of descriptions immediately

followed by Paris's interpretations, which are often illustrated with examples drawn from many different cultures, including some with no cultural ties to Cambodia, a view that seems to imply a classical social and technological evolutionist approach. For Paris, the design of the hulls in the naval battles looked like the *rua chalom*, a type of plank boat found in the Gulf of Thailand that he reckons must have evolved from a dugout design (Paris, 1941: 340-341). Although he does not credit Quaritch-Wales, he also explores the idea that the Thai Royal Barges depicted in European engravings from the 17th century were similar to the boats of Angkor, as well as other connections to the Bronze Drums of Southeast Asia (ibid.: 356-357), and decorated barges of Java and Bali (ibid.: 355).

It is at this time that epigraphic information starts exerting its influence in the study of boats; Paris quotes the work of Coedès (1929: 326), who inferred from the epigraphy that there had been a naval battle between the people of Angkor and the neighbouring Champa. Coedès continued the discussion in an article from 1932, where he ratified his position that both the naval battles at Banteay Chmar and Bayon were the same representation of the Cham naval attack of 1177 and the celebrations of the victory of Jayavarman VII (Coedès, 1932: 76-78). The connection between the naval battles represented in Banteay Chmar and Bayon thus became intertwined with this Cham invasion in later studies. Paris agreed with Groslier that the fleet of Angkor comprised of dugout boats used exclusively in inland waters (ibid.: 337-338), and that they were propelled by paddles (ibid.: 354) although he also continued to equate rowing at times to paddling. Paris concludes that the Khmer of Angkor were not sea-going people, preferring to stay in inland waters. This affected Coedès's interpretation of the naval battle since he assumed that the invading boats were coming from the sea, whereas Paris suggested that the Cham fleet was fluvial (Paris 1941: 338).

Paris's article was the last comprehensive study of Angkorian boats of the first half of the 20th century, although Poujade published two ethnographic articles (Poujade, 1946a, 1946b) on the boats of Indochina, in which he discussed the connections between contemporary examples and the boats depicted in the Angkorian bas-reliefs. The extensive archaeological work conducted by the École française d'Extrême-Orient (EFEO) provided substantial epigraphic material to start piecing together the history of Angkor from a historical approach.

In 1944 Coedès presented *Histoire ancienne des états hindouisés d'Extrême-Orient* the first version of what ended up to be his most influential work: *Les États hindouisés d'Indochine et d'Indonésie* (1968). Coedès was not so much interested in the technical aspects of boat design and construction as he was in understanding the evolution of trade routes. His work is a good example of the way later historians such as Kenneth Hall (1985; 2011) continued to look at river trade following relations between maps and the location of archaeological material (both sites and stelae). Coedès understood the limitations to trade routes that were imposed by the environment. He noted, citing Father H. Bernard, that the deltas of Southeast Asia were covered by dense vegetation and inhospitable interiors that made them difficult to cross (1968: 26). Following the theory that the Khmer homeland was in the area of Wat Phu above the Phapheng – Khone falls Coedès identified the latter as a logical terminus for the trade routes crossing the Khorat Plateau from the West (ibid.: 28). His work is particularly useful to grasp the variety of historical sources that mention travel by water, and other important traditions such as "burial by water", a Funanese tradition recorded in the *Book of Southern Qi* wherein the bodies of the dead were deposited in the river (Coedès, 1968: 59).

Despite of references to nautical, maritime, and fluvial activities, it was not Coedès's intention to generate a detailed study of Angkor's waterborne trade networks but rather to make a chronological progression of the history of Cambodia following the sequence of events

documented in the epigraphy (ibid.: 247). Perhaps the most influential piece of his work for the study of Angkor's fluvial activities was the expansion on his initial proposal of a Cham naval invasion of 1177, this time echoing Maspero's proposition in *Le Royaume du Champa* (1928: 164 cited in Coedès, 1968: 166) that a Chinese pilot had helped the Cham navy to travel up the Mekong River to invade Angkor.

Following Coedès's work, Lawrence Briggs – an American diplomat who served as consul in various places of Southeast Asia – published an influential work for the English-speaking world titled *The Ancient Khmer Empire* (1951). As Mus pointed out, Briggs's work summarized half a century of French scholarship, and added valuable insights on the state of the question at the time (Mus, 1952). Though Briggs considered the Funanese a maritime culture, as opposed to the inland character of the Khmer (Briggs, 1951: 30), his interest in boats and waterborne communications was tangential. Concurrently, he discussed the road network uncovered by Lajonquière (1901) as a stand-alone subject, without discussing its role as a part of a wider communication network that included waterborne transport. His work was nonetheless very influential in the English-speaking scholarly world, and remains amongst the most cited. Gibson-Hill, who based his knowledge of Angkor on Brigg's work, used his discussion on the Pontian ship found in Malaysia as an opportunity to refute Paris's theory that the boats of Angkor were related to the *Rua Chalom*, positing instead that the hulls shared more similarities with the *perahu Butuan Barat* and the *perahu Payang* boats of Malaysia (Gibson-Hill, 1952: 122-124). He then used Briggs's summary of the history of the Khmer empire to point out that the influence of the Khmer extended as far as the Malay Peninsula (ibid.: 124). Gibson-Hill, who was curator of the Raffles Museum in Singapore, had travelled extensively in Southeast Asia and was able to find further similarities between the design of the Angkorian hulls and those of the Botel Tobago and of the Orembai of the Maluku islands, suggesting that the design was very old (ibid.: 127).

Gibson-Hill also provided a very insightful, albeit seldom referenced, digression regarding Paris's appraisal of the planked vessel of the Bayon as a Chinese junk, calling into question his identification of the ship and suggesting that it was most likely of local construction, possibly a Wangkang hull which Gibson-Hill considers to be of Funanese origin (ibid.: 126 f.n. 6, 127-128). Unlike previous publications, Gibson-Hill's grasp of nautical terminology is clear and accurate. His is one of the few articles on Angkorian boats that base the argumentation on the technological aspects of ship design. Though only tangentially relevant to the study of Angkorian boats and waterborne communications, the work of Wang Gungwu *The Nanhai trade: a study of the early History of Chinese trade in the South China Sea* (1958) provided translations of Chinese texts with references to ocean-going ships during the Funan period.[13] Osborne analyzed the role of Sambhupura in the network of communications that linked it to the Annamite range in his *article Notes on early Cambodian provincial history: Isanapura and Sambhupura* (1966: 447). His other works also contain important information on the role of the Mekong in Cambodian history (see Osborne, 1975, 2001).

Subsequent studies of the boats of Angkor were concerned with the interpretation of the individual reliefs instead of offering an integrated approach that would include environmental and cultural aspects of fluvial culture. For example, Bénisti published an analysis of the nautical representations of the frontons in Ta Nei and Preah Khan, comparing them to other regional examples but without further comments on the boats themselves (Bénisti, 1963). Similarly, Bernard-Philippe Groslier focuses his interest on the interpretation of the naval battles, which he assumes to be the representations of the alleged 1177 Cham invasion of Angkor (Groslier, 1973: 165-168, 176). He draws attention to the construction of Vat Nokor near the confluence

[13] See particularly pp. 31-45.

of the Tonle[14] Touch and the Mekong River (ibid.: 1973: 67), suggesting that the location of the temple has to do with the importance of the Tonle Touch for the Khmer.

The 1970s was a convulsive period in the history of Cambodia. In 1970 king Sihanouk was ousted by General Lon Nol. The Khmer Rouge, an insurgent communist group, opposed the government of Lon Nol and eventually took over the country in 1975. The fall of Phnom Penh in April of that year marked the start of the darkest years of Cambodian history: foreign embassies pulled out of the country and the Khmer Rouge initiated forced evacuations from the cities to the country side and mass killings of what they considered to be counter-revolutionaries. Among the latter were bureaucrats, intellectuals, and educated Cambodians (Clayton, 1998). The political instability of the region affected the archaeological projects in the country. The EFEO was forced to close its research centre in Cambodia in 1975 and archaeology in the country came to a halt. Research after this period had to rely on previous archaeological work and it appears that as a result historical approaches to the study of Angkor gained more relevance.

The study of Angkor's relationship with waterborne communications became part of historical narratives but not the main subject of research. Wolters, for example, discussed the conquest of North-western Cambodia in the early phases of the Khmer Empire looking specifically at Chinese historical accounts. Though his main interest was the polity of Malyang, he reviewed the environmental conditions of the region and the lengths of travel by land, but fell short of discussing how this affected waterborne communications (Wolters, 1974: 371-372). Groslier reconstructed the Angkorian landscape – including the rivers that were later canalized – and its development over the centuries in his paper *La cité hydraulique angkorienne : exploitation ou surexploitation du sol ?* (1979: 181) and provided a toponymic reference to a place used for

[14] Tonle means river in Khmer.

river crossing by boat translated by Coedès as “barque pour traverser” (ibid.: 163). Economic historian Kenneth Hall continued the trend of historical analysis in his seminal book *A History of Early Southeast Asia: maritime trade and societal development 100-1500* published in 1985 and revised in 2011. Hall’s work challenged Coedès’s idea of an Indianized Southeast Asia and emphasized local agency in the development of polities in the region. His work relies nonetheless in the classical works of Coedès and other French scholars, as well as Briggs, albeit with differing interpretations. Although the focus of this book is maritime trade, Hall devotes a chapter to the temple-based economy of Angkor wherein he briefly discusses river trade (Hall, 2011: 180) but his approach is mostly conjectural. Similarly, Higham referred to this river trade in his book *The Archaeology of Mainland Southeast Asia* (1989) as an undefined factor that supported the rise of the polities in the region (Higham, 1989: 247). The presence of canals linking Angkor Borei to Oc Eo and the sea starts to come to the fore, but no discussion ensues on why the people of Angkor Borei would rather invest efforts into canalizing waters for water transport than use the river they had readily at hand.

The most detailed work on Angkorian boats from the 1970s comes from the French historian Jacq-Hergoualc’h who published *L’armement et l'organisation de l'armée khmére aux XIIe et XIIIe siécles* in 1979, translated into English in 2007. In this overview of the armies of Angkor Jacq-Hergoualc’h dedicated a full chapter to discuss the fleet of Angkor and that of the enemies. His work is centred on the publications of Groslier (1921), Paris (1941), Pelliot (1903), and Coedès (1929; 1932), without a mention to Gibson-Hill’s work. He assumed Coedès’s interpretation of the naval battles to be the Cham attack of 1177 and agreed that the boats were dugouts, had shallow drafts, were elongated but broad at the centre, had rudders, and were propelled by rowers. Jacq-Hergoualc’h diverged from earlier interpretations by proposing that the similarities between the two fleets were an indication that the boats were not true models but rather a free interpretation of the Khmer artists. He picked up the subject again in 2001 when he published “*Quelques* représentations d'embarcations monoxyles en Asie du

Sud-Est" in a special number of *Techniques & Culture* that focused on nautical themes. In this article he repeats the theories set forth on his study of the fleet of Angkor and links them to other representations of dugout boats in Southeast Asia, expanding the similarities between the boat representations in Dong Son Bronze drums and those of Angkor that were discussed by Paris in 1941. In the same volume there is another crucial article by Hoc Cheng Siny titled "Le touk Khmer" (Hoc, 2001). Hoc, an archaeologist and ethnographer by training, provides a detailed account on the construction processes involved in the making of Cambodian dugouts. Although he initially connects the article to the boats of Angkor, he does not discuss how the ethnography relates to them. His work nonetheless raises very important issues regarding the construction process and the rituals involved in it.

Another piece of research to take into account is that of Eveline Porée-Maspero[15] who dedicated substantial space on her article "Jonques et po, sampou et sampan" – where she discusses from a linguistic point of view the origin of the terms in the title – to the analysis of the planked vessel in the Bayon, disagreeing with the conclusion that the ship is a Chinese junk as had been suggested by Groslier (1921), Paris (1941), and Needham (1970) and proposing that the boat is Khmer or Southeast Asian built (Porée-Maspero Eveline, 1986: 76). She credited Malleret for asserting that the Pontian boat probably came from Oc-Eo (Malleret, 1960: 120-121), even though his publication is eight years older than that of Gibson-Hill, who first proposed the idea and whose work Porée -Maspero mentions in passing on other matters (see Porée-Maspero, 1986: 74).

The political stability attained by Cambodia in the 1990s resulted in a new phase in the study of Cambodian archaeology. The inclusion of Angkor on the UNESCO's World Heritage list in

[15] Her studies on Cambodian agrarian rituals *Étude sur les rites agraires des Cambodgiens* (1962, 1964, 1969) include several references to boats, however, since the three volumes are ethnographic work they have been left out of the literature review.

1992 paved the way for a new wave of archaeological projects marked by the return of the EFEO in 1990 and the establishment of other international research projects such as the Greater Angkor Project (GAP) from the University of Sydney (established in 2002), the Lower Mekong Delta project (LOMAP) from the University of Hawai'i at Manoa (established in 1996), the Japanese team for Safeguarding Angkor (JAS) supported by the government of Japan (established in 1994) and the Royal Angkor Foundation (RAF) supported by the government of Hungary (established in 1992). While the interpretation of pre-Angkorian and Angkorian inscriptions continued to be a matter of debate among historians (see Vickery, 1998), archaeologists were regaining the ground lost during the years of the Khmer Rouge conflict and started to call for research approaches anchored in the archaeological context (Stark and Allen, 1998: 176; Pottier, 2000: 112). The main archaeological projects that have been conducted so far have revolved around the urbanization of the Angkorian landscape. This has resulted in a comprehensive map of Angkor's seat of power north of the Tonle Sap lake (Evans *et al.*, 2007), further details on canals (see Pottier, 2004: 135), and new data on the palaeoenvironment of the area (Buckley *et al.*, 2010, 2014; Lieberman and Buckley, 2012).

The publications that have come out of this new phase of archaeological inquiry have agreed on the relevance of river networks, canals, and associated infrastructure (Im, 1998: 58-71; Pottier, 1999; Fletcher *et al.*, 2003; Fletcher, Evans and Kummu, 2003; Pottier *et al.*, 2012: 2606), but the subject has yet to receive full attention. The boats of Angkor have been studied briefly from a technological perspective by Jacq-Hergoualc'h (2001) and Hoc (2001), while the nautical scenes have been discussed by Roveda as part of his wide work on Angkorian bas-reliefs (see for example (Roveda, 2005: 284-285, 405-407, 431-435, 440-441; 2007: 291-323, 353). More importantly, the widely extended idea of a naval battle between Champa and Angkor that had been traditionally associated with the naval battles of Bayon and Banteay Chmar temples was contested by Vickery (2005: 58), who reviewed the epigraphic data and

concluded that there were no grounds to sustain this claim. This was incorporated into Roveda's work, who favoured the idea that the battles represented a celebration (2007: 353).

On the other hand, while the studies of maritime trade networks and ships used in these have received considerable attention (see for example Manguin, 2004: 282-308; Miksic, 2003; Manguin, 1993; Manguin, 1980), and some attention has been granted to the study of river trade systems elsewhere in Southeast Asia (Manguin, 2009: 434-485; Bronson, 1977; Miksic, 2009), the critical analysis of river networks in Cambodia has remained on the periphery of studies on Angkor road networks (see Im, 1998; Hendrickson, 2007; Lorrillard, 2014a, 2014b). In his analysis of masonry bridges along the Angkorian roads, Bruguier mentions that transhipments could have taken place in the vicinity of masonry bridges, but fails to critically examine the impact of this type of construction on river navigability (2000: 534-535).

The same absence can also be found in Loofs-Wissowa (1991), and in Hendrickson (2007: 135-139). The latter has produced a series of articles based on his doctoral dissertation where he uses GIS analysis to study Angkor's transport network. Although he often reiterates the importance of river basins and waterborne transportation, the terrestrial approach that he applies to his studies makes it difficult for him to fully address the role of water transport in Angkor's communications landscape. For example, Hendrickson uses water catchment analysis to determine the relationship between temples and rivers (Hendrickson, 2011: 94-98) but does not discuss river navigability or geographical limitations to watercraft and often removes rivers from his maps (see Hendrickson, 2010: 448-449). As a result of treating road and water networks separately, he proposes that the temples of Banteay Chmar, Banon and Prei Nokor – which were constructed during the reign of Jayavarman VII – were not connected to the visible road network (2010: 493), without highlighting the fact that Banteay Chmar and Banon are located in strategic places with access to the Sangker River Basin, and that Prei Nokor is

located in Kompong Cham where seagoing ships still arrive from the sea to this day and within easy access to the Tonle Touch, the river that was identified by Groslier as being of great importance for the Khmer (Groslier, 1973: 67). Nevertheless, Hendrickson importantly reiterates the relevance of seasons for transport and the necessary combination of water and land transport (2007: 255, 262). Concurrently, Hendrickson has suggested that the ditches on the sides of the elevated roads could have acted as canals for water transport during the rainy season (2007: 130-131). In studying Angkor's road network in Wat Phu, Lorrillard came to the same conclusion although he does not credit Hendrickson (Lorrillard, 2014b: 74-76). In both cases there are no references to the technical aspects involved in using these canals for water transport. Lorrillard's work in southern Laos provides additional details in terms of land and river routes connecting both sides of the Mekong River (see Lorrillard, 2014a), but he does not integrate further details on navigation.

The studies of the boats of Angkor that have been conducted so far rely on the same historical, iconographic, and ethnographic material presented by Groslier in his 1921 publication and by Coedès's suggestion of a naval attack by the Cham in 1177. The uncritical analyses of these sources have led to a consensus that oversimplifies nautical technology and downplays Angkor's interactions with its aquatic environment. For example, the current literature assumes that the boats of Angkor were somewhat homogenous following a single tradition (i.e. fluvial watercraft made from a single log with the implication of a narrow hull), but studies on nautical design suggest that function and environment give rise to different hull types (Steffy, 1998: 10-11). This variety of design is patent in Vietnam, where the coast line shows at least six different traditions of boat construction including sailing rafts, basket boats, and planked ships (see Pham, Blue and Palmer, 2010: 265-273). The geographic analysis of Angkor's territory suggests that there were different environments where boats could have been used: sea-river, lake, canals, ponds, and rivers with rapids. Just by evaluating the function

of the boats and the environment in which they were used it is possible to suggest that Angkor probably developed various types of hulls, thus the idea of a single type of boat design for Angkor needs to be challenged. For example, the conditions on the Tonle Sap Lake allow for the development of flat hulls that offer good initial stability, but the rapids of Prek Patang and Sambor would have required hulls with narrower and rounder beams that offered less initial stability but better final stability (see McEwen, 2006: 29-33).

Additional problems are encountered in the literature with the use of technical terms that define boat types without providing a definition of what they mean when terms such as pirogue, junk, or sampan are used – some times interchangeably – in relation to the boats of Angkor. Similarly, discussions on the naval battles[16] have not reflected the logistical problems associated with travelling from afar with boats overloaded with soldiers with no space for storing food and water and no hand rails to hold on to or space to sit down. Paris already pointed out that the boats were exclusively fluvial and proposed that the invasion came through the river system across the Annamite range (1941: 338), but he failed to ask important questions such as: were the boats made *ad hoc* or were they stored somewhere? How stable would the soldiers had been if they had to cross the Prek Patang and the Sambor rapids standing up with no place to hold on to? Would the width and length of the boats made it possible to cross the rapids? Surely the length of the oars would have prevented this type of propulsion to be used in the rapids. How feasible is it to have soldiers standing up for a trip that lasted several days? Where were the water and the food stored to feed soldiers and rowers? By taking the boats out of their context these questions have been left unasked.

The study of waterborne networks has been previously done with no regards to the limitations imposed by the environment and by nautical technology. Since Parmentier's initial attempts to

[16] See scenes BC-EG-SW.I, BY-SG.II and BY-SG.IV in the Appendix.

analyse the boats of Banteay Chmar (1910: 209-211), their study has been dissociated from the study of waterborne transport. What is more, the use of inscriptions to map river communications has not been followed up with more in depth analysis of the affordances and constraints of the environment on river trade except for the acknowledgement of the Phapheng-Khone Falls as a blockage to direct river trade through the Mekong River. This represents a wider trend in archaeology pointed out by Van de Noort wherein socio-economical practices are considered with no regard for the practicality of the artefacts' journeys and the skill and knowledge required for waterborne transport (Van de Noort, 2011: 235).

Perhaps the most problematic issue is the dissociation between the study of road and river networks, which has resulted in a distorted view of Angkor's landscape of communication. Although authors like Parmentier (1927) and Hendrickson (2011) have been quick to point out the relevance of river networks, the study of Angkorian roads and associated infrastructures have been conducted without due consideration to water transport. As a result there have been no reflections on the way stone bridges would affect navigation, and the location of important temples such as Banon and Prei Nokor, have not been fully evaluated in light of their connection to important river transport points. And while Hendrickson has pointed out some issues with the weather pattern in road and river transport (2007), no thorough analysis has been made.

The greatest omission is the study of the nautical events represented in the bas-reliefs of Angkor, which show a wide variety of activities that take place on water. These activities show the complex relationship that Angkor had with its watery environment, which served as the backdrop for multiple events that not only included warfare, fishing, and trade, but also nautical celebrations, pilgrimages, and State Progress by Water. Academic interest in these

bas-reliefs has focused on warfare, with a few works on the study of boats as objects, but the cultural expressions contained in many of the reliefs have not been thoroughly discussed within the context of Angkor's human-environment interactions.

Looking at the shortcomings of the literature, it seems that an integrated study of Angkor's connection to water as a space for human activities provides a more complex view of the subject and allows for the use of a wider array of data more effectively. This will be done in this study by analyzing the entanglement between environment, nautical technology, and social activities surrounding boats. By looking at river navigability, chapter 5 will set forth the multifaceted character of the Mekong River Basin and the foreseeable transport zones based on accessibility of the river by water transport, chapter 6 will look particularly at nautical technology available to the people of Angkor, while chapter 7 will discuss known uses of boats in Angkor based on iconographic data. The final discussion on chapter 8 will bring together these aspects of human-environment interactions and hypothesize on the way they intertwined to give form to Angkor' fluvial cultural landscape.

Chapter 4

4. Maritime approaches to the study human-environment interactions

The compartmentalized studies that have been carried out so far on the subject of Angkor's relationship to its watery environment have resulted in interpretations that do not reflect the complexity of the subject. It will be argued here that archaeologists who fail to integrate maritime approaches in studies of cultures like Angkor, where waterways play an important role in the environment, are likely to miss important aspects of fluvial cultures. This is particularly noticeable in the study of Angkor's transport system, where land transport has been given priority and studied as a stand-alone system with few meaningful references to river transport. This thesis aims to review the subject from a maritime perspective, that is, one that integrates key aspects of water oriented cultures (i.e. environment, boat technology and cultural activities) to the study of Angkor's relationship with its watery environment. The theoretical inspiration for this analysis comes from Christer Westerdahl's concept of the Maritime Cultural Landscape.

The Maritime Cultural Landscape (or MCL) is a cross-disciplinary[17] mode of archaeological research where the customary divide between land and sea is erased to give way to a comprehensive study of human use of watery spaces (Westerdahl, 2011b: 733). It serves as a way to counteract the excessive emphasis that traditional studies have placed on cultural

[17] It could be argued whether the proposed landscape is truly cross-disciplinary or whether the term interdisciplinary should be used. Here I have retained the term cross-disciplinary, as it is Wersterdahl's preferred choice, but the approach can be interdisciplinary, cross-disciplinary, or multidisciplinary. For a discussion on the meaning of each term see Stember, M. 1991. Advancing the social sciences through the interdisciplinary enterprise. *The Social Science Journal*, Vol. 28, Num. 1, pp. 1-14.

activities taking place in land (Westerdahl, 2011a: 338). These activities often leave behind monumental remains that are easily identifiable in the landscape, whilst remains associated with the human use of watery spaces are less visible (ibid.). The MCL theoretical framework was initially proposed by Westerdahl in the 1970s as a result of archaeological survey that he undertook in the Swedish Norrland coast between 1975 and 1980. At the time Westerdahl realized that to fully understand underwater archaeological remains he had to develop a seamless approach that would also address the remains found on land (Westerdahl, 1992: 5). This approach, which stemmed from previous anthropological and ethnographic studies conducted by Nordic researchers, was centred on the analysis of the cognitive landscapes of the past, that is, the way humans ordered and engaged with the functional aspects of their surroundings (Westerdahl, 1992: 5). Westerdahl's attempt to broaden the reach of maritime archaeology reflected an increasing desire of maritime archaeologists to address maritime cultures from an anthropological approach (see Gould, 1983).

Although Westerdahl's theories were initially published in Swedish in the 1970s and 1980s, it was his 1992 English article *The Maritime Cultural Landscape* that reached a wider audience and resulted in a paradigm-shift in the discipline of archaeology that triggered a review of previous research, and has offered a new agenda for future work (Flatman, 2011: 311). This new framework considers that in order to fully understand maritime cultures, it is important to explore all kinds of human relationships to the sea or any large bodies of water (Westerdahl, 2011b: 754). Thus remains such as coastal dwellings, ancient ports, anchorages, boat houses, roads, forts, place names, stories, songs, terminology, and social practice are inextricable parts of the complex network that made up past maritime landscapes (Westerdahl, 1992). The nature of the data naturally results in the need to use interdisciplinary or crossdisciplinary approaches that are entrenched in a broad and geographically oriented landscape perspective (Ford, 2011: 1). The ability to combine different sources of data (i.e. environmental, archaeological, historical, iconographic, ethnographic, and linguistic) centred on the cognitive

processes of maritime communities makes the MCL particularly useful for areas where archaeological remains are elusive, or for activities that would not have left visible traces in the archaeological record directly, but which can be inferred by proxy. It has been noted that conservatism among maritime communities is often the result of little environmental change and an early optimization of boat design (Hunter, 1994: 263), which makes ethnography an invaluable resource for research. However, ethnographic work can be problematic because the uncertainty generated by aquatic spaces is likely to have exaggerated the effect of these spaces on society (see Hunter 1994: 264).

In his work in Scandinavia, Westerdahl has noted that relict patterns of transportation have been in active use until recently, especially in nodal areas (Westerdahl, 1992: 6). Though this should not lead to a unilinear evolutionist approach, the landscape contains multiple layers of use throughout history that can be studied through archaeological remains as well as other immaterial data – cognitive or indicatory, such as toponyms or the cognitive perspective of local traditions (ibid.: 5-6). Therefore, the MCL engages with both material and immaterial remains to blend in together the multifaceted aspects of maritime cultures without creating artificial boundaries that may not have existed in the past. This way, it offers a versatile way of understanding past human activities that may be difficult to grasp with material remains alone. As Flatman argues, "the concept's theoretical model is frequently more tangible, more approachable, and certainly more understandable than its observable archaeological reality […]" (2011: 312).

Westerdahl's theoretical model is not without its critics. Hunter reckons that although cultures may have maritime components, a balance should be sought to avoid missing non-maritime groups within seemingly maritime communities (Hunter, 1994: 261–262). The issue relies on groups whose main activities, while belonging to communities that are dependent on aquatic resources, are not maritime in nature (i.e. industrial production or preparation and

organization of trade). Hunter argues that maritime components are reflections of the broader culture and form an integral – not separate – part of the economic and social elements of a given culture (ibid.). The "maritimeness" of a community is therefore directly proportional to its reliance on aquatic resources, but terrestrial aspects of these communities should not be overlooked. Similarly, Van de Noort argues that Westerdahl's anthropocentric approach leads to the perception of the maritime space as "encultured landscape", and therefore underestimates the sea's agency as co-constructor of the landscape (Van de Noort, 2011: 229). Hence in the application of MCL there must be a balance between terrestrial and maritime, and between human and nature. This will be done in this study by examining the cultural biography of boats, that is, boats will be studied in relation to the cultural context surrounding the boats' creation, modification, usage, and ending (see Van de Noort, 2011: 38-42). By focusing in the entangled elements that make up a cultural landscape, it is possible to strike a balance between human agency and other-than-human agencies.

The theoretical framework of this chapter so far has made references to the term "maritime" which technically refers to the sea. There is some dissent among scholars on the appropriateness of using the term "maritime archaeology" in a broad sense that includes all types of water environments as suggested by McGrail (1984) and Westerdahl (2011b). The culture of Angkor developed in a fluvial environment and thus the use of a theoretical framework that stems from sea cultures could be challenged. However, it has been argued that communities living in large inland lakes share common cultural manifestations with maritime communities in terms of cognitive and functional aspects (Westerdahl, 2003). While rivers can be seen as functional arteries of sea transport networks, this research will apply the MCL approach in order to push beyond this boundary and see whether the environmental conditions of the Angkor civilization – with the Tonle Sap Lake as its main communication nexus – resulted in the development of specific cognitive and functional traits that gave form to Angkor's fluvial cultural landscape.

4.1. Sources of Evidence

The holistic perspective brought forth by the MCL theoretical framework allows the use of a wide variety of sources. The ones used in this research fall under the categories of archaeology, environment, toponymy, epigraphy, iconography, and historical and ethnographic data.

Archaeological data

Land remains

The spatial, chronological, and typological distribution of archaeological sites and material (i.e. stele) in relation to waterways has been documented since the late 19th century (see Lunet de Lajonquière, 1901; Parmentier, 1927). The latest cartographical inventory project *Carte Interactive des Sites Archéologiques Khmers* has been conducted by the École française d'Extrême-Orient in conjunction with the Cambodian Ministry of Culture and Fine Arts. The aim of the project was to incorporate new data from archaeological work conducted from the 1990s onward (see Phann *et al.*, 2007; Pottier, 1999) and was initially available through an interactive website.[18] Further work by the Greater Angkor Project has resulted in a more detailed mapping of the archaeological sites in the Angkor area using novel technology (Evans *et al.*, 2007) and recently these efforts have been expanded to include other areas of Angkor (see Evans *et al.*, 2013; Evans, 2016).

The distribution of sites in relation to river networks and resources is vital to hypothesize on waterborne transport and communications. As Hendrickson has noted, many Angkorian sites are not connected to the road grid but they are in close proximity to rivers so waterborne transport was likely the preferred method of transport (2007: 234, 251). This research will build up on previous work on Angkor's road network and associated infrastructures, especially

[18] Launched in 2010, the website (http://www.cisark.org) was not accessible in 20/06/2016.

the work on bridges conducted by Bruguier (2000), and the transport geographic study conducted by Hendrickson (2007, 2010a, 2010b, 2011). As will be seen in chapter 5, the data is used in this research to discuss the different transport zones of the Mekong River basin and discern how the different areas were used.

As part of the identification process and the formal iconographic analysis enunciated in chapter 7, the monumental remains were used to identify forms and reduce the observer's bias discussed by Knight (2013: 130-157). The architectural elements from Angkor that have survived to the present are the strongest link that there are to the representations, since they belong to the same period and culture. Four surveys were conducted in the dry and the rainy seasons to document space where boats were likely to have been used such as ponds, moats, island-temples, and reservoirs. Special attention was given to architectural elements that are known to have been used as landing places for boats, such as the eastern steps of the Preah Khan temple that led to the Jayatataka (the reservoir of the temple), the island temples of Neak Pean, West Mebon, and East Mebon, and a feature on the south section of the west wall of the East Baray, which has been identified by Cunin as a possible harbour structure (Pers. Comm. 2013).

Boat remains and shipwrecks

At present, two boats have been found in the Angkor area. A complete dugout of 12.83 m was found during construction works in the Angkor Thom district in April 2016 according to the APSARA Authority (Sen, 2016). Radiocarbon dating analysis indicates that the boat is early 13th century, which places it during the reign of Jayavarman VII (Handley and Sen, 2016).[19]

Although the report is yet to be published, some images were released by the APSARA Authority on their social media platform and in some media outlets. The images show an

[19] The results were presented as 1207 AD, without the formal range of radiocarbon dates.

unfinished dugout in a remarkable state of preservation. The remains of a second – more deteriorated – dugout were excavated in 2006 in the proximity of the Siem Reap River, and radiocarbon tests have yielded a date of around the mid 15th century (An, 2014), which corresponds to the immediate post-Angkorian period. These boat remains are analyzed in chapter 6, and compared to the nautical iconography and ethnographic data on boat construction.

Only one shipwreck has been partly documented so far in Cambodian coastal waters, the Koh Sdach wreck, and it has been dated to the early post-Angkorian period (Beavan *et al.*, 2012). The contents of the cargo suggests that the ship was part of a coastal trade route that linked Thailand with the hill tribes of the Cardamom Mountains (Beavan *et al.,* 2012: 1; Tep, 2014: 571), but its connection to post-Angkorian trade routes have not been studied yet.

No surveys have so far been conducted in the Mekong or the Tonle Sap Lake to search for sunken craft, but there is a substantial database of shipwrecks in Southeast Asia (Brown, 2009) that can provide information on the nautical technology horizon of the region's maritime trade network. Any ship sunk in SEA potentially used Angkor's maritime trade infrastructures, since water-borne trade is trans-regional. A recent study on cargo assemblages has highlighted the difficulties involved in using this kind of data for archaeological inquiry due to inconsistencies in recording the data, problems with post-excavation management, and the unscientific excavation of some of the shipwrecks by salvage companies (see Fahy, 2016). Similar problems have also been red-flagged in the Mediterranean (see for example Parker, 1995; Wilson, 2011), but some scholars have posited that cargo assemblages and the distribution of archaeological material found in terrestrial sites can be used to conduct socio-spatial networks analyses (see Leidwanger *et al.*, 2014). Although sea routes are out of the scope of this study, this approach to the study of maritime connectivity will be discussed in chapter 8 as a future line of academic inquiry to complete the study of Angkor's waterborne transport and communications.

Geographical and environmental data

The transformation of spaces into places with cultural meaning is one of the key issues studied in the MCL (Ford, 2011: 1). The landscape is transformed by human activities, and human activities are constrained by the affordances and limitations imposed by the environment (ibid.: 2). The Mekong River Basin provides over 4,000 km of fluvial connectivity but not all areas are navigable by the same type of boats and the same kind of navigation, and some areas are not navigable at all. The effect of geography in the development of hulls may be noticeable for example in the width of the boat; whilst broad stretches of river may allow for the development of broad beams, narrower stretches with stronger currents may favour the use of narrower boats that may be easier to manoeuvre. On the other hand, the conditions of the rivers may change from one season to another and the effects of unusual events – such as a prolonged drought or unusual rainfall – may trigger changes in human behaviour. So even though hull design and development are tightly linked to culture, nature also imposes certain restrictions to nautical technology and navigation that need to be accounted for (Westerdahl, 1994: 268; 2011b: 749; Steffy, 1998: 10-11).

Similarly, the resources available in a particular place may lead to the appearance of monumental remains that reflect attempts to manage and control access and/or production (Westerdahl, 2011b: 746-747). These natural constraints and resources can be used as proxy to theorize on the organization of water transport activities in terms of trade and migration, and convey more details to the generic concept of river transport and trade. Exploring these factors in the analysis of Angkor's fluvial landscape, though some times challenging, provides a new depth to the discussion as will be seen in chapter 5.

The main problem when studying the landscape stems from the dynamic nature of the environment and the difficulties of studying the past using current environmental data.[20] This is particularly obvious in the Cambodian landscape, where it is fairly easy to identify numerous oxbow lakes in the courses of tropical rivers that drain into the Tonle Sap Lake from satellite images.[21] Sedimentation is another issue in river environments, a phenomenon that affects particularly the Mekong Delta and the Chaktomuk areas as will be seen in Chapter 5.

Apart from natural processes, the human impact on the landscape must also be considered. The Mekong River has suffered substantial alterations, particularly from the 19th century onward. The delta is crisscrossed with multiple man-made canals and riverbeds in the region have been mechanically dredged[22] since 1893 to improve navigation (British Naval Intelligence Division, 1943: 439-440). Numerous dams have been constructed in the 20th century, and more are being planned for the upcoming years (Douglas, 2005: 199-202). However, it is thought that anthropogenic alterations to the river flow did not affect the course of the river until the late 20th century (Gupta, 2005: 49), so the broad patterns of river flow and navigation conditions documented in the 19th and 20th centuries[23] can be used critically for the study of Angkor's past fluvial landscape in conjunction with corrective material. Fortunately in this case there is a substantial body of work on the palaeoenvironment of the Angkor region (see for example Kummu, 2003; Penny, 2014; Penny *et al.*, 2014), including the documentation of severe weather events that occurred in the 14th and 15th centuries (Buckley *et al.,* 2010).

[20] For a similar study conducted in the Mycenaean world see Tartaron (2013); for an economic study on fluvial networks see Franconi (2014).
[21] For a similar study on navigation in the Medieval Nile see Cooper (2014).
[22] It is estimated that the total volume of dredged material between 1913 and 1930 fluctuated between 6 and 10 million m^3 (British Naval Intelligence Division, 1943: 439).
[23] Particularly Gariner (1885), Groslier (2016), and data published by the Mekong Committee (now the Mekong River Commission).

Toponymic data

The study of toponyms has been used successfully (see for example Westerdahl, 1980; Ossowski, 2010; Cooper, 2014) to understand the social organization of the landscape in terms of shipping-related activities such as portages, routes, fishing grounds, danger zones, and so on (Westerdahl, 2011b: 747; 2015). Although a linguist may be able to reconstruct old forms of a name, archaeologists have to content themselves with studying what is apparent from the place name in modern times (Westerdahl, 1980: 317). In the case of Khmer place names this approach can be difficult due to unsystematic transliterations from Khmer to Roman script and the Romanization of Khmer names, particularly in maps dated to the late 19th and 20th centuries.

During the preliminary review of the cartographic data, some elements were detected that had the potential to inform about the traditional use of water spaces in Cambodia. For example, the term *touk*[24] refers to boat and could be a good indicator for nautical activities. Some place names in early 20th century maps appear written as *tuk* which may be interpreted as "boat", but this analysis may be problematic because the maps show no reference to the word in Khmer script and there are other Khmer words like water, *teuk*,[25] that have been Romanized as *tuk*.[26] These nuances require a specific background in Khmer language that exceed the researcher's capabilities, so the toponymic analysis was made using the unequivocal Khmer term *kompong* or *kampong* (kaṃvaṅ /kəm'wɔŋ/), a noun that describes a river port, landing, crossing place, or wharf (Vickery 1998: 440-441; Harris 2007: 89).

[24] ទូក

[25] ទឹក

[26] In Lunet de Lajonquière's 1901 inventory map the term appears in the toponyms of *Baray Tuk Laak* and *Tuk Angong*. The first one can be translated as the "lagoon of murky waters", while the second one is roughly translated as "water with waves moving in circle" (Kaseka Phon Pers. Comm.; Chen Chanratana Pers. Comm.). In both cases the Romanization is *tuk*, but the term refers to water, not boat.

The term implies the use of water transport, and was thus used as a proxy for navigable rivers where goods and people are transported by boats. The term *kompong* has a long history of usage in Khmer, it appears in several inscriptions dating as far back as the pre-Angkorian and the Angkorian periods; for example, from inscription K.262S (*IC IV*: 117) found at Preah Einkosei temple dated to the 10th century CE we learn that this type of sites may had been subjected to annual taxes.[27] It is also present in the names of important settlements such as Kompong Chhnang, Kompong Cham, and Kompong Thom, which are nodal points for waterborne transport (see British Naval Intelligence Division, 1943: 438-443). The term Kompong thus appears to have been intertwined with waterborne transport up to now, and further analysis of the accompanying terms suggests that these harbours are associated with goods or other aspects of trade. For example, Kompong Speu[28] can be translated as Port of the Starfruit, Kompong Chnnang[29] as Port of the Pottery, Kompong Srolao as Port of the Crape Myrtle,[30] Kompong Srolao Pir[31] as Port of the Crape Myrtle 2, and Kompong Cham[32] as Port of the Cham people.[33]

This data is used in chapter 5 to identify navigable rivers and to create a diachronic topological map of the Mekong River basin. The data will be integrated with the geographical distribution of monuments from the Angkor era to identify the extent of Angkor's river transport network

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[27] K.262S:29 gi kaṃvaṅ oy canlyāk vās pvān pratisaṃvatsara ..., `The port is to give four vās of cloth for the lower garment annually... For further details see the SEAlang Library entrance for the term "kaṃvaṅ" at (visited on 03/05/2016):
http://sealang.net/api/api.pl?query=ka%E1%B9%83va%E1%B9%85&service=dictionary&language=oldkhmer

[28] កំពង់ស្ពឺ

[29] កំពង់ឆ្នាំង

[30] កំពង់ដើមស្រឡៅ. Srolao is the local name given to two types of wood in Cambodia, *Lagerstroemia calyculata* and *Lagerstroemia cochinchinensis* (Winrock, 2015: 153). The first one is corresponds to the crape myrtle, but the second name appears as unresolved in The Plant List search engine as of 23/06/16: : (http://www.theplantlist.org/tpl/record/kew-2354056)

[31] កំពង់ដើមស្រឡៅពីរ

[32] ក្រុងកំពង់ចាម

[33] This work is in great debt to colleagues Socheat Nhean, Phalla Chea, Kaseka Pon, and Chanratana Chen for their support in the translation of Khmer.

and see if there is a correspondence with the continuity of traditional economies. Since the term is Khmer, the scope of the map is limited to the territory of Cambodia, leaving out the Mun River basin in Thailand and southern Laos, and the Mekong Delta.

Epigraphic data

The corpus of Khmer inscriptions from the pre-Angkorian and Angkorian period has been the subject of continuous study for over a century, however, new inscriptions are being found on a regular basis. George Coedès compiled many of these in his six-volume work *Inscriptions du Cambodge,* the last of which was published in 1966. Claude Jacques also published his work on Khmer inscriptions, "Études d'épigraphie cambodgienne", in separate articles.[34] Apart from the punctual publications of translations that are often be found in the Bulletin de l' École Française d' Extrême Orient (BEFEO), later inventories can be found in the EFEO's *Corpus des inscriptions khmères* (EFEO, 2005), and a searchable database of Khmer inscriptions is available online in the SEAlang Library (2005).

Inscriptions from the Angkorian period use the Sanskrit script to write in Sanskrit and in Khmer; the former always refer to the gods, whilst the latter centres on economy and society (Stark, 2004: 102). References to boat, boatman, and harbours/wharfs are scarce, but a few can be found in textual contexts that refer to relevant questions such as taxation.

Iconographic data

The representation of boats is particularly important for the field of maritime archaeology since they provide data that does not usually survive in the archaeological record such as the form of the upper sections of the hull, and details of appendages such as masts, sails, rigging, rudders, and propulsion methods. Furthermore, the complexity of the nautical representations

[34] 1968-99, Études d'épigraphie cambodgienne [EEC, 11 articles], BEFEO 54, p. 605-622 ; 56, p. 57-69 and 70-73 ; 57, p. 57-67, 68-89 ; 58, p. 163-176 ; 59, p. 193-205, 205-220 ; 63, p. 351-365 ; 65, p. 281-332; 86, p. 357-374.

from Angkor also shows the intricate performances that were conducted on board these boats, activities difficult to identify in the archaeological record. This makes it very hard to understand the way in which humans interacted with watery environments, unless representational imagery is available for research.

This type of archaeological source can compensate for the lack of physical remains of nautical events, but problems with interpretative approaches to nautical iconography have made this a contentious field of study.[35] Methods and theories have been developed in archaeology to reduce speculation and provide plausible interpretations of the material (see for example Knight, 2013); however, the field of nautical iconography has not yet delivered a consistent methodology and accompanying methods that help support theories based on visual imagery. This research uses approaches developed by Knight (2013), Flatman (2007: 1-5), and Wedde (1996, 2000).

A corpus of descriptions of nautical scenes from Angkor was published by Paris in 1941, but some of the images in the publication are unclear, and not all of the described scenes are accompanied by a photograph in the publication. Furthermore, other images were documented separately in the second half of the 20th century (see Bénisti, 1963; Roveda, 2005). Since some of the temples were restored after Paris published his work, it was necessary to go back to the field to document these images and to survey the temples for other possible nautical representations. Between 2010 and 2014 three surveys were conducted by the author in the Angkor Archaeological Park and the temple of Banteay Chmar.

The aim of the surveys was to document *in situ* the nautical bas-reliefs described in previous works, and to observe the landscape and the environment of which they were part. At the same time, the temples were further examined and new boat paintings were found in the western gopura of Angkor Wat (Walker-Vadillo, 2009), a discovery that led other researchers

[35] See for example the case of the Akrotiri frescos in Thera in McGrail (2001: 113-122).

to find more paintings in the central temple using decorrelation stretch analyses (Tan *et al.*, 2014). The author has been able to identify two European ships; one in the Western gopura, and another one (at least the rigging) in the central temple.

During fieldwork priority was given to recording and examining the location of nautical iconography described by Parmentier (1910), Groslier (1921), Paris (1941), Bénisti (1963), and Roveda (2005), Scenes where animals were used as water transport were also documented. The four main characteristics used for the formal identification and analysis of the nautical iconography were the genre, the media, the scale, and the composition. Genre in this case refers to "a category of artefact devoted to a distinct functional purpose" (Knight 2013: 176), while media is the combination of materials and techniques used for the representations. Scale is concerned with the overall size of the representation, and composition refers to the identification of the boundaries of the scene. The scenes were then classified into different "visual themes" that represent the same subject matter based on an internal analysis - that is, using data from the iconography only (Knight, 2013: 88).

The final corpus contains more than one hundred boats represented in thirty-four nautical scenes distributed in 9 temples (see Appendix). Some temples are not fully restored, so it is possible that more nautical scenes will be found in the future. The two temples most likely to yield more scenes are Banteay Chmar, where five scenes are identified, and Preah Khan, where there are eleven scenes. The former has many sections of its decorated walls scattered, whilst the latter has reliefs both sides of three of its causeways, but the fourth one has not been excavated. The iconographic data is discussed in relation to nautical technology in chapter 6, while the context of the scenes are analysed in chapter 7.

Historical and ethnographic data

Historical documents and ethnographic data are used in maritime archaeology to test theories stemming from the aforementioned datasets, and to develop new ways of thinking about the archaeological material (see McGrail, 1984: 149–150; Blue, 2003: 334; Tartaron, 2013: 46–47). These type of information will be used in chapter 6 following Blue's premise that "by attempting to identify the variables that determine the shape of a boat in an ethnographic context, we can then perhaps begin to provide a more comprehensive set of criteria with which to address the interpretation of archaeological remains" (Blue, 2003: 335). Similarly, this data will be used in chapter 7 as possible referents of the nautical activities depicted in the bas-reliefs following Knight's premise that iconographic interpretation needs to be thoroughly grounded in ethnographically framed possibilities (2013: 132).

Data was gathered from regions that shared cultural or environmental connections with Angkor, namely Thailand and Burma-Myanmar in order to establish environmental and historical homologies with cultures that have links to Angkor and/or thrived in similar environments, and use them to observe differences and similarities in their approach to nautical events. Nevertheless, it is worth remembering that direct analogies cannot be made because "continuous form does not imply continuous meaning" (Kubler, 1970: 143). Foreign elements are introduced to local cultures and have their meaning altered to meet the local world view, whilst forms that continue through time have its meaning reinterpreted by the new generations (Knight, 2013: 71-76). This spatial and chronological disjunction needs to be taken into consideration when using diachronic material. There are no indigenous accounts on nautical activities from the Angkor period, so the material recorded here presents an etic vision of regional traditions, that is, they present information from outside the group either because the accounts were recorded by people foreign to Angkor, or because they represent contemporary knowledge of traditional practices.

In chronological order, the material used for this research comes from 1) a contemporary account about Angkor written by Zhou Daguan, a foreign emissary, 2) foreign accounts on navigation in the Mekong River, 3) foreign accounts of similar nautical events from later periods of time in the neighbouring state of Ayutthaya, 4) contemporary ethnographic material of current nautical events in Thailand and 5) contemporary ethnographic material from Cambodia.

The most relevant historical account due to its proximity to Angkor's cultural horizon was written by Zhou Daguan (Harris, 2007; Uk and Uk, 2016). The tale contains several references to boat construction, boating activities, and offers some information on navigation in the Mekong. Further data on the latter can be found in the Spanish (San Antonio, 1604) and Dutch (Van der Kraan, 2009) accounts from the 16th and 17th centuries, and in the journals published by Garnier from the French Mekong River expedition of 1866-68 (1885). Following Quaritch-Wales, further data can be extracted from a different cultural and geographic space: the kingdom of Ayutthaya. Quaritch-Wales posited that the nautical events of Ayutthaya documented by foreign travellers were a reminiscence of the nautical scenes from Angkor (Quaritch-Wales, 1931: 112-113). Detailed descriptions of the nautical events in Ayutthaya were recorded by early European travellers; the three accounts that were taken into consideration for this research were those of Ribadeneyra (1601), Tachard (1688) and Gervaise (1688).

This shift in the cultural horizon undoubtedly carries the disjunction mentioned above; however, the accounts offer an interesting approach to the visual effect that decorated barges had on the bystanders and additional data regarding function and social structures attached to the use of the boats. Images of these barges have been depicted since the 17th century, and they have been photographed in the 19th century and 20th centuries. Contemporary ethnographic material from Thailand provided data regarding the construction, maintenance

and use of the royal barges, as well as details on the logistics involved in the coordination of large nautical parades. This material was documented during two trips to Bangkok in 2013 and 2015 where the researcher photographed historical barges that are currently kept in the Royal Barges Museum and the Thai Navy Dockyard (Royal Barges Division). Videos of the restoration process of the royal barges published online by the Thai Royal Navy (2012a, 2012b) and of broadcasts of the 2012 royal barges procession in the Chao Phraya River (Tanan Suwannabhach, 2012; Television Pool of Thailand, 2012) were also reviewed for this work. They provided frameworks of movement and navigation in a river context for discussions in chapters 6 and 7.

Last, but not least, this work looked into ethnographic material from contemporary Cambodia. Over the course of the research three short seasons of fieldwork (2008, 2010 and 2012) were conducted to document nautical traditions in the area of the Tonle Sap. A longer season was conducted between June 2013 and January 2014 in order to experience and document the seasonal changes in the landscape between the confluence area of the Mekong and the Tonle Sap Rivers and the north shores of the Tonle Sap Lake brought about by the monsoon cycle.

The main aim of this fieldwork was to observe first hand traditional practices (stilted houses, fishing, water transport, boat storage, water festivals) and nature that may provide clues for the identification of forms. The fieldwork was based on the observation of relevant features in areas that were flooded in the rainy season, which later provided the basis for the interpretation of forms during the creation and organization of the iconographic corpus. These features were documented using a digital SLR camera. Several interviews with a local boat builder from Siem Reap were conducted in 2008 and 2014 using a translator. These were conducted under the university guidelines of ethical research and permission was granted by the Central University Research Ethics Committee (form CUREC/1A for Social Sciences). Data collection was conducted following Pham (2012). Additional information was obtained through

previous ethnographic work by Groslier (1921; 1931), Porée-Maspero (1962, 1964, 1969), Poujade (1946a; 1946b), and Hoc (2001), and through an interview with a boat builder conducted by journalist Nou Thearit (2013).

In summary, the datasets and methods followed in this research reflect the interdisciplinary character of the theoretical framework of the MCL that is applied. In chapter 5 the subject of Angkor's landscape of transport and communications draws from environmental data, toponymy, and historical and ethnographic accounts. These are used to hypothesize the extent of navigable rivers, seasonal changes, and the impact of stochastic climatic events in tropical river environments. The distribution of the main archaeological sites will be taken into account to discuss navigable rivers during the Angkor era. Nautical technology will be discussed in chapter 6 using archaeological material from boat remains, iconographic data, and historical accounts. This data will them be compared to ethnographic data. Chapter 7 is focused on the context of boat usage during the Angkor era, for which iconographic data is the primary source of information. Monumental archaeology from the Angkor era, historical accounts and ethnographic data will then be used in the interpretation process. After discussing these three sections – environment, technology, and culture –, the results will be integrated together in chapter 8 to hypothesize about the main characteristics of Angkor's fluvial cultural landscape and how these affected other aspects of Angkorian culture.

Chapter 5

5. Angkor's fluvial landscape of transport and communications

> *Now I saw the nature of the rapids…Angered by the sudden barrier they encountered, the muddy waves furiously attacked the banks, leaped over them, rushed into the forest, foaming about each tree and each rock, leaving only the largest trees and the heaviest outcrops of rocks standing. Debris piled up along the waves' passage. The banks were leveled and in the middle of a broad, strikingly white sea of water, full of whirlpools and flotsam, a few forest giants and dark rocks still withstood the assault, while columns of spray rose and fell ceaselessly on their summits.*
>
> Francis Garnier, *Voyage d'exploration en Indo-Chine*, 1885: 80 [36]

With these words Francis Garnier described the rapids of Prek Patang in the Mekong River as he was coming to the realization that the river he was to explore would not yield easily to the wishes of the French government to find an alternative trade route into China. Garnier's words act here as a reminder that assumptions on river environments must be challenged to prevent drawing straight lines of communication in past human activities. Rivers should not be seen as featureless elements of the landscape, quite the opposite. Rivers offer throughout their course multiple environments that affect the way they can be used by humans. By analyzing the relationship between the people, the landscape, and the needs that both impose on transport, it is possible to pave the way for alternative interpretations of archaeological finds (Westerdahl, 2015: 101). In this chapter the aim is to discern the multifaceted character of rivers, both in terms of geography and climate, and discuss how navigation in these areas

[36] Translated by Osborne (1975: 49).

imposed certain conditions on nautical technology and river transport. This adds a level of complexity to the study of Angkor's fluvial landscape of transport and communications that has not been considered before.

5.1. Transport and communications from a fluvial perspective

The landscape of transport and communication is here applied to the economic, military, and political use of fluvial spaces by boats. The importance of implementing a geographically oriented landscape perspective lays in the way topography and hydrology impose certain constraints on nautical design and river usage. These constrains vary according to space (topography) and time (weather), for example, the stream current depends on flow volume, the gradient of the terrain, and the morphology of the river. These conditions tend to remain persistent over time, so once a technological solution has been optimized, the routes and methods are known to go unchanged for long periods of time (Hunter, 1994: 263). This optimization of technology and river usage results in a set of skills and knowledge of the environment that can be described as traditional zones of transport geography (see Westerdahl, 2011b: 746-747). These zones often have their boundaries marked by natural conditions like topography, and hydrology, or by cultural constraints, such as the limitations of nautical technology.

Identifying these transport zones in the Mekong helps to problematize the role of river networks in Angkor. This can be done by laying out transition zones where there may have been a need to change boat types (transshipment), or where river transport was changed for land transport (portage) (see Westerdahl, 2011b: 749). Topographic transitional spaces can be rapids or cataracts, while hydrological features may refer to stretches of river with dangerous currents (these are often seasonal in river environments), always taking into account that

weather patterns may transform the landscape from season to season.[37] Points of transit may show signs of a *longue durée*, but in some cases use is discontinued when the conditions change (i.e. change of the topography by human or natural factors, change in nautical technology). Settlements located in transit points often depend on activities linked to fluvial transport; the people will likely work as pilots, transporters, crews, or provide their services for unloading and loading cargo (Westerdahl, 2011b: 749). Depending on the conditions, these occupations may be year-long, establishing a dependence on fluvial transport, or seasonal, serving as a secondary or complementary occupation for other activities (ibid.). Apart from the topography and the weather patterns, it is possible to extract further information on the cognitive landscape of fluvial networks by conducting toponymic analyses of place-names connected to navigation or water transport (Westerdahl, 1992: 9; Ilves, 2004, 2006). On the other hand, navigation accounts in the past and in the present can also provide additional information on the challenges that the river imposed on nautical technology and river usage during the Angkor era.[38]

By integrating geography, environment, place-names, and navigation it is possible to create a diachronic map of Cambodia's fluvial landscape of transport and communications. This map can be a powerful tool to interpret archaeological sites from the Angkor era within the context of water transport and help develop a theory on Angkor's fluvial landscape of transport and communications. The obvious limitation of the map is the difficulty of reflecting the dynamic nature of the landscape, and therefore it is likely that the representation will be more static that it actually was in the past (see Westerdahl, 2011b: 747). The result is nonetheless expected to break away from concepts of featureless rivers and shine light on their role in shaping Angkor.

[37] For an analysis of the impact of winter in inland transport in Russia during the Viking age see Westerdahl 2015.
[38] For a similar study in the Medieval Nile see Cooper (2014).

Geography of the Mekong River Basin

With an extent of 4,160 km,[39] the Mekong river is the biggest in Southeast Asia and has a drainage basin of 795,000 km^2 (Douglas, 2005: 193). The river starts at 5100 m in the Tibetan plateau, where the river is known as Lancang (ibid.), and runs through steep-walled gorges across Tibet (Xizang province) and Yunnan from north to south. The Mekong continues its path to the South China Sea through the mountainous regions of Myanmar and Laos, and then slows down in the alluvial plains in Southern Laos before crossing the Dangrek Range in the Phapheng-Khone Falls (PL. 4A-4D) and continuing down through more alluvial plains and discharging in the sea forming the Mekong delta (PL. 5).[40]

Although the summer snowmelt of May contributes to the river's flow, the majority of its waters come from rainfall, most of which originate from precipitation on the northern and eastern basin (PL. 6) in the mountainous regions of Laos PDR and Vietnam (Gupta, 2005: 75; Douglas, 2005: 193-197). These rains are governed by two monsoonal periods, the southwest monsoon that brings in heavy rain in the region from March to October and the dry northeast monsoon (Chuan, 2005: 81-83). Thus the flow of the Mekong and its tributaries is remarkably seasonal (PL. 7), with drastic changes in water discharge: from June to September-October there is a spike, followed by a steep decrease of flow from October to December when the river experiences a low but somewhat constant flow until May (Douglas, 2005: 196). The tributaries from the west bank run on a steep gradient, whilst the tributaries on the Thai side have a lower gradient and contribute only 6 % of the Mekong's flow (Dietsch, Densmore and Wilson, 2014: 4).

The course of the Mekong is tightly linked to tectonic movements; it was not until the Quaternary that the river gained its current drainage basin and transformed into a major river

[39] This is the extension given in Scott et al. (2014: 216), however, in other sources the extension is quoted as being 4 800 km (see Douglas 2005: 193).
[40] Plates (PL.) can be found in the Appendix.

basin (Carling, 2009: 81). The nine channels that distribute the Mekong's waters into the sea were formed during the Holocene period (PL. 8), whilst the previous mouth of the river would have been located near Kampot in present-day Cambodia (Carling, 2009: 80-81). Carling suggests that the present course of the Mekong was the result of sea level rises, particularly due to the event that occurred in the last 17,000 years when the sea rose 120 m from its present line (ibid.: 81).

The Mekong delta wetlands started to form 8,000 years ago as a result of the sedimentation of a former estuary (Scott, Frail-Gauthier and Mudie, 2014: 216). The delta region has since then prograded seawards 250 km from the Cambodian border (PL. 9). The Mekong River carries large amounts of sediment that is deposited in the delta, which has expanded over the last 3,000 years at a rate of 16 to 26 m per year (ibid.). The Ca Mau peninsula, on the western side of the delta, is the result of sea currents shifting the sediments of the river, another marker of the coastal progradation of the river. Further upstream, at the confluence between the Tonle Sap River and the Mekong, it has been estimated that the Chroy Changvar peninsula, which separates the two rivers, has experienced a rate of elongation of 10 m per year since 1876 (Chaktomuk Project Management Unit and DHI Water and Environment 2002: 32, cited in Dietsch, Densmore and Wilson, 2014: 6). The confluence is therefore migrating southwards at great speed and thus it can be theorized that the area had a different configuration in the Angkorian and post-Angkorian period. The deposition of sediment in this area is also noteworthy; dredging operations are constantly taking place to ensure access to the Phnom Penh port is clear for large shipping vessels (Dietsch, Densmore and Wilson, 2014: 6).

Anthropogenic alterations to the river flow did not affect the course of the river until the late 20th century (Gupta, 2005: 49), so it would be reasonable to assume that apart from specific areas (i.e., Chaktomuk) and changes to secondary river paths (i.e., abandoned meanders), the Mekong river basin of the Angkor period would have experienced similar dynamics as those

recorded during the 20th century. Palaeo-environmental studies suggest that the ecosystem of the Tonle Sap was already in place during the Angkor period, and that there have not been any significant variation in depth since then (Kummu, 2003: 14). Lieberman and Buckley have pointed out that the development of Angkor coincided with the Medieval Climate Anomaly, which is a climatic period from the 10th to the 14th century AD characterized in mainland Southeast Asia by a monsoon-rich period (Lieberman and Buckley, 2012: 1054–1055).

Weather patterns and the transport network

Before delimiting the zones and its implications for Angkor's fluvial landscape, it is necessary to reflect on the seasonality of the Mekong River Basin and its implications for transport and communications (see Fig. 1). During low waters, approximately from January to April, the river runs within the confinements of the riverbanks, the depth of the river decreases, and the rocks of the riverbed appear above water (Gupta, 2005: 75-78). From June to September the gauges on the Mekong read a rapid increase of monthly discharge, with the water levels sharply decreasing from October onwards (Douglas, 2005: 196). Though they carry less flow, the effect is similar in the tributaries due to their tropical character (see chart in Douglas, 2005: 196). During high waters the Mekong breaks the confinements of its embankment and spreads over the landscape into flooded forests.[41] At this time sections of bedrock and islands are covered, and the flooded forest makes it difficult to pinpoint the location of the riverbanks. As Garnier pointed out, navigation during the dry season would have been relatively easier since the boats only needed to follow the river channel (1885: 163-164). The cognitive mapping of the area, that is, the skill of pilots and their ability to navigate the waters, would have been needed to determine which channels were passable.

[41] See Mekong River Commission (2011) to see the maximum extension of floods in 2000 and 2011.

Cool / Cold		Hot / Dry		Wet						Cool / Cold	
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
NE Monsoon		Transition		SW Monsoon						NE Monsoon	

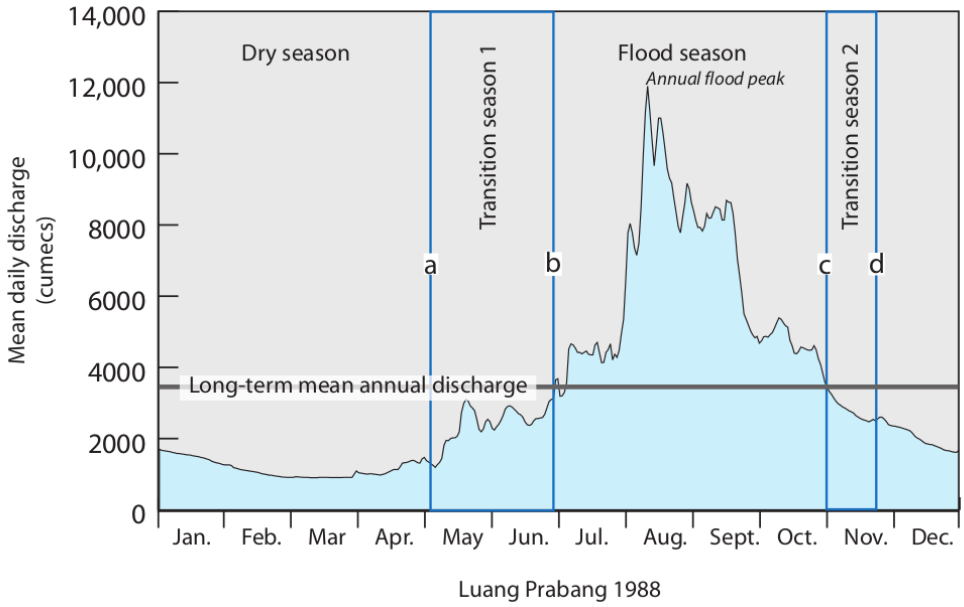


Fig. 1: Discharge measurements from Luan Prabang in 1988 showing the monthly flow rate of the Mekong River expressed in cubic meters per second (cumecs). Source: Mekong River Commission (2009: 6).

During high waters navigation would have been more challenging: the floods would make it difficult to find reference points, the riverbanks would not be easily identifiable, and the risks of being washed into the main current of the river by flash floods of tributaries would have been a concern (Garnier 1885: 163-164). The effects of flooding are even more dramatic in the delta and the Chaktomuk area since the floodplain occupies vast extensions of land (PL. 10).

Except for the Tonle Sap Lake, seasonal variations of the water level in the lower parts of the Mekong were probably not a problem for navigation since the depth of the river in this section is considerable; however, in the upper reaches it gravely affects the economy. The volume of goods shipped nowadays in the area above the Phapheng-Khone Falls decrease by over 50 % during low waters due to the reduced drafts (Mekong River Commission, 2010: 192–193) and difficulties involved in bypassing rapids. This data highlights current problems, but the natural

cycle of the river would not have been different in the past (Gupta, 2005: 49); so it is likely that trade also suffered a similar decrease in Angkor during the dry season due to the constraints that low waters would have imposed on boats. This relates to the size of the boat and the depth of the draft; small boats could navigate year-round but carry little or no cargo.

An example of how transshipment and portages affected transport can be seen in one of Delaporte's engravings from the late 19th century (PL. 11). The low waters would have similar effects in the Tonle Sap basin where the main Angkorian settlements are located. The extent of the lake varies up to four times from season to season, reducing or extending the reach of boats into Angkorian settlements around the lake. Rivers would have been critical to ensure easier travel inland from the lake, as boats would have continued their way upstream. Nonetheless, since these rivers were tropical, that is, they depended on the rain for their flow, during the dry season they would have suffered a steep decline in their flow, imposing limits on water transport. According to Harmand, who travelled in the region in the 19th century, the Stung Sen River was navigable at least half of the year (Harmand, 1876, p. 353), the issue is what kind of boat; it may have been restricted but not impassable by a small boat with a shallow draft.

The first aspect that thus needs to be acknowledged before discussing the different transport zones of the river basin is that the fluvial landscape of Angkor is seasonal, with a period favorable to water transport from around late June or early July to December, and a period of reduced water transport from January to June depending on the arrival of the Monsoon winds. The difficulties would have been twofold during the dry season: reduced volume of cargo both in volume (depth of the draft limits the weight of the cargo) and the number of vessels that could use the river (space constraints due to the narrowing of the river channel), and increased journey times due to necessary transshipments and portages.

Historical accounts from the 17th century show that the sea-river transit zone was not severely affected by the dry season, although large ships, such as 17th century Dutch yachts ran into difficulties with the sandbanks at the river mouth. Local boats with shallow drafts could use this area, but ships arriving from the sea would run into difficulties if they had deeper drafts.

Therefore, the sharp decrease of transport capabilities during the dry season would have affected communications within the Mekong River and the Tonle Sap basins, but not necessarily with overseas merchant ships in the sea-river transit zone, which would have been affected by other factors, such as the Trade Winds.

The role of land transport

If water transport was hampered for any reason, the logical alternative would have been to travel over land. The use of complementary land routes when rivers are not navigable has been proposed for river trade networks in Srivijaya, emphasizing the fact that bulky goods would not be cost-effective if transported over land (Manguin, 2009: 472). On the other hand, goods of small size but high value could be carried over land (ibid.). A similar relation could be proposed for Angkor, factoring in the seasonal monsoons. Traditionally, the study of Angkor's land transport network has been conducted independently from the river network. The relevance of rivers is largely acknowledged (Hendrickson, 2007: 133-135; 168), but its relation to the road network has not been fully understood within the seasonal landscape. Angkor's road network (PL. 12) linked the capital to Phimai in the northeast, to Wat Phu in the northwest, to Preah Khan of Kompong Svay in the east, to Sambor Prei Kuk in the southeast, and to Sdok Kok Thom in the west (see Hendrickson, 2007, 2010a, 2011).

The monsoon climate affects land transport as well. The ideal period for land travel in tropical climate is from December to March, but as the dry season presses on there are issues with access to water for human and animal consumption (Hendrickson, 2007: 45-46). The rains of

the wet monsoon, on the other hand, make travel by road difficult in areas where there is rice cultivation due to the low permeability of the soil that makes the roads impassable for wheeled traffic (ibid.). If we combine the optimal months of travel for land and water transport it becomes apparent that both systems are complementary to each other, as Hendrickson suspected (2010: 493). The optimal months of travel on land (January to March) coincide with the least favorable months for water transport. On the other hand, the best months for water travel (July to November) are not ideal for land transport. The longest roads of Angkor lead to the upper reaches of the Mekong, but the ones connecting to the east and southeast only go as far as Sambor Prei Kuk, although recent discoveries using LiDAR technology suggests that Sambor Prei Kuk may have been linked via road to Preah Khan of Kompong Svay (Evans, 2016: 7). The rivers on the north shore of the lake would have provided access to Angkor's road network (see Groslier, 1979; Hendrickson, 2010a; Uchida and Shimoda, 2013).

Corbelled bridges and navigation

The masonry bridges found in the Angkor road network are made in two ways: the corbelled arch is used for the largest constructions and the culvert style for the smaller ones (Hendrickson, 2007: 138). The culvert bridge (PL. 13) effectively blocks the waterway for boats, whilst the corbelled bridge (PL. 14) poses a serious hazard to navigation during the dry season – boats would have had to navigate through the narrow span between the piers (PL. 15) – and imposes tight constraints on hull design because only narrow boats would have been able to navigate between the corbelled arches. On the other hand, during the rainy season the water rises over or near the top level of the culvert. This would have made it impossible for boats to continue up or down (PL. 16), thus forcing an unnecessary man-made transit point.[42]

[42] Groslier mentions that in the ancient road between Angkor and Banteay Chmar, the derelict bridges of Angkor were now a serious problem for navigation during the rainy season, and that local people had to seek alternative routes to bypass the blockage imposed by them (Groslier, 1973b, p. 367).

As Manguin pointed out in his study on upstream-downstream relations during the Srivijaya period, when rivers are used as the primary means of communication, they must remain open for navigation (Manguin, 2009: 472). Elements that block these waterways, such as stone bridges, might be interpreted as technologies for surveillance and control used to oversee, regulate, or tax river transport, and therefore they need to be considered in relation to water transport.

Wooden bridges have not been identified in the archaeological record, but they are mentioned in one inscription dated to the 11th century (Jacques, 1968: 123)[43] and examples have been found in the iconography (Bruguier, 2000: 541; Groslier, 1973: 16; Roveda 2007: 435); it has been suggested that construction techniques would not have varied too much in modern times (Hendrickson 2007: 138). The modern bamboo bridge between Kompong Cham and the island of Koh Pean can be a good example to understand the role of wooden bridges in Angkor's road network. The pillars of the bridge are very close together, but a large gap is left to allow boats to pass through (PL. 17).

That the Khmer had the resources and the ability to move the required manpower to build such structures is attested in Dutch accounts from the 1600s. According to these sources, the Cambodians were capable of constructing two bamboo bridges (pontoon-style) across the Tonle Sap River in less than 4 days (Van der Kraan, 2009: 53-55). At the risk of being anachronistic, it seems that the construction of bamboo bridges as needed[44] may not have been an insurmountable task for the Angkorian population, especially if it granted them the ability to link roads and keep rivers navigable. Wooden bridges may also have been the preferred option if the riverbanks had soft soil or the river course shifted from year to year.

[43] Vickery (cited as Pers. Comm. in Hendrickson 2007: 270) points out that the mention of this wooden bridge comes from a philosophical passage and may not refer to an actual bridge.
[44] It seems likely that these structures would not have survived the strength of the debris-loaded current and during the peak of the rainy season.

Current scholarship considers that there is no evidence to suggest that masonry bridges were erected before the 12th or 13th centuries, but that the increasing activities in the East road from the 11th century onwards necessarily implies the existence of masonry bridges dated to this period (Hendrickson, 2010a: 491). The problem with this argument is that it follows a terrestrial bias that grants land transport precedence over water transport, and does not consider the aforementioned limitations that masonry bridges imposed over the latter. Given the absence of masonry structures dated to before the 12th or 13th centuries, it seems reasonable to propose that wooden bridges were used in earlier periods to allow transit across rivers without blocking navigation. Alternatively, the inscriptions indicate that ferries were used where bridges could not be constructed (see interpretation of the term *kompong* in Vickery, 1998: 440-441; Harris, 2007: 89). This change form wooden to masonry bridges seems to suggest changes in transport, for example, there may have been an interest in reducing access to rivers or it is possible that land transport became more important in some parts of Angkor's transport network from this period onward.

It seems logical to assume that the people of Angkor were capable of maximizing the resources of their landscape taking into account the extensive hydrological features they left behind. The decision to construct masonry bridges in certain rivers and springs should therefore be seen as a conscious decision to block rivers either to control access by water, and/or because the river was expendable (i.e. did not have great economic or political value) and land transport therefore took precedence over water transport. As Bruguier pointed out, masonry bridges, along with hospital chapels, are integrated in areas of economic activities associated with roads and rivers (2000: 535-536). Taking into account Angkor's water management system, it seems likely that they had the capacity to build masonry bridges before the 12th and 13th centuries (Hendrickson, 2010a: 491), but wooden structures would have been more versatile to accommodate both land and water transport and their requirements during the dry and the rainy seasons.

The combination of open rivers and road access for sites such as Preah Khan of Kompong Svay and Koh Ker suggests that Angkor's transport network was a complex dual system designed to provide year-long communications using alternative means of transportation depending on the season (Fig. 2). It would be logical to suggest that river transport took precedence over road transport since it could accommodate heavier and bulkier goods and could be used for a longer period, while the road network probably developed to improve connectivity with areas that were not accessible by river (see Hendrickson, 2007: 247).

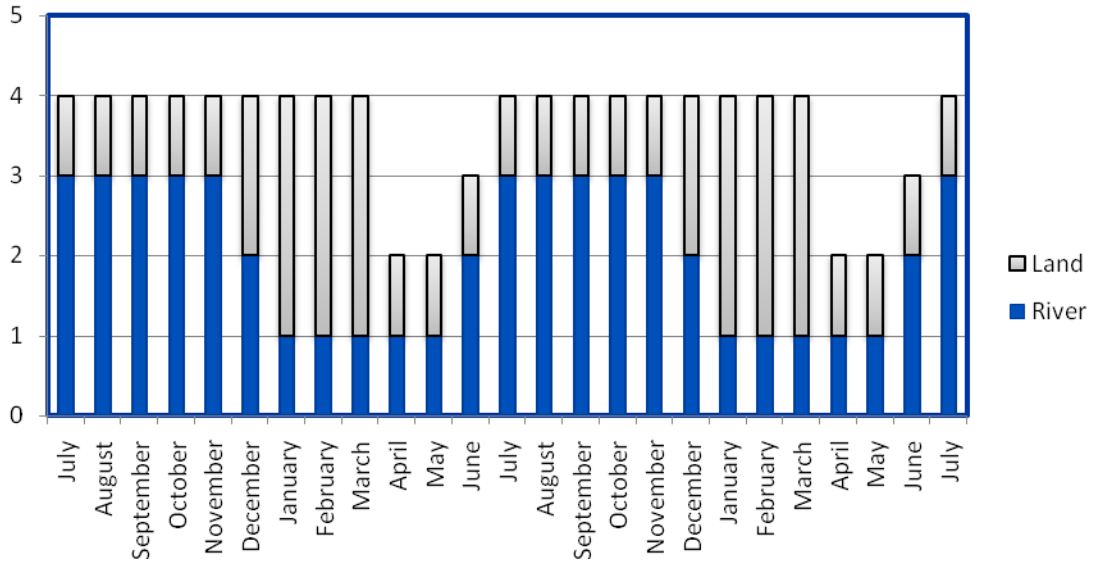


Fig. 2: Usability of river and road networks. (1) Difficult, (2) good, (3) optimal.

The combined system of river and road network would have maximized accessibility, reducing from five (from January to May) to two (from April to May) the months when communications within the region were difficult. This, however, only takes into account the environmental conditions. In terms of human use of these networks, the livelihood cycle has to be factored in. Data from the early 21st centuries shows that livelihood activities around the Tonle Sap Lake diminish significantly between August and November (Keskinen, 2006: 474). Fishing activities take place between November and March, with a spike in late January, and agricultural activities take place from January to June (Fig. 3). Livelihood activities in modern times revolve

around the dry season, so provided that the weather and the flow were not an impediment, it would have been possible for the people of Angkor to engage in transport activities after the harvest and the fishing season were over.

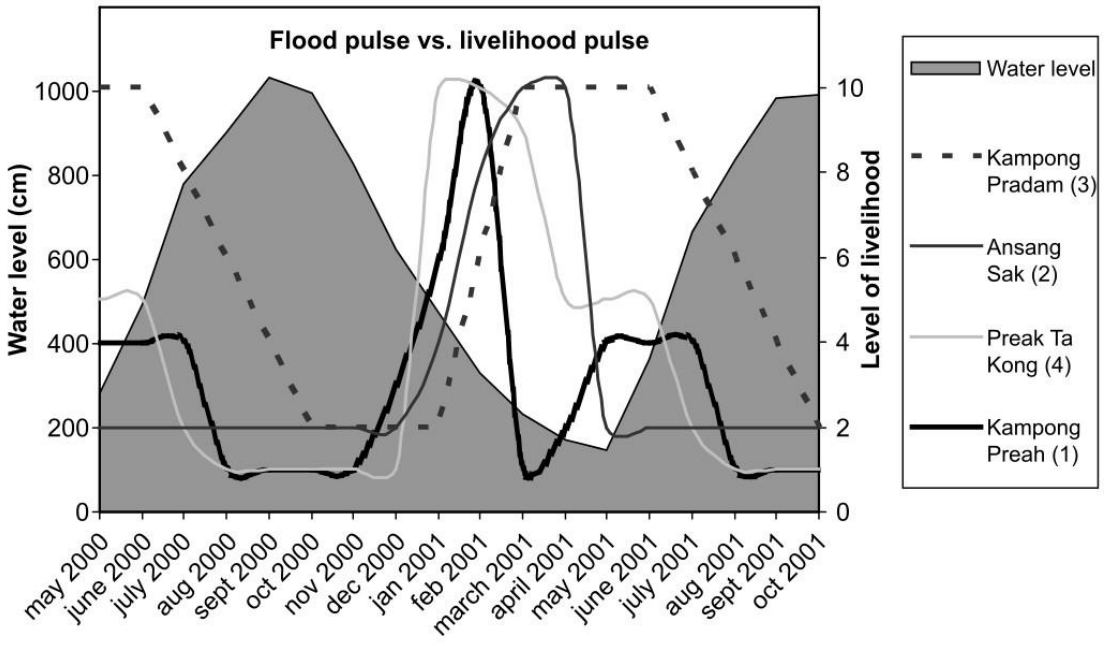


Fig. 3: Livelihood cycle around the Tonle Sap. (1) Fishing, (2) and (3) agriculture, and (4) modern urban life. Source: Keskinen 2006.

The exploitation of the Mekong River basin has been archaeologically documented from prehistoric times (O'Reilly, Driesch and Voeun, 2006; Higham *et al.*, 2012: 43–55; Voeun, 2012: 229–246). Fish remains have been found as part of grave goods (often found inside containers), as well as in non-burial contexts; the most common types of fish found are snakeheads and carps but all fish species are found, albeit in lower numbers (O'Reilly, Driesch and Voeun, 2006: 207). Other aquatic or amphibious animals have also been identified, such as freshwater shellfish and gastropods, soft-shell turtles, and crocodiles (Ibid.: 203, 205). The wide variety of fish represented in the archaeological record suggests the utilization of different fishing grounds and fishing methods already developed from prehistoric times (O'Reilly, Driesch and Voeun, 2006: 207). The presence of fish from distant environments in the site of Phum Snay in north-western Cambodia has been attributed to short-distance trade

networks by O'Reilly, Driesch & Voeun (2006: 207), however, this interpretation fails to acknowledge the mobile character of fishing communities, and assumes that the only fishing grounds available for exploitation are the ones immediately adjacent to the settlement.

References to aquatic life can also be found in pre-Angkorian and Angkorian inscriptions, like shell-fish, crab, eel, and crab (Jacob, 1979: 124-125), and also in Zhou Daguan's account, where the Chinese emissary reckons that the black carp was the most abundant, followed by the common and crucian carps, and the big goby fish (Uk & Uk, 2016: 97). The wide variety of fish available (both from sweet and salt water) was also mentioned by the Chinese emissary as well as other aquatic resources such as crocodiles, prawns, goose barnacles, clams, cockles, and snails (Ibid.).

It has been estimated that around 70 to 80% of the animal protein intake of the diet in the Lower Mekong Basin comes from fish, of which 90% comes from capture fish (Bush, 2003: 7), that is, fishing activities that involve capturing wild fish or shellfish. Cambodia is the country with the largest consumption figure, which is estimated to be 75.6 Kg per person per year (Ibid.: 9). One of the most important fish products of the Cambodian diet is *prahok*, a fermented fish paste used as a condiment in Khmer cuisine (Gruvel, 1925: 206-224; Hortle, Lieng and Valbo-Jorgensen, 2004: 17). *Prahok* is produced mostly from a small low-value fish called trey riel that is salted, dried, and fermented into a paste. The by-products are fish-fat used to make soap, while the heads and entrails of the fish are used as animal food or fertilizer (Ibid.). The trey riel is best caught along the banks of the Tonle Sap Lake between December and March, which triggers mass population movements of people from across the region to either fish trey riel or exchange rice for the fish (Hortle, Lieng and Valbo-Jorgensen, 2004: 17). As the fish retreats via the Tonle Sap and the Mekong Rivers into the Phapheng – Khone Falls, some fishermen follow the schools along their migration route (Ibid.). It seems likely, as

Jacques pointed out (2008: 332), that this condiment or a similar one was also used in Angkor to preserve fish.

Fish migration and people's movement

The trey riel is only one of the many fish species that follow the Lower Mekong Migration System (LMS); around 127 species have been documented to follow this migration route yearly (Poulsen *et al.*, 2002: 35). The fish affected by this system take refuge in the deep pools below the Phapheng – Khone falls during the dry season (particularly between Kratie and Stung Treng), and as the water rises they move into the floodplains of the Tonle Sap and the Mekong Delta where they feed (Ibid. 32). As the water recedes, the fish move back into the Tonle Sap and the Mekong River, and migrate upstream as far as the Se Kong, Se San and Sre Pok rivers (Ibid.).

Large population movements following this migration patters have been documented in the early 20th century (see Gruvel, 1925: 206-224); fishermen of Chinese, Vietnamese, and Khmer ethnicities were known to converge in the Tonle Sap Lake arriving by boat from tributary rivers (Ibid.; ORSTOM, 1993). Activities associated with fishing, such as the construction of fish traps or floating and stilted villages grew considerably during this time (Gruvel, 1925: 208-209). Since the 1990s the trend is to be more sedentary (Ibid.), but yearly migrations of thousands of people converging in the shoreline of the Tonle Sap from December to March are still recorded nowadays (Hortle, Lieng and Valbo-Jorgensen, 2004: 17). Hence archaeological evidence such as the one extracted from Phum Snay should be interpreted within this framework of nomadic fishing communities or, alternatively, of highly mobile fishermen with a variety of fishing grounds located at considerable distance (which may require temporary boat dwelling) that were exploited at different times of the year.

Evidence of this system is hard to find in the archaeological record, although settlement patterns in the Angkor region may provide some evidence of labour division. The structure of the urban complex in the area of Angkor is characterized by the presence of embankments whose purpose may have been connected to irrigation and transport (Fletcher *et al.*, 2003: 110–111). These linear features appear to be part of two different systems of residence and production, one centred on the exploitation of the land for rice cultivation, and the other one characterized by a linear occupation of the embankments with dwellings having access to the road on one side, and to a channel or river on the other (Ibid.: 109). The second type of residence is thought to have been connected to water transport that provided easy, long distance networks that extended over 40 km (Fletcher *et al.*, 2003: 110-111). These embankment settlements are also found in the old canal on the line of the Siem Reap river (Ibid.: 109). It can thus be inferred that these embankment dwellings had direct access to the Tonle Sap Lake, and apart from transport they were likely involved in fishing activities.

A current socio-economic study of main occupational activities in the Tonle Sap area based on distance from the lake can provide some ideas as to how this dual production system may have worked in the past (see Fig. 3-4). Between 1995 and 1998 Zone 1, which is the one with direct access to the lake, between 55.2 and 60.9% of people declared fishing to be their main activity, while between 26.1 and 17.1% were dedicated to agriculture, and between 10.3 and 8% were traders. Between Zones 2 and 4 the majority of the people were working in agriculture, while Zone 5 (urban centres) declared trading or agriculture as their main occupation (Keskinen, 2006: 470).

Main occupational involvement in different zones

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	All zones
Census 1998						
Agriculture	26.1%	91.0%	83.5%	77.0%	21.5%	63.4%
Trade	10.3%	2.1%	4.9%	8.3%	30.2%	12.0%
Fishing	55.2%	2.1%	2.4%	1.4%	0.6%	5.7%
FHS 1995–96						
Farming	17.1%	86.9%	86.5%	76.4%	31.7%	67.2%
Fishing	60.9%	3.6%	3.8%	6.4%	6.3%	15.5%
Trade combined	8.0%	1.2%	2.5%	4.4%	28.5%	5.3%

Source: NIS (1998); COMBASE (1996).

Fig. 4: Relation between occupational activities and geographic location. Source: Keskinen 2006.

Logically, people with direct access to the lake had fishing as their main activity and most important source income (Keskinen, 2006: 473); it is possible to extrapolate these results and propose that those with direct access to water and no access to agricultural lands engaged in fishing activities (and likely in fish processing) and, to a lesser degree to agriculture, trade, and transport. Fishing, nonetheless, would have been their main source of livelihood. These, however, were land dwellers that probably exploited the resources available in the vicinity, returning to land after the catch. The transport activities proposed by Fletcher *et al*. (2003: 110-111) may have played a complementary activity at specific times (i.e. after the harvest) or may have been opportunistic, such as occasional transportation of people. At present, people in the agricultural belt (Zones 2-4) participate in secondary activities when their work is not required in the field, with fishing being the most prominent (Keskinen, 2006: 472).

Therefore it is apparent that there were two types of full-time fishing communities: sedentary and nomadic. Sedentary fishing communities, who were likely landless and did not have access to agricultural land, could have provided a year-round provision of fish. These fishermen need not have been from a different group; they could have been part of a social network that would have provided access to aquatic resources for their social network. The nomadic fishing community, on the other hand, would have been important for the collection of fish during the

fishing season for personal consumption as well as for the creation of the necessary excess to provide non-fishing communities with the fish destined for preservation (i.e. preparation of salted fish and/or *prahok*-like paste).

The socio-economic analysis conducted in contemporary Cambodia clearly demonstrates that the livelihoods of the population in the Tonle Sap area are tightly intertwined with the hydrological cycle of the lake (Keskinen, 2006: 474). It could be expected that this entanglement was also experienced elsewhere in the Mekong River basin. Perhaps what is most important to realize is that the livelihood pulse (that is, the means of securing the necessities of life) peaks after the waters start receding in October (Fig. 3). This is because the most productive fishing period of the year roughly coincides with the harvest of the main rice crop (Keskinen, 2006: 474). If a similar association between people and environment can be assumed for the Angkor period, fishing communities, both sedentary and nomadic, would have provided the agricultural community with fish at a time when their hands were tied up on the fields. If the transport component is factored in (see Chapter 5), the period from October to December was the peak season for population movement via waterways.

Extreme weather events

Taking into account the delicate balance of Angkor's dual transport system, so dependent on the tropical rains for both river and road transport, it can be argued that alterations to the natural weather cycle would have had considerable impact. A research team led by Buckley recently published environmental data from the region that strongly suggests severe disruptions to rain patterns that affected Angkor in two periods of time, the first between 1345 and 1374, and the second between 1401 and 1425 ((Buckley *et al.*, 2014: 17). This phenomenon, known as a mega monsoon, is characterized by a long period of drought followed by unusual levels of heavy rainfall (ibid.).

Current scholarship argues that these mega monsoons gravely affected Angkor's hydraulic infrastructure and significantly contributed to the collapse of the Khmer Empire (Buckley *et al.*, 2010). The relocation of the political centre from the Tonle Sap to the Chaktomuk area has thus been ascribed to an increasing importance of maritime trade and the destruction of Angkor's infrastructures (ibid.: 6750). It is possible now to expand these arguments to include the communications factor: if Angkor favoured fluvial transport, particularly using minor tropical rivers in the northern shore of the Tonle Sap basin as was suggested by Parmentier (1927), then a disruption of the traditional weather pattern lasting for several decades would have severe effects in Angkor's communication network. High energy flood deposits have been found in the Angkorian canal of what is today the Siem Reap River (Buckley *et al.,* 2010: 6749). Radiocarbon dating suggests that the rapid sedimentation of the canal by coarse sand and gravel happened in the 14th century as a result of a single flood event (ibid.). This kind of event would have probably resulted in damage to boats and likely river blockage, whereas the prolonged droughts that preceded the abnormal surge of water would have affected navigation in the region, especially in tropical rivers and canals that depended exclusively on rain. On the other hand, land transport would have not presented a good alternative taking into account that the drought would have diminished water availability for travelers and animals alike. The increasingly variable monsoon would have disrupted Angkor's transport system, which would in turn affect its ability to communicate and move goods within its territory. Presumably the capital would have needed food from its immediate area, so this disruption may have also affected its viability as a city.

5.2. Toponyms: the cognitive landscape of water transport

The analysis of toponyms, or place names, in this research is limited to the location of the term *kompong* or *kampong* (kaṃvaṅ) in the landscape. This Khmer word appears in numerous pre-Angkorian and Angkorian inscriptions and has multiple meanings: a shallow place in the river,

shoal, crossing place, wharf, as well as waterfront, bank, shore, beach, landing place or river port,[45] though the latter is often preferred (see Vickery, 1998: 440-441; Harris, 2007: 89). All of the *kompong* or *kampong* places found in the course of this research can be found by rivers, lakes, and on the coast. The term appears in the names of important river ports such as Kompong Chhnang (Fig. 5) and Kompong Cham, but other river ports such as Phnom Penh or Stung Treng do not have it as part of their name, so not all of the settlements that function as ports are named as such. On the other hand, there are many settlements in riverbanks that are not identified as *kompong*, so it seems logical to suppose that the name is associated with a specific function of the settlement.[46]



Fig. 5: Stilted houses of Kompong Chhnang

The definition of port is a town with a harbour where vessels can moor to load and unload people and cargo. This may lead to the assumption that *kompong* settlements have mooring facilities as part of their infrastructure, and that their main function is to gather and redistribute goods within the transport network. However, the epigraphy suggests that the term was also used to name landing places, or points where river crossing was possible. Hence the concept seems to revolve around the idea of a stretch of land by the river where boats can be beached or docked, where people could be ferried across the river, and presumably, a place

[45] http://sealang.net/api/api.pl?query=ka%E1%B9%83va%E1%B9%85&service=dictionary&language=oldkhmer

[46] Clues as to the character of the *kompong* may be found in further analyses of the accompanying terms or the names of the rivers where they are located. Kompong Speu is the port of the Starfruit, but the stream where the port is located is called Prek Thnot, the stream of the Sugar Palm. This type of analysis requires formal linguistic training, and is therefore beyond the scope of this research.

where people could seek transport to other places and/or bring goods for trade. This broader description of a *kompong* seems to be more versatile and more in line with the epigraphic evidence.[47] Archaeological remains of this type of settlements are yet to be located and excavated, but their remains may not be so easily identifiable in the soil. If inferences from ethnographic data can be made, the houses of present-day *kompong* are stilted and the common infrastructure associated with landing places are either non-existent (when boats are beached) or are made up of elevated footpaths of a single plank set on wooden poles; sometimes floating rafts are used (PL. 18). Boats are secured by driving poles on the ground around the hulls, in some cases boats are brought completely above the water (PL. 19).

The chances of being able to identify these features archaeologically and be able to distinguish them from other settlements by the river seem difficult, but logic dictates that such interfaces are needed in any riparian society. There are at least two instances in the iconography where port structures can be identified; one looks like a peer (Fig. 6) and the other one appears to be a roofed building onto which troops are disembarking (Fig. 7). These are remarkably similar to contemporary stilted buildings.

[47] K.105:28-9: tai kaṃvai ti duñ nu prāk ta yvan kaṃvaṅ ta diṅ translated as `Tai Kaṃvai was bought for silver from a Vietnamese from the opposite shore'. K.412:15: vraiy kaṃvaṅ khtār, toponym translated as `wood by the plank landing'. Translations from http://sealang.net/api/api.pl?query=ka%E1%B9%83va%E1%B9%85&service=dictionary&language=oldkhmer



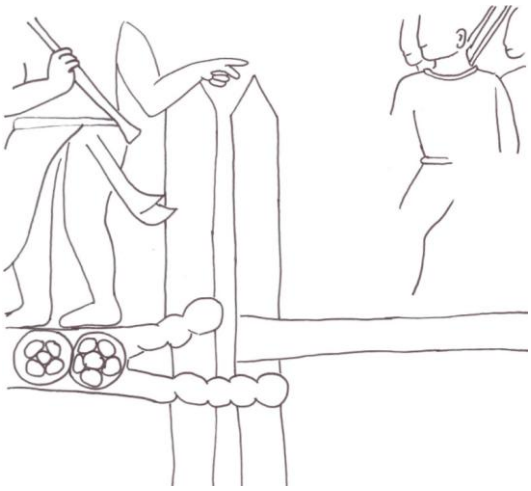


Fig. 6: BC-EG-NW.I in Banteay Chmar depicting a raft tied to a pier. Source: Roveda 2005. Right, drawing of the scene. Source: V. Walker.



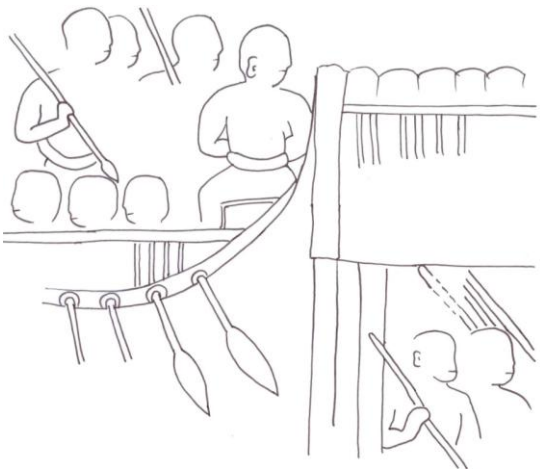


Fig. 7: Scene BC-SG-EW.I in Baneay Chmar depicting what seems to be soldiers disembarking. Source: Roveda, 2005. Right, drawing of the scene. Source: V. Walker.

The epigraphic records, albeit limited, can shed some light on how these settlements worked. In an inscription found at Preah Einkosei temple (K.262S:29) dated to the 10th century CE there is a reference to a *kompong*:

riy sre dharmmapura lvaḥ iss sre prāṅ thve devakāryya [ta]76 gi (29) gi kaṃvaṅ oy canlyāk vās pvān pratisaṃvatsara dau ta vraḥ kamrateṅ□ añ□ āy dvijendrapura

Translated as by Jenner as: As to the ricefields at Dharmapura, including all of the dry fields, [people] are to carry out work in the service of the deity on them; the port shall furnish four vās of cloth for the lower garment annually to My Holy High Lord of Dvijendrapura.[48] And by Coèdes (*IC IV*: 117) as: 'Quant aux rizières de Dharmapura jusques et y compris toutes les rizières de saison sèche, elles assurent le service divin là, le débarcadère donnant 4 *vās* de vêtements par an à V.K.A. Dvijendrapura'.

Hence the *kompong* provides clothing to the temple, but whether this was a duty or a donation is unclear. Jenner uses the term "shall" which implies an obligation, while Coèdes simply uses the term "donnant" which is translated as "give" without any indication of an obligation. The early Angkor polity had a temple-based economy where goods were donated to a temple and these were later redistributed, a system that persisted over time (Hall, 2011: 161-163). This redistributive economic system eventually transformed into a polity-wide network of temples linked to the king's central temple at the capital (ibid.). According to Hall, temples were probably located in strategic places to maximize the collection of goods from the Khmer countryside (Hall 2011: 162), although it is possible that other factors influenced the location of temples. Since rivers provide the easiest way to move goods in Cambodia, it would be to the advantage of a temple to be in the vicinity of a *kompong*. Based on Hall's premise, temples located in the vicinity of navigable rivers have been used in this project as proxy of Khmer river management, assuming that goods and people would gather in these economic spaces and participate in the temple's economy. Whether *kompong* were endowed to specific temples to control the flow of goods and store part of it on its grounds – as was often the case

[48] Unpublished English translation by P. Jenner available at SEAlang database (http://sealang.net).

with land (see Hall, 2011: 164-164) – is yet to be determined, but the aforementioned inscription seems to imply that this may have been the case.

The data collected here regarding the location of *kompong* in the Cambodian landscape was gathered from 19th and early 20th century maps, notably those of Lunet de Lajonquiere (1901, 1911), Pavie (1901), Parmentier (1927), and Madrolle (1930). Additional information was gathered from Google Maps and various reports from the Cambodian Ministry of Transport and the Mekong River Commission. The data is therefore diachronic in nature and should be regarded as such. The location of the *kompong* settlements is important in as much as it provides information on the traditional organization of the landscape and the navigability of rivers, but it is necessary to recognize that the map in no way suggests that these have been in continuous use since the Angkor period. Some are likely to be new settlements that respond to new demands, while others may have been abandoned because they ceased to be useful. Geographic and environmental factors are likely to have resulted in the continuous use of some of the sites, so it is possible to hypothesize on the rough lines of Angkor's fluvial landscape of transport and communications by integrating the location of archaeological remains (particularly temples) and observing how they related to transit points for navigation.

5.3. A topological map of fluvial networks

The following topological map created for this project aims to visualize the relationship between topographic, environmental, toponymic, and archaeological data (Fig. 8-10).[49] This schematic map shows the navigability of the rivers in different seasons. The road network is understood here as an extension of the river network and has been included. The dry season has been split into two maps to reflect how the end of the dry season affects land transport. The location of 19th and 20th century *kompong* settlements is marked with black dots, and

[49] For the list of kompong and their river systems, as well as references used to elaborate the topological map see Appendix 7.

these have been used as proxy for the identification of navigable rivers probably used for economic activities (domestic or regional). Important riverine settlements without the term *kompong* in their name have also been included, as well as rivers with the term *kompong* in their names. Unlike previous maps of the road network where rivers were not fully incorporated, this map provides a better understanding of the extent of navigable rivers in Cambodia and, better explains the potential network of Angkor's landscape of transport and communications. Based on various features that are discussed in what follows, the network has been divided into four transport zones described from downstream to upstream:

1.- The Mekong Delta transport zone, with the main transit points located in Kompong Chhnang in the Tonle Sap River and Kompong Cham in the Mekong River;

2.- The Tonle Sap transport zone, with a main transit point in Kompong Chhnang and several transit points located at the entrances of rivers;

3.- The Sambhupura transport zone, set between Kompong Cham and Stung Treng, and

4.- Wat Phu transport zone, set between the Khone Falls and the site of Wat Phu.

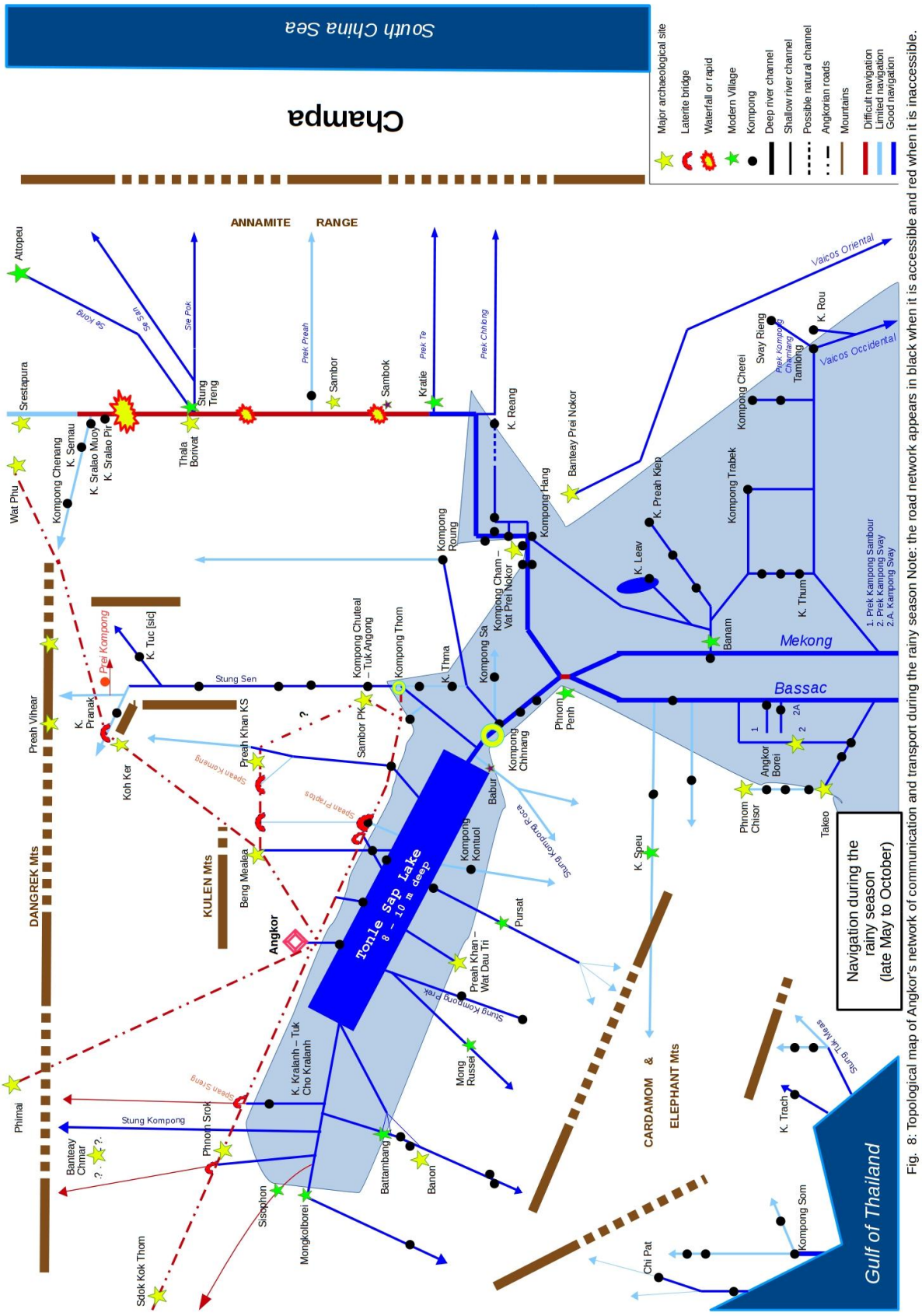


Fig. 8: Topological map of Angkor's network of communication and transport during the rainy season Note: the road network appears in black when it is accessible and red when it is inaccessible.

Fig. 8: Topological map of Angkor's network of communication and transport, rainy season.

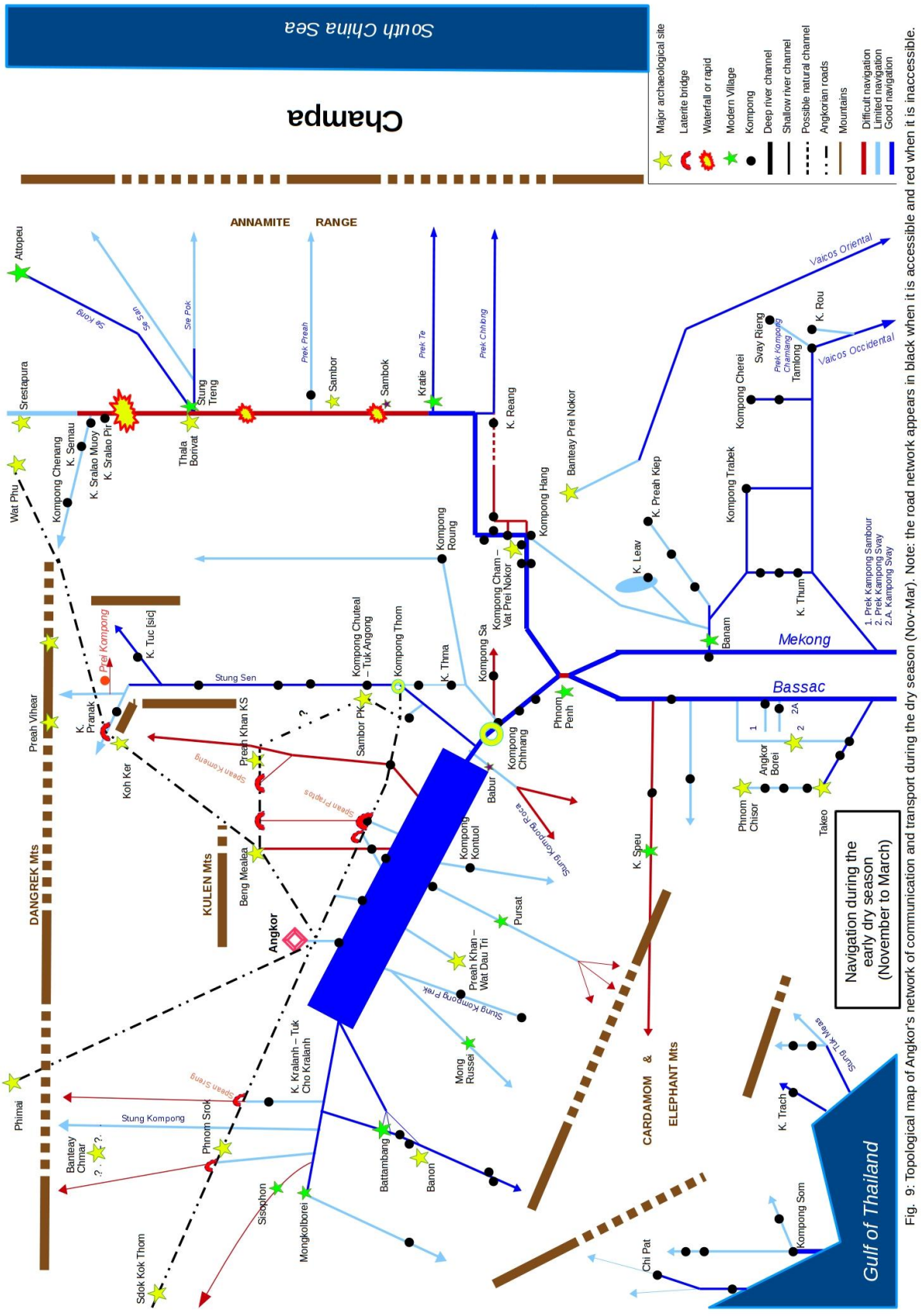


Fig. 9: Topological map of Angkor's network of communication and transport during the dry season (Nov-Mar). Note: the road network appears in black when it is accessible and red when it is inaccessible.

Fig. 9: Topological map of Angkor's network of communication and transport, dry season (Nov-Mar).

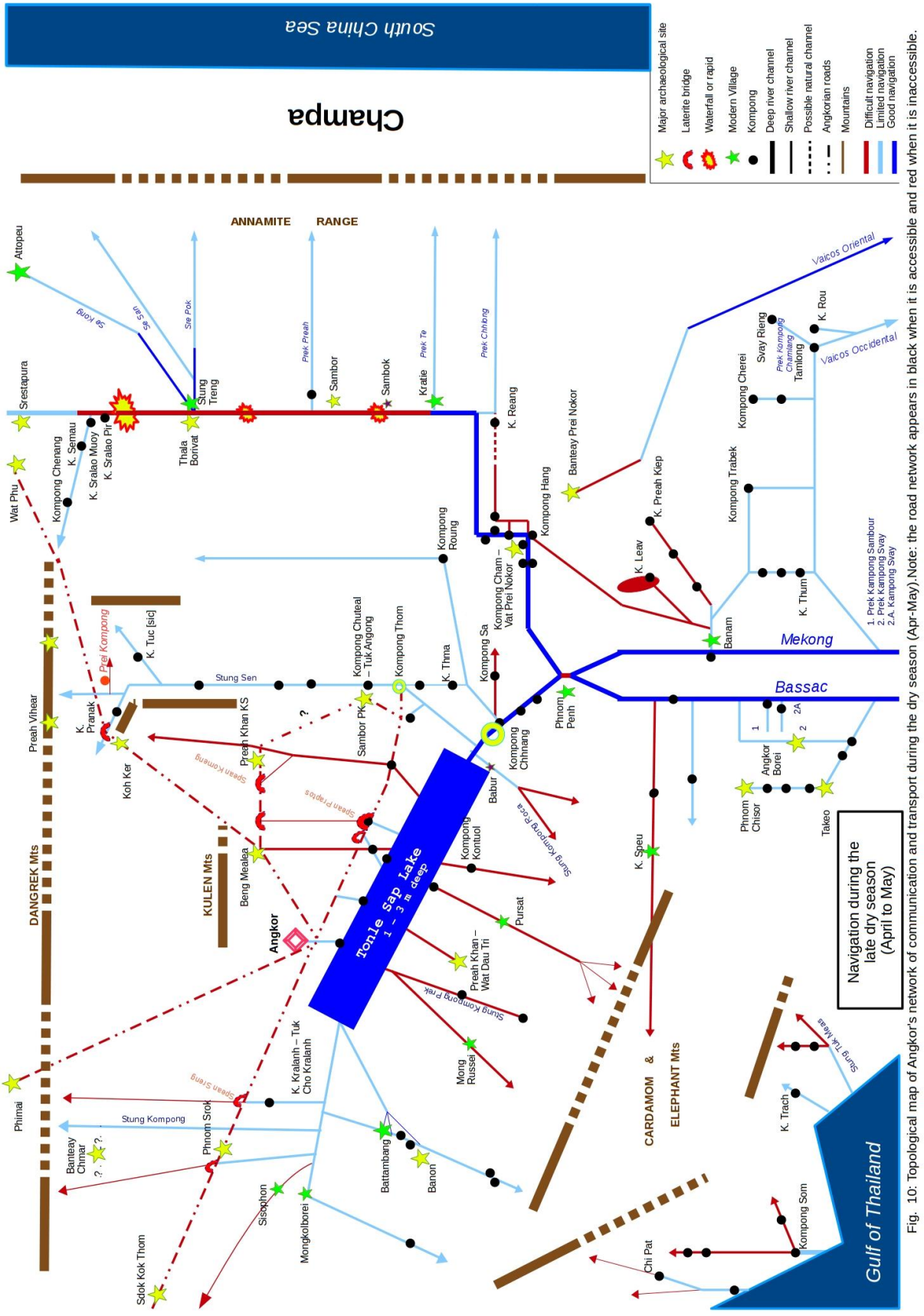


Fig. 10: Topological map of Angkor's network of communication and transport during the dry season (Apr-May).Note: the road network appears in black when it is accessible and red when it is inaccessible.

Fig. 10: Topological map of Angkor's network of communication and transport during the dry season (Apr-May).

5.4. Transport zones and transit points

The Mekong Delta transport zone

Geography. The Mekong delta transport zone is defined here as the area of contact between sea and river transport (Fig. 11). The absence of a major site in the vicinity of the river mouth suggests that coastal and sea-going ships travelled upriver to access the Angkorian markets. This was a common feature in Southeast Asia, where sites like Palembang and Ayutthaya are located far inland (see Manguin 2009). Based on geographic, archaeological, and historical data, this transport zone lies between the South China Sea and two major transshipment areas: Kompong Chnnang in the Tonle Sap river and Kompong Cham the Mekong river.

The Mekong splits into two branches in the area of present-day Phnom Penh, known as the Chaktomuk area,[50] forming the Mekong River and the Bassac River; the Bassac runs parallel to the main course of the Mekong until it discharges into the South China Sea. An interconnecting channel is found 125 km from the sea; from this point south the river enters into the delta (Gupta, 2005: 78). The mouth of the river is a network of tributaries, backswamps, and levées (ibid.). The main channel has a thalweg[51] depth of 10 m up to the mouth of the delta, where it decreases to 5 m (Woodroffe, 2005: 223–224), with a semidiurnal[52] tidal range at springs[53] of 3.5-4 m in the South China Sea, and a diurnal tidal range of 0.5-0.8 m in the Gulf of Thailand — the latter affects the western margin of the delta (Scott *et al.,* 2014: 218).[54] The behavior of the river and sea at this point creates a dynamic environment that is reworked during the dry season, when the sea current pushes the sediments back into the river, creating sandy ridges

[50] The term translates as "Four Faces" in reference to the four branches of the rivers.
[51] The line of lowest elevation within a watercourse.
[52] An area is said to experience semidiurnal tide cycles if it experiences two high and two low tides of approximately the same height every lunar day, whilst diurnal tide cycles only have one high and one low in the same period. Source: http://oceanservice.noaa.gov
[53] A spring tide is the maximum range reached by the tide twice a month around new moon and full moon.
[54] The masurements vary depending on the sources. In Woodroffe (2005: 223-224) the tides are indicated as 2.5 – 3.8 m in the South China Sea, and of 0.5 – 1 m in the Gulf of Thailand. Scott et al. (2014) represent the latest publication.

parallel to the shore (ibid.: 224). Beach ridges indicate the evolution of the coastline from 4,550 years ago, and analysis of the regions of the Plain of Reeds and the Longxuyen Quadrangle show a change of environment from brackish waters and mangroves to grasses and sedges, with mangroves dominating the landscape around 5680 years BP (Woodroffe, 2005: 224). The average gradient of the plain up to the delta is 0.00005 (Gupta, 2005: 77).

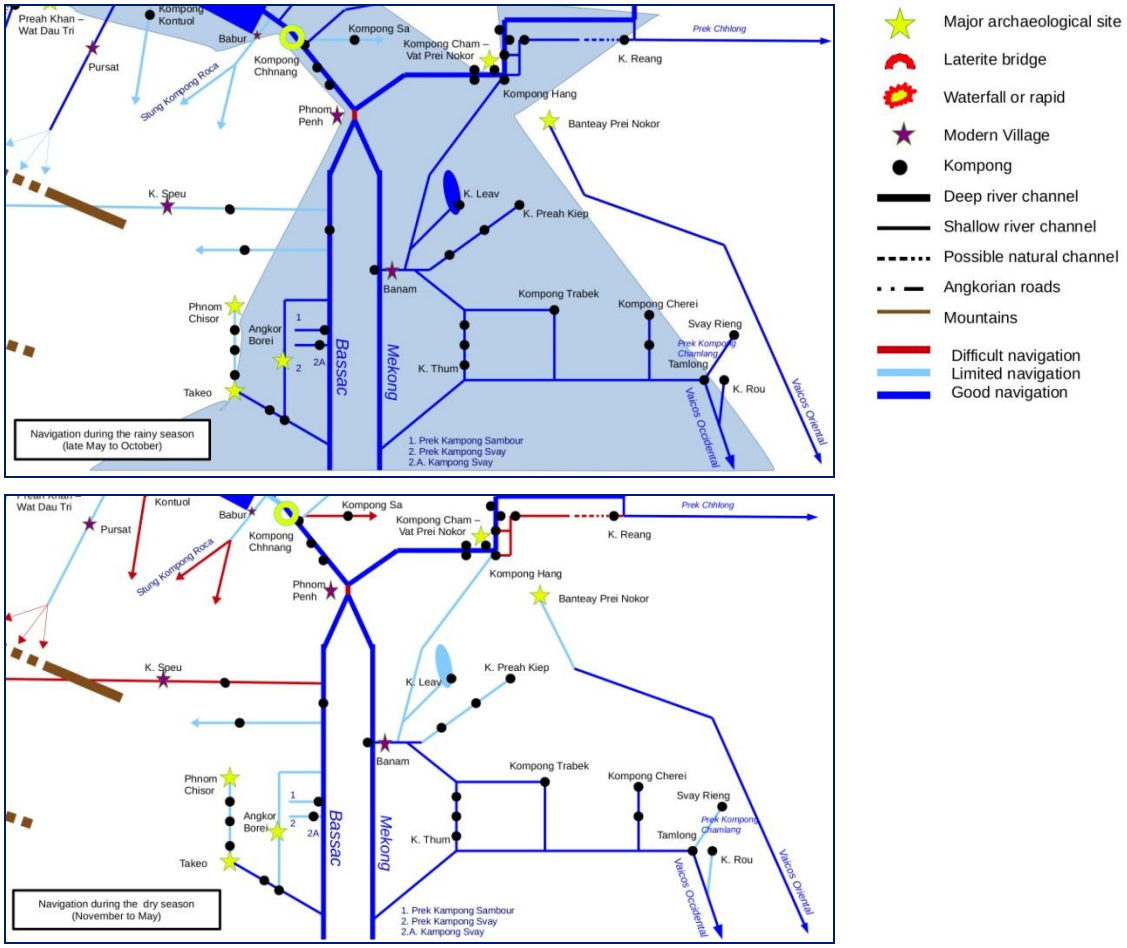


Fig. 11: Section of the topological map of the Mekong delta transport zone during the rainy season (above) and the dry season (below).

Navigation. The only data available on navigation in the Mekong during the Angkor period is found in the writings of Zhou Daguan, a Chinese emissary who visited the area in the late 1200s. In his writings Zhou Daguan describes how his ship navigated upriver without any transshipment in the delta area. Although he reckoned that there were many estuaries, only

the fourth one (counting from the east, as he was coming from China) could be used since the rest were silted up (Harris, 2007: 45). The current names of the estuaries (PL. 20) cluster them into three in the Mekong branch (Song Qua Tien, Song Ham Luong, and Song Co Qien), while the fourth one could have corresponded to the Bassac estuary. It took Zhou Daguan's ship 15 days with a favorable current to travel from the estuary to a city he calls Zhanan. Though Harris points out that "favorable current" may be a reference to the Tonle Sap River's change of course (Harris, 2007: 90), it may also refer (alone or in combination) to the tidal range that reached to the area of Phnom Penh and/or the winds that blow toward the Mekong river during the dry season and which can be used to tack[55] the river (PL. 21). The Spanish friar Quiroga de San Antonio wrote: "[...] esta ciudad [Angkor] esta en la playa del rio Meccon, ciento y setenta leguas de la mar llegan a ella las crescientes, y mareas deste rio, como a Seuilla [sic] las del Guadalquibir [...]"[56] (1604: Ch. III, P. 6). This reference to the tides is made explicitly by his comparison to the city of Seville, from where the galleons originally departed to the New World.

European accounts written three centuries later describe the use of the Bassac channel to enter the Mekong, and the difficulties that they went through to cross the sandbars of the delta (San Antonio, 1604: 14–15; Van der Kraan, 2009: 47). The VOC had a trading post upriver (Van der Kraan, 2009: 7–22), so it is likely that they would have known the best way to access the river based on local knowledge. This seems to coincide with Zhou Daguan's account, so it seems that there is certain continuity in the use of the Bassac branch to reach Cambodia, at least for sea-going ships. Although San Antonio's 1604 account is quite sparse in navigational details, the Dutch accounts provide further data on the difficulties of crossing the mouth of the river in May 1644, which coincides with the dry season. Though measures of the ships are offered below, it should be noted that these were not designed to be riverine ships.

[55] A sailing manoeuvre by which a ship moves in zigzag against the wind.

[56] Translation: […] this city [Angkor] is on the beach of the Mekong River, one hundred and seventy leagues from the sea [where] the floods and the tides from this river [reach], like the ones from the Guadalquibir reach Seville […]

The VOC flotilla was comprised of two yachts, two flutes, and a frigate (Van der Kraan, 2009: 47). Although the exact measurements are not available, after the 1630s the VOC established specific measurements for their ships (Hoving and Emke, 2000: 52). According to a 1637 resolution, a large yacht had to measure 39 m in length, 8.5 in breadth, and 3.65 in depth; a medium yacht would measure 35 x 7.9 x 3 m; and a small yacht would have to be 32 x 7.3 x 2.7 m (ibid.). A flute could measure around 30 x 6.7 x 3.35 m (ibid.: 53). There are no details on the draft of the ships. Frigates were small vessels almost always listed as yachts (Parthesius, 2000: 80), so we could assume that this type of ship was no larger than a small yacht. According to the accounts, the ships of the expedition had to be unloaded of heavy cargo every time the ships ran into sandbanks, and the crew would then have to wait for the tides to move the ship (Van der Kraan, 2009: 47). A report by the Mekong River Commission states that nowadays this section of the river is still difficult to navigate, as the entrance to the main course needs to be timed with the tidal window, and the mouth of the Bassac river is subject to winds, heavy waves, and typhoons (Mekong River Commission, 2012: 262–263). Contemporary engine-powered seagoing ships use the Mekong River, not the Bassac branch, to reach Phnom Penh (ibid.: 248).

After entering the deeper waters of the river, the Dutch ships moved slowly, tacking upriver (Van der Kraan, 2009: 48). The river has a narrow stretch known to the Dutch as the Mosquito Passage, which was difficult to navigate because of the strong current and the sandbanks (ibid.: 28). Upon exiting the Bassac, the Dutch arrived in Phnom Penh. The city is located at the confluence of the Tonle Sap and the Mekong Rivers. Bathymetric data from the confluence of the Tonle Sap and the Mekong rivers during the dry season reveals an average depth of 9 m just after the confluence (downstream), with a shallower section in the Mekong at the bend of the river immediately after the Bassac separates from the main course (PL. 22). Deeper channels are located right at the confluence of the Mekong and the Tonle Sap River, which is the result of continuous mining/dredging operations (Dietsch, Densmore and Wilson, 2014:

14). The Mekong upstream the confluence has a deeper channel, with a depth of up to 24 m. The entrance of the Tonle Sap River, on the other hand, is shallower, with an average depth of 5 m (ibid.: 15). The northernmost section of the survey by Dietsch, Densmore and Wilson suggests a deep channel beyond this point toward the Tonle Sap Lake of between 12-15 m.

The peninsula that separates the Tonle Sap and the Mekong rivers has progressed south at a rate of 10 m per year since 1876 (Dietsch, Densmore and Wilson, 2014: 6), and therefore the environment in this area may have been different during the Angkor and early post-Angkorian periods (PL. 23-25). Problems with the sedimentation of the Chaktomuk area and the southern migration of the peninsula affect water transport nowadays (Dietsch, Densmore and Wilson, 2014: 6; Mekong River Commission, 2012: 248-249), however, there are no mentions to this issue in the historical accounts of the 13th, 16th and the 17th centuries. There is also lack of information on the problems generated by the complex hydraulic system of the area, where river current reverses into the Tonle Sap River from around August to mid-November. This should not come as a surprise, since the Dutch VOC considered their charts and navigational instruments as secret, and invested considerable efforts in retaining said information within the VOC (Schilder, 1985: 109). At present, the Mekong River Commissions considers navigation in the Chaktomuk area to be very dangerous, particularly in the section that runs in front of the Royal Palace (Mekong River Commission, 2012: 248).

Though not mentioned in historical accounts, the east bank of the Mekong river is crisscrossed by the river system of the Tonle Touch, which has outlets running through the Mekong River and the Vàm Cỏ Tay River into the South China Sea (Seng, 2010: 11). The headwaters of this system are located in Kompong Cham, but the upper reaches are not navigable during the dry season (ibid.). The west bank of the Bassak River also has some important streams and backwaters (Seng, 2010: 10). Stung Thnot, where Kompong Speu is found, is not navigable in the dry season and in the rainy season the river is presently prone to flash floods. These floods

are thought to be linked to the rapid deforestation happening nowadays (Grainger and Sopha, 1998), and therefore it is possible that this kind of phenomenon did not occur during the Angkor era. However, if the flashfloods are a natural occurrence due to the gradient of the terrain, then it cannot be discarded either.

Canals have been built to link the settlements of Takeo and Angkor Borei (Hun, Lun and Ly, 2010: 140–144; Seng, 2010: 12), so even though nowadays the rivers are navigable year-round, it is difficult to determine with certainty the way these works have impacted the navigability of the rivers. Archaeological remains at Angkor Borei have been identified as the likely capital of the region during the Funan period, or at least as one of its largest settlements (O'Reilly, 2007: 93). Early surveys of the area showed that Angkor Borei was linked by a canal network to the sites of Oc Eo and Ta Kev in the Gulf of Thailand (Stark, 2004b: 77). This suggests trade was conducted via these outlets, instead of using (or in conjunction with) the Bassac River. The high number of kompong in the area of Tonle Bati and Phnom Chisor may be related to salt trade (see Hendrickson, 2007: 226-227).

Chaktomuk to Kompong Chhnang. During the 13th century the Tonle Sap River was accessible up to a village called Zhanan by Zhou Daguan. It has been suggested that Zhanan may refer to (Kompong) Chhnang at the entrance of the Tonle Sap Lake (Harris, 2007: 89; Coedès , 1968: 213). The identification of the term *kompong* as pier or landing (Vickery, 1998: 440-441; Harris, 2007: 89) strengthens the identification of Kompong Chhnang as the location for transshipment from a sea-going ships to smaller boats (Harris, 2007: 45); in the 20th century during low water the head of the Tonle Sap River was effectively Kompong Chhnang due to mud banks above this point (Great Britain Naval Intelligence Division, 1943: 440). From a geographical perspective this area seems pivotal to navigation, as the river narrows and runs between two groups of mountains forming a bottleneck. The hills could have been used as reference points by sailors and/or vantage points to control access to the lake. Its strategic

location is reflected in the existence of archaeological remains in the area from the Chenla period contemporaneous with Thala Borivat (Stung Treng), Sambor, Angkor Borei, and Sambor Prei Kuk (Piphal, 2012: 195). The Dutch flotilla went only as far as Oudong (Van der Kraan, 2009: 51), 40km away from Phnom Penh but before Kompong Chhnang. They did not enter into the stream that provided access to Oudong fearing that the ships would run aground (ibid.: 52). The river was still navigable further north toward Kompong Chhnang for sea-going ships, as the Dutch recorded seeing two Portuguese yachts and a few Chinese junks being towed upstream (Van der Kraan, 2009: 51). Thus large boats could be towed upstream by smaller vessels, suggesting that in the post-Angkorian period there were local pilots who possessed skills and knowledge of the local waters and took over ships to maneuvre them safely into the port.

Chaktomuk to Kompong Cham. There is very limited information on this area of the river in terms of navigation; between Phnom Penh and Kratie the river runs through a gentle gradient and the depth of the thalweg reaches up to 24 m close to the confluence of the Tonle Sap River (Dietsch, Densmore, and Wilson, 2012: 14). San Antonio did record that the Spanish were prevented from travelling to Srei Santhor, where the king had his residence in 1595 (San Antonio, 1604: 35-36; Dusmet de Arizcun, 1927: 115). Srei Santhor is located around 50 km upstream from Chaktomuk. Given the depth of the river and San Antonio's account, it is possible that the site was accessible by the Spanish sea-going ships although it cannot be discounted that they were carried on smaller local vessels. On the first half of the 20th century sea-going ships sailed up to Kompong Cham (Great Britain Naval Intelligence Division 1943: 440). Rubber and rubber wood sea-going trade ships continued to travel to Kompong Cham up to 1991, when the last wooden pier for these vessels collapsed (Mekong River Commission 2012: 245). The area is currently considered a challenging space for navigation where local knowledge is required, as some channels are too shallow, and those that are navigable shift their position due to deposition (ibid.: 246). On the other hand, the section between Kompong

Cham and Kratie has very slow currents, but even local pilots often run aground in due to the shallow depths and shoals (ibid.: 243-244), presumably because of its dynamic rapidly changing environment.

Taking all this into account, it could be argued that the Mekong River upstream from Chaktomuk was navigable by sea-going ships up to Kompong Cham, an area with archaeological remains linked to the Khmer Empire. The temple of Wat Prei Nokor —initiated by Jayavarman VII in the 13th century and located less than 2 km northwest of the modern city (Hendrickson, 2010a)— seems to point to the relevance of this area for Angkor's transport system. It is worth noting that studies on Angkor's road network have not yielded any evidence of a land road connecting Kompong Cham (see Hendrickson, 2007), so unless evidence to the contrary surfaces, it seems that goods arriving to Kompong Cham were redistributed by boat. Based on historical accounts and the bathymetry of the river, sea-going vessels would have been able to cross the shallow entrance of the delta in the Bassac branch of the river and move upstream all the way to Kompong Chhnang and Kompong Cham.

It is difficult to determine the maximum size of ships that could have been used in Angkor's sea-river transport zone, but it is possible to get an idea of the types of sea-going ships used in this period based on historical accounts and archaeological remains from shipwrecks. Zhou Daguan specifically describes his travel from Wenzhou to Angkor, so even though he does not specify whether the ship he uses is Chinese or foreign (Uk & Uk 2016: 1), it is clear that there were ships sailing between China and Angkor in the 13th century CE. This, however, does not provide any information on the frequency of the contact or the size of the ships (and volume of cargo). The Chinese emissary mentions a list of Chinese trade goods that were sought after in Angkorian markets: pewter, lacquered trays, celadon, mercury, vermillion, paper, sulphur, saltpetre, sandalwood, angelica, musk, linen, *huangcao bu* (yellow straw fabric), umbrellas, iron woks or pots, copper trays, crystal [or porcelain] beads, tung oil, fine-tooth combs, wood

combs, needles, and other bulky goods such as mats from Mingzhou in today's Ningbo, south of Shanghai (Uk & Uk 2016: 88). However, archaeological data seems to suggest that the volume of porcelain exported to Angkor was small compared to what was exported to insular Southeast Asia, which seems to suggest that the China-Angkor trade was relatively modest (see Miksic 2009b: 76-78).

The Spanish accounts of the late 16th century provide details of the different types of ships that they encountered in the Mekong: war junks from Siam with Chinese crew, Cambodian junks, sampans used by Chinese merchants, Japanese war junks and *prau* (Dusmet de Arizcun 1927: 19, 23, 35-36, 55, 58-59),[57] information that is also corroborated by Dutch VOC accounts (see Van der Kraan 2009). This data shows that between the 16th and the 17th century the Mekong delta transport zone was teeming with coastal and sea-going ships, although there is no way of knowing what was the size of these vessels. The only thing we can know for certain is that ships with hulls similar in dimensions to those of the VOC yachts and flutes would have had a hard time bypassing the sandbar of the river in May.

Smaller boats could have used the secondary channels that crisscrossed the east bank of the Mekong River, specially the Tonle Touch branch, which provided access to Kompong Cham and drained in the Mekong River and Vàm CỎ Tay (former Vaicos Occidental). The relevance of this secondary river network for the local economy was already noted by Groslier (1973: 67). The

[57] The Spanish accounts referred here suggest that the term *junk* was linked to overseas travel and not to a specific ethnicity (i.e., Chinese). The reference to Cambodian *junks* relates to the presence of these boats in Manila, having been sent there by the king of Cambodia. The ships used by the Japanese and Portuguese mercenaries are also called *junk*, as well as the war *junk* of the king of Siam, which was manned by Chinese sailors. It would seem that the term was used by the Spanish to describe the larger ships of Southeast Asia, as Manguin suggests for Portuguese sources (Manguin, 1980). However, the British Naval Intelligence Division called "local junks" to local ships of medium size used to carry heavy material (1943: 436); hence the term does appears to have different meanings at different times or used differently by foreigners. On the other hand, the word *prau* (also written as perahu, prahu, proa, prow, and parao) is a Malay-Indonesian word that broadly describes all sailing vessels that were made locally, except for canoes (MacKnight, 1980: 117). The controversies surrounding the terms *junk* and *prau* are out of the scope of this research, the references are included to highlight that during the 16th century the Mekong River, up to Chaktomuk, was a busy commercial area with different types of ships coming from overseas.

archaeological remains of Banteay Prei Nokor southeast of Kompong Cham seem to be better placed to use the Vàm Cỏ Dong River (former Vaicos Oriental) and northern land and river routes would have connected it to the Mekong River upstream from Kompong Cham (Goloubew, 1936: 468–469). Banteay Prei Nokor is a poorly understood site in dire need of excavations to consolidate the theories that have been set forth regarding its role in Angkorian history (O'Reilly, 2007: 112-113). The site has been dated to the end of the Chenla period (Coedès, 1968: 98; Higham, 2002: 251; Piphal, 2012: 7-8); Vickery has suggested that the Vyadhapura of the texts was located in the region of Banteay Prei Nokor (1986: 102) and it is thought that Jayavarman II started his political career there (Coedès 1968: 98-99; Heng 2012: 7-8). Nonetheless, the area does not seem to have been able to become a significant large scale trade centre during the Angkor period, which Piphal adduces to environmental and geographic constraints (2012: 10).

The use of two transit points, instead of using exclusively Kompong Chhnang, which is the one closest to Angkor, brings forward the issue of the hydraulic system of the Chaktomuk area. Whilst Kompong Cham is accessible throughout the year, it may have been difficult for sailing or man-powered vessels to navigate in the currents of the Chaktomuk area when the Tonle Sap reverses its course (the Dutch crossed this area in May, so it was possible for sailing vessels when the Tonle Sap River ran toward the Mekong River). Additionally, vessels with shallow drafts could reach Kompong Cham (presumably in the rainy season) via the Tonle Touch river system, perhaps avoiding this way the strong currents of the main channel and making Kompong Cham the head of this secondary river system with various exits through the Mekong River and Vàm Cỏ Tay (Vaicos Occidenal). The use of this route, along with Banteay Prei Nokor's likely use of the Vàm Cỏ Dong would have diverted traffic from the Bassac branch of the river, where the pre-Angkorian sites of Angkor Borei and Oc Eo were located. It can thus be hypothesized that the location of Banteay Prei Nokor may signal an attempt to compete against other regional centres for the control of the resources coming in and out of the

Mekong River. The bid was eventually unsuccessful; perhaps its inadequate location in terms of environment and geography resulted in the decline of the region, as Piphal suggests (2012: 10), but it is also likely that Angkor was able to monopolize waterborne trade in a more efficient way by controlling the region of Kompong Cham.

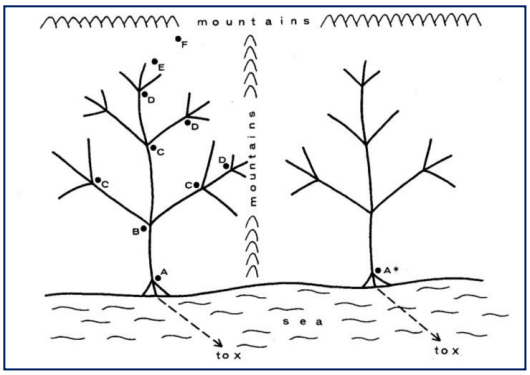


Fig. 12: Bronson's theoretical model of upstream-downstream exchanges. Source: Bronson 1977: 42.

Following Bronson's model of upstream-downstream exchanges (1977: 42), the hierarchy of settlements in a river network is determined by the ability to control access to resources. In the examples proposed by Bronson of island Southeast Asia and Peninsular Malaysia, the river network is small enough to allow a settlement located in the upper section of a delta to control access to resources moving in or out of the river system (Fig. 12). Though the location of the settlements of Angkor Borei and Oc Eo initially benefitted from their position between the Bassac and the Gulf of Thailand, the move of the centre of power upstream during the Chenla period may be in part a result of fierce competition to control access to river networks and their associated resources (Higham, 2002: 292-295).

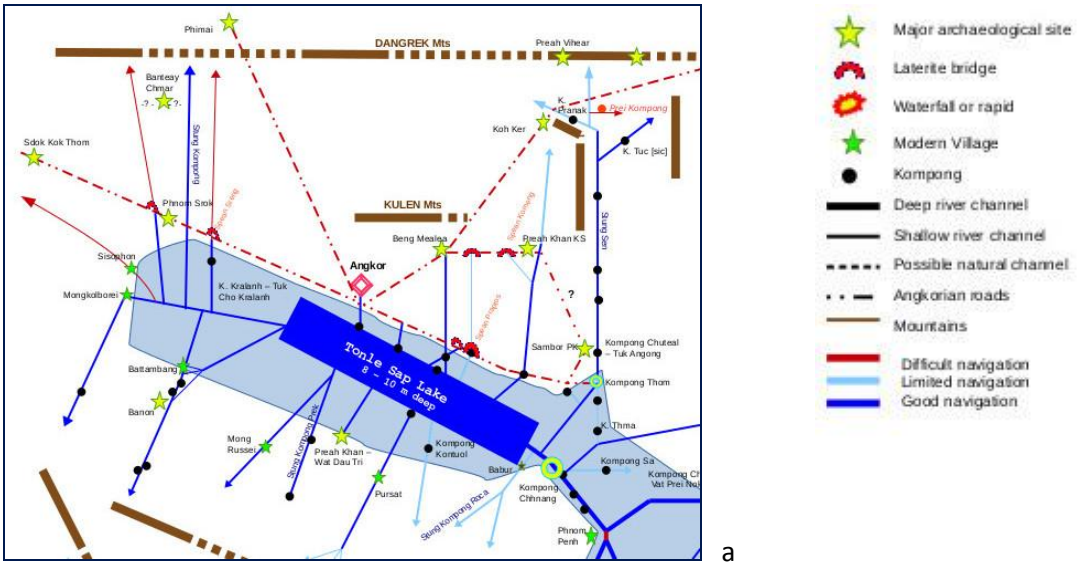
The absence of a seat of power in the area of Chaktomuk, which would have been the ideal place in Bronson's model, suggests that the region was difficult to settle (due to the environment and/or the hydraulics). The location of important points of transit in Kompong Chhnang and Kompong Cham instead of Chaktomuk calls into question Bronson's model, as it appears that environmental reasons may result in a different location of sites to manage river traffic coming from the Tonle Sap and the Mekong Rivers respectively. Miksic has challenged Bronson's model since it does not account for the road networks that linked highland and lowland populations in Sumatra (Miksic 2009: 70-99). Referring to gold transport, he notes

that caravans of up to 100 men carrying 20 to 25 kg each were used to transport this precious metal overland instead of using the river network (Ibid.: 97). As will be seen later on, the road network of Angkor suggests that in some sections, like the Angkor-Wat Phu connection, land transport took precedence over river transport. The pattern proposed by Miksic is therefore a better fit for the Mekong River, especially if we take into account the impact of the coastal polities of Champa, who took advantage of their position and diverted goods from the Stung Treng area toward their territory to the disadvantage of the Mekong Delta (see Higham, 2002: 294). Additionally, the location of both Kompong Chhnang and Kompong Cham may suggest a focus on internal rather than external trade, although this would not prevent seagoing trade ships from travelling upriver.

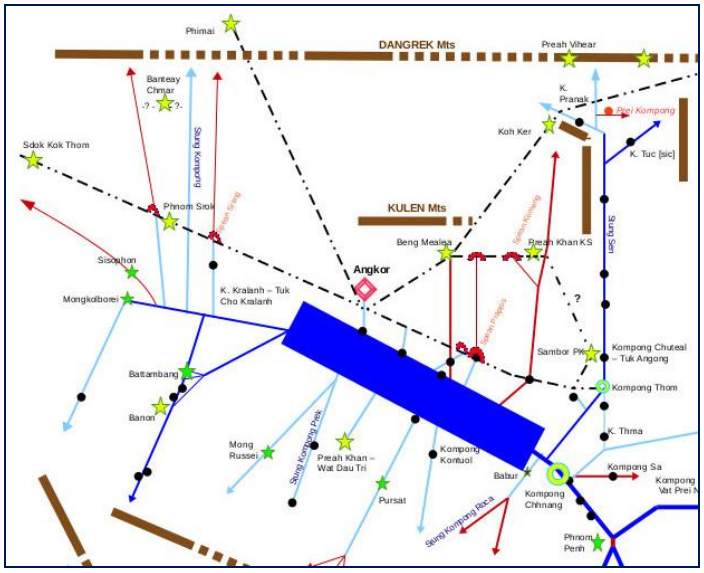
The Tonle Sap transport zone

Geography. The Tonle Sap transport zone is the area that connects the sea-river transshipment area at Kompong Chhnang with the Tonle Sap Lake and the rivers that pour their waters into the lake (Fig. 13). This region, which forms the Tonle Sap Basin, has a very unique ecosystem; during the rainy season the Tonle Sap River is unable to discharge its waters into the Mekong and therefore it is forced to reverse its flow back into the Tonle Sap Lake (Douglas, 2005: 204). This remarkable characteristic has the effect of flooding the Tonle Sap Lake, which experiences a drastic variation in its extension from 2,400-2,500 km^2 in the dry season to 10,000-15,000 km^2 during the rainy season, though figures vary (Douglas, 2005: 204; Campbell *et al.*, 2006: 357; Carling, 2009: 91). The average depth of the lake varies between 1-2 m during the dry season, and 8-10 m during the rainy season (Carling, 2009: 91), with no significant variation in depth since the Angkor period (Kummu, 2003: 14). The bathymetry of the lake at its lowest water mark shows varying depths (PL. 26), with a maximum season depth of 3.3 m (Campbell, 2006: 357). From Kompong Chhnang to Chong Kneas near Angkor, the

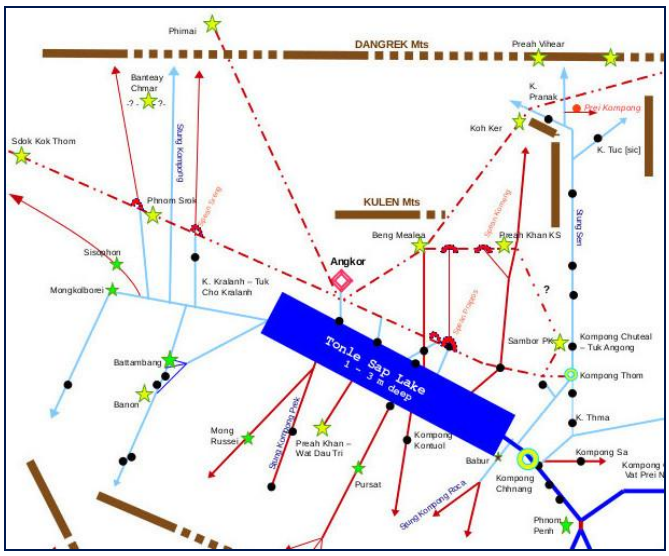
water is accessible for large ships during the rainy season, but during the dry season vessels with a draft over 0.80 m cannot pass (Mekong River Commission, 2012: 252).



a



b



C

Fig. 13: section of the topological map with the Tonle Sap transport zone.

(A) **Rainy season, (B) Start dry season, (C) dry season.**

NOTE: the road network is shown in black when accessible and red when inaccessible.

The forests that surround the lake are flooded up to 5 m during the rainy season. Although the area of this flooded forest has been severely reduced, it is estimated that it extended around 1 million hectares around the lake (Douglas, 2005: 207). The average slope between the Kulen Mountains and the Tonle Sap is only 0.1 % (Fletcher, Evans and Kummu, 2003: 2). Tropical rivers such as the Pursat, the Sangkhae, the Siem Reap, the Roluos, the Steung, and the Sen drain their waters into the lake on this gentle gradient. These rivers are characterized by substantial changes in water flow depending on the season, and by a type of tropical seasonal forest known as “gallery forest” that runs along the course of the river—though some of this vegetation has been cleared out by human action (Corlett, 2005: 107). It is important to highlight that the southern tributaries of the Tonle Sap Basin suffered grave alterations to their morphology as a result of the canals constructed during the Pol Pot regime in the 1970s (Douglas, 2005: 207).

Navigation. The Tonle Sap transport zone sits at the core of the Khmer empire, with many archaeological sites distributed along the riverbanks of tributaries of the Tonle Sap Lake (Parmentier, 1927: 374). The entrance of the Tonle Sap Lake hosts the confluence of the Stung

Chinit, a river used nowadays by local farmers and fishermen to transport their goods (Seng, 2010: 9), and the Stung Sen River, which provides access to Kompong Thom and Sambor Prei Kuk (Piphal, 2012: 189), and possibly to Koh Ker and the Northeast road of Angkor. This river is navigable all year around and it is currently a nodal point for Cambodia's economy (Seng, 2010: 9). The next river on the northern shore of the Tonle Sap is Stung Stoeung, which provides access to Preah Khan of Kompong Svay and is only navigable during the rainy season (ibid.). Stung Chikreng, on the other hand, is blocked by Spean Praptos, a masonry bridge from the Angkor era. The river is navigable but the span width of the bridge makes it impossible for vessels to cross underneath it. Downstream from the bridge, the dense vegetation makes this river useless for navigation nowadays (Seng, 2010: 9). Other minor rivers and streams can be found on this side of the lake, many of which are blocked by the bridges of the ancient Angkorian south road. Though empty now, the Damdek canal from the Angkor period is clearly visible from the satellite images. Stung Roluos, with its popular floating village of Kompong Phluk, is barely navigable during the dry season, and during the rainy season the water is quite shallow.

Navigation in the lake between Kompong Chhnang and the area of Angkor should be considered. The expansion of the lake, particularly during the rainy season, would have been a challenge for navigation since the width of the lake and the flatness of the plain makes it difficult to keep reference points in the landscape (PL. 27); orientation may thus have been sought in the sun and the stars. The only contemporary reference to navigation comes from Zhou Daguan, who travelled across the lake after changing boats in Kompong Chhnang. According to Zhou Daguan, it took him another ten days to arrive in a place called Ganpang,[58] which the Chinese emissary places 25 km away from the city of Angkor (Harris, 2007: 45-46).

[58] The distance between Kompong Chhnang and Chong Khneas, south of Angkor and likely place of arrival of Zhou Daguan, is between 145 and 160 km (the former across the lake and the latter hugging the coast line), which means that Zhou Daguan's party was covering between 14 and 16km per day. This seems to be an extremely slow progress for water transport.

His trip took him across the Freshwater Sea (Tonle Sap Lake), bypassing Halfway village and Buddha village (ibid.). These were probably stops en route for replenishing the boats. Although Zhou Daguan's was a diplomatic mission, it seems likely that other boats engaged in trade could have used these points to load/unload passengers and cargo. Navigation could have been done in two different ways: following the shore line, or via direct navigation (using a direct line from point of origin to point of destination across the lake).

The colourful boats and floating houses located at the edge of the Tonle Sap Lake nowadays can give us a hint on how reference points can be artificially constructed: the red and blue colours stand out in the green landscape (PL. 28), and may be used to locate replenishment stops or entry points to rivers. The shortest way to Angkor would have been across the first section of the lake to the northwest shore in the direction of the floating village of Pean Bang. After passing the narrow passage of the lake, the boats would have headed north along the shoreline. The location of Ganpang is still a matter of debate (Harris, 2007: 89), but since it acted as a transit point, it would be logical to assume that the site was at the mouth of the old Siem Reap channel,[59] is currently located, or the mouth of the Roluos river, where Kompong Phlok is found. Both are located between 20 and 25km away from Angkor. Chong Khneas is located at the mouth of the current Siem Reap River, but further archaeological research should be conducted to confirm the exact location of the mouth of the former Siem Reap channel and its associated settlement (Fletcher *et al.*, 2003: 120; Pottier *et al.*, 2012: 2610). Nowadays the access channel to the port of Chong Kneas is shallow and muddy, and it is inaccessible for large vessels (Mekong River Commission, 2012: 252). The Siem Reap River is not accessible during the dry season, but it is navigable during the rainy season (Seng, 2010: 9). Kompong Phlok, on the other hand, would have provided access to the Roluos group via the Roluos River (Uchida and Shimoda, 2013: 1164). These sites would have also granted access to

[59] Fletcher has proposed that the port was located in the vicinity of Phnom Krom (Pres. Comm., 2015), something that Uchida and Shimoda seem to agree with (2013: 1164)

Angkor's road network, as they are within reach of the lower Southeast road (Hendrickson, 2010a), and Angkor's canal system that goes as far as the Kulen mountains (Groslier, 1979; Pottier, 1993; Fletcher *et al.*, 2003: 109–111; Uchida and Shimoda, 2013). The relevance of these sites as transit points for water transport bound for Angkor has been suggested, although no archaeological work has been conducted in the area so far (Pottier *et al.,* 2012: 2610).

The Stung Sreng discharges its waters into the Tonle Sap on its western side but it is not navigable. During the rainy season the current is too strong, and during the dry season there is not enough water (Seng, 2010: 9). There is an Angkorian bridge from the Western road upstream of Kompong Kralanh. The Sangkhae river system is more important economically, as it supports transportation from the provinces of Banteay Meanchey and Battambang. The rivers from the former wash from the north into the Sangkhae system, like Stung Kompong. There is no information regarding navigation on this river, upstream of which the temple of Banteay Chhmar is located, but there are no bridges along its course. The river found on the west side of Banteay Chhmar is blocked by one of the Angkorian bridges of the western road. The Stung Mongkolborei has restricted navigation during the dry season, but it is good for navigation during the rainy season (Seng, 2010: 8). The Stung Sisophon, on the other hand, is too shallow and nowadays the road is more commonly used (ibid.).

Finally, the Stung Sangkhae in Battambang province provides access to the north of the Cardamom Mountains and is navigable in both seasons, at least in the lower reaches (Seng, 2010: 8). There is an ancient canal identified by Pavie that seems to shorten the distance between Battambang and the Tonle Sap (Pavie, 1901: 99–101). The river of Moung Rossei and the Pursat River also grants access to the Cardamom mountains but they are only navigable during the rainy season (currently navigation is not possible due to a bridge and two sluices) (Seng, 2010: 8). Other minor rivers in the south-eastern side of the Tonle Sap Lake and River up

to the Kompong Chhnang area are not navigable during the dry season, but they could have been used during the rainy season (ibid.: 7).

In summary, the Tonle Sap transport zone can thus be characterized by the use of the lake as the nodal point from which water transport was distributed to inland sites located on the riverbanks of tropical rivers. The area of Kompong Chhnang would have been a strategic military point, as the settlement controls access to the Tonle Sap Lake. Transshipments from sea-going and coastal vessels to lake vessels took place here. The lake would have allowed the use of broad-beamed shallow boats of considerable size, as there are neither navigational impediments nor environmental constraints that would have required boats with narrower beams. Zhou Daguan indicates that the Khmer boats did not use sails (Harris, 2007: 78), rowing was only used for warfare according to the iconography, so paddling was the most likely means of propulsion. Navigable rivers may have required boats with narrower beams, at least during the dry season, so it is possible that transshipment was required either at river mouths or further upstream where stilted or floating villages are often found nowadays.

The high incidence of *kompong* in the Stung Sen confirms the economic importance of the river nowadays, and seems to reinforce Hendrickson's suggestion that the region was very important for its resources during the Angkor period, particularly the iron deposits of Phnom Dek (2010: 449, 452). The river was linked to the northeastern road and Koh Ker through the river, as the presence of Kompong Pranak in the vicinity of Koh Ker indicates the river is navigable up to this point. The sites of Sambor Prei Kuk, dating to the Chenla period, attest to the relevance of this river since the pre-Angkorian era. Preah Khan of Kompong Svay is also placed in an ideal location for economic resources (ibid.) via the Stung Stoeung; since the river is not navigable during the dry season, the road connecting it to Angkor guaranteed year-long transportation (Hendrickson, 2007: 247). Recent work conducted in the Kulen mountains suggests that a west canal parallel to the west road to Beng Mealea was used to carry stone

from the quarries to Angkor (Uchida and Shimoda, 2013: 1164); the width of the canal (up to 20 m) suggests that wide barges or bundle rafts were likely used for transport. The site of Banteay Chhmar has one river on each side, but the one on the east called Prek Kompong is not blocked by a bridge, so it is likely that this river was the preferred option for water transport. The importance of the Sangkhae River, which is navigable year-round, is marked by the remains of the Banon temple commissioned by Jayavarman VII. The rivers on the southern shores appear to have been less reliable. The tropical character of the rivers in this region would have made them reliant on the cyclical pattern of rain to feed the tropical rivers, therefore the Tonle Sap transport zone would have been particularly vulnerable to stochastic events such as prolonged droughts.

The Sambhupura transport zone

Geography. The Sambhupura transport zone delimits the area of the Mekong River between Kompong Cham, Kratie, Sambor, and Stung Treng (Fig. 14). The modern city of Kratie is found on the east bank of the Mekong River, while Sambor lies just 35 km upstream from Kratie. The riverbanks in this area are 20 m above the main course of the river in the dry season and the gradient between the Phapheng-Khone Falls and Kratie is 0.32 m/km average (Meshkova, 2012: 36–38). From the area of Sambor to Stung Treng, which is located around 95 km upstream, the river alternates long straight stretches with anastomosed sections (PL. 29); [60] the rocky bed of the river is at some points visible, and in some sections there are waterfalls and rapids, like the Sambor rapids between Kratie and Sambor, and the Prek Patang[61] rapids between Sambor and Stung Treng (ibid.: 34-35). At Stung Treng the river has a single channel that is 1 to 2 km wide and 18 metres deep, and the riverbanks are 15 metres above the main course of the river in the dry season (Meshkova, 2012: 34). Stung Treng is located south of the Phapheng-Khone Falls on the east bank of the Mekong at the confluence of the Sekong river

[60] Multiple channels diving and reconnecting, separated by semi-permanent banks.
[61] Also written as Preatapang in earlier works.

basin, which is formed by the Srepok, the San, and the Kong rivers. This tropical basin drains the Annamite Range on the east, and connects the Attopeu province with the Mekong (Great Britain Naval Intelligence Division, 1943: 442).

Navigation. Navigation in this stretch of the river is challenging due to the geography and hydraulics, but there are no contemporary accounts on how it was done during the Angkor era. Detailed accounts from the French Mekong River expedition of 1866-68 documented a transit point in Kratie, where they had to switch from a steamboat to several dugout boats in order to continue upriver. The cargo that had been comfortably placed on the steamship had to be loaded into eight narrow boats of between 15 and 25 m of length (Garnier, 1885: 74). These had been equipped with awning and bamboo frames. According to Garnier, the bamboo frames were in place to tackle the strong currents of the river; they ran all around the narrow boats and formed extended platforms at the bow and the stern (PL. 30). This provided the crew easy access to maneuver the boat (ibid.), but it probably also provided them with added security, as the frames would prevent direct impact of the hull of the boats against rocks or trees. A rudder was placed on the stern platform and the crew, which was comprised of between six and ten men, moved the boats upstream using long poles with a small forked end in one side and an iron hook on the other (Garnier, 1885: 71).

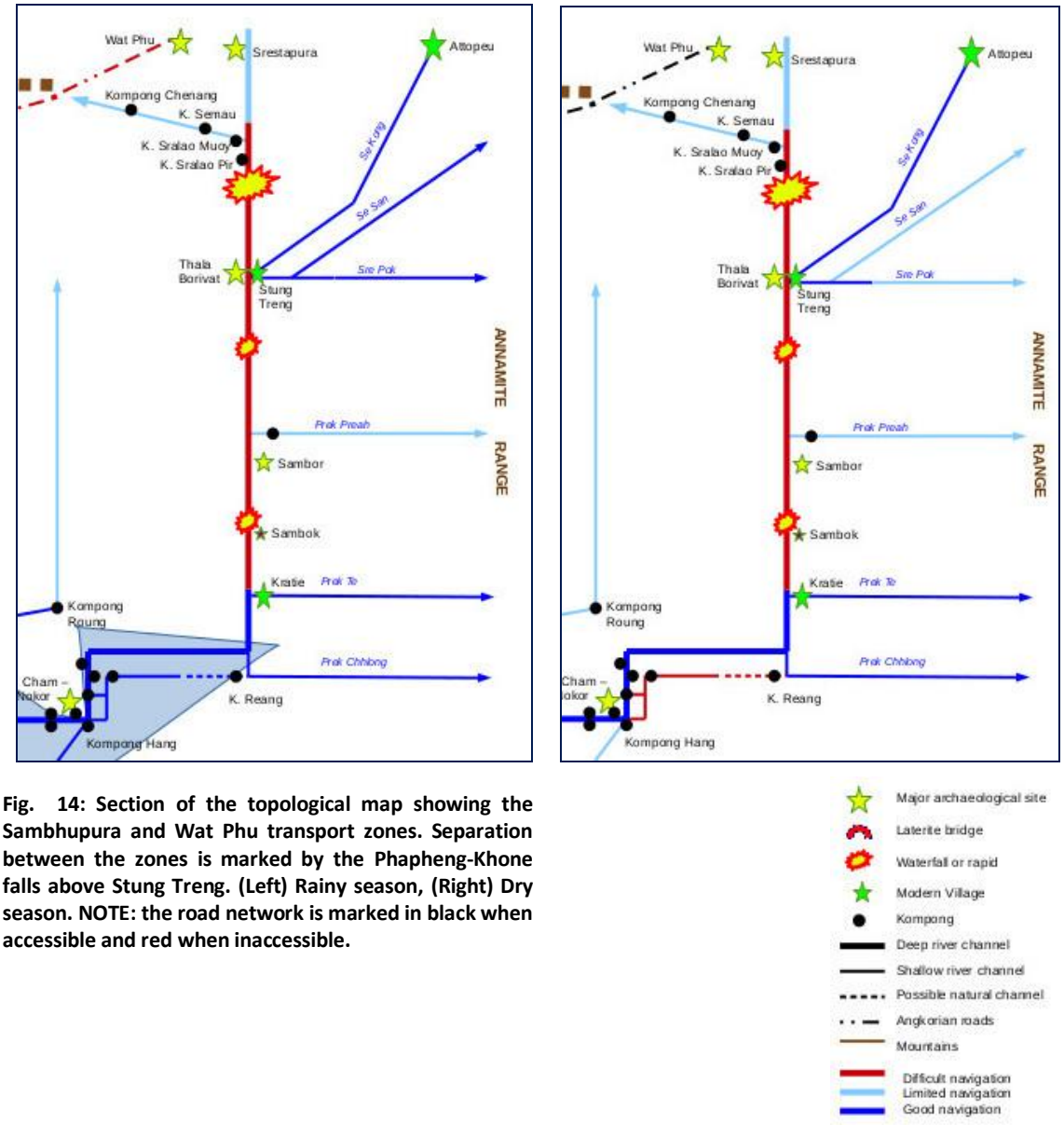


Fig. 14: Section of the topological map showing the Sambhupura and Wat Phu transport zones. Separation between the zones is marked by the Phapheng-Khone falls above Stung Treng. (Left) Rainy season, (Right) Dry season. NOTE: the road network is marked in black when accessible and red when inaccessible.

As the boats hugged the west bank, the iron hooks on the poles were used to grab stones and trees to pull the boats and the forked ends to push the boat forward as required. The bow had to be slightly pointed toward the bank to prevent the boat being dragged with the current if a strong wave hit the side the boat (ibid.). At the time of the French expedition, the water level was high, the current was strong and the river was flooding the riverbanks transforming the shore into flooded forests. They moved upstream at a slow pace, around 8 km per hour, seeking shelter for the night at the confluence with small rivers since they could not find places to land (Garnier, 1885: 74). However, flash floods were a real concern, as the sudden flow of

water threatened to push them into the main current of the Mekong (ibid.). Even in the 1970s motorboats had to be close to the riverbank if they wanted to make any progress against the current (Osborne, 1975: 74). It took the expedition one full day to reach Sambor from Kratie —with only 30 km between them—, and eight days from Sambor to Stung Treng —roughly 100 km apart. Nowadays navigation is difficult even for experienced pilots due to the strength of the currents, water turbulence, sharp bends with strong side currents, sandbars, shoals, and the vegetation that blocks the view, especially in the dry season when the riverbanks become wetlands (Mekong River Commission, 2012: 240-242). In areas where the river widens, it is difficult to identify the location of the channel (ibid.).

In the 19th century, the French adventurers changed boats in Stung Treng, which served as a nodal point for goods coming from the Annamite range using the Sekong River basin. Lagrée explored this river, moving upstream as far as Sieng Pang, a small province —located 20 leagues (111 km) from Stung Treng— that acted as intermediary between the city of Attopeu and Stung Treng (Garnier, 1885: 86). In the 20th century, the Sekong River basin was navigable by large local cargo boats up to Attopeu (Madrolle, 1930: folded map); a boat trip from Stung Treng to Attopeu via the Sekong river (roughly 200 km) could be made in 18 days –10 to 12 km per day–, while the return took only 3 days –60 to 65 km per day (Great Britain Naval Intelligence Division, 1943: 442). The lower section of the Srepok is navigable all year round, but the upper section of this river and its tributary, the Sesan, are hard to navigate during the dry season and present challenges during the rainy season due to the geography of the river (Seng, 2010: 6). Nowadays road transport has taken precedence over river transport (ibid.).

The region delimited by the Sambhupura transport zone has much archaeological evidence indicating its long history (Osborne, 1975: 43-44). The ruins found in Sambor have been associated with the *mandala* of Sambhupura, an important polity in the 8th century with links to Jayavarman II, founder of the Khmer Empire (Coedès , 1968: 85-86, 97; Higham, 1989: 324).

This *mandala* bloomed from the 7th century onwards and during its heyday its influence seems to have extended up to Stung Treng. The location of Sambor between the rapids suggests that the Sambhupura *mandala* was taking full advantage of the limitations of navigation, placing itself at the southern end of this transport zone in a key location for transhipments (Higham, 2002: 248). Stung Treng was of great strategic importance since the 6th century (Lévy, 1970: 113–129; Higham, 1989: 254, 267, 315; Vickery, 1998: 379–380). The remains of Thala Borivat (6th century) found in the confluence of the Sekong River basin suggest an earlier attempt to establish control over the river traffic, though the area eventually fell under Sambhupura's influence (Vickery, 1998: 379). The tight connection between Sambhupura and river trade is reflected in the title of *mahanauvaha*, "great shipper", attested in epigraphic records from this region (ibid.). The role of the settlements would not only have led to tariffs or charges imposed by the local authority to shippers, but it would have also sustained the local population as transhipments require considerable manpower to unload and load cargo.

Since there are no navigational impediments that would prevent sea-going ships to travel as far as Kratie (Garnier, 1885: 65-68), the presence of rapids before Sambor suggests that either the area of Kratie was used for transshipments between sea-going vessels and river vessels, or that narrow river boats were used from another transshipment area downstream up to Sambor. However, the difficulties involved in navigating this area, and the construction of Wat Prei Nokor in the 13th century in the area of Kompong Cham, seems to suggest a preference for a sea-river transshipment point in this region.

Although there is no evidence of a land road used in ancient times to bypass the Sambor and the Prek Patang rapids, a GIS analysis of U.S. bombings in Cambodia during the Vietnam War conducted by Owen (2006) shows how the targets were closely related to river transport in the Stung Treng and Srepok areas. Further analysis of the image (Fig. 14b) shows an alternative land route on the right side of the Mekong River that bypasses the rapids. This area should be surveyed to see whether this path was also used during the Angkor period.

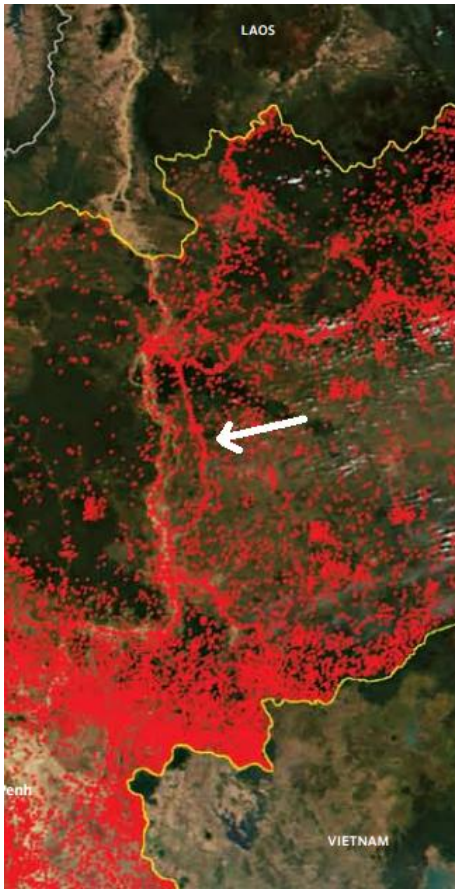


Fig. 14b: Map of the U.S. bombings of Cambodian in 1973. Arrow points to possible land route. Source: Owen.

In summary, the Sambhupura transport zone heavily constrains navigation due to shallow waters and shifting sandbanks between Kompong Cham and Kratie, and rapids between Kratie and Stung Treng, especially during the dry season when the waters leave the rocky bottom uncovered. During the rainy season boatmen need to negotiate the strong current of the river and the spill of the river into the flooded forest. Similar problems would have affected navigation in the past. The sequence of rapids between Kratie and Stung Treng would have required the use of boats with narrower beams and round bottoms. Although there is no archaeological evidence to suggest that ships used in this section of the river during the Angkor period had the same bamboo frames mounted on top of the hull described by Garnier (1885: 74), it seems reasonable to suppose that a similar adaptation to the harsh conditions of navigation was already in place to protect the hull from direct hits against rocks or trees. As suggested by Vickery, it seems likely that control over river transport led to the development of the Sambhupura *mandala*, with key sites along the river where transshipment was necessary (Vickery, 1998: 379-380). Sambhupura, which was

incorporated into the Angkor sphere in the 9th century, lost its role in the region when trade declined (ibid.). It has been suggested that the matrilineal system of Sambhupura allowed the rulers of the polity to become independently wealthy, and therefore they did not feel the need to control all trade, or that perhaps the rich men of the port capital lost their influence over the elite (Vickery, 1998: 380). However, it seems possible that growth of river transport may have been hampered by the constraints imposed by the river (and the subsequent construction of the Northeastern road of Angkor). The need to use narrow boats to bypass the rapids and move through the flooded riverbanks would have limited the ability of shipbuilders to increase cargo capacity in order to accommodate increasing demands. Carrying bulky goods, for example, may not have been cost-effective except for the wood trade, as logs can be simply floated downstream. On the other hand, the chances of loosing the cargo would have been considerable due to the difficult journey. As a result, tradesmen may have sought alternative ways of obtaining goods, thus stripping Sambhupura of its strategic role in river traffic.

The Wat Phu transport zone

Geography. The Wat Phu transport zone is delimited by Stung Treng downstream and Wat Phu upstream. The area is characterized by a line of cataracts, the Phapheng-Khone Falls (Fig. 14), that run the entire width of the river and actively disrupts navigation (Gupta, 2005: 77; Great Britain Naval Intelligence Division, 1943: 442). Above the falls, the Mekong runs straight through a flat plain displaying sections of anastomosed channels, the most notable of which is the area of the Four Thousand Islands where the Mekong widens to 15 km and is cut by channels and islands. The river runs through alluvial plains, its path does not meander (Gupta, 2005: 76).

Navigation. The location of Stung Treng at the confluence of the Sekong River basin, and only 50 km away from the Phapheng-Khone falls where navigation is cut off, makes this an area of

particular interest (Higham, 1989: 267). It was discussed above how the region acted as a transshipment point between the Mekong River and the Annamite Range, but its role in the bypass of the Phapheng-Khone Falls en route to/from Wat Phu is less clear. The French accounts provide information on a change of boats to travel from Stung Treng to the island of Khon in the Phapheng-Khone Falls region (Garnier, 1885: 86). When they departed from Stung Treng to continue their exploration of the Mekong, the French left the boats behind and changed to local ones, which were moved by two paddlers, one at each end, using a paddle to battle against the current (ibid.: 75-77). The first part of the journey ran across the flooded forest; advancing was cumbersome as the low branches of the trees prevented the boats from moving swiftly (Garnier, 1885: 90 ft. 1). After crossing the flooded forest, boats were confronted by the imposing noise of the cataracts. Bypassing this section is very dangerous and Delaporte noted that the bodies of dead alligators and fish were found aplenty below the falls (Osborne, 1975: 55). Local inhabitants navigated upstream of the cataracts with light boats using the channels located at the extremes of the river (ibid.: 54). Once at the top of the cataracts, navigation was easier, as the river expanded into the four thousand islands section. To tackle the cataracts, the Frenchmen were provided with lighter craft (Garnier 1885: 90-91). Above the falls there were other boats waiting for them in order to take them to Khong island; an engraving based on Delaporte's work shows three boats with relatively narrow beams (Garnier, 1885: 95).

From Khong Island, the expedition took five days to reach the settlement of Bassac on the west bank of the river, which was then the main provincial centre and where the ruins of Wat Phu are located (Garnier, 1885: 98, 141-148). An engraving depicts the steep riverbank of Bassac with many slim boats beached at the foot of a ladder used to climb the bank (PL. 31). According to Garnier, Bassac was the transit point between two main routes: a waterway toward Phnom Penh and a mixed route toward Bangkok via the Mun River across the Khorat plateau (Garnier, 1885: 160). He reckoned that the average tonnage of cargo that a local boat

could carry was around 2.5 tn. Voluminous cargo was loaded into boats that had been adapted with two additional planks on the splashboard to increase their size. When travelling downriver, according to Garnier, the merchants also used rafts made of bamboo that were 26 m long and 7 m wide and could carry around 20 tons of cargo (ibid.).

Pondering on the exploitation of the river for France's economic interests, Garnier reflected that the volume of cargo and the costs of water transport, which were slow and could damage the goods when moving upstream, were something that the French government should take into account if they wanted to develop the area (Garnier, 1885: 160). However, he recognized that fluvial transport with the current in favour was the fastest and most comfortable choice. November was identified as the best time to move upstream, but the strong current and the changes in the landscape, with reference points disappearing from sight, made this a dangerous journey; the dry season, on the other hand, ensured that the riverbanks were clearly visible (ibid.: 163-164) but the rocky bed would be exposed and shippers who would need to overcome the steep banks. In a recent risk assessment report prepared by the Mekong River Commission, the whole area from Pakse to the Phapheng-Khone Falls was considered the area extremely difficult to navigate due to "the complexity of the waterway system and the labyrinth of canals, waterways, islands, sand banks and rock outcrops, hidden or not" (Mekong River Commission, 2012: 237).

The key site to understanding the importance of this region above the falls for the Khmer Empire is Wat Phu. The temple is located on the west bank of the Mekong River, at the foot of a mountain that resembles a *linga,* from where it gets the name of *Lingaparvata* (Lorrillard, 2014a: 187). Archaeological evidence suggests that this mountain has been venerated since at least the 5th century (Lorrillard, 2010: 189), while the chronology of the architectural elements that form the archaeological complex demonstrates a continuous use of the site up to the 13th

century (ibid.: 196-197). Though the nature of the early vestiges is still a matter of debate,[62] it seems that by the 5th century the site was under Cham influence but toward the end of the 5th or beginning of the 6th century the area fell under the control of Chenla, establishing strong links to the cultures downstream of the Mekong River (Coedès, 1968: 65-66; Lorrillard, 2010: 194). At this time a settlement was founded on the banks of the Mekong River with one of its sides opened directly to the river (Lorrillard, 2010: 194). This pre-Angkorian settlement (PL. 32) shows a large village with a double enclosure of 2.4 x 1.8 km on the west and south, a river that was canalized on the north side, and the Mekong River closing the settlement on the east side (Santoni and Hawixbrock, 1998: 387). There are several concentric enclosures and walls inside, with over thirty brick sanctuaries and areas of brick production (ibid.). The settlement was founded by a certain Devanika toward the end of the 5th century (Santoni and Hawixbrock, 1998: 387) and was abandoned toward the end of the 7th century (Santoni and Hawixbrock, 1999, pp. 400–401). The area of the riverbank where the pre-Angkorian site was located was eventually abandoned by the end of the first millennia (Lorrillard, 2014b: 76). At this point all construction efforts seem to have been focused on Wat Phu and its surroundings, with the majority of the monuments dated to between the 10th to the 12th centuries (Lorrillard, 2010: 188). The abandonment of the riverbank site suggests that toward the end of the first millennia there is a decline of river transport from goods coming from this area. It is possible that land routes, especially those connecting Wat Phu with the Angkor area in the Tonle Sap became more important with the establishment of Angkor, but it should also be considered the role of Champa in diverting goods from this area to their coastal harbours using overland routes across the Annamite Range.

Surveys of the area have resulted in a detailed map of archaeological sites (see Lorrillard, 2014a). The region shows a high concentration of archaeological remains on the west bank of the river (PL. 33), including the road that links Wat Phu with Koh Kher and Angkor (ibid.: 186).

[62] See discussion in Lorrillard (2010: 202-203).

A surge in construction on this road seems to have taken place in the early 11th century (Hendrickson, 2010a: 491), around the time when the west riverbank was abandoned (Lorrillard, 2014b: 76). This suggests a change in the communications network between Angkor and Wat Phu, marking a decline of water transport via the Mekong River and an increasing use of westward routes to Angkor (ibid.: 40-43). The most obvious of these roads would have been the aforementioned land road. It has been suggested that the ditches on the side of the road could have been used as channels for boat use, although the width of these channels diminishes significantly as they approach Wat Phu (Lorrillard, 2014b: 74-75). Lorrillard has proposed that these channels were used by boats during the rainy season based on the Ban That stele found in the area (ibid.: 75), which reads:

> *xxxi. Pour me faire venir, me sachant expérimenté et digne de confiance, il m'envoya chercher avec un grand appareil pour le voyage et avec une foule de jonques,*[63] *comme jadis Lomapâda fit Rçyaçriiga.*
>
> *xxxii. Des rois venus d'autres contrées. . . . sur la route royale, il y eut des fêtes sans précédent organisées par les divers métiers propres à chaque pays.* (Finot, 1912, p. 21)

The boats, referred to as *naukânikàyaih*, seem to have been used in a celebratory context (Finot, 1912: 5). There is no reason to suppose that these boats were used in canals and not in the river, and while it is possible that the canals that result from the construction of elevated roads were used for water transport, as suggested both by Hendrickson (2007: 130-131) and Lorrillard (2014b: 74-75), some things need to be considered before accepting this theory. For example, were the channels wide enough to accommodate vessels going in both directions? Or was transport limited to one direction? Did they offer enough space to accommodate heavy transport to justify their construction? Were there any walls and locks that would help retain water and compensate the differences in heights of the terrain? Lorillard clearly states that with the changing heights of the terrain in the Wat Phu area, currents could go in different

[63] The choice of the word "jonque" to translate a term that refers to boats should be looked into, as the term has specific connotations for nautical technology. This is out of the scope of this research, so the term here will be understood as boat without further connotations.

directions in different sections of the road (ibid.). If walls and locks were not built to retain water and create a homogenous waterway for vessels, further proof is required to accept that these canals were fit for water transport. At best, they could be used opportunistically, but it is highly unlikely that they were designed for water transport without walls and locks to retain and regulate water flow.

A second westward route between Wat Phu and Sambor Prei Kuk —and from there to Angkor's Tonle Sap Basin road and water network— has been proposed by Lorrillard: first using the Tonle Repou River (which runs at the foot of the Dangrek Mountains and dumps its waters in the Mekong next to Khong island),[64] and then the Stung Sen River, which connects Preah Vihear temple at the top of the Dangrek Mountains, with Sambor Prei Kuk, the village of Kompong Thom, and the Tonle Sap Lake. The connection via the Tonle Repou seems to be confirmed by Harmand, who annotated a port (Kompong Chenang) on this river very close to the mountains (1876: 368). These waterways, either natural or artificial, would have been subject to the monsoon cycles and may not have been operational —fully or partially— during the dry season, when traffic would have been diverted to the road. The absence of masonry bridges in the northeast route from Angkor to Wat Phu beyond Koh Ker has been interpreted as an indication of Angkor's lack of interest in this area (Lorrillard, 2014b: 71), an argument that does not reflect the efforts invested in the construction of rest-houses along the way from the 11th century onwards (Hendrickson, 2010a: 491). However, the absence of masonry bridges across important rivers cutting the Northeast road, such as the Stung Sen River, could also be considered as an indicator of the preference of river over land transport in this road. Therefore, it is possible that goods were distributed from the Northeast road to the Stung Sen River when the season was favourable to river transport, as was previously suggested (Briggs, 1951: 111; Bourge, 1970: 291; Hall, 2011b: 180–181).

[64] Also written as Nam Lepou.

It is possible that a southward route ran across Don Det and Don Khon islands, following a path similar to that of the French railway, which was built at the end of the 19th century (Great Britain Naval Intelligence Division, 1943: 442), or by footpath around the banks of the river. Though accounts from Francis Garnier indicate that light craft were used in the late 1800s by people living in the area to move upstream, this would have been a poor choice for economic endeavors, as the boats would have been small with low cargo capacity and the risk of loosing the cargo would have been high. Nevertheless, the presence of sanctuaries in the islands of Khong and Khone on the way to the Phapheng-Khone Falls (Lorrillard, 2010: 200) ascribes relevance to this route southward. Another alternative option would be across the Boloven plateau toward the east, where the sites of Attopeu and Huei Tomo are located at the same latitude as Wat Phu (Lorrillard, 2014a: 192). While based at Bassac, Garnier and Lagrée explored the east bank of the river. Garnier explored the waters of the Xe Don searching for information regarding possible silver mines and discovered that on the west branch of the river there were waterfalls that would require bypass (1885: 128, 148). He first travelled up the Xe Don River up to Salavan, and then going south to the headwaters of the Sekong River and the city of Attopeu (Garnier, 1885: 125; Osborne, 1975: 63). The trip required boats to be unloaded and loaded at several points due to rapids and waterfalls. The river was deemed to be navigable, albeit with bypasses, up to a village named Smia from where the party headed to Salavan and hence on to the Sekong River on foot and using elephants to carry the cargo (Garnier, 1885: 148-151). Lagrée followed the river on foot until they reached Ban Coumkang where they could travel once again by boat. From Salavan it took them eight days to arrive in Attopeu (ibid.: 150-151). The Sekong River could therefore have been used in historic times to move goods downstream; however, Lorrillard has noted that no Khmer remains have been located in the lower basin of the Sekong, although he suspects that this may be due to the lack of fieldwork conducted in this area (Lorrillard, 2014a: 191). On the other hand, the middle basin has yielded several sites with pre-Angkorian material that links this region with the sites

of Stung Treng and Thala Borivat. Further work needs to be conducted in the lower basin of the Sekong, particularly in the area of Sanamxai, to appraise this route as a possible bypass.

In summary, the Wat Phu transport zone would have distributed traffic from the upper reaches of the Mekong on their way southward. The area of Wat Phu appears to have acted as a transit point, though river traffic had no need to change vessels at this point. The location of the settlement may not be related to navigation but rather to the presence of the mountain in the form of a *linga*. Like in the Sambhupura transport zone, the archaeology of this region hints to a change of use over time. Once Khmer influence was established in the late 5th century there is a period of fluvial activities stemming from the pre-Angkorian village established at that time on the riverbanks of the Mekong River. At this time the bypass routes would have sought a way southwards in order to continue on toward Stung Treng and the Sambhupura transport zone, something that would have benefited the Sambhupura *mandala*. The decline and abandonment of the pre-Angkorian village of Wat Phu in the 7th century (Santoni and Hawixbrock, 1999: 400-401), and the abandonment of activities in the riverbank toward the end of the 10th century (Lorrillard, 2014b: 76) seems suggests a decline of river transport via the Mekong River coinciding with the establishment of the Angkor *mandala*. This decline happened before increasing activities in the Northeast road of Angkor, which started at the beginning of the 11th century. Although Stung Treng would have still received goods from the Annamite range through the Sekong River basin, it seems that the westward routes (both by land and by water) at the foot of the Dangrek Mountains gained importance from the 11th century until the 13th century. Although everything points to a decline of river transport between the Angkorian capital and the Mekong River at the end of the first millennia, if nomadic fishing communities were active during the Angkor period, then this section of the river would have still been a vital artery for Angkor's economy. Goods for local consumption probably moved with these communities, but the most important resource in this case would have been the services they provided during the fishing season.

5.5. Conclusion

While it has been clear since the early 20th century that the Mekong River basin was a conduit for communication and human dispersal (Parmentier, 1927: 374), the characterization of the river into different environments has never been set forth in relation to Angkor's use of river networks. As a result, the limitations that these environments imposed on technological solutions and human activities have not been fully understood. In the *longue durée*, the first half of the 1st millennium Funan took advantage of the delta region, which granted access to maritime trade routes (Stark, 2003: 89–90). Toward the 7th century the centre of power shifted inland and developed in a north-south axis along the Mekong (O'Reilly, 2007: 111-112).[65] It is likely that the difficulties of managing the river in the Sambhupura transport zone ended up favouring the transfer of power to the Tonle Sap area in the 9th century, where the hydrology is better for navigation. Additionally, the river links from the Annamite Range to the coast may have played an important role in diverting goods to Champa that would have otherwise travelled through the Sambhupura transport zone, diminishing the power of Sambor and making this region less relevant in terms of trade. The shift toward the Tonle Sap basin offered Angkor a good communication network through the myriad of tropical rivers and streams of its basin (Parmentier, 1927: 374) and good fishing grounds. Once controlled, the lake had a great strategic advantage against naval warfare, since invading forces would have needed to cross the bottleneck that is the Tonle Sap River. The archaeological remains found in key transit points like Stung Treng, Kompong Cham, and Kompong Chnnang, as well as in the vicinity of navigable rivers such as the sites of Banon, Sambor Prei Kuk and Preah Khan of Kompong Svay, are testament to Angkor's exploitation of the river networks.

[65] A similar shift has been documented for Srivijaya in the Musi River basin in Sumatra, where the coastal settlements acted as intermediaries between maritime trade routes and resources exchanged through the Musi River basin in the first half of the 1st millennium; however, after the 7th c. the nodal point of trade shifts to Palembang, 80km upstream (Manguin, 2009: 442-443).

The aim of this chapter was to set forth the four main transport and communications zones in which Angkor operated. For Angkor to be able to colonize the Mekong River basin, technological solutions had to be found to meet the needs of the Angkorians and overcome the limitations of the environment. Understanding the environment is therefore a necessary first step to the integrated approach of this study. From a nautical perspective, the geographical analysis of transport zones and transit points clearly indicates that the Mekong River system was not a homogenous space; instead, it highlights that the four different transport zones would have required/accommodated different types of watercraft, as will be discussed in the following chapter. Sea-going and coastal ships would have mixed with local cargo and utilitarian watercraft in the Mekong Delta transport zone, while the hydrological and topographical conditions of the Sambhupura transport zone would have required the use of vessels adjusted to rough waters and collision hazards. The Phapheng-Khone Falls prevented direct transport between Wat Phu and Stung Treng. The Tonle Sap transport zone, on the other hand, offered a more benign option for transportation with limits to vessel draft due to the shallow depth of the lake. These zones would have required a specific set of skills and piloting knowledge in order to successfully navigate through them, but in order to know who was doing the navigating there is a need to have further details on the activities that were taking place and who was likely to be conducting then. This will be discussed in chapter 7.

Since navigation depends on current flow, the seasonal character of the region's climate would have resulted in two completely different landscapes with their own characteristics: the dry and the wet monsoon landscapes. The seasonal flow of tropical rivers imposed certain conditions on the width of vessels, as well as restrictions to navigation during the dry season. Rivers like the Stung Sen and the Sangkhae, which are navigable year-round, have retained their economic relevance up until nowadays, as can be seen by the number of *kompong* documented in them. However, rivers like the Stung Stoeung, which were clearly important for Angkor's economy have not retained their relevance. The seasonality of the river network

likely resulted in a dual system of land and river transport; how this affected human action remains to be discussed, as movement may have been additionally constrained to agricultural and fishing cycles.

Reliance on tropical rivers for transport would have made Angkor vulnerable to extreme weather events, such as the two droughts that have been documented for the 13th and the 14th centuries (Buckley *et al*., 2014: 17). River transport would have been severely compromised due to low waters: there would have been limits to the number of boats that could travel up and down the river, and also on the size of these boats. Some areas may have been left isolated if they depended on small streams. Land transport would have been in jeopardy, as it depended on rain-fed ponds for human and animal consumption. Additionally, flash floods produced by the intensity of the rain may have affected the Angkorian merchant fleet and resulted in damage to ports. So apart from destroying Angkor's water management systems (Buckley et al. 2010: 6750), it is reasonable to assume that the two mega monsoon periods documented (Buckley *et al.* 2010; 2014) would have severely disrupted Angkor's network of communications and transport.

This chapter has characterized the various spaces present in the Mekong River basin, and how these tested human ingenuity if they were to use them as conduits of communications and transport. Having set the environmental background, the next two chapters will discuss the nautical solutions to these limitations, and the nautical activities for which boats were designed.

Chapter 6

6. Nautical technology in Angkor

In the previous chapter the focus was on the geography and the environment and how the characteristics of each transport zone would have imposed certain limitations to waterborne transport. In this chapter the focus is on nautical technology as a means to understand how people moved in the Mekong River basin and the solutions that were developed to overcome the aforementioned constraints.

New archaeological evidence from boat remains

In the past decade two dugouts have been excavated in the Angkor area: the Angkor Thom boat dated to the 13th century (Handley and Sen, 2016) and the Kra Raleung boat dated to the mid-15th century (An, 2014).[66] The Angkor Thom dugout (PL. 34), which measures 12.83 m, was found in March 2016 while construction works were being carried out in the Angkor Thom district (Sen, 2016). The boat was made from koki wood (*hopea Odorata*), a kind of hardwood endemic to Southeast Asia that can reach a height of 45 m (Jøker, 2000), which confirms Groslier's suspicions that Angkorian boats were made from this wood (1921: 111). There has not been an official report yet on the Angkor Thom boat, but photographs showing the complete vessel have been published by the APSARA authority via their official social media, and in June 2016 they communicated via a press release the 14C results. The Kra Raleung boat (PL. 35), which measures around 15 m and was also made from koki wood, was found in 2006

[66] A description with accompanying photographs can be found in the Appendix in the Archaeological Data section.

in the village of the same name (see An, 2014). The incomplete dugout was unearthed by a farmer at a depth of 1.3 m as he was digging a fish pond; the documentation of the remains was conducted before the dugout was placed in the moat of Angkor for conservation and published online (Ibid.). The discovery of these boats makes it possible for the first time to begin a discussion on Angkor's nautical technology using actual boat remains, something that was not available to early researchers who had to rely on iconographic and ethnographic data alone.

The nautical technology that will be discussed in this chapter is divided into three categories: dugouts (and expanded dugouts), rafts, and plank-built ships (Fig. 15). Since archaeological and iconographic data points toward the dugout as the main shipbuilding tradition of Angkor, this will be discussed first. Following Blue (2003), ethnographic data will be used to develop a set of criteria to interpret archaeological and iconographic data and hypothesize on the transport zones where these vessels could have been used. Similar approaches will be taken to discuss rafts and plank-built ships. The social context of shipbuilding techniques will be discussed in chapter 7.

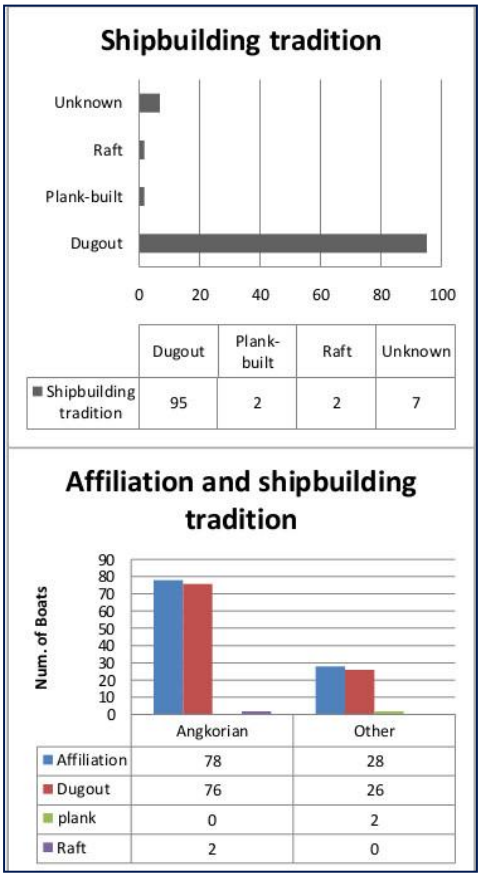


Fig. 15: Distribution of shipbuilding traditions in the iconography in number of boats (above) and associated users (bottom). Source: V. Walker.

6.1. Dugouts

It has long been suspected (Groslier 1921: 18; Paris 1941: 337-338; Hoc, 2001; Jacq-Hergoualc'h, 2001; 2007: 135) that the boats of Angkor were made from a single log based on

the iconography, the ethnographic data, and Zhou Daguan's description of boat building techniques in Angkor:

> *Small boats, on the other hand, are made from a single very large piece of wood, hollowed out by chiselling. They treat wood with smoke from a fire, which makes it soft, then use timber to stretch it out. The boats, which they call* pilan*, are large in the middle and pointed at either end. They don't have a sail, can hold several people, and have to be rowed with oars.*
>
> *Zhou Daguan (1296), chapter 32 (trans. Harris 2007: 78).*

The boat remains found in Angkor Thom and Kra Raleung corroborates that this dugout tradition was present during the Angkorian and the immediate Post-Angkorian periods and that it was used for boats of up to 15 m long (see An, 2014).[67] Furthermore, the remains of the Kra Raleung boat shows a series of holes drilled on the boat at equal intervals, which are marks that can be interpreted through the ethnographic data. In contemporary Cambodia similar marks are found in boats as a result of holes drilled on the hulls to even out the walls of the dugout, a process called *chak bansak* (Hoc, 2001: 4). Further documentation of the Angkor Thom boat is needed to determine if the *chak bansak* system was in place during the height of the Angkor period; however, the curvature of the hull of the boat suggests that the log was discarded before it was finished so it is possible that the holes were never drilled. Nevertheless, given that the system is well developed in the Kra Raleung dugout it seems reasonable to assume that this construction technique was in use at least since the late Angkor period. The use of embers and timbers to expand the walls of the dugout also resemble the technique documented in contemporary dugouts (Poujade, 1946b: 6; Hoc, 2001: 3), as was noted by Groslier (1921: 18), and the description of the hull design (large in the middle and pointed at either end) could easily be applied to contemporary Cambodian vessels (PL. 36). In Cambodia, boats are also made of koki trees (Hoc, 2001: 6; Nou Thearit, 2013: 37), like the Angkor Thom and Kra Raleung boats.

[67] A description of these boat remains can be found in the archaeological data section of the Appendix.

Conservatism among maritime communities is widely documented (Hunter, 1994: 263); since environmental conditions tend to remain persistent (i.e., currents, flow, winds), once an optimal solution has been achieved the introduction of new designs are met with scepticism (Ibid.). This is mostly due to what Hunter calls common sense: the optimized designed has proven to be efficient in facing the dangers involved in navigating the waters that it was designed for, so change appears superfluous and risky (Hunter, 1994: 263). Given the accumulated archaeological, historical, and ethnographic evidence, and taking into account the aforementioned conservatism, ethnographic data can be used to provide a more comprehensive view of the archaeological material (see discussion in Blue, 2003).

Carving out the dugout in an ethnographic context

Once the *koki* tree has been cut with the use of axes (Harris, 2007: 78), the log is carved in situ by tracing a figure of eight on the upper part in order to gain maximum extension for the walls of the dugout (Hoc, 2001; PL. 37). Hollowing out the log in situ has the benefit of reducing the weight of the log and make transportation easier (see for example Nicolaisen and Damgård-Sørensen, 1991). The people of Angkor used chisels to carve the wood (Harris, 2007: 78), but other tools like the traditional iron adzes with wooden handles used nowadays (PL. 38) were likely employed as well. The first step in the construction process is the "cracking of the chest" (*puoh truong*) where the log is carved in the centre to begin the hollowing out process (Hoc, 2001: 3). Once the inside of the log has been carved, the walls are thinned out following the curvature of the log (Ibid.). This leaves a shape identical to the form of the Angkor Thom boat (PL.39-40), so the boat was likely left unfinished.

After this process, the boat is turned around and three lines are marked using a rope tainted with charcoal; the central line marks the axis line[68] of the boat, while the other two are marked

[68] The axis or keel line runs in the middle of the ship from bow to stern, and acts as the foundation or spine of the boat's structure. In planked ships the keel is a linear piece of wood or iron where the frames are attached to. The dugout does not have a true keel, as it is made from a single log, but when these are expanded with planks the body of the dugout is considered as a broad dugout keel (see Barnes,

as boundaries of the boat's backbone (Hoc, 2001: 3). The outside bottom surface is carved, making sure that is completely flat. This is tested by holding the rope and ensuring that the bottom of the hull is aligned (Ibid.). The next phase, called "to divide the flesh" (*chek sach*) sees work done on the outer walls of the boat (Hoc, 2001: 3). The walls have to be symmetrical, as any mistakes can cause the boat to veer to one side. Further work is then conducted to even out the inside walls of the boat, and once this is finished the boat is placed on top of embers to begin with the opening process.

Opening the dugout

The opening process in Angkor required the walls of the boat to be softened with "smoke from a fire" and then pried open with timber (Harris, 2007: 78). This procedure is achieved in Cambodia by placing the hull on top of embers first; then the walls are pried open as the wood is softened, and pressure is exerted by using levers with counterweights and placing timbers inside the hull (Hoc, 2001: 4). Along the riverbanks of the Sen River, in the vicinity of the Sambor Prei Kuk temple, boat builders use V-shaped pieces of wood to pin the walls of the boat to large logs. These are tied to a large log that sits horizontally to the boat, pressuring the walls while the embers soften the wood (PL. 41-42). A similar system but with a different layout (logs are left to hang from ropes tied to the V-shaped wooden pins) was also documented in the Mekong delta during the mid-20th century (PL. 43) (Boulbet, 1965: 391–392, Pl. LV). Once the temporary thwarts[69] are placed inside the hull to keep it open, the boat is then turned upside down and left to dry for 1 to 2 weeks (Hoc, 2001: 4).

Refining the dugout

After the boat is dried the process of "refining the flesh" (*chaing samrual sach*) takes places to smooth out the boat. After this step, the even-depth holes are drilled on the outside of the hull

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2015: 302). Since dugouts in Cambodia have additional planking, the term keel refers in this work to a broad dugout keel unless stated otherwise. A visual dictionary of nautical terms can be found in the Appendix. The definitions of nautical terms are extracted primarily from (Kemp, 1976).

[69] Thwarts are transverse timbers that are used as seats in rowing or paddled boats.

to act as guides in the evening process of the inside walls (Hoc, 2001: 4). As mentioned earlier, the marks in the Kra Raleung boat could be interpreted as indications of this technique. After the inside walls have been refined, the boat is turned over and the holes are filled with wooden pegs (Ibid.). The hull is then smoothed out and once the surface has been polished, it is coated with resin that makes it watertight, preserves the wood, and protects it against pests (Hoc, 2001: 4). The resin is left to dry for 3 to 5 days, though it could be up to a week before it dries off completely (Ibid.). This coat, called *chear touk,* is produced nowadays from the resin of the *krul* tree (*melanorrhea usitata*) mixed with other oleo-resins (Groslier, 1921: 111). This differs from Zhou Daguan's account, who said that the coat used by the Angkorian people was made up of fish oil mixed with lime (Uk and Uk, 2016: 113). Chemical analysis of the Kra Raleung boat remains may shed some light on this matter.

Expanding the dugout

The use of a single log for the construction of vessels would have constrained their size; however, the nautical iconography represents very large vessels that would have required technological solutions beyond the dugout (PL. 44). Zhou Daguan describes larger boats as being built with planks:

> *Very large boats are made from hardwood broken into planks. The carpenters have no saws, and just chisel the wood with axes so as to make planks. This is very cumbersome, a waste of wood, and a waste of effort. [...] To make boats they also use iron nails. The awning consists of palm leaves held down with strips of areca wood. They use oars for these boats, which they call* xinna*.*
>
> *Zhou Daguan (1296), chapter 32 (trans. Harris 2007: 78).*

While Zhou Daguan's reference to dugouts was quickly incorporated to academic discussions on Angkor's nautical technology, the mention of planks is usually ignored. The plank vessels that are depicted in the iconography are associated with foreigners (see discussion below), but Zhou Daguan's description may be referring not to a plank-built ship, but to an expanded dugout developed to increase the size of the boats. This technological solution is documented

across many cultures (see for example McGrail, 2001; Rönnby, 2003: 68; Rajamanickam, 2004: 75–78; Kapitän, 2009: 45–48; Barnes, 2015: 135-136, 302-30), and appears to be a common progression in boat building techniques. The idea that dugouts eventually evolved into plank vessels of the shell-built tradition was first suggested by Hornell (Hornell, 1946: 192) and has been supported by McGrail (McGrail, 1983: 33–6), and although Gould is more cautious on this evolutionary approach, he also agrees with the premise (Gould, 2000: 102–104). Poujade proposed a similar evolution for the plank vessels of the Mekong, which he considers to have originated from the Cambodian dugout (1946b).Hence, if the boats of Angkor were expanded dugouts, how were they constructed? Continuing with the ethnographic analogy, the construction of large dugouts in Cambodia nowadays has two parts. On the one hand, the stempost[70] of the boat is chiselled out from an independent log (PL. 45) and then attached to the dugout keel using a rabbet joint and iron nails (PL. 46). The dugout keel has hard edges and the rabbet joint is incised to receive the stempost. Each side of the stempost is chiselled to extend over the top side of the dugout keel. The second part consists of adding planks to the top sides of the dugout keel, which is done by making pocket-hole incisions on the planks and using iron nails to attach them (PL. 47). Before the stempost is added, the bow of contemporary dugouts look identical to the Kra Raleung boat (Fig. 16), and likely to the Angkor Thom boat as well, though better images of this section are needed to confirm this.

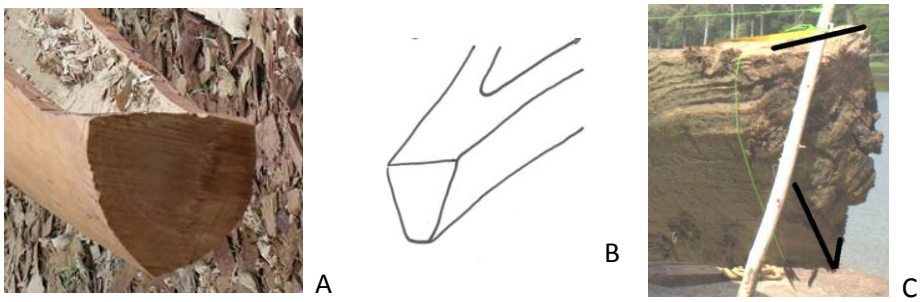


Fig. 16: The inverted triangle shape in the bow of the contemporary dugout (A) and the Kra Raleung boat (C). Source: (A) LWH, (B) V. Walker, (C) N. Gani.

[70] The foremost timber of a wooden boat fastened to the end of the keel that forms the main part of the bow.

The wood used for the stempost and the planks is different from the *koki* tree. While the latter is appreciated for its capacity to retain its quality even when it is submerged in water for long periods of time, boat builders nowadays prefer to use *sro lao* (*Lagerstroemia angustifolia*) for the added planks because while it rots fast in contact with water, it can resist the sunlight and the high temperatures well (Nou Thearint 2014: 37). Jackfruit tree (*Artocarpus heterophyllus*) and lumbao (*Shorea farinosa*)[71] are also used by some boat builders for the stemposts of racing boats (Ibid.).

The planks used in modern-day dugouts are sawed, but Zhou Daguan's reference makes it clear that in the Angkor period planks were chiselled (Harris, 2007: 78). Despite Zhou Daguan's objection to wasted wood, from a technological perspective splitting the wood with a chisel has the advantage of retaining a higher number of fibres that follow the grain orientation in the longitudinal direction (Navi and Sandberg, 2012: 29). This provides the wood with greater mechanical strength for boat construction (McGrail, 1976: 241-240; Steffy, 1998: 100). Maritime cultures such as the Vikings were known to work the wood this way for boat building, something that worked to their advantage when facing the turbulent waters of the sea (see McGrail, 2001: 226; Steffy, 1998: 100).

Variations of this expansion technique can be found in the ethnography; the most prevalent boat building technique in the 21st century is the *touk loeuk kdar*, where the dugout keel has been substituted by planks attached to a stem and sternpost[72] that follow the same design as the traditional dugout (see Appendix for a description of this type of shipbuilding). In the first half of the 20th century, a plank vessel with a broad dugout keel was also documented (Poujade, 1946b). The size of vessels represented in the iconography (PL. 48) and Zhou Daguan's account make it clear that one (or some) of these solutions was used, but further

[71] Also transcribed as Lom bor.
[72] The structural post of the stern of a boat that is fastened to the end of the keel.

archaeological data is needed to determine which one(s) was(were) in place during the Angkor period.

Paris suggested that the dugouts of Angkor were likely to reach 21 m in length and around 1.80 m in width amidships based on the number of rowers depicted on the boats and providing an average of 0.80 m of space between them (1941: 355, 357). Paris did not take into account the width needed between the rowers of each side and he also did not account for the added width necessary to accommodate the two lines of soldiers usually represented in board the war vessels. On the first issue, an example can be found in the *traineras*[73] of the Basque country used for rowing races in the sea; these have a length of 12 m and a minimum width of 1.72 m to accommodate rowers (Elizasu Eguitegui, 1991: 27).

The 1.80 m proposed by Paris for the boats' with could accommodate rowers but not the up to three lines of soldiers that are depicted on board. His measurements were based on the limitations of a simple dugout, but expanded dugouts can reach larger sizes. The royal barges of Thailand from the late 20th century, which were also expanded dugouts made from the *thingan* wood (i.e., hopea odorata), could reach up to 45 metres in length and 3.35 m in width (Graham, 1913: 370). The modern Thai royal barge Suphannahong, which is made from a single log, measures 46.15 m long, 3.17 m wide, 0.94 m deep (with a draft of 0.41 m) and has a displacement of 15 tons (Buapradit, 2006: 18). It can therefore be proposed that the minimum width of the war boats of Angkor was probably around 2.50 m —1.72 m for the rowers and 0.78 m for a single line of soldiers— although boats with more than one line of soldiers would have necessarily needed wider boats. The flagships were likely of the same size as the royal boats of Thailand, measuring up to 45 m long and 3 m wide.

[73] A type of vessel traditionally used for whale hunting and currently used in traditional races.

Appendages

The appendages are parts of the boat that are joined to the hull and contribute to the functioning of the boat. The ones that will be discussed here are those related to the propulsion and steering systems used in the Angkorian dugouts.

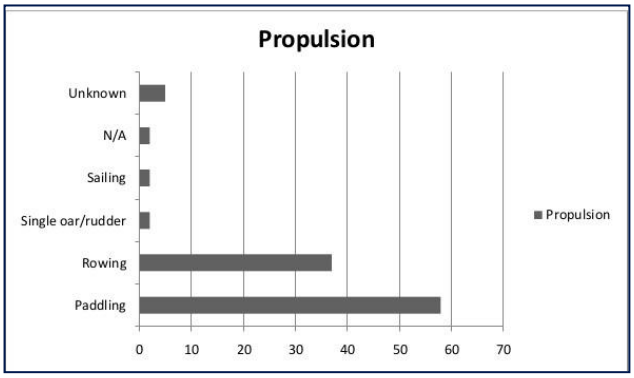


Fig. 17: Propulsion systems in Angkorian nautical iconography per boat. Source: V. Walker.

Propulsion systems in dugouts

The two main types of propulsion systems used by the Angkor boats are paddling, with 58 occurrences in the iconography, and rowing, with 37, although sailing has also been suggested albeit marginally (Fig. 17) (see Paris, 1941: 354). As discussed in chapter 3, paddling and rowing have been used interchangeably by previous researchers, while translations of Zhou Daguan's chapter 32 on boats have always used the terms oars and rowers to describe the preferred mode of propulsion at Angkor (Harris, 2007: 78; Uk and Uk, 2016: 116), even though the Chinese term used in the text could be translated as rowing or paddling, and oar or paddle (Harris, Pers. Comm.). However, there is a clear distinction to be made between them as they offer different technological solutions to the requirements of propulsion.

Paddling

In paddling the body of the paddler is used as a fulcrum between the paddle and the boat, so the paddle is not directly attached to the hull. The iconography shows that paddling was done by kneeling down on the deck of the boat and inclining the torso forward (PL. 49).

The paddles have short looms or shafts and the blade is designed symmetrically with flared top sides and a pointed tip like the shape of a leaf. The throat of the paddle, which is the area where the loom and the blade meet, can be either decorated or left bare (PL. 50). This type of

leaf-shaped paddle is nowhere to be seen nowadays, as the blades are now thinner and square, with no flare on the top side (PL. 51).

Paddlers are required to stay close to the edge of the hull to reach the water with the short loom of their paddles; through a wide range of strokes[74] they can efficiently propel and steer large boats (see Thai Royal Navy, 2012). The paddlers of Angkor can be found in large numbers placed all along the hull of large vessels (PL. 52), or in fewer numbers placed at the fore and aft of the small and medium-sized vessels (PL. 53). Synchrony and coordination when paddlers are distributed along the hull are important to propel and manoeuvre the boat, as the strokes of the crew have to be identical in terms of timing, strength, and length of the stroke for maximum efficiency (Sealey, Ness and Leicht, 2011). In the cases when fewer paddlers are used, the boats would logically have a slower pace but the coordination between paddlers would be easier.



Fig. 18: Training facilities for paddlers in the Royal Barges division of the Thai Navy in Bangkok. Source: V. Walker.

Coordinating the work of large numbers of paddlers would have required a high level of expertise from a coxswain and the paddlers, and a substantial amount of training to keep in synchrony (see Chamaemelum, 2011: 11:30-11:42). The Royal Barges division of the Thai Navy trains in their dockyard, where they have a wooden structure where paddlers can mimic their position in the boat and conduct mock exercises (Fig. 18) (Chamaemelum, 2011: 12:05-12:56). Orders are given visually by a coxswain in the bow using peacock feathers in both hands (ibid.: 11:30-11:42). In the case of the nautical parades of Thailand, synchrony has to be kept not only within the boat, but also with other boats from the pageant. This is done by rhythm barges

[74] For a description of paddle movements in lake and rivers see American Canoe Association (2014).

(Chandavij, 1995: 150), where officers struck large poles with fringes against the hulls to keep visual signs of rhythm (Chamaemelum, 2011: 13:29-13:46), and by an official located in the main barge who chants and is answered with other chants from the paddlers (Ibid.: 13:00-13:24). The formal movement of the paddles in the Thai royal barges creates a visual effect that makes the boats seem like they have wings (see Ribadeneyra, 1601: 164; Chamamemelum, 2011: 12:05-12:56).



Fig. 19: A paddler at the fore could act as a lookout. The paddler at the back is holding the paddle up in what may be construed as a signal. Source: V. Walker.

There is no clear depiction of a coxswain in the iconography of Angkor. It seems unlikely that the large boats that used full lines of rowers would have been able to manoeuvre without direction from a coxswain, but it is possible that the role was taken by the head paddlers or that the officer was not considered important enough to depict. There are, however, some figures that appear to be lookouts (Fig. 19), so these may have helped in directing the boats. On the other hand, the complexity involved in moving a large number of boats carrying a large number of paddlers in a dynamic environment (i.e., a river) should bring forth the ability of Angkorian kings to devote a substantial amount of resources (i.e. manpower, lodging, food, training) to nautical events.

Sweep rowing

In rowing the loom of the oar is attached to the hull through a fulcrum called thole pin and secured with an oarlock system so that the oar can safely pivot and be used as a lever against

the water to move the boat.[75] Sweep rowing is the technical term used to describe the rowing technique where a single oar is manned by one person, as opposed to sculling where two oars are used by the same rower. In Angkorian iconography the oars are fitted in an oarbox made of reed or wood (Paris, 1941: 354; Jacq-Hergoualc'h 2007: 132). The inside section of this oarbox is not visible, but it is likely that the hull was fitted with thole pins and rope to secure the oars.

The oars have a longer loom than the paddles since the blade needs to enter the water at an angle of attack (Caplan, Coppel and Gardner, 2010: 2–4). The oars represented in the iconography are often too short, but the mechanical requirements of rowing suggest that this may be attributed to artistic constraints. Angkorian oars can be described as Macon style, that is, the blade is symmetrical and its top side is flared. The throat of the oar may appear with no decoration, a ring decoration/junction, or with a ridge that extends into the blade (PL. 54). The length of the oars means that rowing boats would have had difficulties operating in narrow spaces. Areas with too much vegetation would also have been a problem, as tree roots and branches can get entangle with the oars and pin the rowers against the boat. This may have been problematic for a region that is characterized by flooded forests (see chapter 5). Although rowing appears prominently in Angkorian iconography, nowadays this propulsion method is not used in Cambodia.

Like paddling, rowing requires a high degree of synchrony and coordination; applying different forces on the blades can be used to steer the boat, but if done while moving forward the boat veers off course. While rowing calls would have differed from paddling calls, as oars and paddles exert forces at different angles, the coordination and training for rowing boats would have similar requirements/solutions and the same investment in human resources than those of paddling.

[75] For a discussion on the mechanics of rowing and the forces applied during the process see Cabrera, Ruina and Kleshnev (2006).

Sailing

Four of the dugouts of Angkor have square-shaped forms that have been identified as possible sails (see Paris, 1941: 346, 350, 354). In BY-IG.V the three boats have these sail-like features in the fore and the aft with riggings attached, but their size is small and paddlers are used at the fore and aft (Paris, 1941: 350). In the dugout of the lower section of BY-SW.III, the sail is also very small and can be found at the fore (Paris, 1941: 346). The size of the sails contrasts with the more realistic sails depicted in the plank boat of BY-SW.III and BC-EG-SW.I (see PL. 55), so it is possible that these were not sails, or that the Khmer artists did not consider them too relevant. Nowadays sailing boats are rare among traditional boats in Cambodia (Groslier, 1921: 112).

Steering mechanisms in dugouts

The dugouts of Angkor are usually steered by paddles, but when full lines of paddlers are used to propel the boat (PL. 57), or when the boats are rowed (PL. 58), rudders are fitted into the watercraft (Paris, 1941: 354). These are usually outboard rudders with tillers attached to the looms (PL. 58), although in some cases the rudder is only an oversized paddle without a tiller (PL. 59). The blades of the rudders show great diversity in form. Some have the same symmetrical leaf-shape blade as the paddles, while others have been adapted to the requirements of the rudder (PL. 60). These are usually cleaver-style blades with a narrow neck and a larger body, though some times the edges of the blade are round and in others they are hard. This suggests that the technology was in development and that the form of the rudder had not yet reached a unified design.

There are no hints in the iconography as to the system used to fit the rudder to the hull, but Paris (1941: 342-343) and Gibson-Hill (1952: 120) have proposed that the system would have been similar to the one used in boats of the Gulf of Thailand. This system uses a robust V-shaped pin placed on the stern and secured with horizontal beams; the rudder is then placed

on a rope that is tied to a transverse wood between the two arms of the pin (PL. 61). Nonetheless, there is no trace of this system in Cambodia nowadays; many of the boats do not have rudders, but those that have are now axial (PL. 62) or very small and fitted to the side of the hull through a protruding pin (PL. 63), but in some cases paddles are fixed to the hull using a single arm pin and a rope (PL. 64). This system is also widely spread in Vietnam (Pham, Blue and Palmer, 2010: 269), so it is possible that instead of using the system described by Paris and Gibson-Hill, the people of Angkor used a simple wooden pin and a rope to secure the rudder to the hull. Similarly, it should be considered whether the dugouts had double lateral rudders, a common feature of Southeast Asian ships (Manguin, 1980: 272) that is also present in the Thai royal barges (PL.65).

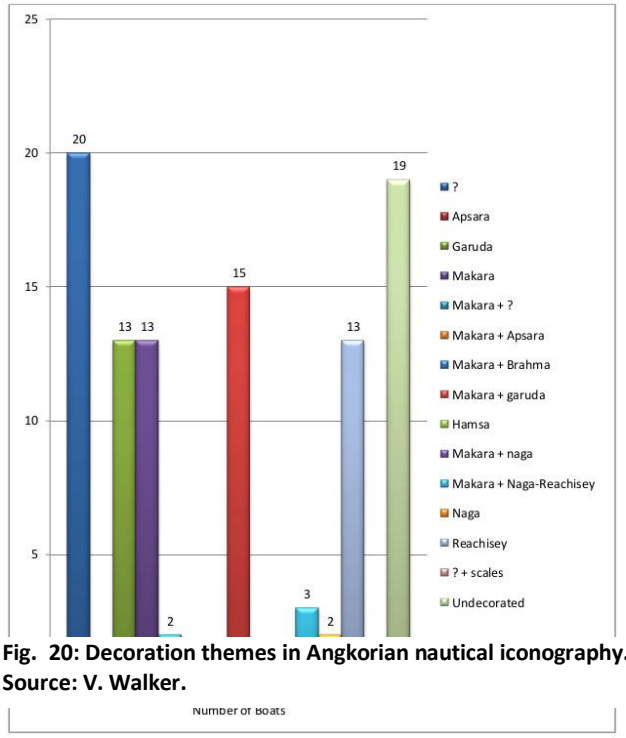


Fig. 20: Decoration themes in Angkorian nautical iconography. Source: V. Walker.

There are two instances where the helmsman is standing up and has his legs close or around the loom of the rudder while holding it with a tiller (PL. 66). In both cases there are no paddlers or rowers depicted so it is unclear whether the standing helmsmen represent a different kind of steering or another propulsion system (i.e., single-oar sculling or push-rowing).[76]

Decoration, pavilions, platforms, and awnings in dugouts

Of all the boats of Angkor, 87 are decorated and only 19 are undecorated. The main decorations are zoomorphic: the head and the tail of the animal respectively decorate the bow

[76] Single-oar sculling or push-rowing standing up are techniques known in present-day Vietnam (Pham, Blue and Palmer, 2010: 269), but the details in the iconography are not clear enough to come to a satisfactory conclusion.

and the stern. The most common types of decoration for the bow are *makara*,[77] *garuda*,[78] and *nâga-reachisey,*[79] but there are various combinations of these and other elements (Fig. 20). Additionally, some of the boats have the top sides decorated with filigree-like patterns (PL. 67).

The decorations of Angkorian dugouts were clearly sculpted in wood judging from the iconographic data (Groslier, 1921: 109) and likely gilded and/or painted (Jacq-Hergoualc'h, 2007: 135), but since no remains of these boats have been found to date ethnographic data can be used to theorize on how these elements were incorporated into the hull without disrupting its balance and flotation. As mentioned earlier, if the walls of the boat were left uneven the boat would tilt and veer to the side. It seems unlikely that the boat builders would risk carving the decorations onto the hull directly first, because any mistakes may have resulted in an unbalanced boat and corrections may have been limited by the material, and second because the size and position of the decoration would have been constrained by the width of the log. The latter does not correspond with the images in the iconography, where the decorations are considerably large.

The best ethnographic analogy available is found in the Thai royal barges. The decorations in these barges are made independently and then they are incorporated into the hull. The figureheads are sculpted stemposts fitted into the hull using iron clamps and nails (PL. 68). This is similar to the technique used to attach the stempost to the expanded dugout mentioned earlier, although the weight of the figurehead and its upright position would have made the use of iron clamps inevitable. The sternposts are sculpted as tails and have a wooden tang that

[77] A *makara* is a hybrid mix of crocodile, fish, tapir, bird, and elephant that is very common in Khmer architecture (Roveda 2000: 75).

[78] A *garuda* is a mythological bird that represents birth, ambrosia, and heaven (Roveda 2000: 76).

[79] A *nâga* is a serpent from the Hindu mythology, the *reachisey*, is a mythical creature of the Khmer pantheon associated with water that has a head of a lion, a small trunk-like nose, and is covered in scales. Although it seems to have common features with the *gajasimha*,[79] it is thought to be a mutation of the *makara* (Roveda 2005: 209). The *nâga* and the *reachisey* are hard to tell apart, as they both sport clenched teeth (see chapter 7 for a discussion on its contextualized use).

is fitted to the dugout and fastened also with iron clamps and nails (PL. 69). Decorations designed to be placed on the hull are carved into thin strips of wood and nailed to the hull (PL. 70). Elements like the eyes or the ears of the hull decorations are sculpted and project outside the plane of the hull to give a more realistic impression of the animal. The hulls of the Thai royal barges are completely painted, and the decorations are painted and gilded, with some sections being encrusted with crystals (PL. 71).

The overall effect is as impressive today as it was in the 17th century when Ribadeneyra described the boat of the Thai king:

> "[…] Later arrived the king in a big boat that considering its figurehead it looked like a heron that, with its wings open, came flying. Adorned with so much gold, that the oars[80] and the boat were gilded, and since there were many rowers[81] and the boat was light, it seemed like it came flying" (Ribadeneyra, 1601: 164).

The decoration of the barges were linked to the rank of the user since at least the 17th century: those belonging to high ranking officers had a small central pavilion, while painted and gilded barges were reserved for the two chief ministers (Gervaise, 1688: 213). The king could gift such a boat to a high ranking officer, but in that case the boat could only be used under exceptional circumstances (Ibid.: 96). In a highly hierarchical society like that of Angkor, where insignia were ascribed to people according to their rank,[82] it would be surprising if the decorated barges were not similarly regulated.

The decorated dugouts involved in non-military activities have central pavilions made out of carved wood (Parmentier, 1914: 7; Groslier, 1921: 112). These are raised on a tall dais with decorations that resemble the ones in Angkorian temples (PL. 72) (Parmentier, 1914: 7); they may have a single room, or may come with two adjacent rooms (one on each side). Thick

[80] The literal translation for "*remo*" is oar, but since the engravings that accompany the later publications show mostly paddlers, and currently only paddles are used in the Thai royal barges, it is most likely that he is referring to a paddle.
[81] Once again, the literal translation of "*remeros*" is rowers, but he is probably referring to paddlers.
[82] See Zhou Daguan's chapters 2, 3, and 4 where he discusses the different residences, clothing, and insignia (palanquins and parasols) ascribed to different ranks (Harris 2007: 49-52).

columns sustain wooden roofs, all of which are elaborately carved. The solid wood structure of the roof suggests that the structure was very heavy. Since part of the weight would have been in the roof, keeping the centre of gravity would have been a challenge for Angkorian boat builders. For a boat to have transverse stability and remain upright, the centre of gravity has to remain below the metacentre,[83] but when a heavy load is placed high on a boat the centre of gravity increases and renders the boat unstable (see Steffy, 1998: 9). The dais could have served to act as a counterweight to the heavy roof and provide stability to the boat. Placing the structure amidships would not only take advantage of the maximum width of the boat, it would also contribute to keep the longitudinal centre of gravity.

In the Thai royal barges, the structure is constructed independently and then placed on the deck. The roof in some cases has tiles and in others it is composed of an iron frame and covered by a silk canopy (PL. 73). A cabin that belonged to a royal barge from at least the early 20th century is exhibited in the National Museum of Phnom Penh, and shows that it was made as an independent structure. Two thrones from the late 19th century kept at the same museum show great similarities with the dais used on the decorated boats (PL. 74). It thus seems probable then that the pavilions of the royal barges were made in a similar way.

Zhou Daguan mentioned that the boats of Angkor had awning made from palm leafs held down with areca wood (Harris 2007: 78); but this feature is not depicted in the iconography. It is likely that Zhou Daguan was describing the awning of the common watercraft. Keeping a roof on board would have been particularly useful for long travels, as it would have protected the people on board from the heat and the rain (Groslier, 1921: 112). The use of boats as houses are commonplace in the whole region, so roofs would have necessarily been used by people whose main living arrangement (temporal or permanent) was the boat. In

[83] a point located at the intersection between the centreline of the hull and a vertical line that passes through the centre of buoyancy (Steffy, 1998: 9).

contemporary Cambodia the awning is made with a light wooden frame that is covered with palm leafs (PL. 75).

There are only three instances of a structure or platform placed at the stern or the bow. One is at the fore of a war vessel (PL. 76), and one at the aft of each of the two Angkorian flagships (PL. 77). These structures are placed directly on top of the stern or the bow, and are of small size. The function of these platforms is unclear; in Thailand smaller pavilions are used to transport relics (Chandavij, 1995: 154), so it is possible that the aft platforms were destined to transport regalia/relics since they appear in two Angkorian flagships. The platform on the fore, on the other hand, seems to be linked to military purposes (i.e., getting a vantage point). While these platforms do not seem to be part of the boat's functional appendages, placing a heavy load on the end of a dugout (i.e. a heavy stem or sternpost, a heavy platform) would have required that similar weight was placed on the opposite side to act as counterbalance. Therefore, Angkorian boat builders would have needed to maintain the boat's longitudinal flotation line in check and use counterbalance weight in order to prevent the boat from trimming.[84]

Hull design

After discussing boat-building construction it is now time to reflect on hull design in Angkorian dugouts. Small and medium-sized vessels depicted in the iconography have hard keels and low-raised bows and sterns that are slightly raked (see Table 3 in the Appendix and PL. 78), a form that is also present in the Angkor Thom and the Kra Raleung boats (PL. 34,35). Larger boats, however, are represented with round or hard keels. In total, there are 59 boats depicted with hard keels and 24 boats with round keels.

[84] It is said that a boat has a trim when the longitudinal centre of gravity is displaced and the boat tilts to the fore or the aft.

When Paris first discussed the boats of Angkor in his seminal paper of 1941 he compared the form of the hulls to that of a coastal vessel known as the *rua chalom,* and concluded that 52 of the 60 boats that he recorded could be identified as such (Paris 1941: 353). The *rua chalom* is a type of shell-built boat widely documented in the Gulf of Thailand (see Warington Smyth, 1906: 369–376; Gibson-Hill, 1952: 118–121). It has a shallow draft, a hard keel, and a round bottom; the hull has a plank-keel, rabbeted stern- and stem posts, and strakes are joined together edge to edge using pegs, whilst the ribs are set with iron nails (Warrington Smyth, 1906: 369; Gibson-Hill, 1952: 119). The stern is nearly vertical to the water, whilst the bow is raked at a steep angle. The *rua chalom* is usually fitted with one mast on which a high-peaked lugsail is placed, although some larger samples use two masts with Chinese-style rig. Sail propulsion was combined with rowing, which was done standing up and facing forward (Warrington Smyth, 1906: 370-371). According to Pietri, this type of boat is also known as *touk chaleum* in Cambodia and in the first half of the 20th century users of these boats were mostly people of Khmer-Chinese and Thai-Chinese descent from the coastal regions (Pietri, 1949: 29).

The identification of the boats of Angkor as *rua chalom* was problematic for Paris from the beginning since he was convinced that the former were hollowed out logs; however, he found it difficult to reconcile the hard keels of the reliefs with the contemporary boats of Cambodia, which have a round keel (Paris, 1941: 341). He concluded that the construction technique of the *rua chalom*, without a true keel and using a stern- and stem posts, necessarily evolved from a dugout (Ibid.). This theory, he thought, was strengthened by the Angkorian use of a lateral rudder in similar fashion as the one used in the *rua chalom* (ibid.). Gibson-Hill strongly opposed this idea, adducing that the identical plain high stern- and stem posts represented in the war vessels did not look like the *rua chalom* at all (Gibson-Hill, 1952: 122). He argued that these resembled more closely the *perahu payang* and the *perahu buatan barat* of the northeastern Malay states (Fig. 21), although he agreed that the lateral rudder used in Angkor was similar to the one used in the *rua chalom* (Ibid.). Based on the similarities between the

enemies (identified as Cham) and the Khmer, he proposed a double ended Cham-Khmer boat type with high stern- and stem posts. Since he considered the Cham to be more of a maritime community than the people of Angkor, Gibson-Hill proposed that the boats of Angkor were of Cham origin (Gibson-Hill 1952: 127).

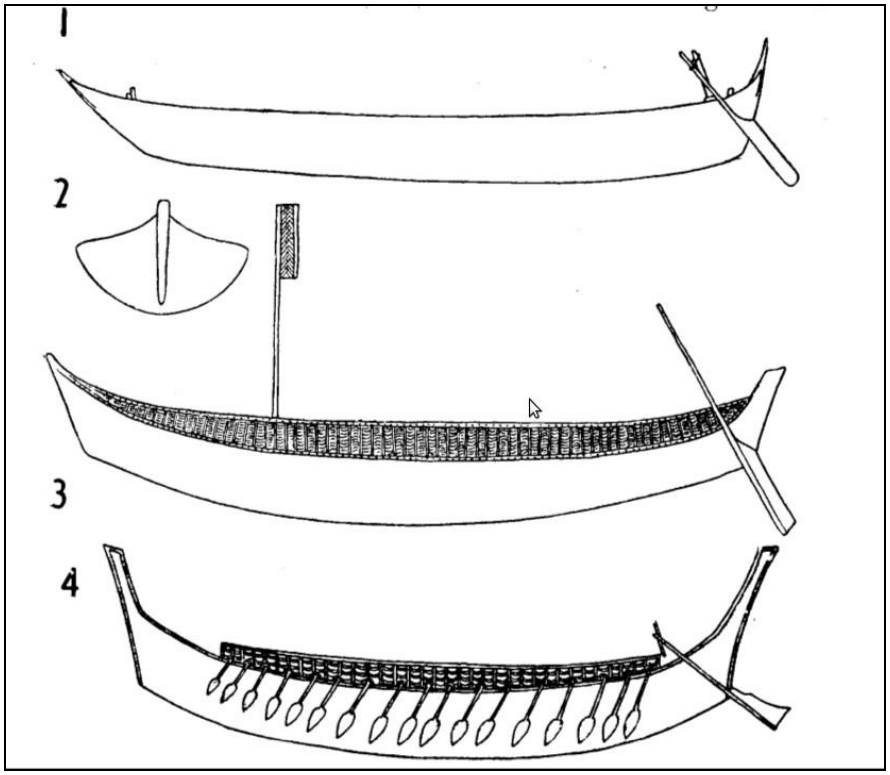


Fig. 21: outline of the boats of Angkor discussed by Gibson-Hill. 1) and 2) show the hull design of the rua chalom, 3) depicts a foreign undecorated vessel of the Bayon, and 4) enemy war boats with high stern- and stem posts. Source: Gibson-Hill 1952.

I agree with Paris (1941: 338) that the absence of parallel lines in Angkorian vessels except in three instances (BY-IG.V), which can be attributed to expanded dugouts or decoration, precludes the theory of these being plank-built boats, which the *rua chalom*, the *perahu payang* and the *perahu buatan barat* are. The hard edges of the hull design, which was one of the issues raised by Paris (1941: 341), can be achieved in the carving process as has been documented in the Angkor Thom and the Kra Raleung boats (PL. 79B-79C) and demonstrated in experimental archaeology (PL. 79). The large boats depicted in the iconography could be made expanding a broad dugout keel. The fact hard edges are nowhere to be found in

contemporary Cambodia should lead to discussions on why this change happened instead of ascribing a foreign origin to the boats of Angkor given that construction techniques in Angkor and nowadays are very similar. Hard keels are in fact found in Cambodian dugouts but they are covered by stemposts that give the boats their distinctive final round shape (see above). Hence the alteration to the form seems to be connected to decorative appendages that eventually altered the design of the typical Cambodian hull.

Regarding a possible Cham origin of the boats of Angkor, archaeological evidence points to an early use of the Mekong River basin for transport, with important settlements from the pre-Angkorian period located in key trans-shipment places (see Chapter 5). It seems unlikely, therefore, that the Khmer would not have developed their own nautical traditions, and that they would have relied on technology and designs from the Cham. Technology transfer likely happened (see discussion on plank-built ships below), but the continuity of nautical traditions in Cambodia that can now be demonstrated through the archaeological record suggests a strong adherence to local practices, which is in line with the homogenous character of Khmer culture, religion and character proposed by Groslier (1973b: 372).

6.2. Rafts and pontoons

In his analysis of the reliefs of the Bayon temple, Groslier interpreted a structure over water as either a pontoon bridge or a raft used by soldiers and elephants (1973a: 163). Groslier considered that the circular depictions of the bridge were bundled bamboo in cross-section and suggested that there were wooden planks attached by ropes (Fig. 21). Groslier was puzzled by the bridge; he thought there was no need to construct them for the rivers in Khmer territories because they could be waded across, and was sceptical about the possibility that such infrastructure would be constructed across the Mekong or the Tonle Sap (ibid.). Roveda revisited the topic in his 2007 re-interpretation of the reliefs and attributed to Groslier the idea that the construction was “flimsy”, though Groslier did not make any comments in this regard.

Roveda suggested that it was possible that the pontoon bridge could be one of a series of rafts used to transport soldiers and elephants across a river (2007: 351).



Fig. 22: Pontoon used to cross a river. The bundled bamboo is represented in circles. Source: EFEO.

Their reservations as to the sturdiness of these structures are unfounded if historical accounts are to be trusted. As discussed in chapter 5, the Khmer were capable of building two pontoon bridges over the span of the Tonle Sap River in just a couple of days in order to cut off the retreat of VOC ships (Van der Kraan, 2009: 53-57). They did this to prevent passage along the river by the Dutch VOC merchant fleet that had been waiting to see the Cambodian king in Oudong, upstream Phnom Penh, to protest against the killing of members of the Dutch VOC Company in 1642 (see Van der Kraan, 2009). Consequently, the reasons behind the construction of such bamboo pontoons could be both to allow and to block access. It took twenty five Dutchmen three hours to cut through the bamboo and the planks of the pontoons to free their ships from the trap (ibid.: 57). So even though the Dutch were under extreme duress, they were being shot at from the riverbank, it shows that the bamboo structure was well built.

If we took the iconography literally, it would seem that the pontoon was built with planks set on transverse bundles of bamboo. However, ethnographic data shows otherwise (Fig. 23). Pontoon style bridges in Kratie are constructed using two floats of bundled bamboo topped by planks that sit on top of cross-beams. The bamboo bundles are extended by overlapping sections tied together by rope or cable so that it can be built over the width of the river; the cross-beams are tied to the floats and the planks are laid over them to create the platform – these seem to be placed edge to edge but the ends are overlapping on top of cross-beams. These lengthwise bundles seem to strengthen the structure and provide it with considerable flexibility and stability. The additional benefit of this pontoon-style bridge is that the platform would adapt to the water's depth as it raised or lowered depending on the season, but navigation would be blocked.

Likewise, rafts would have been made using the same technique and used for structures that required stable platforms such as floating houses, wharfs or jetties. These rafts were probably punted with poles, but they would not have been easy to manoeuvre. The examples provided here use only two floats, but there is no reason why the number of floats could not be increased when necessary both in rafts and pontoons (i.e. to accommodate broad cargo such as an elephant or large stones). Although it is possible that the iconography is depicting an alternative or earlier construction technique, it cannot be discarded that the cross-section is an artistic convention to represent the floats.



Fig. 23: Pontoon-style bridge and bundle raft in Kratie 2015. Source: K. Finn.

6.3. Planked ships

There are two depictions of sailing ships built with planks, one in Banteay Chmar and another one in the Bayon temple. Both of them are adjacent to naval battles and appear to be part of them, as will be discussed in what follows.

The plank vessel of Banteay Chmar

The sailing vessel of Banteay Chhmar appears on the right side of the naval battle scene (Fig. 24). Though noticed by Parmentier in his initial description of the temple (1910: 209), it has been largely ignored. The vessel has clear indication of planking in the form of parallel lines on the hull. The bow is decorated with a *makara*, and the strakes overlap the stern post. Although the upper section of this bas-relief is not very clear, there seems to be two large square sails possibly made of rattan.[85] The boat has an overboard rudder governed from an elevated platform constructed in the aft. There is a dais running three quarters of the length of the vessel from the fore, and the vessel has twenty five people on board. There is no railing, so even though it looks sturdy enough to be a coastal or sea-going ship the crew would have found it difficult to protect themselves against high waves.[86]

The building tradition of the Banteay Chmar vessel is characterized by the overlapping strakes at the stern. This tradition is not present in contemporary Cambodia, but this technique is known in other places like Vietnam and Burma. This type of craft has been documented in central and southern Vietnam (Pham, Blue & Palmer, 2010: 268-270), but it seems that the presence of this type of craft in the south may have been a result of mass migration of

[85] The author is very grateful to Christophe Pottier who spotted the sails and shared his observations in personal correspondence.

[86] To get an idea of the sturdiness that this ship may have had, there is an example of a riverine craft documented in Burmese waters in the late 19th century that could be used for comparison (PL. 81). These were riverine boats with a hard bow, vertical stern, and a detachable bipod mast used to carry rice to Rangoon on the Irrawaddy River (Smith, 1905: 74–77). When unloaded, these boats have an extremely shallow draft, and when they are loaded the waterline is very close to the gunwales (PL. 82).

northern Vietnamese refugees who fled southwards after the French and the Viet Minh signed a peace treaty in 1962 (Brooks and Bui Quang Trach, 1962: AII-87).



Fig. 24: Drawing of the plank vessel in Banteay Chhmar. The upper section of the bas-relief is degraded but two square sails seem to be depicted. The lower section of the rudder is not visible. Source: V. Walker.

The Junk Blue Book has identified five types of vessels that use this construction technique of overlapping planks (Brooks and Bui Quang Trach, 1962: AII-81). These vessels are shell-built and are characterized by a broad flat stem with the side planking overlapping and extending ahead of the stem (Ibid.). The cross section of the boat is characterized by a chine.[87] The stem and stern are set in place using exterior timbers, while side and bottom strakes are warped to the desired shape over a fire. Once the strakes are added to the chine, the stern, and the stem, frames are added inside and the external supports are removed (ibid.).

The overlapping strakes are eventually trimmed to follow the curve of the hull (Fig. 25). These vessels have axial rudders that are inclined 45 degrees toward the aft when it is fully extended, but it can be set at different heights using wedges. The NTBC-1 type is particularly interesting

[87] The chine is a sharp change in angle in the cross-section of a hull.

because of the unusual daggerboard[88] placed in the fore (Ibid.: AII-78).[89] These vessels are used for coastal and river transport, but they can also venture to the sea for up to three days in a row without loosing sight of the coast line (Brooks and Bui Quang Trach, 1962: AI-8-9, AII-84).



Fig. 25: Detail of the bow (above) and stern (left) with overlapping strakes from southern Vietnam. Source: C. Palmer in Pham, Blue & Palmer 2010: 270.

Nonetheless, almost twenty years prior to the migration Poujade documented the presence of a type of vessel in the Rach Gia area in Southwestern Vietnam (close to Cambodia's coastal border) that also had overlapping planks attached to the stern- and stem posts (Poujade 1946c). According to Poujade, these coastal sailing boats are clearly developed from extended dugouts, with solid stern- and stem posts to which overlapping planks are nailed (Ibid.: 5-6). The Rach Gia vessels are decorated with eyes on the hull and painted bows and sterns, thought Poujade reckons they may have been fully painted in earlier times (Ibid.: 14). The masts and sails used by this type of craft is similar to the Ca-Vom and other fishing vessels of Cambodia (ibid.).

[88] A daggerboard is a retractable centreboard that slides in a casing. This element is used by sailing craft to grip de water and avoid being blown in the direction of the wind.

[89] For a discussion on the development of the daggerboard in Southeast Asia see Spennemann, D.R. 1984. Some critical remarks on the boats depicted on the Southeast Asian kettledrums: an assessment of the daggerboards. *International Journal of Nautical Archaeology*, Num. 13, Vol. 2, pp. 137-143.

In Burma, this type of construction technique is found nowadays in the Kaladan River (PL. 80). The tramson stern[90] is overlapped by the strakes mounted on a horseshoe frame, the upper strakes are floating, and in some instances the top strake is tied to the strake on the opposite side. The absence of this type of boat design (in form and in construction technique) in the inland waters of Cambodia, and the presence of people with distinctive headdress and clothing that differs from those normally attributed to the Khmer suggests that this plank vessel is of foreign construction. Judging by the depiction of the stern, it seems that planks are overlapping and trimmed in a specific way as part of the vessel's stern decoration. Although nautical construction techniques with overlapping strakes can be found in vessels from northern, central and south-western Vietnam, as well as in Burma, further archaeological data is required to evaluate these possible connections.

The migration of this type of boats from the north to the south of Vietnam in the 1960s highlights the problems that arise with the use of ethnographic material and ascribing a specific type of construction technique to a region without a link to archaeological evidence. The presence of overlapping strakes over the stern- and stem posts in south-western Vietnam raises many questions regarding the evolution and distribution of this type of construction technique, but does not offer any immediate solution to the problem presented by the iconography.

The decoration of the Banteay Chhmar vessel's bow with the head of a *makara* raises further questions, as many boats of Angkor have similar decorations. However, the form is hardly unique to Angkor, and many examples of sculptures and bas-reliefs from neighbouring regions such as Champa depict the same creature in a similar style. However, the headdress and clothing of the main character on board and his retinue is very different from the headdress usually attributed to the Cham and the construction technique seems to be more in tune with

[90] A tramson stern is characterized by a flat surface that makes up the back panel of the stern and is made of beams that run side-to-side.

North Vietnam than with Southern Vietnam. Hence, there is conflicting data that undermines any meaningful interpretation of the boat without incurring in too much speculation.

The only thing that can be said without any further evidence is that the bas-relief represents a type of sea-river vessel used in the Mekong Delta and the coastal regions of present-day Vietnam that was used by foreigners to travel to the Angkor region. While the construction technique shows different approaches to the processing of material for boat construction, the *makara* decoration suggests that the culture where the vessel originated had shared cultural traits with the people of Angkor in terms of the mythology that surrounded ships and their relation to the water spirits or gods (a longer discussion on *makara* decorations can be found in chapter 7).

The plank vessel of Bayon

Much has been written about this sailing vessel (Fig. 26), whose origin is still a matter of debate between scholars who think it is a local ship or at the very least a hybrid vessel with mixed Southeast Asian and Chinese features (Poujade 1946b; Gibson-Hill 1952: 127-128; Manguin 1984: 202; Porée-Maspero 1986: 74-76) and those who have interpreted it as a Chinese ship (Groslier 1921: 113-114; Paris 1952: 267-278; Needham, 1971: 460-463; Groslier 1973: 164-165; Green 1997: 7-9; Roveda 2007: 351).

The sailing ship is plank built with a deeper draft than the rest of the boats represented in Angkorian bas-reliefs. The rigging is clearly of the Chinese style (Needham, 1970: 461; Manguin, 1984: 202), while the narrow pointed stern seems to imply a Southeast Asian design (Manguin, 1984: 202). Needham wanted to see in this representation a transom bow typical of the Chinese flat bottomed sailing ships (1971: 461), but I agree with Manguin (1984) and Poujade (1946a) that the lines of the relief resemble more closely the stem post of Southeast Asian ships. Poujade suggested that the steering apparel represents a quarter rudder hanging from the aft castle, a view supported by Manguin (1984) and Porée-Maspero (1986: 74–76).

Needham dismissed this claim by asserting that the image depicts an axial rudder, attributing the reversed position of the blade to artistic convention (Needham, 1971: 461, 648), but Manguin argues that the quarter rudder could assume this position and is therefore more likely to be of this type (Manguin, 1984: 202). The anchor is clearly seen in the bow connected to a pulley (Groslier, 1973: 113), its form – made of wooden arms and stone – was discussed at length by Poujade (1946b: 14).



Fig. 26: Outline of the plank vessel in Bayon temple. Source: V. Walker.

The arguments presented by Needham of the ship being purely Chinese preclude the possibility of complex interactions between Chinese merchantmen and Southeast Asian shipbuilders, and ignores both ethnographic and historical data that points to a fluid environment where technology transfer likely happened. Manguin has brought forward compelling archaeological and historical evidence that indicates hybridity was the norm and not the exception in the South China Sea from the coasts of Fujian to the shorelines of Indonesia and Thailand (1984, 1993). Before arriving to this conclusion, Manguin had hypothesized that the Southeast Asian ships had influenced the development of the Chinese trading vessels after the 8th century CE based on historical descriptions of what the Chinese

accounts called the *kunlun bo*,[91] large Southeast Asian merchant ships that traded in Chinese ports as early as the 3rd century CE (Manguin, 1984: 200-201; 1993: 261-264). This *kunlun bo* impressed Chinese writers for their size (Manguin, 1980: 274-276), and it is though to have been mentioned in the mid 1st century CE Greek text Periplus of the Erythraean Sea as *kolandiophonta,* a likely corrupted form of the *kunlun po,* a very large ocean-going ship that traded between India and Southeast Asia (Needham, 1971: 460; Paine, 2013). Manguin postulates that the hybridization of Chinese and Southeast Asian nautical technology was likely a result of commercial interactions between the peoples of Southeast Asia and the Chinese, especially as the latter settled in relevant harbour-cities of the South China Sea from the Song dynasty onwards (Manguin, 1984: 201).

From an ethnographic perspective, Poujade suggested that the Bayon ship shared many similarities with the "Chinese junks of the Gulf of Thailand" that he had recorded in Kampot, coastal Cambodia (Poujade, 1946a: 16–18), pointing out to hybrid aspects of the representation such as the quarter rudder (Fig. 27-28). Gibson-Hill argued against attributing these trading vessels to the Chinese, preferring to use the local term Wangkang instead (Gibson-Hill, 1952: 128). According to him these boats were between 15 and 24 m long and were constructed by Chinese migrants (Ibid.: 121-122). The construction technique shared many similarities with the rua chalom, particularly in regards to the bow (Ibid.). However, he posited that if the Wangkang were Chinese, it was most likely by adoption and not by design, arguing that the Wangkang were likely of local design but adapted for use by Chinese seamen (Ibid.: 128).

Gibson-Hill also noted that this was not an isolated phenomenon, as other vessels of European design – the *tongkang* – had also been assimilated by Chinese merchantmen (1952: 128). Based on this analogy, he postulated that the vessel in the Bayon represents an early example

[91] Written in Needham as *Khun-lun po* (1971: 460) and in Manguin as *k'un-lun po* (1980: 274-276).

of the Wangkang that was eventually taken over by the Chinese merchantmen who settled in the region (Ibid.). The *Rua Ta*, a vessel with the distinctive overhanging stern castle similar to the Wangkang was described by Warington-Smyth as being extensively used in the Gulf of Thailand and the Chao Phraya River and suggested a Cambodian origin (1906: 377).

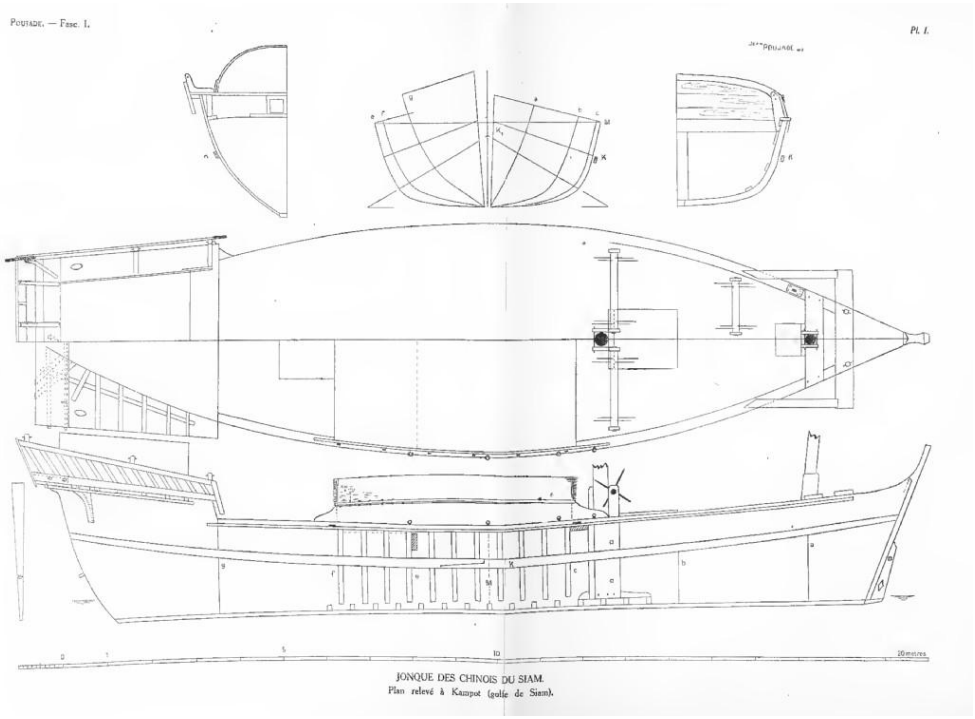


Fig. 27: Plan of a Wangkang vessel or Gulf of Thailand trader from Kampot. Source: Pouade (1946a).

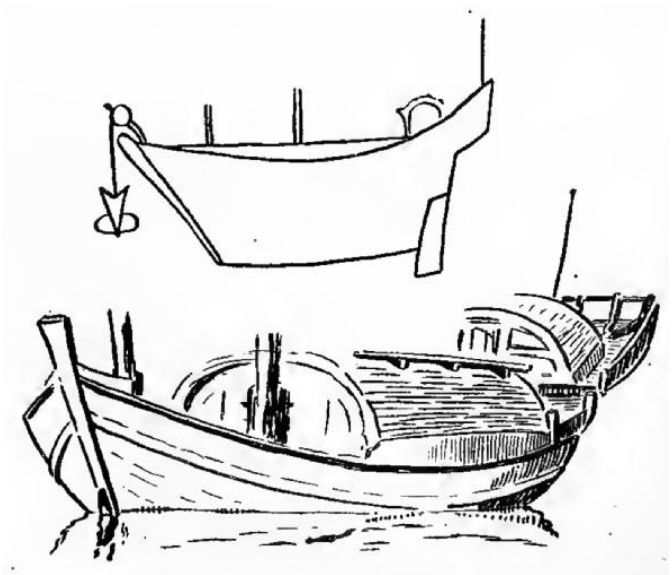


Fig. 28: Comparative drawing of the Bayon vessel and the Gulf of Thailand trader. Source: Poujade (1946a)

The arguments brought forth by Poujade, Gibson-Hill, and Manguin to support their identification of the Bayon ship as an early Wangkang are more compelling than the one presented by Needham, especially since the majority of the shipwrecks found in the South China Sea present mixed features that differ from what is considered to be pure Chinese or Southeast Asian (Manguin, 1993: 270-271).

Other shipbuilding techniques

Regardless of whether the Bayon ship was a Wangkang or a Chinese-built vessel, Zhou Daguan's description of his trip to Angkor leaves no doubt that sea-going ships were travelling from overseas into the Mekong Delta transport zone (see Uk & Uk 2016: 1). Spanish sources corroborate that ships from all around Southeast Asia, China, and Japan could be found in the Mekong River (Dusmet de Arizcun, 1927: 19, 23, 35-36, 55, 58-59), information that is also mentioned by 17th century Dutch VOC accounts (see Van der Kraan, 2009). Furthermore, the Selden Map of trade routes between Southeast and East Asia clearly marks Cambodia as a port of call and places it upstream the Mekong River (Batchelor, 2013: Fig. 1-2). [92]

As an international trading hub, sea-river transit points like Kompong Chhnang and Kompong Cham (Prei Nokor) would have received these foreign ships, so it can be assumed that the people of Angkor would have been aware of the existence of a wide variety of construction techniques such as the sewn-plank and lashed-lug vessels of Insular South-East Asia prevalent during the first millennium CE, the Southeast Asian trading jong, the hybrid "South China Sea tradition", and the Chinese traditions of the second millennium CE (see Manguin, 1993), and perhaps even the Arab sewn plank ships that have been documented in the Belitung wreck in Indonesia (see Flecker, 2001) and, more recently in the Phanom Surin wreck in Thailand (see Komoot, 2014). So even though the iconographic data does not offer a wide range of shipbuilding techniques, the role of Angkor (via Kompong Chhnang or Kompong Cham) as a

[92] The Selden Map of China (MS Selden Supra 105) is a c. 1619 map depicting Chinese shipping routes to East and Southeast Asia. The map was incorporated into the Bodleian Library in 1659, and subsequently rediscovered by Batchelor in 2008 after it had been kept in storage since 1919 (Batchelor, 2013).

port of call during its existence necessarily involved the arrival via the Mekong Delta Transport Zone of sea-going and coastal vessels from different shipbuilding traditions.

6.4. Conclusion

This chapter has discussed the technological solutions available in Angkor that allowed people to move across the Mekong River basin. The most prevalent type of watercraft in the iconography is the dugout (or extended dugout) with hard keel, although during the 12th and 13th century the round keel was also in use and eventually took hold in Khmer culture. The dugout was probably, as nowadays, the dominant vessel of the Tonle Sap basin Transport Zone, where beams could be broader, and the Sambhupura Transport Zone, were beams were likely narrower to face the currents and the rapids of the region (see chapter 5). Bamboo frames around these boats would have prevented direct impact with the rocky bottom of that section of the river, but since this frame has only been documented in the 19th century (see chapter 5), it has yet to be demonstrated whether it was also used during the Angkor period.

The incorporation of heavy stem and sternposts in the decorated boats, as well as wooden pavilions, are indicative of the mastery of the Angkorian boat builders and their ability to maintain boat stability. These decorated vessels were certainly used in the benign environment of man-made reservoirs, canals, the open waters of the Tonle Sap Transport Zone and perhaps up to the Kratie area, but the rapids of Sambor would have been a challenge for the boats' stability as the tall and heavy stem and sternposts would have contributed to destabilize the boats in rough waters.

The transit points of Kompong Chhnang and Kompong Cham (Prei Nokor) would have seen these riverine vessels redistributing cargo and people from ships arriving from overseas. Pontoon-style rafts or jetties would have been ideal structures for loading and unloading cargo, as they have good initial stability for this type of activities.

It is likely that local specialists were engaged in activities surrounding international maritime trade hubs such as piloting, towing foreign ships upstream, loading/unloading cargo, and redistribution of goods to Angkor. Piloting is a key skill in ports because the foreign crew of a ship would not have had the knowledge to bring the boat in safely, so experienced pilots would have been crucial for the functioning of the Angkorian ports. Towing larger sea-going boats could have been done by full lines of paddlers or by rowers, as both are depicted in the iconography and there are references to towed boats from the 17th century (Van der Kraan, 2009: 51). Similarly, loading and unloading cargo from/to a ship is a difficult task that requires understanding of boat stability. Another of type of specialization would have been undoubtedly the refitting of ships, which would have brought these specialists closer to the foreign ships and their shipbuilding traditions. As it has been seen, the ships arriving to Angkorian ports were of different shipbuilding traditions, all of them plank-built and carrying sails.

This is an important point to consider, because even though all the evidence suggests that the people of Angkor had knowledge of plank vessels, which arguably make a more efficient use of wood, the people of Angkor retained their traditional construction techniques based on the dugout up until the beginning of the 21st century. In fact, the iconography shows a direct correlation between the use of dugouts and Angkorian people, as there is not a single foreign vessel depicted in the iconography that is used by a local person. This is not to say that they did not use other kinds of ships, as going overseas would have required a sea-going or coastal vessel and there are references of Cambodian people using this type of watercraft in the 16th century (see Dusmet de Arizcun, 1927). However, the iconography does not reflect this outward journey, concentrated instead in local technology.

The strong cultural identity posited by Groslier (1973b) is therefore reflected in the nautical technology of the Khmer people, showing that adherence to boat building practices is deeply

intertwined with group identity. This adherence is not limited to boat technology, but also to wood processing; planks were chiselled even though saw technology would have been available at least through contacts with Chinese travellers, as Zhou Daguan pointed out (Harris, 2007: 78). This preference of chiselling tools also extended to house construction (Ibid.), so it seems that the way wood was processed was an intrinsic part of Angkorian culture.

This chapter has presented the technological approach to watercraft available during the Angkor period. As seen, boats are complex machines designed to colonize the aquatic environment, but whilst their function is often related to economic or military endeavours (Muckelroy, 1978: 216), the study of nautical technology and boat design should not be reduced only to function and technological phenomena (Adams, 2001: 307). The choices that influenced the construction processes are deeply entrenched in social ideas (Adams, 2001: 300; Blue, 2003: 334–338), and therefore it is important to contextualize boats (as objects) within their social interactions with people (Van de Noort, 2011: 38–39). Hence after looking at the ways in which people moved across the Mekong River basin from a technical perspective, the following chapter will discuss the social context that surrounded boats during the Angkor period.

Chapter 7

One day, Preah Pisnukar saw his father making a boat. When the boat was about to be launched, Pisnukar said: "Father, why don't you place the eyes of the boat inside?" To which his father replied: "If I do that, how will she be able to see in front of her and avoid crashing in the river?"

A tale of Preah Pisnukar, the divine architect.[93]

7. The cultural biographies of boats in Angkor

The two previous chapters have dwelt on the environmental and technological aspects of Angkor's relationship with its aquatic environment, but in order to understand Angkor's fluvial landscape the study has to turn now to the social context of creation, usage, modification, and ending of boats. Previous studies on Angkorian boats have centred on the functional and technical aspects of nautical construction (see chapter 3), subjects that have been reviewed and updated with new data in chapter 6. The context of usage for boats engaged in activities other than warfare, however, has been largely ignored. The aim of this chapter is to set a framework for the study of Angkor's fluvial cultural landscape by leading a contextualized study of boats. Following a similar study for objects was set forth by Gosden and Marshall (1999), this type of study proposed by Van de Noort (2011: 38–43) and Adams (2001) revolves around the analysis of the interrelationship between people and boats, and how the resulting dialogue generates the traditions that give form to maritime, or in this case, fluvial cultures.

With 34 contextualized nautical scenes depicting over 106 boats available for study, this analysis can be done in considerable detail (see Tables 1 and 2). In the following chapter the boats of Angkor have been divided into four biographical case studies based on context of use

[93] Adapted from Hoc (2001: 7).

and features of the watercraft. First, riverine watercraft will be discussed as the functional objects that allowed the people of Angkor to colonize the aquatic space for its resources (fishing, transport, and trade). Second, the chapter will consider the transformation of functional watercraft into zoomorphic vessels used in culturally charged activities where they act as liminal agents and are imbued with symbolic meaning. The third biography is centred on boats as war machines adapted to accommodate the needs of amphibious warfare and the system of Angkorian beliefs surrounding the use of aquatic spaces. The fourth case study moves away from riverine watercraft to explore sailing vessels and their role as conduits for interaction with overseas communities and the exchange of exotic goods.

7.1. The cultural biographies of boats

In his study of canoes and sailing in Panua New Guinea, Malinowski wrote: "a craft, whether of bark or wood, iron or steel, lives in the life of its sailors, and it is more to a sailor than a mere bit of shaped matter [...]" (1922: 80). To Malinowski, the emotional attitudes of people toward their craft were the motor by which to know what boats meant in the eyes of their users (ibid.: 81). This anthropological approach to the study of watercraft results in a more meaningful understanding of boats within their social context, but to reconstruct this for past societies is a challenge, as users are no longer available for questioning. An alternative way of studying the boats in their cultural context is by analysing the different elements that affect the life of boats. These can be defined as purpose, technology, tradition, materials, economics, environment, and ideology (Adams, 2001: 300–304). The purpose or function of a vessel is determined by the needs of a society, but their ability to deliver an efficient watercraft is constrained by technological advancements. Function and technology nonetheless exist within a tradition that embodies the idea of what a boat is and how it must be constructed, and thus boat construction is, above all, social practice (ibid.: 301–302).

As a product of society, boats are carriers of symbolic and ideological constructs that have been put in place to ensure best practice. Failure of boat design comes at great personal and material cost, and therefore it has been noted that boat builders exerted great caution in the introduction of new designs (Steffy, 1998: 8; Hunter, 1994: 263). However, as Adams pointed out, barriers erected by ideology are not immutable and are subject to human desire to refine and innovate (Adams, 2001: 302). Thus change occurs as a result of a dialectic process between the numerous factors involved in boat construction (Ibid.). Materials, economics, and the environment are some of these factors; the availability of materials, the resources involved in the processing of boats, and the constraints imposed by the environment limit the development of boat construction, and as a result, alterations to them can lead to changes in boat design (Adams, 2001: 303–304). But perhaps the most distinctive factor that affects boat construction is the ideological concept that determines what is a boat (ibid.: 304). In this respect, it is the bow and the stern where researchers have to turn to if they are to understand the philosophy that governs a society (Steffy, 1998: 11). These sections of a boat are probably one of the most prominent features in boat design, as they confer the visualization of what a society thinks a boat should look like. It also becomes an identifiable cultural trait that demarcates the boat–builders' adherence to a specific group, a display that is as much for those belonging to the same group as it is to those outside the group (Adams, 2001: 304). The production of boats is therefore entangled in multiple elements that affect the design of boats in different ways; however, it is "in the social aspects of life surrounding the production and use of ships that ideologies are played out and become most visible" (Ibid.).

By studying the boats of Angkor as part of fluvial material culture embedded in the nature–culture interaction debate it is possible to begin to understand the role of boats in Angkor's fluvial cultural landscape. The approach taken here is to look at boats as culturally constructed entities "endowed with culturally specific meanings, and classified and reclassified into culturally constituted categories" (Kopytoff, 1984: 68). This approach focuses on the dialectic

process that takes place between boats and people, and aims to discern how the former is redefined and used throughout its life time through the study of its cultural biography (ibid.: 66). As with any human being, the cultural biography of boats can be elaborated by looking specifically at the construction, use, modification, and demise of boats within their social context (Van de Noort, 2011: 38–43).

Processing iconographic data

The use of nautical iconography for the study of past maritime societies always challenges the researcher to balance hard data with post–processual approaches needed for interpretation (Flatman, 2007: 4–5). Although this kind of material has been recognized as an important source of data, serious concerns regarding the accuracy of the images were raised as early as the 1930s (see for example de Garies Davies, 1929: 29–42). The controversy surrounding the use of this type of source is still ongoing, with many discussions centring on the lack of technological accuracy of the images, the subjective interpretation of the researcher and the lack of comparative material.[94] The interpretation of nautical iconography is more often than not marred with speculation brought about by inappropriate methodology (Wedde, 1996: 121).

The key is therefore to reduce the amount of speculation by examining the material critically (Waschmann, 1998: 4–5; Wedde, 1996: 121). The study of iconography has been developed mostly in Art History theory and was spearheaded by researchers such as Panofsky (1962), and Gombrich (1968); however, a recent publication by Knight manages to merge these Art History theories with social science theories in order to provide a methodology for the study of iconography in a context where textual evidence cannot be used as correlating material (Knight, 2013). In his work, Knight emphasizes the need to stop searching for meaning in iconography, and start looking for referents. Images may have different meaning for the

[94] See for example Farrell, 1979: 227; Basch, 1987: 38–39; Wachsmann, 1998: 3–5; McGrail, 2001: 2–3; Flatman, 2007: 22; Rey da Silva, 2009: 9–14; Polzer, 2011: 349–378.

artisan who made it, for the person who commissioned the work of art, for the contemporary observer or for observers from later periods of time. This suggests that the meaning of iconography is multivalent and very difficult to extract with accuracy since it would take the researcher into unknowable domains such as religion or world view (Knight, 2013: 13). In turn, what an iconographic analysis should look at is the links between representational images and their referents in the real world, always aiming at a generic interpretation (ibid.: 3–5). It is therefore a matter of identification (Panfosky, 1962: 6).

Iconographic analysis thus focuses on relational connections between two or more different areas of research; one is undoubtedly the iconography and the other one is the thing/event that is being represented, which may have its origin in material culture, the environment, folklore, historical events, and so on (Knight, 2013: 3–5). As Wedde pointed out, there needs to be an internal analysis to extract repetitive information in order to postulate theories (2000: 16), but there is also a need to seek external referents to reinforce the ensuing narrative, be it in the archaeology (Flatman, 2007: 1–6), the ethnography (Farrell, 1979; McGrail, 2001: 2–4), or the texts. Based on Wedde (2000), Knight (2013), and Panofsky (1962), the approach followed in this research has three stages:

Stage 1: Creation of the corpus. This was compiled from a single culture and studied chronologically. The research material comes from a single genre (i.e. architectural decorations) and a single media (i.e. bas–reliefs).

Stage 2: Internal analysis. This was done through a pre–iconographic analysis, where relevant forms were identified, and an iconographic analysis, where scenes were clustered into groups that narrowed down the identification of the scene.

Stage 3: External analysis. This is the interpretive process that Panofsky calls the iconologic analysis (Panofsky, 1962: 15), where the data is compared with other sources, such as archaeological material, environmental data, historical accounts, and ethnographic data.

7.2. Utilitarian vessels

Of the 106 vessels depicted in the iconography, 16 are undecorated utilitarian vessels used in peaceful activities (see table 3). The majority of these vessels are small fishing boats used by commoners (10), others —also filled with commoners— are taking part in a festivity (4), and in two different scenes a small undecorated vessel is used by a court lady to pick lotus flower (see PL. 83–85).

Context of construction and usage

The technological aspects of boat construction were discussed in chapter 6, where a continuity in boat–building traditions was established between Angkor and contemporary Cambodia through archaeological evidence. Although the social context of boat–building during the Angkor period is not available, the similarities between old and present traditions suggests that similar social behaviour was likely followed in Angkor. This section will discuss the context of construction of boats in Contemporary Cambodia, and theorize on how this may have been applied in Angkor.

In the cultural biographies of objects the first thing that needs to be addressed is who made the object —in this case the boat— and why (Kopytoff, 1986: 66). In contemporary Cambodia it is usually a man, who will become a private owner, the one who orders the construction of the boat (Hoc, 2001: 7). The construction of a boat has an economic and apotropaic character, as it is expected to provide good business and bring good luck to the family (see Hoc, 2001: 7). Hence since its conception the boat is already expected to have its own agency that will affect the safety of the journeys and the prosperity of its owner.

Before explaining the rituals surrounding boat–building in Cambodia, it is important to provide a context to these actions, as they form part of the Khmer traditional system of beliefs. According to this system, the world is divided into two different spheres: the world of the forests (*prei*) and the world of the village (*srok*); the former is governed by wild spirits while the latter corresponds to domesticated spaces (Ang, 1986, 2004: 58; Forest, 1992: 15–16; Arensen, 2012: 54–58). These are not immutable landscapes, as forests can be transformed into domesticated spaces, and the forest can take over them if the proper ritual is not followed.[95] So even though there is a clear demarcation between the *prei* and the *srok*, there is also a fluid relationship between them.

There are two ways in which this system of belief affects boat construction nowadays: the processing of the wood and the location of boat–building activities. First, it is thought that the spirits inhabit trees (Forest, 1992: 45–46), therefore there is a ritual procedure destined to get permission from the spirit before felling the tree (see Hoc, 2001: 6 and Appendix). The way the wood is processed is also very revealing; the wood is given form with chiselling tools, and the fire used for opening the walls of the dugout is fuelled with the debris of the hollowing out process. Helms has proposed that as living forms with ascribed supernatural potencies, trees that were transformed into boats likely retained the extraordinary powers of the parent tree (Helms, 2009: 151). The ideological context surrounding this work would have required the boat–builder to carefully manage the intangible forces contained in the material (Ibid.). In this sense, the consumption of the boat's debris from the hollowing out process in the fire on which the boat is later placed can be seen as part of this material processing wherein the discarded wood is burnt and made part of the boat through the smoke and the heat.

The way in which wood is processed in Cambodia for the construction of dugouts therefore ensures the continuation of the tree's supernatural powers (and agency) into the boat. The

[95] For a study on the re-colonization of an abandoned village after the Khmer Rouge conflict in the late 20th century see Arensen (2012).

need for other-than-human agency in watercraft that could contribute to safe and profitable journeys may explain the survival of this type of wood processing for boat–building in Cambodia up until the early 21st century even though other technologies (i.e., plank–built ships) were available through contact with other cultures (see chapter 6).[96]

The second way in which the Khmer traditional system of beliefs affects boat construction is the location of work. The tree is felled in the forest, which is a space controlled by wild spirits, so while the work takes place in this landscape there are a series of taboos related to behaviour (i.e., no loud conversations, no laughter) that need to be observed. Additionally, offerings and rituals have to be conducted to protect the boat–builders from the wild spirits (see Hoc, 2001: 6). Once work in the forest is finished the boat is called *touk kamrol*, wild boat; a ritual is performed to ask the wild spirits for permission to leave the premises and take the boat, and another ritual is performed in the village to ask the domestic spirits for protection (Hoc, 2001: 6). The polishing of the boat then takes place, and the village's shaman takes over the rituals (Hoc, 2001: 6–7).

The final transformation of the wild boat into a boat is marked by two actions and accompanying rituals. First, a pair of symmetrical eyes for the boat are carved from wood and placed on the hull. These will help the spirit of the boat see any dangers on the river and avoid collisions (Hoc, 2001: 6–7). The second action is the launching of the boat once it is finished; the owner and the family get on board and the shaman (*acar*) directly addresses the boat to let it know that in the forest it was a *koki* tree, but in the village it is now a boat and its name is luck and prosperity (ibid.: 7).

[96] It is worth noting that the changes in boat-building traditions in Cambodia toward the end of the 20th century are related to deforestation, which has increased the costs of the logs, and to a loss of ritual knowledge (see Hoc, 2001: 7). The latter can likely be blamed partly on the Cambodian genocide of the Khmer Rouge that took place between 1975 and 1979. The displacement and murder of large portions of the population would have necessarily affected the passing of knowledge from one generation to another. Fear of retaliation of the spirits for not knowing the proper ritual likely prevents people from taking up the trade. As a response to this problem, the Cambodians now use the *touk loeuk kdar*, a boat that has the same hull design and retains the bow and stern as chiselled elements, but is made of planks (see appendix for description).

The processes involved in the construction of dugouts in Cambodia are conducive to the creation of watercraft imbued with other-than-human agency destined to bring luck and contribute to the safe journey of the owners (Hoc, 2001: 5–6). Malinowski posited that the need for this type of apotropaic ritual stems from the anxiety that the sea provokes in humans (Malinowski, 1948: 13–14), however, this shows that the Mekong River Basin can exert the same kind of apprehension in humans.

The archaeological evidence indicates that dugouts were used in Angkor, and that these were made in a similar fashion to the ones documented in the ethnography. More importantly, wood processing was done in the same manner: chiselling the log and never using saws (see Harris, 2007: 78). Taking this into account, it seems likely that similar ritual practices and apotropaic attributions were therefore in place during the Angkor period. The activities of these utilitarian vessels, such as fishing and transport,[97] would have dangers associated to them (see chapter 5 for details on navigation) that could result in the loss of cargo, loss of life, or both. Creating apotropaic mechanisms that would contribute to safe and profitable journeys suggests that even though the people of Angkor used the Mekong River basin, they perceived it as a dangerous space for which other-than-human agency was required.

Context of ending

The end of the life of a boat is a matter of great interest for maritime archaeologists, as the way a boat is discarded can provide data on the user's perception of the object (see Van de Noort, 2011: 41–42). Although the iconography shows great detail in the context of usage, there are no references to the end of a boat's life cycle. The Angkor Thom boat is the only

[97] Guaranteeing safe journeys would have been an important aspect for the fishing communities from the Sambhupura transport zone who were documented in the early 20th century to have travelled yearly to the Tonle Sap basin following the river's fish migration patterns (see Gruvel, 1925 and chapter 5). Those travelling from Stung Treng would have had to cover more than 200 km to reach Kompong Cham (Wat Nokor), and over 300 km to reach the entrance of the Tonle Sap River. If similar human movement patterns can be assumed for Angkor based on fish migration and fishing traditions, these communities would have to face long and perilous journeys every year. These fishermen would have had to develop a cognitive map of the landscape to navigate safely from one transport zone to another; the attribution of agency to the boats would reflect the perception of danger that surrounded this journey.

Angkorian dugout found to date,[98] and it was found 7 m underground (Sen, 2016). No archaeological excavation was conducted, so knowledge of the context in which the boat was found is nonexistent. The only other feature that can shed some light on the demise of this boat is the curved walls of the vessel, as they closely resemble the form of an unopened dugout that was found by the author in Kompong Khleang in 2010 (PL. 86). The latter was a boat left unfinished due to flaws in its design (the bow–stern axis was not aligned). The subject of faulty boats is taboo among boat–builders, who reluctantly say that when a boat is flawed and cannot be used, the hull is taken to the *wat*[99] so that the Buddhist monks can appease the spirit (Nou Thearit, 2013).

It is likely that the Angkor Thom boat was left unfinished since the inward curvature of the walls suggests it was never opened. If proper archaeological excavations had taken place at this time it would be possible to debate whether the boat was deposited or if it ended up there for another reason. The fact that it was found 7 m underground seem to suggest that it may have been deposited there, which is an intriguing possibility. At the time of its construction in the early 13th century the reigning king, Jayavarman VII, favoured Mahayana Buddhism, but there were other religions practiced in Angkor —Brahmanism, Shaivism, and Theravada Buddhism (see Harris, 2005: 17–26). The current solution of leaving the faulty boats in the pagoda corresponds to acceptable actions within the Theravada Buddhist religion practiced nowadays. If the Angkor Thom boat was buried, then this may signal an earlier solution to the problem of faulty boats wherein the boat and its spirit are given back to the earth by burying the remains, similar to what Helms has proposed for the Dover boat (2009: 156).

[98] The Kra Raleung boat was dated to the beginning of the post-Angkorian period (An, 2014).
[99] Term for Buddhist temples in Cambodia, Thailand, and Laos. The sect of Buddhism practices in Cambodia is Theravada Buddhism (see Harris, 2005).

Information about the ending of the boats that go through their full life cycle is very limited, since it has not been fully documented. Throughout the course of fieldwork it could be seen that boats were refitted and amended over time (PL. 87). In some cases there were sunken boats on sight but no sign of attempts to refloat them even though they were in shallow waters. In general, it seems boats are kept in the premises of the owner's property and refitted well beyond their use. This may be related to the way Khmer people interact with the spirits and the idea of merit. Khmer animist behaviour indicates that boat spirits need to be nourished in order to exact their cooperation, and Buddhist monks have the ability to control these spirits because they are faithful (see Ang, 1988: 37), that is, they have merit. Spirits in the Khmer world are domesticated through offerings and ritual (PL. 88-89); this domestication grants protection of the spirit against outside threats, but the spirit can also retaliate against immoral attitudes of the people of the village (Arensen, 2012: 112–115, 119–120). This behaviour is also reflected in the boat building process in the form of taboos. When the eyes of the boat are carved boat builders take great care in not breaking things or argue with the leading boat–builder in fear of retaliation from the spirit (Hoc, 2001: 6–7). It is possible that a sunken boat may be seen as retaliation from the spirit against a meritless owner, and this perception may affect the way boats are treated toward the end of their lives, but further ethnographic fieldwork is required to understand people's behaviour upon the end of a boat's life cycle.

Utilitarian boats: summary

The ritual behaviour that surrounds contemporary boat construction in Cambodia indicates that the utilitarian boats of Angkor, which the evidence suggests were made in the same way from a technological perspective, possessed the same apotropaic and other-than-human agency attributions as their modern counterparts. The need to create a functional object with independent agency to bring good luck to the owner and help in the success of the journey was likely the result of the perceived dangers of navigating the Mekong River basin. This would

have been particularly important for fishing communities if they followed fish migration patterns, which could result in journeys of over 500 km for people navigating from Stung Treng to Angkor. However, the cooperation of the spirit came at a cost in terms of construction process, material processing, and ritual behaviour that had to be observed throughout the life cycle of the boat. The perception of boats as living creatures that were owed respect not only marked the way ship-building traditions developed, but also set the tone for the modifications and uses that will be seen below in the context of peace and war.

7.2. Decorated civilian boats

Decorated watercraft features prominently in Angkorian nautical iconography. There are 77 decorated boats out of 106 boat depictions, 45 of which are used by the elite in peaceful activities (see Table 4). The other 32 are involved in warfare and will be discussed separately in this chapter due to the specific military nature of their modifications. These depictions are often of small or medium size, and are found in areas of the temples where access could be controlled (i.e., inside enclosures or in pavilions with doors), which marks the private character of these depictions.[100] The only representations of decorated boats in public spaces are found in Preah Khan, where the causeways that led to the temple are decorated with nautical iconography, as well as the side doors of the west gopura.[101]

The most important features of these boats are on the one hand, that the hulls have been modified and transformed into zoomorphic shapes, and on the other hand, that the boats are used exclusively by the elite in what can be interpreted as socially charged activities, as will be seen. It is therefore clear that the transformation of the boats is linked to social activities of the elite, likely of ritual character judging by the location of the representations in private spaces. Since there is no data on the context of creation, in this section the biographical order

[100] For a discussion on scale and the use of private and public space in iconography see Knight (2013: 44-47).
[101] Gopura is the term used for a monumental tower at the entrance of a temple.

will be change to first discuss the context of modification and usage from which inferences can be made in regards to the creation of these barges.

Context of modification

The archaeological, historical and ethnographic data discussed above suggests that the utilitarian vessels of Angkor were imbued with other-than-human agency, and that they acted as liminal apotropaic agents between nature and humans. The boats of Angkor's elite are characterized by a zoomorphic transformation through decoration; boats are no longer utilitarian objects but fantastic mythical animals with prominent heads and tails, and in some instances, with bodies made of scales. There are three main types of decoration which appear independently or in combination: the *makara*,[102] the *garuda*,[103] and the *nâga–reachisey*.[104] Although there are no physical remains of the decorated boats of Angkor, the extensive iconographic corpus shows these decorations in minute detail. The modification of the decoration suggests a need to amplify the boats' potency by transforming the common hull into a mythological animal, so decorations need to be considered within their context of usage.

Makara hull decoration

The *makara* is a hybrid mix of crocodile, fish, tapir, bird, and elephant that is very common in Khmer architecture (Roveda, 2000: 75). One of the earliest appearances of this figure in Mainland Southeast Asia could be from a graffito found in Oc Eo (Malleret, 1962: 350). In Khmer temple architecture they date as far back as the 7th century, especially in the lintels of Thala Borivat, Sambor on the Mekong, and Sambor Prei Kuk (Guy, 2014: 51; Woodward, 2014:

[102] A *makara* is a hybrid mix of crocodile, fish, tapir, bird, and elephant that is very common in Khmer architecture (Roveda, 2000: 75).
[103] A *garuda* is a mythological bird that represents birth, ambrosia, and heaven (Roveda, 2000: 76).
[104] A *nâga* is a serpent from the Hindu mythology, the *reachisey*, is a mythical creature of the Khmer pantheon associated with water that has a head of a lion, a small trunk-like nose, and is covered in scales. Although it seems to have common features with the *gajasimha*,[104] it is thought to be a mutation of the *makara* (Roveda, 2005: 209). The *nâga* and the *reachisey* are hard to tell apart, as they both sport clenched teeth, but the reachisey has a goatee.

122–123).[105] In these they are usually combined with a double–cusped arch, a decoration known as *makara–torana* that was inherited from Indian art (Woodward, 2014: 122).[106] Lintels are transitional spaces that mark the divide between the sacred space of temples and the mundane world (Guy, 2014: 44), so the presence of *makara* as part of the lintel's decoration suggests that these are creatures that can inhabit the threshold of the supernatural world. Their relevance becomes more apparent in the way they are often depicted regurgitating a *nâga* or a *garuda* in boat decorations. The process of swallowing and regurgitating is considered to be a visualization of rebirth (Woodward, 2014: 123). Thus the *makara* represented in the hulls of the boats are extraordinary beings that can move in the liminal world between the supernatural and the mundane, and are associated with the process of rebirth.

Makara appear on nine round–keeled boats,[107] twice on their own (PL. 90), two times in combination with *nâga–reachisey* (PL. 91) and three times in combination with garuda (PL. 92). On their own, they are used in a ritual of unknown character where two boats are confronting/converging towards each other in the confined spaces of a man–made pond (PL. 90). On the shoreline there are sagemen, and the water is filled with large and small fish and crocodiles. On board the vessels, men with poles are pushing other two men into the water, where there are two figures whose bodies are fish tails from below their armpits (Roveda, 2005: 430; 2007: 310). The scene has not been attributed to any stories of Hindu or Buddhist traditions and is instead assumed to represent a local celebration (ibid.) that involved certain degree of aggression judging by the scowl on the face of the main character on the left boat.

[105] For detailed studies on Khmer lintels see Polkinghorn, M. 2007. *Makers and Models: decorative lintels of Khmer temples, 7th to 11th centuries*. Ph.D. Thesis. University of Sydney.
[106] For a comparative study of Indian and Southeast Asian *torana* see Parul, P.D. 2010. *The Toraṇa in the Indian and Southeast Asian Architecture*. New Delhi: D.K. Printworld.
[107] *Makara* with round keel hulls only appear in non-military vessels, in military vessels these are associated with hard keels, see section on military watercraft below.

When combined with *nâga–reachisey*, they appear in a public space (PL. 91) and seem to be involved in a context of local devotion. The boats are only carrying paddlers, in the upper section there are some worshippers on a platform, and above them there is a *Boddhisatva* on a plinth (Roveda, 2005: 406).

On the other hand, the three boats sporting a *makara* and *garuda* decoration are part of a multi–vehicle event where people and offerings are being transported. In the scene BY–IG.V (PL. 92) there are three boats of identical hull design carrying separately three main figures (two Khmer and one Cham) and containers in the aft (Roveda, 2007: 302). The containers are revealed to be offerings in the adjacent scene on the right, where the two main leading Khmer figures are walking towards a carved building with their servants trailing behind with the containers (Roveda, 2005: 302). There are ascetics by the building's door, and beyond the temple there is a mountain with a shrine at the top that has been identified as the ultimate goal of the boat procession (Ibid.).

In summary, *makara* decorations are found in round–keeled boats and are used in the celebration of a politically charged multi–vehicle pilgrimage, a local ritual celebrated in a man–made pond, and for individual transport in what appears to be another pilgrimage.

The figureheads of the stemposts

The three main types of stempost decoration are the *garuda*, the *nâga* and the *reachisey*. The *garuda* is a mythological bird that represents birth, ambrosia, and heaven (Roveda, 2000: 76). This bird–like figure is the mount of Vishnu and is invoked in the Mahabharata as a symbol of martial prowess, speed, and violent force.[108] In Khmer art, its figure is tightly linked to the *nâga*, a serpent–like creature that is considered to be "the guardian of the treasures of the earth, the keeper of the energy stored in water, and the safeguarder [sic] of the prosperity of the region, traditionally related to water availability" (Roveda, 2000: 76). The most common

[108] See for example Mahabharata Book VIII: Karna Parva, section 77; Book VIII: Karna Parva, Section 59.

combination of these two is with garuda mounting on the *nâga*, profusely depicted in the balustrades of Angkor Wat. This combination, however, is not present in boat decorations. The *reachisey*, on the other hand, is another mythical creature of the Khmer pantheon associated with water that has a head of a lion, a small trunk–like nose, and is covered in scales (Boisselier, 1966: 320). Although it seems to have common features with the *gajasimha*,[109] it is thought to be a mutation of the *makara* (Roveda, 2005: 209). The *nâga* and the *reachisey* are hard to tell apart, as they both sport clenched teeth, however, the presence of a goatee and/or scales have been interpreted here as part of the *reachisey*.

Garuda

The *garuda* appears on its own in nine hard-keeled boats carrying the king's guard in a state progress by water, that is, a journey of the king travelling by water (PL. 93). Two boats are depicted on the rearguard of the flagship, the stern of another boat is depicted (unfinished) before the flagship, and six vessels occupy positions on the vanguard. All the vessels carry soldiers with their weapons placed on their shoulders and are therefore not engaged in military operations. Although the subject of hard keels used in combat will be discussed in the military watercraft section below, it is worth pointing out here that 21 of the boats involved in peaceful activities have round keels, while 14 have hard keels. However, 10 of these hard keels are found in the state progress by water where the vessels, though not involved in military operations, are carrying soldiers. This seems to point out that round keels are mostly used in peaceful events, while hard keels tend to be used in military contexts (bellicose or otherwise, as will be seen later). Similiarly, it appears that *garuda* decorations were used by the king as an emblem for his security detail.

There are two other boats with garuda decoration, one in Ta Nei (PL. 94) and another one in Bayon (PL. 95). In Ta Nei the boat has the head of a garuda on the prow, and a gigantic figure

[109] A variant of the *makara*, this creature has the body of a lion and the head of an elephant (Roveda 2005: 209).

occupies the central space. This has been compared to the scene in Preah Khan with a similar figure amidships (Bénisti, 1963). The current interpretation is that the scenes depict the story of *Silanisamsa* from the *Jataka*.[110] Bénisti suggests that in both Preah Khan and Ta Nei the animalistic boat is the nâga transformed into a boat, and interprets the scene as a representation of this story, though Roveda has some reservations (Roveda, 2005: 251). The decoration of the Ta Nei boat resembles more a *garuda* than a *nâga* so in that sense the interpretation of Bénisti may be challenged. What seems to be clear is that the boat is being used to transport an important figure. Since the scene is located in the private space of the central sanctuary it seems probable that the journey had religious connotations.

The other boat with *garuda* decoration is found in a scene in Bayon depicting the story of Pradyumna that appears in the *Baghavata Purana* (X, 55).[111] The *garuda*–decorated boat has a large pavilion amidships covering three–fourths of the length of the boat. A high ranking character whose gender seems to be female is located in the central room and is surrounded by a cohort of servants and parasols. The function of the decorated boat is unclear since it does not fit in with the narrative. It is possible that the placement of this high ranking woman in the story of Pradyumna follows a similar pattern found in Western art, where it is not uncommon to find patrons depicted in commissioned paintings of religious nature to

[110] The story, which is also known as the *jataka of the merits of practicing the law,* tells about the predicament of one of the disciples of Buddha and a companion who embarks on a ship that sinks (ibid.: 96-97). The two men arrive on an island, and after the disciple meditates, a king of the nâga transformed into a fabulous boat to carry Buddha's disciple to the continent (Ibid.).

[111] The myth describes how Kama, who was killed by Shiva, was reborn as Pradyumna, the son of Krishna. Upon hearing the news of the rebirth of Kama, his mortal enemy, Shambara, ordered to kidnap Pradyumna as a baby and have him thrown into the sea. A fish then ate little Pardyumna, but fell on the net of a fisherman who then gifted it to Shambara. As the cook cut the fish open, he found Pradyumna well and alive, and placed him in good care (Roveda 2005: 91-96). The story seems to be depicted as well in an incomplete fragment located in the southeastern quadrant of the temple, where two boats are represented (Dagens 1969: 49; Roveda 2005: 433).

demonstrate their piety and eagerness to be present in the most important stages of the life of Christ.[112] This scene can therefore be construed as the representation of a fictional boat.

In summary, *garuda* decorations appear as emblems of the king's guards taking part in a state progress by water, as vehicles for individual transport, and as a fictional space from which to observe and take part in the story of Pradyumna.

Nâga–reachisey

Boats decorated solely with *nâga-reachisey* stemposts are used for a multiple vehicle event (PL. 96), for individual transport (PL. 97, PL. 98), and for playing a chess game (PL. 99). The former are located on the west wall of a royal pool located outside the north wall of the royal palace. The central section of the wall has disappeared, but the boats on both sides seem to converge in the centre and have identical features, so it is likely that they belong to the same scene. The scene is only partially visible nowadays, but a picture of one of the boats was taken when the site was uncovered in the early 20th century (see Marchal 1924: pl. XXIX–B). The scene is composed of two boats on the southern end, and five on the northern end, all depicted one after another. These are heavily decorated medium–size vessels filled with parasols but without the pavilions. The main characters are seated amidships and are attended by servants. As seems to be the trend, the servants holding containers are depicted behind the main character. The main character of the last boat from the north section is turned back and has his hand inside an open chest (Roveda, 2005: 284).

The decoration of these boats, which are clearly taking part in a ceremony or festival that involves carrying offerings or containers to a specific place, have their hulls meticulously covered in scales. The exclusive use of reachisey and scales decoration in this event suggests a deliberate selection of boat decorations for this particular celebration. The scene, which is

[112] For example, in Jan Van Eyck's *The Virgin and Child with Canon van der Paele* painted in 1434, the kneeling figure of the donor (Joris van der Paele) was depicted on the left side of the virgin and was designed as an epitaph for the latter (Brine, 2014).

found behind the Terrace of the Leper King, seems to depict an organized procession of high ranking men who are converging to a point that may be connected to the northern gate of the royal palace and/or to the Terrace of the Leper King. The latter has been considered a place for royal cremation ceremonies (Roveda, 2005: 446). The location of the boats on the wall of the pond suggests that the scene was integrated into the constructed landscape, that water likely filled the pond up to the hulls to generate a three dimensional representation of the event.

The other case in which a boat appears decorated with a *nâga-reachisey* is found in the central sanctuary of Banteay Samre (PL. 97), which Roveda attributes to an unspecified story from the Jataka (2005: 121, 393–396). Unfortunately, the central section of the boat is incomplete so interpretations are limited. It is likely that a central figure was depicted and was later defaced (Ibid.). In the upper register there are men walking in the same direction as the boat, the last two are carrying a large fish on poles resting on their shoulders.

Another scene with what could be either *nâga* or *reachisey* decorations are found in the inner gallery of the Bayon temple (PL. 98). The scene depicts a large Shaivite temple floating on a lotus and in the bottom section there are two boats facing each other (Roveda, 2007: 294). Each boat has a small pavilion occupied by a court lady. The scene takes place in a natural environment, and has been interpreted as part of a larger scene depicting pilgrimages or displacements of soldiers and commoners alike, all converging to the floating palace (see Roveda, 2007: 356).

The final scene with a *nâga* decoration is found in Preah Khan (PL. 99). Commonly referred to as “The chess game” (Roveda, 2005:406), the image depicts a heavily decorated boat paddled by 8 paddlers wearing uniforms. A large portion of the boat is occupied by a pavilion raised on a dais with three rooms. There are curtains hanging and two men are playing a board game

which is likely *ouk*, the Khmer version of chess (ibid.).[113] There are praying sages on the shoreline (Roveda, 2005: 406). Roveda presents two opposing interpretations of the environment in which the scene is taking place; he first suggests it is taking place in a man–made space (ibid.: 251), and later affirms that it is taking place in a natural environment (ibid.: 406). The steps depicted on the shoreline suggest the scene is taking place in a man–made environment, so this work favours the first interpretation. The chess game is not mentioned in the *Jatakas*, but Roveda suggests that the scene represents a local version of one of its stories (Roveda, 2005: 251).

In summary, *nâga–reachisey* decorations appear in very specific multi–vehicle event that involves the exchange of offerings, as individual transport, and also as a stage for playing chess. It has to be noted nonetheless that some of the boats in the causeways of Preah Khan appear to have garuda decorations (PL. 100), but these are too deteriorated to extract a meaningful interpretation of the context of usage beyond that they are part of a multi–vehicle event depicting people moving in or out of the Preah Khan temple.

Stempost decorations in flagships

There are four boats in three scenes that can be identified as flagships; two are part of the same festival scene, another one is also taking part in a festival but is surrounded by utilitarian craft, and the last one is the flagship of the state progress by water discussed above.

The first scene is located in the southwest corner pavilion of Angkor Wat (PL. 101). The carving covers the majority of the wall and contains a single scene of two very large vessels set in a natural environment.[114] The one in the upper section has a reachisey decoration with its

[113] It is worth noting that the pieces of the rook and the pawn were modified in the Khmer version of the game to become the Touk (boat) and the Trey (fish) respectively, which seems to highlight the relevance of the aquatic world in Khmer culture. See Gifford, G. 2010. *Thai chess and Cambodian chess: Markuk and ouk chatrang*. Marston gate: lulu publishing.

[114] For a detailed description see Roveda (2003: 122-126).

distinctive goatee.[115] A contiguous line of paddlers wearing livery and high chignons propel the boat toward the west. There are two elevated platforms filled with women, some with children. Male musicians play in the background. The women in the aft are seated; behind them there are some trees with men picking up their fruit. A grand central pavilion is located amidships where two men are playing chess (Roveda, 2003: 122–126); the traditional pieces of the game in the Khmer version are visible.[116]

The vessel on the lower section has a *hamsa*[117] decorating the bow (Ibid.). Paddlers are also wearing livery, but they are only spread at the fore and the aft. The central section does not have paddlers because it is occupied by the dais of the pavilion. At the centre there is a couple depicted in a large size surrounded by three children. On the left room there are two women embracing each other, while on the right side room there is another large bearded male figure[118] nearly identical to the central figure looking at a cock fight that is taking place on the aft platform. A child embraces him from behind.

It has been suggested that this scene depicts the Dvaravati Water Festival described in the *Harivamsa* II: 45–46 (see Coedès, 1911: 131; Groslier, 1973: 172; Roveda, 2003: 122–126). Dvaravati is the city of Vishnu from where he departs on a maritime pilgrimage to a city called Pindaraca (Roveda, 2003: 125). Vishnu encourages all those taking part in the nautical parade to indulge in the pleasures of life as they board magnificent vessels shaped like geese, peacocks, and sea monsters, with golden pavilions decorated with gold and precious stones and crowned with garlands. Music, singing, dancing, and love games are enjoyed by all on board (ibid.).

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[115] Roveda uses the term dragon (2003: 123), but for consistency, if the dragon has a goatee here it is identified as a reachisey.

[116] For an example of Khmer chess pieces see Gifford, G. 2011. Thai Chess and Cambodian Chess: *makruk* and *ouk chatrang*. Marston Gate: Lulu Publishing.

[117] An avatar of Vishnu in the form of a swan or goose.

[118] Groslier suggested that the bearded man was of Chinese origin, and compared this scene with the one in Bayon with the plank vessel (1973: 172). This discussion is out of the scope of this thesis, as the focus is placed here in the nautical event.

The second scene with a flagship can be found in the Bayon's inner gallery (PL. 102). The scene shows a very large vessel decorated with a makara regurgitating a multi–headed *nâga* (three of its five heads are visible). The majority of the vessel is covered by a large pavilion with three rooms. The central room is deteriorated, but there seems to be two people playing chess (Roveda, 2007: 298). A cohort of servants wearing diadems is located at the fore. On the lower section there are four undecorated boats engaged in joyous activities: the larger boat that occupies the middle section depicts a figure jumping into the water, while another group at the aft celebrates a cock fight. Someone in the bow appears to be drinking from a gourd. The three small boats beneath it have less people on board and their activities are unclear.

The other scene depicting a flagship in a peaceful environment is in the state progress by water depicted in the southwest corner pavilion of the Bayon temple. The stempost of this large boat is decorated with what appears to be the neck of a multi–headed nâga, but instead of continuing with what should have been the head of the serpent the stempost shows the carved outline of a female figure, probably an *apsara* (PL. 103).[119] This part of the representation is unfinished. The vessel is occupied by court ladies in the fore and the aft with accompanying cohort of servants, but the central figure was never carved. There are some clues that indicate that the main figure of the barge was likely the king. The location of the gap (amidships), the size of the space left for the main character, the terminal pieces of the platform or throne where the figure would have been seated, the size of the piece of cloth incised, all point toward a disproportionate figure that can only be compared to the king's depiction on the right side of the Bayon's naval battle, and the one depicting Suryavarman II in Angkor Wat. It is therefore logical to propose that the missing figure was likely that of the king, and that the scene represents the king's journey by water. The context depicts a natural environment, and on the shoreline there are people carrying large fish on poles toward some

[119] The *apsara* are water nymphs profusely depicted in Angkorian art. They appear around gods in narrative reliefs watching and supporting their actions (Roveda, 2000: 25).

kneeling figures (Roveda, 2007: 323). There are also court ladies carrying gifts and kneeling in front of a tree where there is a small animal (Ibid.). This has been identified as a possible depiction of animistic worship (Ibid.). Additionally, the location of a small pavilion in the stern of the flagship, which as discussed in chapter 6 could have been used to carry regalia or offerings, seems to point to a royal journey of religious character.

In summary, the flagships of Angkor depicted in peaceful activities are shown to have very distinctive decorative stemposts that mark the relevance of the vessels. These are used for a fictional festival, a festival, and a state progress by water of likely religious character.

Context of usage

The decorated boats involved in peaceful activities are depicted in nautical scenes of religious character, the majority of which are located in private spaces. This establishes a clear link between the modification of the barges through decoration brought about by the religious context of usage. Political power and legitimacy in Angkor depended on the ability of the king to demonstrate his association with the divine world through ritual re–enactment and the configuration of centres of power that represented the divine macrocosm in the mundane world (Stuart–Fox and Reeve, 2011: 105). If the festival in the southwest corner pavilion of Angkor Wat is interpreted as the Angkorian interpretation of the boats used in the mythological story, then it seems logical that in attempting to reproduce the divine macrocosm into the mundane world the boat builders of Angkor would have copied these models for the boats of Angkor. While the agency of spirits in utilitarian vessels may have been good to exert influence on the mundane world, the transformation of boats into zoomorphic creatures from the realms of the gods suggests that these were more than apotropaic mechanisms to deal with the perils of navigating mundane waters.

The transformation of boats into mythical creatures that are believed to inhabit the threshold of the divine world suggests that the elite of Angkor was seeking to colonize the metaphysical

space attributed to the aquatic environment and reinforce that connection between the divine macrocosm and the mundane microcosm.[120] The correspondence between the Angkorian decorated boats and the divine creatures after which they were modelled would have transformed boats into important symbols of the elite since this symbolic correspondence would mean that by using these boats they would become the divine counterpart of the creature depicted in the bow. This phenomenon is documented in Thailand; when the king, who is thought to be an avatar of Vishnu on earth, boards the royal barge *Anantanagaraj* (PL. 104), boat and king are considered to be the living representation of the *Vishnu Anantasayin* myth (Buapradit, 2009: 28).

Vishnu Anantasayin is a theme from Hindu mythology where Vishnu is represented sleeping on the serpent Ananta on the cosmic ocean from where all things will be created. Vishnu's dream between creations and the birth of Brahma, who is the creative force that will generate a new universe, are the main elements of the *Vishnu Anantasayin*, while the role of Ananta is to be the floating bed of Vishnu.[121] Although the first representations of this mythological theme depicted Ananta as a coiled snake, this form was eventually substituted first by the elongated

[120] See Stuart-Fox & Reeve 2011.

[121] There are references to the Anantasayin story in Khmer inscriptions as early as the 5th century CE, however, the iconography does not appear until the 7th century (Bénisti, 1965: 93). During the first phase of representation (7th century), Ananta appears coiled under the body of Vishnu, while its hood inward over the head of the god (Bénisti, 1965: 93).[121] A second phase of representation has been dated to between the second half of the 10th and the first half of the 11th century, when the body of Ananta appears both plied and elongated under the body of Vishnu. A third phase toward the end of the 11th century shows the serpent's body with out any folds and a crest is added to the hood (ibid.: 96). A fourth phase dated to the first half of the 12th century corresponds to the art of Angkor Wat, a temple dedicated to Vishnu where images of Ananta with Vishnu show the body of the snake completely elongated and its hood forward like a fan, although in one instance (central sanctuary) it seems its body is coiled (ibid.: 97). On the 12th century, however, the figure of the serpent is replaced by of what Bénisti calls a dragon (1965: 98), and Roveda a *reachisey* (2005: 55). As seen earlier, the *makara* and the *reachisey* seem to be different expressions of the same creature, or at least creatures with the same influence over the aquatic world. Bénisti notes that the transformation of the *nâga* into a dragon (*makara, reachisey*) would have been a natural process, as both are gods of the waters (1965: 98). In some instances Vishnu is reclining over an elongated Ananta resting on the body of a *reachisey* (Bénisti, 1965: 99; Roveda, 2005: 58). The combination of these two creatures in the same image ledBénisti to suggest that there never was a transformation of the *nâga* into the *reachisey*, but rather a substitution that was likely connected to autochthonous traditions (Bénisti, 1965: 99). After Angkor Wat, the Vishnu – *reachisey* combination becomes the norm while the serpent disappears from the iconographic theme completely (ibid.: 101).

form of the snake, and then eventually by a *reachisey*. The reasons for this change are unclear, but it may be related to the personification of the ocean in the figure of the *dragon–makara–reachisey*; Bénisti reckons that Ananta is one and the same with the ocean, and reminds that one of the names of the ocean is *makaralaya*, the residence of the *makara* (1965: 105–106).

The round sculpture of *Vishnu Anantasayin* that was consecrated in the island temple of the West Mebon in the early 12th century by Suryavarman II (Feneley, Penny and Fletcher, 2016: 290) could be construed as a precursor of this symbolic correlation. This colossal figure, which measures 6 m in length (ibid.: 286), was placed at the centre of the West Baray, the largest man–made body of water of Angkor.[122] It has been suggested that by placing the round figure of Vishnu Anatasayin in the West Mebon Suryavaman II aimed to sanctify the waters, which were both a functional water mechanism and an intensely ritualized space (Feneley, Penny and Fletcher, 2016: 290–291).[123] By the 13th century, the multi–headed *nâga* decoration is already used on the flagship in the festival scene of the Bayon, which suggests that this symbolic correspondence was being used at the time.

The use of a multi–headed decoration to evoke the serpent *Ananta* and associate the user (i.e., the king) with Vishnu and transform the water where they navigate into the cosmic ocean (thus sanctifying them) is a clear example of how this correlation may have worked. The variety of stempost decorations suggests that these were linked to specific activities or specific ranks. In a highly hierarchical society like that of Angkor, where insignia were ascribed to people according to their rank,[124] it would be surprising if the decorated barges were not regulated. Examples of this type of regulation are found in the royal barges of Thailand. During

[122] Incidentally, these waters were sanctified with representations of Visnu Anatasayin carved on the riverbed of the spring that feeds the reservoir (Feneley, Penny and Fletcher, 2016: 290).
[123] Feneley, Penny and Fletcher have proposed a coiled Ananta as the likely platform of the reclining Vishnu, of which there are no remains (2016: 288). However, it is also possible that Ananta was depicted with its elongated body, making it look like one of the decorated boats of Angkor.
[124] See Zhou Daguan's chapters 2, 3, and 4 where he discusses the different residences, clothing, and insignia (palanquins and parasols) ascribed to different ranks (Harris 2007: 49-52).

the Ayutthaya period the decoration of the barges were linked to the rank of the user: those belonging to high ranking officers had a small central pavilion, while painted and gilded barges were reserved for the two chief ministers (Gervaise, 1688: 213). The king could gift such a boat to a high ranking officer, but in that case the boat could only be used by the officer under exceptional circumstances (ibid.: 96).

This takes the discussion to the origin of the decorated boats' biography: who commissioned them and why? It seems probable that such powerful symbols were under the direct control of the king, who would determine boat decoration by rank. As seen with the flagships, there would have been specific decorations used exclusively by the king, such as the multi–headed *nâga*. In that case, it is likely that the king would have been the one commissioning the boat.

Having a fleet of decorated vessels for use within Angkor would have contributed to the illusion of reflecting the macrocosm of the divine world in the mundane microcosm, so it would have been to the king's advantage to have their subjects travelling by these boats in official missions. The decorated boats would have therefore been also a reflection of Angkor's hierarchically organized society. This is similar to the case of the royal barges of Thailand, where the king would send his royal fleet to bring foreign envoys up the Chao Phraya river in the 17th century (see Ribadeneyra, 1601; Gervaise, 1688; Tachard, 1688).

Context of ending

The strong symbolism that surrounds the decorated boats of Angkor would have been reflected in their decommissioning process; however, the available archaeological and iconographic data do not shed light on this matter. Ideas on how these boats were treated toward the end of their life cycle can be found in examples related to racing boats of the Water Festival available in the ethnography.

The Water Festival is a celebration that takes place in November as the waters of the Tonle Sap River reverse and flow toward the Mekong River. They are associated with fertility rites, and

also inaugurate the fishing season (Hortle, Lieng and Valbo-Jorgensen, 2004: 17).[125] Almost every *wat* has a racing boat in its premises; these are lodged in trestles and usually protected in sheds (PL. 105) (Ang, 1988: 37). According to Ang, these boats are inhabited by *brāy*, malicious spirits of women who died in childbirth or spirits of virgins who suffered a violent death (ibid.). The monks of the *wat* are in charge of nourishing the spirit to ensure its cooperation, and people appeal to boat spirits as "providers of magic virtue" (ibid.). In the Sen River, close to the ruins of Sambor Prei Kuk, the remains of bows from former racing boats were found placed against a fence, and next to them there is a small house-shrine with offerings (PL. 106).

A similar attitude is found in Thailand regarding the Thai royal barges. The decorated stern and stemposts of historical barges have been re–used in the construction of new barges (Buapradit, 2006: 23), and where reconstruction was not possible the barges were left to decay in the Thai Navy dockyard (PL. 107). Their status as objects of worship is marked by colourful ribbons tied to the bows, and a shrine with offerings. All the logs from the boats are kept inside the boat and there is no re–use of these parts for other purposes.

The aforementioned examples of decommissioned barges with important spiritual attributions suggest two possible options for the ending of a decorated boat's life cycle in Angkor. It is possible that boats were conserved in full and worshipped in spaces of ritual meaning (i.e. the precinct of a temple) to guarantee the cooperation of the spirit, who may have been perceived to dispense magical power, as Ang has documented for contemporary racing boats. Another possibility is that the bows were dismantled and either re–used for other boats, like in some

[125] In Leclère's early description of the Water Festival, he concluded that the celebration did not seem to be of Buddhist nor Hindu origin (1904: 130). His description of the last day of the celebration is very enlightening in this respect. According to Leclère (1904: 130), the participants chanted to the ancestors' spirits: *Go back to your countries, to the fields that you live in; go to the mountains, the rocks, the trees that serve you as residence; go! And return! In the month, the season, the time, at a later moment, your sons and grandsons will think of you; then you will come back! Come back! Come back!* This propitiatory chant and the surrounding ritual of the Water Festival celebrated at a crucial time for the region's livelihood is an acknowledgement to the relevance of retaining that hydrological cycle, hence it applies both to agriculture and fishing (see Loofs-Wisowa, 1991: 47).

cases in Thailand. Van de Noort suggests that the fragmentation of an object does not diminish its significance (2011: 42), so bows may have been refitted into new boats without affecting its spiritual value. But if the life of the boat reached its end, then the bow of meaningful boats would have been kept in the precinct of temples and worshipped in the same manner as the full boats.

Decorated boats: summary

Starting from the conceptualization of the Angkorian utilitarian boat as an entity with other-than-human agency and apotropaic qualities, in this section it has been seen that the basic essence of the utilitarian boat was transformed by the elite in their search to reproduce in their realm the divine macrocosm. The modification of the utilitarian watercraft into zoomorphic creatures that were known to inhabit the threshold of the divine world allowed the Angkorian ruler to colonize the metaphysical space of the aquatic environment and enabled them to tap into the divine as the source of royal power. As Stuart–Fox and Reed have argued when discussing the construction of Angkorian cities, "belief in the reality of this source of power, and the means by which it could be tapped, both legitimised royal rule and motivated the learned architects who designed, and the tens of thousands of labourers who built, the city" (2011: 120). The same could be said of the boat builders and —more importantly— the crews who were part of the performance of the boats through their paddling and/or rowing.

It is likely that the inspiration behind the modification of these boats had its origin in mythological stories from the Hindu and Buddhist traditions, like the Dvaravati Water Festival, but as Kopytoff points out, what defines an object's biography "is not the fact that they are adopted, but the way they are culturally redefined and put to use" (1986: 67). The pre–existence of a well–established ship–building tradition with an ideology that ascribed agency to boats not only through ritual behaviour associated with the construction process but also

through the nature and processing of the wood, likely contributed to consolidate the incorporation of decorated boats into the ruler's reconstruction of the divine macrocosms.

7.4. Vessels of war

Angkorian nautical iconography widely depicts vessels of war. There are 34 scenes in total, and although only 7 of them are devoted to nautical warfare, 40% of all the vessels can be found in these scenes (a total of 43 out of 106). Unlike the scenes with decorated boats, all of the war scenes are depicted in great size in the outer galleries of the temples of Bayon and Banteay Chmar commissioned by Jayavarman VII (see table 5), and would have therefore been accessible to a public audience. Hence the role of these scenes can be interpreted as part of the political propaganda of Jayavarman VII to emphasize his prowess in nautical warfare and his ability to fend off naval attacks. The two main characteristics of these boats is their decoration and their propulsion system, which will be discussed in this section as part of their context of modification and usage.

The origins of the fleets in the naval battles: an integrated discussion

While it is clear that the fleet of Angkor would have been commissioned by the king, there is an ongoing discussion on the origin of the enemy fleet. The nautical battles of Bayon and Banteay Chmar were initially thought to be a depiction of a naval battle fought between the Khmer and the Cham before Jayavarman VII was crowned king (Coedès, 1932: 76–78; Paris, 1941: 338; Coedès, 1968: 169–170; Groslier, 1973: 172). This assumption has been disproved by Vickery, who concluded that the interpretation was the result of an incorrect translation by Coedès of Angkorian texts (2005: 58–70). However, the identification of the enemies as Cham resulted in discussions on the origin of the invading fleet. Paris reckoned that the boats were exclusively fluvial, and consequently had to arrive from the Mekong delta or from the river network that connected Champa with the Mekong (1941: 337–338).

Invasion from the Sambhupura transport zone

There are two main problems with this option. The absence of a direct water route from the settlements of Champa to the Mekong River would have required the invading forces to haul the boats in several points along the Se Kong river basin, which seems a daunting task if we consider the likely weight of the boats and the environment (see Chapter 5). Cultures like the Vikings are known to have done this so it is not unheard of, however, it should be questioned whether it would make economic sense for a mostly seafaring culture to invest time and effort in constructing fluvial boats for a naval invasion when they could have deployed their forces in coastal vessels via de Mekong River. Alternatively, the Cham could have seized boats upon their arrival in Stung Treng–Thala Borivat. Whether the settlement had the fleet depicted in the bas–reliefs or enough large boats to accommodate soldiers is debatable, but if they did it is unlikely that the standing soldiers would have been able to bypass the rapids of Sambor and Prek Patang unscathed seeing as their boats do not have handrails. Additionally, it should be questioned whether rowing boats would have been able to cross this section without trouble taking into account that rowing is unsuitable for the narrow spaces of the rapids. Furthermore, the river route between Stung Treng and Angkor is over 500 km, which means that the standing soldiers would have had to make such a long journey with barely space to move on board. It thus seems unlikely that an invading fleet from Champa would have arrived via the Se Kong river basin. Smaller river systems could have been used, but the same problems would have applied. If the armies crossed below the rapids, they would still have depended on finding suitable boats to launch their invasion.

Invasion from the Mekong Delta transport zone

Launching a fluvial fleet from the Mekong Delta also raises problems. For instance, there would not have been any advantage in changing coastal vessels for fluvial war boats since the former could have moved more efficiently upriver using wind power while the latter would have exhausted the rowers since it takes considerable time to reach the Tonle Sap River – even

with a sailing ship (see Harris, 2007: 45). Furthermore, coastal ships were likely to be higher (see for example the plank vessel of Bayon), so that would have likely given them a tactical advantage in war over the low river boats of the Angkorian fleet.[126] Additionally, the Cham would have had to have access to a fluvial fleet in the Mekong Delta in order to change their sailing vessels for fluvial war boats, and still it would not make strategic sense to switch sailing ships for rowing boats before the Tonle Sap River. On the other hand, if the fight took place on the river and not in the lake, there is no reason for the Cham to abandon the tactical advantage of their sailing vessels to change to a fluvial fleet.

The bottleneck of the Tonle Sap River

Having reached the Tonle Sap River from upstream or downstream the Mekong, the invading forces would have to traverse the narrow confines of the river to gain access to the Tonle Sap Lake. This course would have taken them through narrow channels that would have been perfect locations for ambushes launched from the shoreline (see chapter 5). They also would have had to go through Kompong Chnnang, which was a major sea–river port already in the 13th century according to Zhou Daguan (Harris, 2007: 45). It seems unlikely giving its strategic location that this port would not have been an Angkorian stronghold with enough soldiers to fend off naval attacks.

Historical accounts from the 17th century contain information on how this area of the river was defended by the Cambodians; according to the Dutch, on the 11th of June 1644 four of its sailing ships (the *Waeckende Boey*, the *Leeuwerick*, the *Dolpheyn*, and the *Kievith*) were ambushed in Phnom Penh as they returned from Oudong (Van der Kraan 2009: 53–62). Only three days had gone by since the Dutch fleet had passed Phnom Penh on their way to the Cambodian capital, but upon their return they found themselves cut off by two pontoon bridges protected on either side by batteries of cannons (ibid.: 53). Hundreds of Cambodians

[126] For a discussion on this issue in the Classical period see Murray, M. 2012. *The age of Titans: the rise and fall of the great Hellenistic navies*. New York, Oxford: Oxford University Press. P. 29.

occupied the pontoons carrying torches and muskets. The first pontoon was 150 m wide and was secured by heavy wooden anchors (ibid.: 54), which is reminiscent of the system used to tie the elephant–carrying raft in Banteay Chmar discussed in chapter 6.

The second pontoon was bigger; 7.5 m wide, 1.9 m thick and around 190–220 m long (Van der Kraan, 2009: 54). It was secured to an iron chain, covered, and protected by a thick layer of thorn bushes (ibid.: 54–55). The only way the Dutch could dismount the pontoon was by disembarking with 50 men on the left riverbank and taking over one of the battery defences, in order to allow their soldiers to cut through the thorn bushes and destroy the pontoon. The Dutch ships were able to break free after almost three days of intense fighting, during which the ships were severely battered. Their crews suffered great losses as well: 62 of 348 were killed, and 145 were injured (Van der Kraan, 2009: 57).

The iconography indicates that the Angkorian people were capable of constructing bundle rafts that could carry the weight of elephants and soldiers. Access to this technology would have made the pontoon block tactic available during the Angkor period, and judging from the Dutch account it would not have required a long time to construct these bridges. An invading force could have been prevented from crossing the Tonle Sap River by using these floating bridges, or they could have been cut off during their retreat.

Although there is no archaeological evidence of this defensive tactics, the accumulated environmental, iconographic, and historical data suggests that this option should be carefully considered. An invasion from the Mekong would not have been impossible, but it would have certainly been a difficult task. The battle of Phnom Penh of 1644 shows that sailing ships would have had an advantage, but the shallow depth of the lake (particularly toward the shoreline) would have prevented the enemy forces from using these ships to invade Angkor without the additional support of a fluvial fleet. In this scenario, it is possible to speculate that an invading fleet arriving from the sea could have taken over Kompong Chnnang, but they would have then

had to take over the fluvial war boats of the forces stationed there. This would account for the depiction of the invading fleet using war boats identical to those of Angkor.

The Malyang rebellion

After Vickery's rebuttal of a Cham naval invasion, it cannot be discarded that the nautical battle depicts civil conflict within the Tonle Sap transport zone. While the leader of the invading fleet in Banteay Chmar has the same coiffure as the soldiers (Paris, 1941: 340), the enemy leader in Bayon has short hair that identifies him as Khmer (Paris, 1941: 344). Additionally, the rowers depicted in the enemy waterborne raid of Bayon have been identified as Angkorian (Roveda, 2007: 320), and there are a few people on board one of the Khmer vessels in Banteay Chmar wearing Cham coiffures (PL.108). There are enough elements in scenes depicting amphibian warfare in Bayon and Banteay Chmar to make this interpretation of a local conflict with Cham allies and mercenaries feasible.

During the early period of Jayavarman VII's reign there was a rebellion in a region called Malyang located south of Battambang (Coedès, 1968: 102, 170; Wolters, 1974: 357–358). The depiction of land warfare has been associated with Jayavarman's suppression of the uprising (Coedès, 1932: 78), but while these scenes depict fratricidal warfare among Angkorian forces it has been pointed out that the sources explicitly say that the Cham had a prominent role in subduing the rebels (Scheweyer, 2007: 68; Roveda, 2007: 353). Consequently, Schweyer has proposed that the amphibious warfare depicted in the reliefs may be a representation of the Malyang rebellion, which included a naval invasion of the Malyang homeland (2007: 68).

Schweyer's proposal is consistent with all the elements found in the iconography and the limitations of amphibious warfare. First, the lake would have been an ideal environment for rowing due to its mild current and flat waters. Additionally, the distance by water between the shoreline of Angkor and Battambang is roughly 70 km as the crow flies. Travelling that distance would have been exhausting but likely within the limits of endurance of the rowers. Similarly,

standing soldiers could have maintained their precarious position (though painfully) with no handrails and no space for movement if the distance was short and the surface of the water flat, conditions roughly met by the Malyang rebellion hypothesis.

It should also be added that Malyang had a strong regional identity and had previously defied external authority (Wolters, 1974: 358). The pacification of the lake that took place in the 9th century during the reign of Jayavarman II (see Wolters, 1973; 1974), suggests that amphibious warfare in the region likely developed as a result of conflicts within the lake. The ability to deploy or neutralize armies via war boats would have been a *conditio sine qua non* Angkor would not have been able to exert control over its territory. On the other hand, a power willing to defeat Angkor would have required a fleet that could intercept the Angkorian forces before they landed. A well established regional overlord would have had the capacity to construct a functional fleet of war boats to challenge Angkor's authority on the lake. Based on all of the above, it seems more likely that the nautical battles depict a fight between two local forces with external participants than a foreign invasion via the Mekong river that required subduing a major port and taking over a fluvial fleet to continue the invasion toward Angkor.

Context of creation

Taking into account the overwhelming evidence in favour of a local conflict, it seems more likely that enemy fleets were commissioned by regional overlords of the Tonle Sap transport zone or that the war vessels were originally part of the Angkorian fleet but were persuaded to join the uprising. This would account not only for the similarities in the hull design and modifications that will be seen below, but also for the identical decorations that suggests both navies belonged to the same cultural sphere. It has been posited as well that the naval battles are in fact a celebratory naumachia that was part of a celebration, as has been suggested by Roveda (2007: 353). If this is proven to be true, it would also explain the similarities between the two fleets.

Context of modification

The hulls of the war boats are modified into two ways: decoration and propulsion. These are discussed in this section within the context of warfare.

Modification of keels and decoration

Like the decorated boats of Angkor, the vessels of war depicted in the iconography are modifications of the utilitarian vessels transformed into zoomorphic creatures, so the same agency and symbolic attributions would have applied to them. However, they present specific characteristics that differentiate them. All the vessels of war depicted in the iconography except one of the Angkorian flagships have hard keels. This contrasts with decorated boats used in peaceful activities where the majority had round keels. This is probably related to the decoration, which shows that 26 out of 43 have *makara* depicted in their hulls (Fig. 29). *Makara* depicted in the hull have the lower jaw aligned with the hard edge of the keel in what can be construed as an aggressive stance. So apart from the symbolic attribution of the *makara* as the personification of the ocean (Bénisti, 1965: 105–106), from a technological perspective, if the tip of the keel was underwater a hard keel would have helped keep the course of the boat on a straight line. The need for better control of the war boat is shown in the incorporation of a rudder, as will be discussed further on.

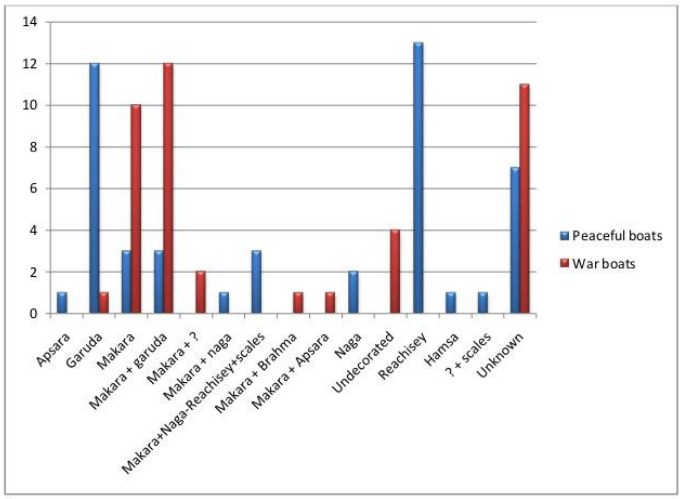


Fig. 29: Differences between decorations in war boats and boats engaged in peaceful activities, labelled in the graph as civilian boats. Source: V. Walker.

Decorated boats used in peaceful activities may have been more eager to modify the keel to a round shape to better accommodate the decorations (i.e., to better represent the chest of the

animal decorations and increase realism) because the propulsion system (paddling) and the activities they were engaged with did not require additional support to maintain a straight line. However, war vessels seem to prefer the combination of *makara* and hard keels as a response to functional and decorative purposes.

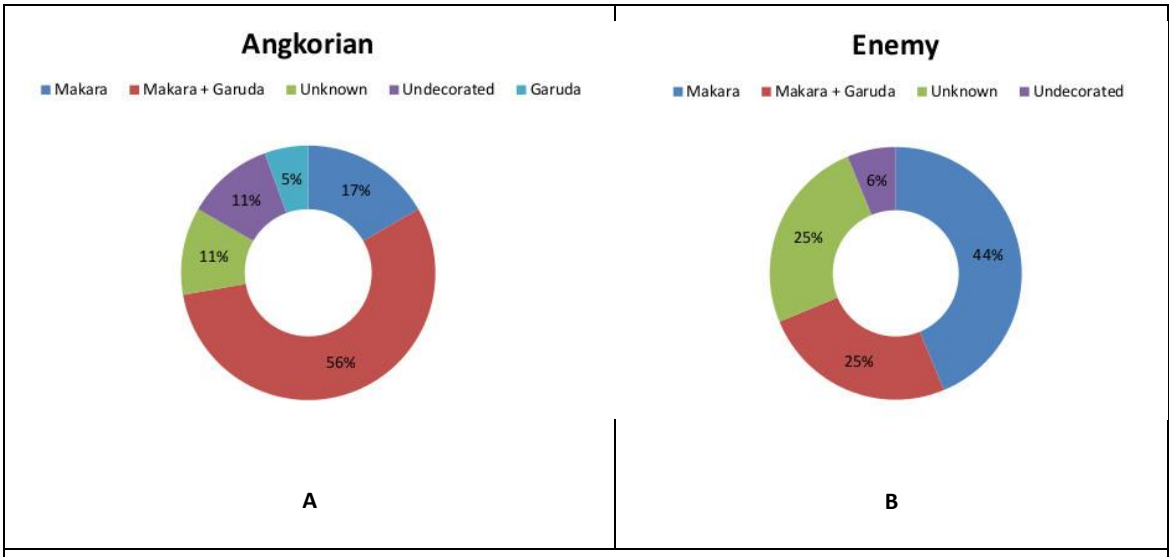


Fig. 30: Graphs detailing the percentage of decoration themes in Angkorian war boats (A) and enemy war boats (B). Source: V. Walker

It has been proposed above that both fleets were either part of the same cultural sphere, or that they belonged to opposing factions of the same fleet, which would explain the identical decoration. Comparative graphs of decorations used on Angkorian and enemy war boats shows that while using the same themes, the boats of Angkor have higher number of makara + garuda, while the majority of the enemies have makara only (Fig. 30).

When analyzing the decoration in relation to the users of the boats it becomes clear that there is a direct connection between these (Fig. 31). In the naval battle of Banteay Chmar, boats BC1b and BC2b have *makara* + *garuda* decoration and they have a leading figure on board (PL. 109), while the enemy boats have *makara* decoration and there are no leaders. The only exception is BC4t, where the admiral of the enemy fleet is depicted on a *makara*-decorated boat.

In the Bayon naval battle the relation between users and decorations is more striking. The boats on the left section are boats carrying leaders or special units (i.e., archers like in B2c, or soldiers with jackets like B1-2t) and are decorated with *makara* + *garuda*.[127] The boats on the right side, however, are undecorated or have *makara* decoration only, there are no leaders on sight and they are carrying troops wearing loincloths. Once again the enemy forces are depicted without leaders and using *makara* decorations. The admiral of the enemy fleet —who is identified as Angkorian (PL. 110) — can be found in an undecorated vessel in B6t.

This analysis indicates that the decoration was used as hierarchical emblems with *makara* + *garuda* marking the presence of leaders of status or special units, and *makara* or undecorated vessels indicating boats where infantrymen with no leaders were located. However, the three invading enemy war boats of Bayon have *makara* + *garuda* decoration but no leaders on board (PL. 111), so the premise of "*makara* + *garuda* = leader" is not always true for the enemy forces. This hierarchical system was either employed by both fleets, or the Angkorian artists were instructed to depict the enemy fleet as using low ranking war boats. If the latter turns out to be true, then it needs to be assumed that the depicted enemy fleet could be an idealized version of the Khmer artists, which would also account for the identical decorations. Nonetheless, this does not preclude the existence of a Malyang enemy fleet in the Tonle Sap transport zone since the modifications of Angkorian war boats are clearly indicative of well-developed watercraft for amphibious warfare.

[127] Boats with leaders or special units and *makara* + *garuda* decoration are found in: B4t, B2-3c, B2-4b. Boats in B1-2t, B1c and B1b have leaders or special units as well but decorations are not visible.

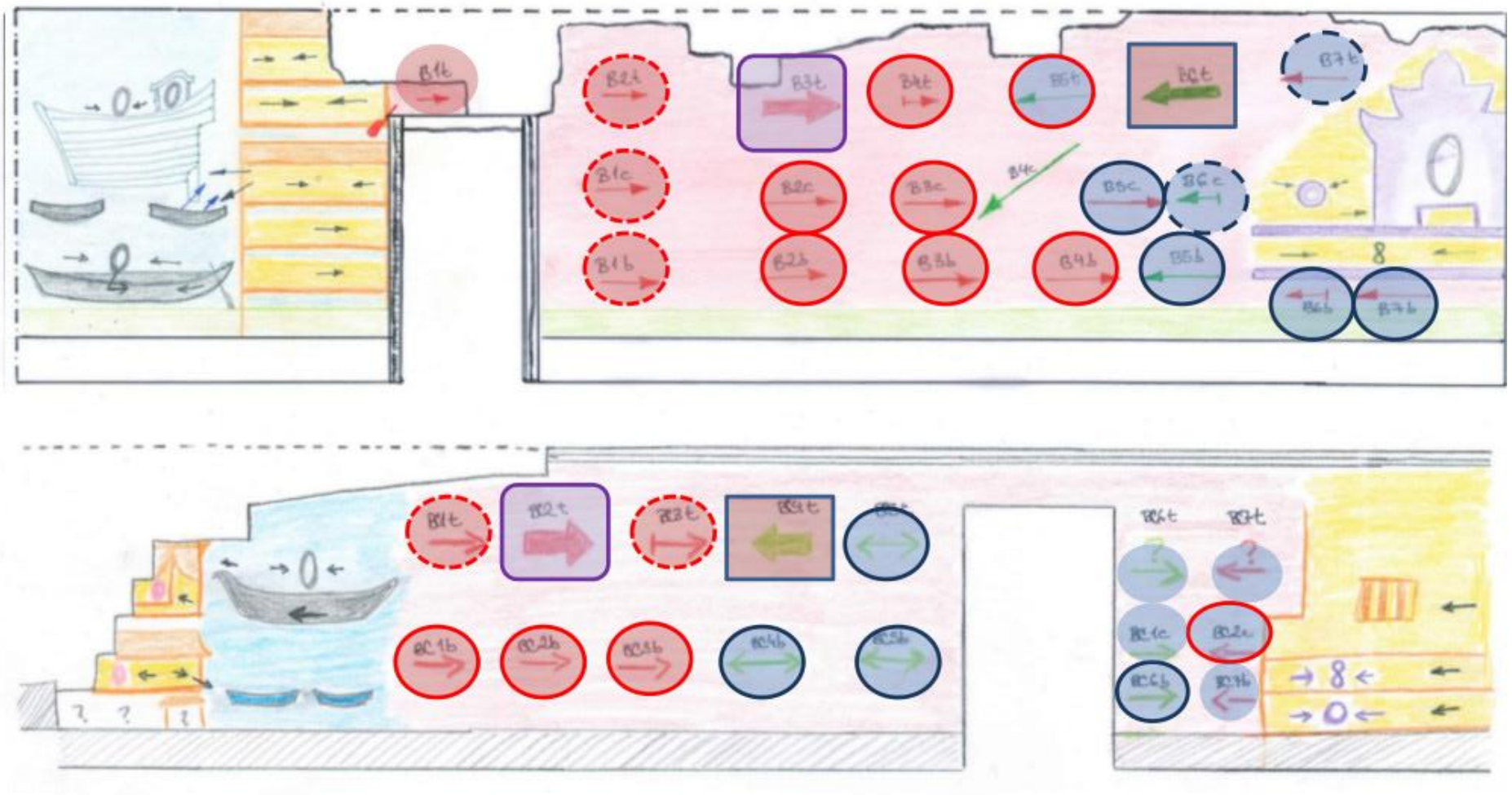


Fig. 31: Boat decorations and fleet hierarchy in the nautical battles of Bayon (above) and Banteay Chmar (below). Source: V. Walker.

Soldiers + possible undecorated boats

Soldiers + makara/undecorated boats

Leader/Sp. Unit + possibly decorated boats

Leader/Sp. Unit + makara-garuda decorated boats

Soldiers + unknown decoration

Leader/Sp. Unit + unknown deco

Enemy leader + makara/undecorated

Admiral-king of Angkor's fleet

The Admirals' vessels

The Angkorian fleet is ledby an admiral of imposing figure in both naval battles. The disproportionate size of the Angkorian leader in both instances suggests that the admiral was the king. This has been proposed by Roveda in the case of Banteay Chmar (2005: 440), but he does not recognize the admiral in the Bayon as such likely because on the top right section of the scene there is another large figure that he assumes to be the king (2005: 426). It seems unlikely that the hierarchical society of Angkor would use the proportions to depict the king to depict other characters, since size in art defines hierarchy (see Knight, 2013). It seems more likely that both figures represent the king, and that the inclusion of both in the same scene represents passage of time.[128] This way of representing time is used in other nautical scenes, like BY-IG.V mentioned above where three boats with noblemen on board are seen on board vessels and immediately to the right the main characters are depicted walking toward a temple (see Roveda, 2007: 302).

The vessels of the admiral-king have identical *makara* decoration, but the boat in Bayon has a stempost depicting a Brahma sculpture (PL. 112), while the one in Banteay Chmar has a female figure (Groslier, 1921: 110; Jacq-Hergoualc'h, 2007: 131) that Roveda has interpreted as a *devata*[129] (2005: 440). However, it seems more likely that the figure is that of an *apsara*, which are very popular in Khmer art, usually mark the presence of divine figures, and by observing the actions of the divinity they provide their support.[130] This stempost is identical to the one used by the king's flagship in the state progress by water, but in the state progress there is no makara. In fact, although the king is surrounded by boats filled with soldiers and decorated with *garuda* stempost, none of them have *makara* decorations. So it is possible that military boats were fitted with *makara* decoration when in war but that these decorations were

[128] See Knight (2013: 105-112).
[129] The devata are female being of the gods' paradise usually depicted as guarding the doors of the temples (Roveda, 2000: 26).
[130] See definition of *apsara* in Roveda (2000: 25).

removed in peaceful activities. This would have an analogue case in the racing boats of the Water Festival, where the eyes of the boat are only placed on the hull when they are taking part in a race, but must be removed immediately after the race is over (Ang, 1988: 40).

In summary, the people of Angkor modified war boats by decorating the hulls with creatures that embodied the power of the ocean. The aggressive attitude of the open jaws of the creature would have been intimidating, specially taking into account that boats were sentient beings with their own agency. Retaining the hard keel of the original design of Angkorian boats was favourable to the decoration, as the hard angle could confer more realism to the jaw of the creature, but incidentally, if this part of the keel was underwater it would have helped the boats maintain a straight course. Stem post decorations, on the other hand, would have served to mark the hierarchy of the boats within the fleet: boats with garuda stem post would mark a high rank, whilst no decoration would be associated with a low rank. The most elaborate decorations were reserved for the king.

Context of modification to the propulsion system

The other main modification of the war boats is the propulsion system, which is characterized by a change from paddling to rowing and the addition of oar-boxes, both of which are only found in war vessels. Paris (1941: 354) initially suggested that oar-boxes were used to protect rowers, and though the author does not disagree with this stance, it is worth reflecting on the processes that led to the change, which has never been discussed before. The difference between paddling and rowing is that the oars usually have a longer shaft and they are fixed to a hinge in the boat known as rowlock. This way the boat and the oar are used as a lever against the water. Consequently, the shaft of the oar has to be longer in order to enter the water at an appropriate angle. All of the rowing boats depicted in Angkor have been fitted with an oar-box, a wooden or reed panel where the oars are fixed (Jacq-Hergoualc'h, 2007: 132). Paddlers, on the other hand used their bodies as hinges connecting the boat to the paddle and the water.

The shaft of the paddle is shorter, more manoeuvrable and enters the water at a steeper angle.

An initial assumption may be that rowing was used for warfare because it was faster, but this is not true. In ideal conditions such as the 2012 Olympic Games, the gold medallists of the coxless-four rowing team finished 2,000m in 06:03:97 minutes.[131] On the other hand, the kayak 4 paddling team finished 1,000m in 02:55:085 minutes, so they would have need around six minutes to cover 2,000m (see full results in International Olympic Committee, 2012). While rowing allows for longer and stronger strokes (low rate), paddling allows for more strokes (higher rate) per minute, hence they both provide similar results in terms of speed in ideal conditions (i.e. using light boats and in flat waters) by applying more power on the stroke at low rate in the case of rowing, and applying less power on the stroke at a higher rate in the case of paddling. Rowing therefore does not seem to provide any additional benefit in terms of speed.

In fact, while a paddler can potentially leave his paddle and join the fight, a rower would not be able to do so, as the unmanned long shaft of an oar would likely get entangled with the other oars. On the other hand, a rowing boat requires wider spaces for the oars. There are other additional problems with oars, at least in the modern sport of rowing:[132] the blades can get entangled with the vegetation, which may lead to "crabs". This effect, where the rower is pinned by the stuck oar, can also happen when the oar is sucked under the water. In some cases the force of the trapped oar can lead to an ejector crab, where the rower is thrown out of the seat. Additionally, it would seem that because the force of the oar is applied at a longer

[131] Modern Olympic rowing differs from earlier forms of rowing in that it uses sliding seats that allow rowers to apply the strength of their legs into the stroke (see Cabrera, Ruina and Kleshnev, 2006; Caplan, Coppel and Gardner, 2010), therefore we need to take into account that modern rowing is probably more efficient than earlier types of rowing.

[132] As part of her research strategy the author joined her college's rowing team in order to gain embodied knowledge of rowing. From the mechanical movement of the sport to coxing, the author has acquired practical experience in rowing that has been applied to this part of the research.

distance from the boat, there needs to be more synchronicity between the rowers lest the boat change course with a stronger stroke from one side. This must have been an apparent problem because the rowing boats were fitted with rudders that allowed them to maintain a straight course.

The modifications of Angkorian war boats reflect an adaptation to amphibious warfare. Since Angkor's environment is fluvial, a natural development of amphibious warfare would include the use of projectile weapons (bows, arbalests, and ballistae, all of which are depicted in Angkorian bas-reliefs) from the shoreline (see Jacq-Hergoualc'h, 2007: 28-35). One of the ways of disabling a ship is by cutting off its propulsion system (i.e. the paddlers/rowers), and projectile weapons seem to be an effective way of doing this. In fact, in the admiral's flagship in Banteay Chmar there are two lines of paddlers, which may depict replacements for paddlers lost in combat or due to exhaustion (PL. 114). Protecting the propulsion system would have been important in Angkor's nautical warfare strategy, as suggested by Paris (1941:354). The problem is that paddlers have to be close to the water in order to take a stroke, so adding a barrier to protect them would have made paddling impossible. Thus by adding protective measures for the propulsion system, the Angkorian fleet had to make a compromise in the propulsion system and change from paddling to rowing, and add the rudder to maintain course. Rowing must have been see as an inconvenience outside of warfare since in Angkorian boats depicted in peaceful activities paddling is always the preferred propulsion system. Nowadays rowing is not used in Cambodia.

Context of ending

The context of decommissioning decorated boats is unknown; there is no historical, iconographic or archaeological data, and there is no analogous material in the ethnographic records. It seems logical to assume that there was a specific procedure to ensure that the spirit of the decommissioned boat was under control, perhaps similar to the decommissioned racing boats of the Water Festival. Since these boats were of a more aggressive nature, there may

have been differing procedures from those used on peaceful boats like for example the removal of the makara decoration to reduce the reach of the spirit's power as is done with the racing boats of the Water Festival. However, until archaeological evidence is found knowledge on this issue will remain highly speculative.

Military watercraft: summary

Angkor was not a maritime culture, but it controlled a network of rivers that enabled access to and from the sea. These waterways were conduits of transport, and the accessibility of some parts of the river network to sea-going and coastal ships has been demonstrated through environmental, iconographic, and textual data (see Chapter 5). The strategic location of Angkorian sites indicates that controlling waterways was a key aspect to their success.

Much like in the case of medieval and modern Europe, the socio-geographical conditions of Angkor's territory would have resulted in an encroachment of commerce and amphibious warfare.[133] Maintaining and expanding privileged positions in these key sites resulted in conflict on or around water;[134] cutting access to rivers, controlling traffic, or taking hold of strategic points would have been in the agenda of Angkorian kings if they wanted to ensure that the prosperity that arrived via these water networks continued.

The nautical iconography of Angkor reflects this struggle to control the waterways and retain their advantage over competitors through the development of fluvial warfare. The boats used in warfare were modified to incorporate a new propulsion system that would give them an edge in battle, but since the system was also incorporated by the enemy they would have been levelled. On the other hand, the decoration of the hulls reflected their identification of the makara as the embodiment of the ocean and as an aggressive creature that could intimidate the enemy. Stemposts were used as signposts of the user's ranks, another indication of the

[133] For a study on amphibious warfare in Europe and its role on commerce and state formation in Europe see Trim and Fissel (2006).
[134] For a comparative study on riverine warfare in Europe see Trim (2006: 357-419).

sophistication of the Angkorian fleet. All of the above indicates that the people of Angkor and their enemies had developed and perfected naval warfare within the Tonle Sap transport zone, which suggests that naval warfare was a rather common event in the history of Angkor.

7.5. Sailing ships

The last boat biography to be discussed is that of the two sailing ships of Banteay Chmar and Bayon. These are studied in relation to their context of usage, looking particularly at the way in which they were perceived by the people of Angkor.

The sailing ship of Banteay Chmar is decorated with a makara, and has a dais where a large figure is being attended by a cohort of servants wearing a distinctive coiffure (PL. 115). The clothing and headdresses identify them as non-Khmer. The boat is filled with parasols, and there are more people at the rear engaged in different activities: two are around a container, another one is drinking from a gourd, one is perched on the sail, and another one has his hand wrapped around the pole of a banner. Ahead of this group of people —who are not wearing the same coiffure as the servants and, in fact, have their hair in a low chignon— there is a standing figure wearing a long jacket although he is not depicted in a larger size. The loom of the rudder or a steering aide is represented, but details of the blade or its handle are not visible.

The scene was originally described as being part of the nautical battle that continues adjacent to the sailing vessel (Parmentier, 1910: 209; Paris, 1941: 339), however, the Khmer artists depicted elements uniting the boating scene with the buildings on the left (PL. 116) so these appear to be part of the nautical scene. The two buildings have court ladies reclining on pillows or being fanned. Under the stilts of the building, on land, there are at least three exhibition fights with fighters armed with spears and bucklers (Parmentier, 1910: 209). Despite the

ensuing battle on the right side, the activities taking place on this nautical scene do not appear to be connected to the battle (PL. 117).

The second scene is found in the eastern wing of the southern gallery of the Bayon temple. The upper section of the wall has a large sailing vessel built with planks; there are two fishing boats in the central section, and a medium size boat in the lower registry (PL. 118). Some of the people in the scene appear to be from the same ethnic group, traditionally identified as Chinese (see Paris, 1941: 345-347; Groslier, 1973: 172; Roveda, 2007: 320). Two men are bowing in front of the central figure of the sailing vessel; two attendants kneel behind this figure. In the fore there are two people playing a board game, and another one close to the pulley of the anchor (Roveda, 2005: 426; Roveda, 2007: 320). The aft of the ship has a cabin with someone inside, while three other figures are tending the riggings and the sails.

Two fishing boats are throwing and pulling their nets. The boat on the right side appears to be holding the lower part of a basket that is being pulled by people on the adjacent building while the paddler appears to be talking with another person inside the building.[135] These buildings have been previously identified as floating palaces or rafts (Roveda, 2007: 320-322), but the characteristic cross-section usually used for rafts is not present, and stilts are visible crossing through all the levels (PL. 119) so these could be stilted multi-story buildings, although Roveda argues that that the poles that this work identifies as stilts are a separation element (Roveda, 2007: 320). However, the interaction between characters from both sections and the fact that the stilts are not a continuous depiction from bottom to top suggests that the buildings are part of the nautical celebration. The buildings are filled with soldiers at ease facing in the opposite way of the sailing ship. Fish are depicted between the soldiers, so the building is in the middle of the water. In the upper building a court lady and a cohort of attendants are depicted.

[135] Groslier identified this basket as fishing gear (1921, 122) but it could equally be a device to pull goods into the multi-story building.

On the shoreline there are numerous people involved in everyday life activities, like women selling fish under a roofed structure, and a group of bearded people identified as Chinese betting in a cock fight against a group of locals (Gibson-Hill, 1952: 124). The scenes of everyday life extend from beneath the nautical celebration all the way to the doorframe and beyond it, where the naval battle is located. They continue in this scene up to the end of the wall, where a palace is depicted with the king inside surrounded by exhibition fights, soldiers at ease, musicians, and dancers (Roveda, 2007: 322).

Context of boats usage in Angkor's overseas connections

It has been suggested that the naval battles of Banteay Chmar and Bayon are similar (Groslier, 1973: 174-176; Roveda, 2005: 441). This similarity increases if the nautical celebrations are taken into account; in both instances there is a group of boats in the midst of celebrations and fishing activities on the left side of the battles (PL. 120). In Bayon the nautical celebration is separated from the naval battle by a stilted building. In Banteay Chmar the buildings are on the left of the celebration, while the peaceful boats are exposed to the naval battle. The nautical celebration in Banteay Chmar, however, lacks the everyday life scenes although it does have other peaceful activities on the shoreline.

Further parallelisms are found in the depiction of the palace on the right side; Roveda noted that the exhibition fight and the acrobat-dancer are identical in both scenes and similar to another scene in the northern gallery of the eastern wing in Banteay Chmar that also depicts an acrobat-dancer with musicians (Roveda, 2005: 441). He concluded that the dance was performed for the royalty on special occasions (Ibid.), so the similarities could be a repetition of the same performance or it could indicate that both scenes depict different versions of the same theme/event.

In Banteay Chmar the king is not inside the building but, as discussed above, the size of the admiral points to him being the king (Paris, 1941: 344-345; Jacq-Hergoualc'h, 2007: 129-131;

Roveda, 2005: 426; Roveda, 2007: 322). The king is depicted in the palace in the Bayon and as admiral of the fleet (Paris, 1941: 344-345; Roveda, 2005: 426; Roveda, 2007: 322). The repetition can be assumed to respond to a common artistic convention (also present in Khmer art, see above) where the duplication of a main character indicates the passage of time.

Parallels can be drawn due to the layout of the scenes; the *makara* decoration of the Banteay Chmar sailing ship, the clothing and headdresses of the people on board, and the strong hierarchy of size —particularly visible between the main character and the attendants on the aft— suggests that the main character was identified as a member of the elite by the Angkorian artists (PL. 121). On the other hand, the sailing ship of Bayon has slight changes in the hierarchy of size to identify the leader, but these are not as marked as in Banteay Chmar. The scene in Bayon seems to be connected to overseas contacts, possibly with China if the Chinese identity of the occupants is accepted, and the one in Banteay Chmar is likely related to regional politics. It seems likely that the panels are a conventionalized form of representing a naval victory and its consequences, although it cannot be discarded that the naval battle is actually a celebratory naumachia[136] and both panels depict a celebration, as has been suggested by Roveda (2007: 353). The latter interpretation does not imply that Angkor's fleet was not functional, on the contrary, staging these battles would have served as drills and showcased Angkor's naval prowess in front of foreign observers. The location of the representations in exterior walls and their large size indicate that the aim of their purpose was to show the Angkorian population the prowess of the Angkorian king in nautical warfare and its connections to regional and overseas politics. In the case of the Bayon, Groslier interprets the presence of the foreign ship as a metaphor for the prosperity of the kingdom after the victories of Jayavarman VII (1973: 172). It should be noted nonetheless that recent studies on ceramics suggest that international trade was not as relevant in Angkor as it was in insular Southeast Asia (see Miksic 2009b: 76-78). Angkor took part in tributary trade missions with

[136] Naumachia is a Latin term used to describe staged naval battles in the Roman Empire.

China (see Stuart-Fox 2003: 41, 47), but references to their missions are scarce compared to other regions in Southeast Asia, like Champa or Southern Sumatra (Stark 2006: 153, 161). If the image depicts people of Chinese ethnicity, then it is possible that the presence of this ship in the Bayon was used to emphasize the relationships between Angkor and China in the 12th -13th century CE. However, further research needs to be conducted to confirm whether the people on board were Chinese or if the panel depicts Angkor's relations to other regional polity. In any case, based on the iconography there seems to be a direct relation in both Banteay Chmar and Bayon between naval victories /naumachia and the presence of foreign vessels.

7.6. Conclusion

Through the biographies of the four main types of watercraft available during the Angkor period it is possible to reconstruct to some extent the way people perceived boats and their role in society. The Angkorian utilitarian watercraft was the functional vessel needed to use the water environment for economic purposes, either to travel toward resources or to exploit its resources. The anxiety generated by the risks involved in these journeys resulted in a specific behaviour surrounding the creation and use of these boats and the perception that a spirit imbued with energy living in the boat could help them overcome these dangers. The apotropaic character of this boat spirit was probably deeply entrenched in Angkorian society as that would explain the modification of these vessels into zoomorphic beings and their use as part of the elite's reconstruction of the divine macrocosm in the mundane world. As Stuart-Fox pointed out, the power of the Angkorian kings was dependent on their ability to reflect the heavenly realm of the gods on earth (Stuart-Fox, 2003: 51). The designs of the decorations may have stemmed from Hindu or Buddhist traditions, but the ability to infuse them with the necessary meaning was embedded in Angkorian culture.

The Angkorian mastery of wood carving and the ability to add weight to the boats without affecting their stability was down to a long standing ship building tradition, but perhaps what

really allowed the king to use boats as symbolic representations of magical creatures was the social behaviour surrounding boats. The attribution of agency to boats and the accompanying rituals would have been a fertile ground for the creation and use of a fleet of zoomorphic boats imbued with magic character. The careful choice of decoration shows creatures that acted as liminal agents between the human world and the world of the gods. Water was therefore seen as a threshold of the divine world within the context of boat use, which is consistent with Khmer cosmological traditions where the ocean features prominently (see Ang, 2007; Dolias, 2012).

The strong symbolic attributes of these decorated boats suggests that their use was tightly controlled by the king. The hierarchical order of Angkorian society was reflected in the boats through decoration and also through the social distribution of space within the boats, which established that the main character had to be amidships. The context of usage of these boats varied from religious to warfare, but in both cases the magical character of the boat spirit contributed to emphasize the divine connection that the kings of Angkor were striving for.

Nonetheless, the river network was not only the threshold of the divine world, it was also the main access that the people of Angkor had to prestige goods arriving from overseas. These were carried by sailing ships made from boat building traditions that were radically different to those used in Angkor. That the people of Angkor had access to these traditions is apparent in the data, the fact that they did not incorporate these into their own traditions —as attested in the iconography and the ethnography— is indicative of the profound attachment they had to their own ways. In this sense, the value of their boats as apotropaic beings and the risks involved in altering the magico-religious practice that surrounded boat construction seems to have outweighed any benefit involved in incorporating new technology.

Chapter 8

8. Conclusion: Angkor's fluvial cultural landscape

This thesis set out to discover whether the people of Angkor developed a specific set to cognitive and functional traits in relation to the use of the aquatic environment that could be labelled as a distinctive form of fluvial cultural landscape. A cross-disciplinary research framework was used, one that was entrenched in a geographically-oriented landscape perspective that would incorporate data from archaeology, iconography, history, and ethnography.

The first task of the thesis was to set aside the idea that rivers were homogenous water highways and bring forth the complex reality behind the use of rivers in terms of navigation. Through the combination of archaeological, ethnographic, environmental, and geographical data I identified different transport zones based on the limitations that hydrology and topography imposed on water transport. This was then combined with previous studies on road networks to see how rivers and roads interacted in order to offer an integrated approach to Angkor's landscape of transport and communications.

The data incorporated in this study was previously analyzed in a fragmentary way, resulting in skewed interpretations of archaeological data. For example, Hendrickson's analysis of the road network fails to recognise the connection between the temples of Banteay Chmar, Banon and Prei Nokor and the river network as part of Angkor's transport network (2010: 493). He uses the apparent disconnect of these temples from the road network to cast doubt on claims that Jayavarman VII, who initiated these temples, was the king responsible for the construction of

the Khmer road system (ibid.). However, these temples are located in the vicinity of navigable rivers, and most importantly, Prei Nokor was constructed in an area that has a long-standing history as a sea-river port. Therefore, the construction of these temples in key areas for water transport points in fact to Jayavarman VII's strategy to gain full control of Angkor's landscape of transport and communications. This is congruent with the iconography of the naval battles depicted in Banteay Chmar and Bayon, both located in public spaces and designed to emphasize the king's prowess in naval warfare and his ability to attract overseas merchants. The integration of this data paints a different picture: that of an Angkorian king profoundly invested in the control of Angkor's transport network through the pacification of the waterways and the improvement of infrastructures, both for roads and rivers.

Similarly, the failure to include aspects of navigation in the study of bridges for over a century has prevented scholars from recognizing that the late appearance of masonry bridges is related to boat transport. The use of corbelled bridges by Khmer architects imposed limits upon the span between columns that was necessary for safe navigation during low waters. Additionally, during the rainy season the water would have been so high that bridges would have impeded continuous navigation. Taking this into account, masonry bridges can be interpreted as mechanisms of control of economic activities (preventing boats from moving freely and forcing a stop) and for surveillance (preventing naval invasions into the Angkorian homeland)., and may point to a change in transport priorities.

The problematization of Angkor's landscape of transport and communications is necessary not only to fully understand the issues mentioned above, but also to provide a more accurate view of the limitations imposed on it by the environment and the true extent of the river network. The integrated data is presented here in a series of topological maps that incorporates details on river navigability and road viability according to season. The maps present the three different aspects of Angkor's landscape of transport and communications during the rainy

season, the onset of the dry season, and the end of the dry season. The combination of these maps with further data on livelihood activities related to fishing and agriculture provides a more complex view of patterns of movement during the Angkor period and can be used as an analytical tool for future studies.

Further analyses of nautical technology and boat biographies have shown that Angkor's river networks were unified culturally through economic and politico-religious activities. Previous studies on the boats of Angkor were reliant on iconography and focused mostly on technological aspects of boat construction. In this thesis I have striven to conduct a different analysis, looking at the context of creation, modification, usage, and ending of boats from a cross-disciplinary perspective.

The discovery of the Angkor Thom and the Kra Raleung boat remains have been of utmost importance, as they clearly indicate a continuity in boat building traditions from the Angkor period to the present. Further to this, the analysis of traditional shipbuilding techniques and hull design shows great cohesion between the Sambhupura and the Tonle Sap transport zones, although their environments are not the same (i.e., the first is a river environment with rapids, the second is a lake environment with mild currents), something that could be explained if during the Angkor period fishermen followed the same migration patterns recorded among fishing communities in the late 19th century (see Gruvel, 1925). This annual movement of fishermen from the Sambhupura transport zone to the Tonle Sap basin following fish migrations would have resulted in a back and forth movement that likely contributed to the dispersal of culture and goods along the Mekong River. Further studies need to be conducted to fully understand the role of these nomadic communities, but they appear to have been involved in transporting goods and providing Angkor with fish at a time when the agricultural communities were busy with the harvest.

In terms of Angkor's fluvial cultural landscape, the annual journey of these fishing communities had two additional consequences. On the one hand, these groups would have developed cognitive maps of the landscape and good navigational skills, as they had to travel hundreds of kilometres every year. This type of skill would have been crucial for piloting sea-going ships moving upstream to trade, as fish migrations also involved people from the Mekong Delta transport zone moving into the Tonle Sap. On the other hand, as seen in chapter 7, the need to travel such long distances every year was probably what triggered the development of coping mechanisms to overcome the anxiety that facing these dangerous journeys would undoubtedly generate.

Archaeological and ethnographic data indicates that the people of Angkor believed that boats were sentient beings with other-than-human agency capable of affecting the outcome of the boat's journey providing safe passage and guaranteeing a profitable endeavour. The cooperation of the spirit depended on the ritual behaviour surrounding the creation and use of the boat, which resulted in a strong attachment to traditional boat building practices discussed in chapter 6. As Hunter suggested, once an optimum design has been developed, change may be seen as superfluous and as an unnecessary risk (1994: 263) even if it made more economic sense. If the spiritual component is factored in, it seems that the apotropaic character of the traditional boats of Angkor and the risks involved in not following traditional practices outweighed potential economic benefits from using other techniques available to them, such as plank-built designs.

The economic use of the landscape and the cognitive processes that led to the development of ritual behaviour around boats is what constituted the core ideological framework of Angkor's fluvial cultural landscape. Studies on folklore suggests that in Khmer oral tradition the aquatic environment is the threshold to the divine world as well as the origin of the cosmos(see Ang, 2007; Dolias, 2012), and it would seem that the boats of Angkor were perceived as liminal

agents of the watery environment capable of inhabiting and moving between worlds. The magico-religious dimension of boats and boat-building has not been considered before, because social behaviour surrounding boats was not taken into account in previous studies or in the case of Hoc (2001), it was not contextualized within the iconography.

By drawing from archaeology, iconography, and ethnography, this work has been able to identify an initial layer of fluvial cultural landscape upon which the kings of Angkor relied when they extended the recreation of the divine world into aquatic spaces. As has been discussed in chapter 7, the power of the kings of Angkor depended on their ability to demonstrate to their subjects that they could tap into divine sources of power. The creation of symbolic associations that attempted to reconstruct the divine macrocosm in the mundane microcosm has been documented in Angkorian city planning (see Stuart-Fox and Reeve, 2011), and can now be proposed for water transport.

Inspired in mythological stories from the Hindu and Buddhist traditions for the design of boat decorations, the kings of Angkor relied on the expertise of Angkorian boat builders to create zoomorphic boats that would confer more realism to the premise of a divine city in a mundane world. Furthermore, traditional practice surrounding the construction and use of boats would have strengthened the premise that these decorated boats were magic beings with agency. The creation of this fleet of decorated boats allowed the kings of Angkor to colonize the aquatic environment with liminal agents under their control capable of moving in the metaphysical space. This suggests that the fluvial cultural landscape of Angkor was part of a wider social framework where water played an important role.

The iconography shows how these boats were used to transport members of the elite across man-made or natural bodies of water. Both the natural and the constructed landscape gave plenty of opportunities for the elite to use these boats. Reservoirs would have been particularly important spaces to display this kind of watercraft since, as Feneley, Penny, and

Fletcher pointed out (2016: 290), these were intensely ritualised locations. The visual impact created by one of this zoomorphic boats navigating to island temples such as Neak Poan, or the East and West Mebon would have undoubtedly contributed to legitimise royal rule.

The direct association that could be made between the decoration and the user of the barge meant that these items had to be carefully controlled by the king. As the example from Thailand suggests, a multi-headed *nâga* decoration in the stem post of a boat could transform the king into the living representation of *Vishnu Anantasayin* when he boarded the boat. The Hindu tradition of assigning mounts to divinities means that the user of a decorated boat could be identified as the divine counterpart of the creature, therefore the kings of Angkor probably had the same degree of control over these vessels as the kings of Ayutthaya had over their royal barges (see Ribadeneyra, 1601; Gervaise, 1688; Tachard, 1688).

Except for the war boats, the location of the majority of the depictions of decorated boats in private spaces of the temples suggests that the activities they were used in were of ritual or religious character. Some activities, like the two facing boats involved in what seems to be a local myth of ritual taking place in a pond in BY-IG.VI, are difficult to interpret but the context shows that nautical events took place in ponds or man-made reservoirs. Pilgrimages are also depicted for single and multiple vehicles; an example of the latter shows how these events could be incorporated into regional politics as BY-IG.V shows the presence of Cham delegates in the closing barge. The use of identical boats in this scene can be interpreted as a sign of the king's control over decorated vessels and access to key pilgrimage sites.

Though there is one instance of a public festival or celebration, there are no indications of festivities that could be seen as analogous to the racing boats of the Water Festival. Additionally, while the races of the present-day Water Festival currently inaugurate the Khmer New Year (Uk and Uk, 2016: 63), in Zhou Daguan's account there are no references to boating events during this month, only to fireworks (ibid.: 60). From the available data it is unclear

whether boat races were celebrated during the Angkor period as part of their fertility rites,[137] but it is possible that propitiatory rituals related to hydrological cycles had other forms in the past.

Zoomorphic vessels were not only used for peaceful activities, they were also used in warfare. As a source of economic wealth, the kings of Angkor would have wanted to secure the sea-river trade route as well as fishing routes into the Tonle Sap. Foreign threats could be neutralized in strategic transit points like Kompong Chhnang, but contesting powers in the Tonle Sap meant that warfare had to incorporate amphibious capabilities to defeat competing powers in the region. The Angkorian fleet was equipped with aggressive-looking decoration aimed at intimidating the enemy not only visually, but also psychologically. The choice of the *makara* for hull decoration implies a continuation of the macrocosm correlation into warfare. Further to this, modifications extended to new methods of propulsion that helped them protect the "engine room" of their boats from projectile weapons thrown from enemy boats or from the shore. War boats were therefore modified to accommodate new technologies and to perpetuate the idea of the king's ability to tap into the divine world.

Social hierarchies were reflected in the fleet of Angkor. Undecorated boats or those with *makara* decorations corresponded to lower ranking soldiers (i.e., soldiers wearing loincloths) while the combination of *makara* + *garuda* was destined for special military units (i.e., archers or soldiers wearing jackets) and/or for vessels with military leaders. The largest war boat with special decoration corresponded to the admiral, setting him apart from the rest of the fleet.

The hierarchical organization and the technological advances that resulted in modification to the war boats suggest that amphibious and naval threats were common enough in the Tonle Sap for the Angkorian kings to retain a fleet and invest the necessary resources to maintain it —such as training and housing rowers as well as the officials in charge of coordinating boat

[137] See Loofs-Wisowa (1991).

movement. The discussion on amphibious warfare in chapter 7 has set forth that the opposing fleet came from the Tonle Sap and not from the Sambhupura or the Mekong delta transport zones. Previous studies on the naval battles focused on the Cham identity of the enemies and assumed that the fleet arrived either through the mountains and down the Sambhupura transport zone, or through the sea and up the Mekong Delta transport zone. These analyses failed to incorporate details on the logistics and strategies of amphibious warfare (see Paris, 1941; Jacq-Hergouacl'h, 2007). For example, an army coming through the mountain passes of the Annamite range would have had to carry their war boats or procure them upon their arrival in the Mekong River, then navigate the turbulent waters of the rapids. Any fleet coming into the Tonle Sap would have had to navigate through the bottleneck of the Tonle Sap River, at which point the armies of Angkor would have been able to cut their access using pontoon bridges and projectile weapons. These and other factors discussed in chapter 7 strongly suggest that the opposing fleet was based on the Tonle Sap Lake, not in Champa.

The public nature of the naval battles depicted in Angkorian art indicate the relevance that king Jayavarman VII placed on promoting his prowess in naval combat. The fact that one of the representations is located in Banteay Chmar, in North-western Cambodia, and not at the entrance of the Tonle Sap River is better explained if the king was trying to intimidate regional powers like Malyang.

The explicit inclusion of sailing ships in the same panels that depict his naval victories may imply to things: 1) that Jayavarman VII was making a direct relation between the pacification of the waters and the arrival of foreign ships that contributed to the prosperity of the king's realm, or 2) that we are before a naumachia celebration where foreigners took part as witnesses of the event. The representation of these scenes in public spaces and in large format indicates that Jayavarman VII wanted to show his prowess in naval battle, probably as a warning for rebellious territories like Malyang.

Angkor's reliance on its river networks affected both its economic and political sphere, so what would happen if the pulse of the river was altered? Two mega-monsoon events have been recorded in the 14th and 15th centuries that were characterized by long periods of draught followed by intensive rain. Damage to Angkor's flood-control mechanisms has been documented, and its decline has been linked to this destruction (Buckley et al. 2010: 6749-6750). However, its effects on water transport and Angkor's fluvial culture have not been evaluated. Prolonged droughts would have affected the extent of Angkor's fluvial network. Seasonal rivers may not have been accessible for long periods of time and year-long navigable rivers likely had diminished flows that reduced their navigability. Furthermore, flash-floods from intensive periods of rain would have increased the risk of navigation (i.e., boats could be carried away in the flash-floods and debris from the strong rain would increase the risk of collision).

A serious reduction of Angkor's transport capabilities probably affected the ability of the Angkorian capital and its surrounding centres to function as cities. The drought would also affect fishing stocks, without which the people of Angkor would have found it difficult to consume protein in their diet. Wind patterns in the South China Sea would also be affected by these mega-monsoon events, so there is a strong possibility that Angkor's ability to engage in international trade suffered as well. So from an economic perspective, the mega-monsoons likely had dire consequences that contributed to the demise of Angkor. On the political sphere, the carefully crafted symbolism around decorated boats may have helped to enshrine regal power in Angkor in times of normal flooding cycles, but the erratic behaviour of the river flow during the mega-monsoon periods may have contributed to undermine the king's authority.

The integrated approach of this study has provided a new way of thinking about old problems, and has contributed to the debate by highlighting the role of Angkor's fluvial cultural landscape both in the economic and the political spheres. Additionally, by setting forth the

way these would have been affected by the mega-monsoon periods I have been able to propose alternative reasons for Angkor's demise that are entrenched not only in the economy, but also in politics.

There are lines of research derived from this work that would benefit from further attention in the future. The role of nomadic fishing communities in the dispersal of knowledge and material culture is a topic that should be closely looked into. Ethnographic data on fishing communities and archaeological remains of material culture could be used as proxy to test the extent of their impact in the homogenization of Khmer culture in the Tonle Sap and the Sambhupura transport zones. The archaeological material could be better understood by conducting socio-spatial network analysis using similar methods to those applied in the Mediterranean (see Leidwanger *et al.*, 2014). This would involve a diachronic approach to river networks and their overseas links, the use of archaeological data (i.e., pottery imports) as proxy for connections between sites, and further analyses of shared styles as indicators of interaction (Ibid.).

Further work should also be conducted in Kompong Cham/Wat Nokor and Kompong Chhnang (both archaeological and ethnographic) to better understand the way in which Khmer riverine ports work(ed). This is particularly urgent as the Khmer Rouge genocide and globalization have eroded lines of cultural transmission and traditional knowledge can be expected to rapidly deteriorate.

Jenner already noted that there was a need to conduct linguistic studies on nautical terminology (1973), this and further linguistic work on place-names along the Cambodian Mekong River could also help reconstruct the cognitive landscape of the region and shed some light on traditional navigation.

The potential applications of this study extend beyond the Angkor period. The post-Angkorian boat paintings found by the author in Angkor Wat (Walker-Vadillo, 2009), which included two European-rigged ships, suggests a continuation of nautical traditions in the early kingdom of Cambodia. The analysis of these paintings within the context of Angkor's fluvial culture can provide insights on local politics and the regeneration of the region's overseas trade during the late 16th and early 17th centuries. Moreover, the fluvial perspective presented in this research can be used to reshape studies on the post-Angkorian capitals of Oudong and Longvek, using the topological maps and information on navigation as well as details on port structures in the Mekong River to define new lines of inquiry.

The work presented here is only an example of what can be achieved by changing the research paradigm to one that fully embraces the nuances of the aquatic world, be that the sea or the rivers. By engaging with theoretical approaches such as Westerdahl's Maritime Cultural Landscape (1992) or Van de Noort's boat biographies (2011), researchers will be able to recognize the impact of maritime or fluvial cultures into their social framework and bring a balance to the narratives of the past in regions with amphibious landscapes.

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The fluvial cultural landscape of Angkor

An integrated study

APPENDICES



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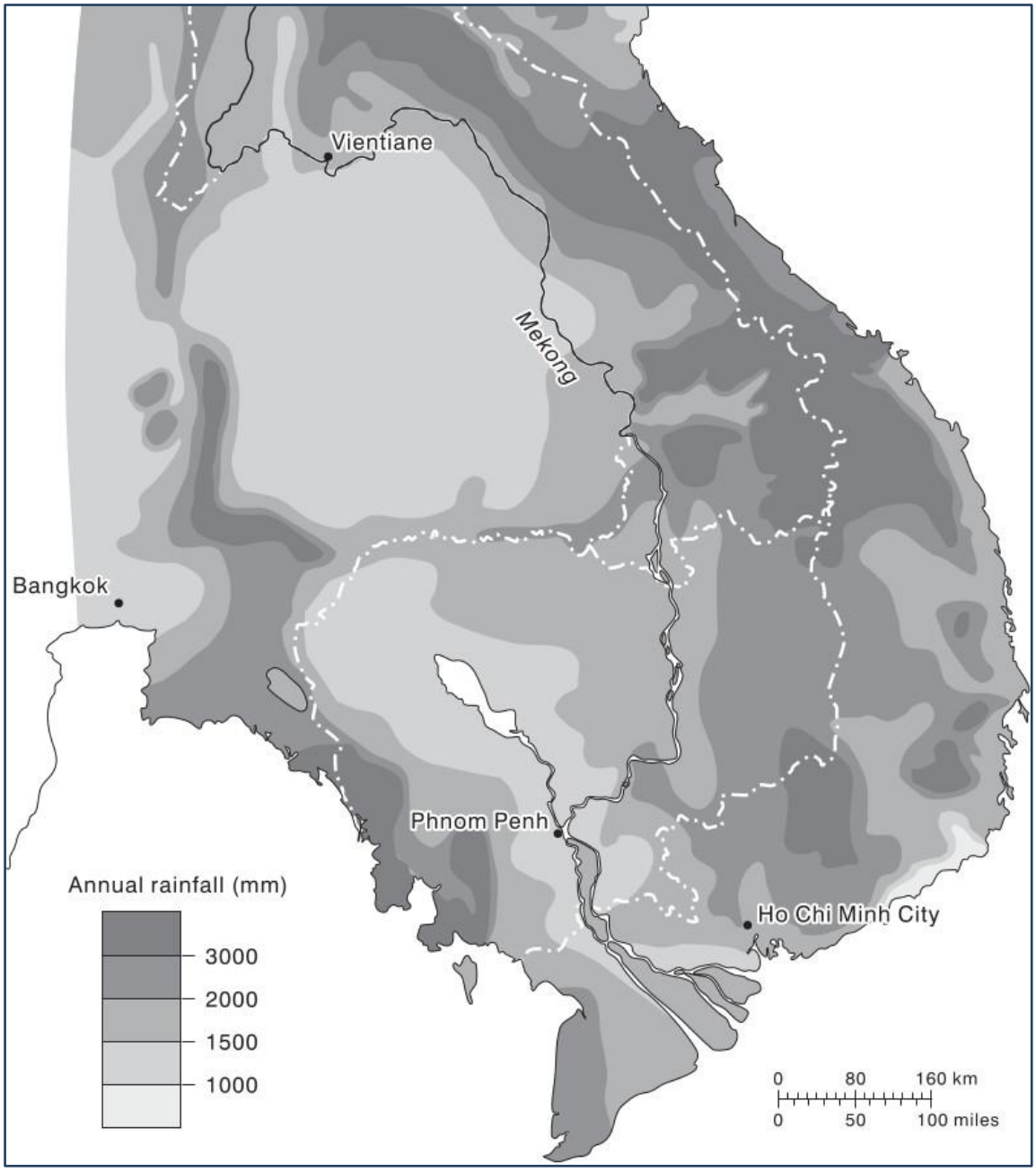
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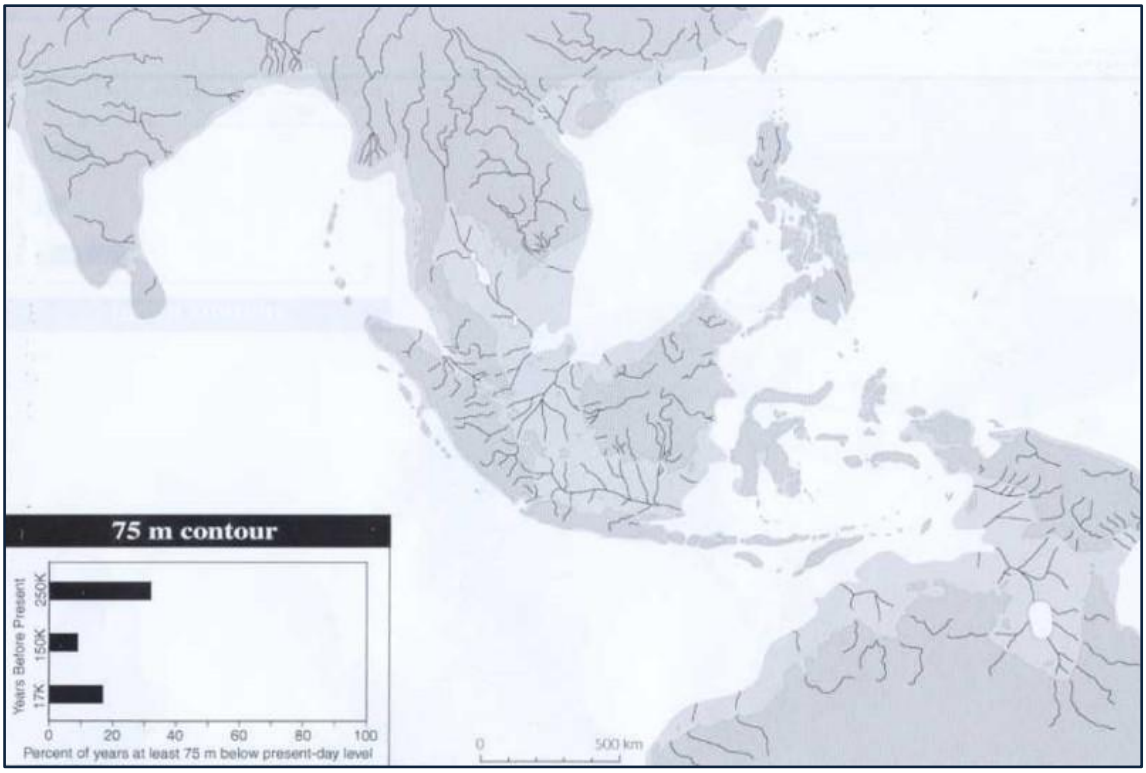
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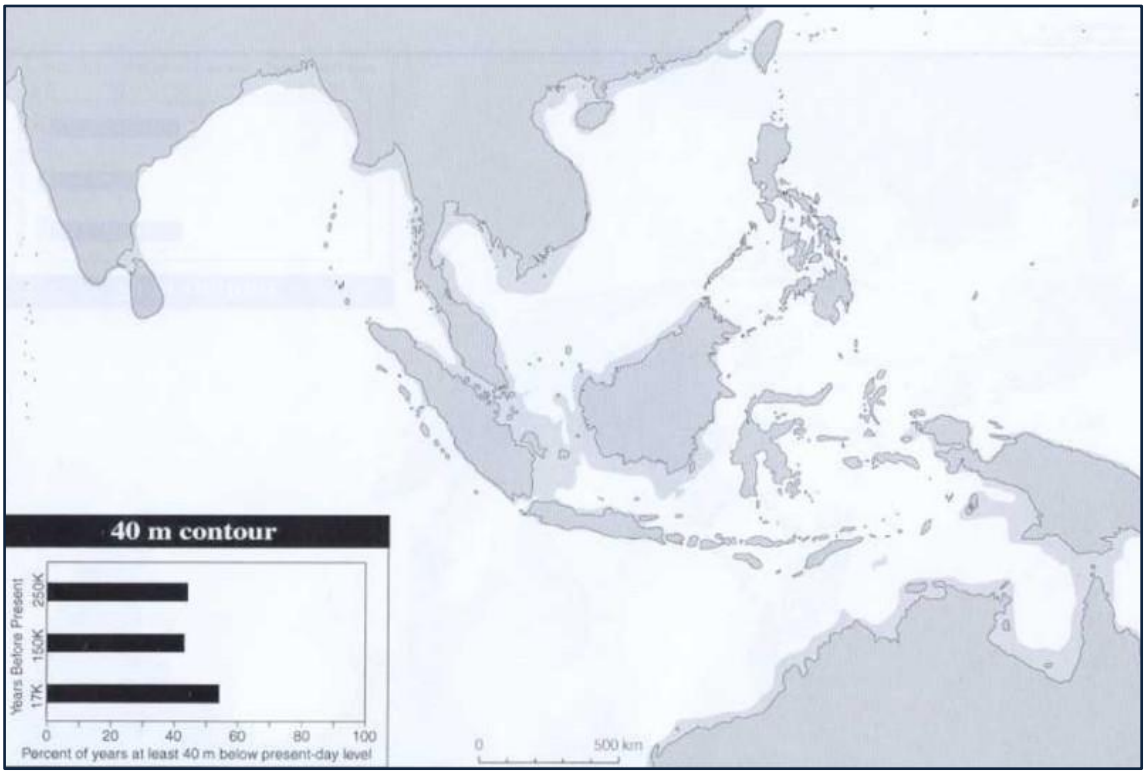
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PL. 1: Annual rainfall in mainland Southeast Asia. Source: Gupta, 2005.



PL. 2: Sea level with a 75 m contour at c. 13,000 yr BP. Source: Voris, 2000.



PL. 3: Sea level with a 40 m contour. source: Voris, 2000.



PL. 4A

PL. 4A-D: The Phapheng-Khone falls disrupt water communications between Cambodia and Laos. Source: Google Earth. Following page: the roaring waters of the falls during the rainy season (August 2013). Source: B & C by T. Cristofoletti, D by Savethemekong.org



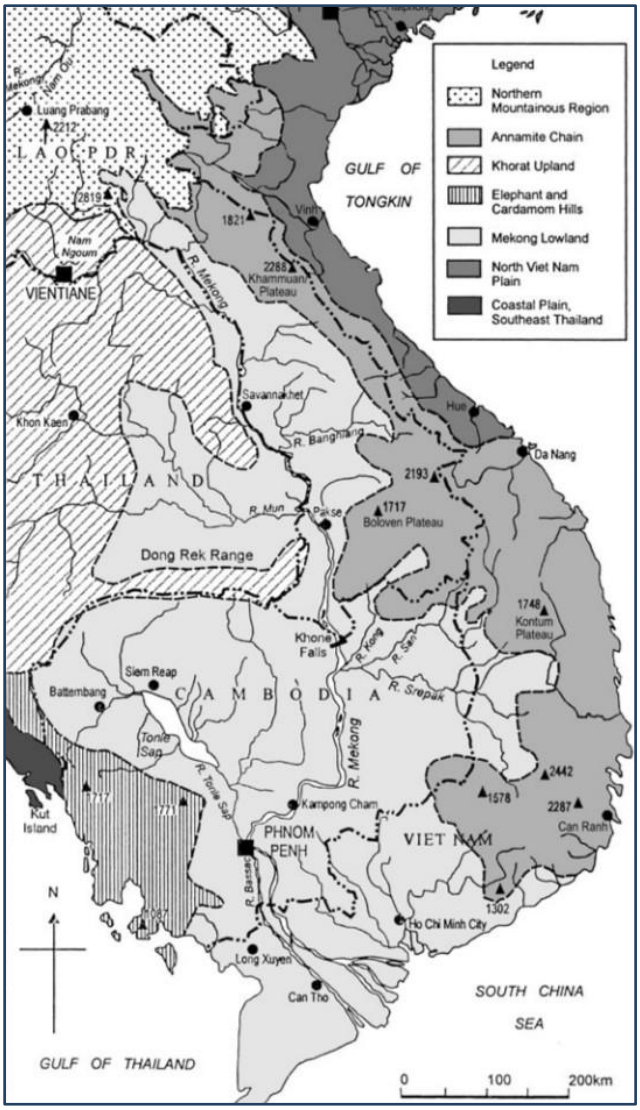
PL. 4B



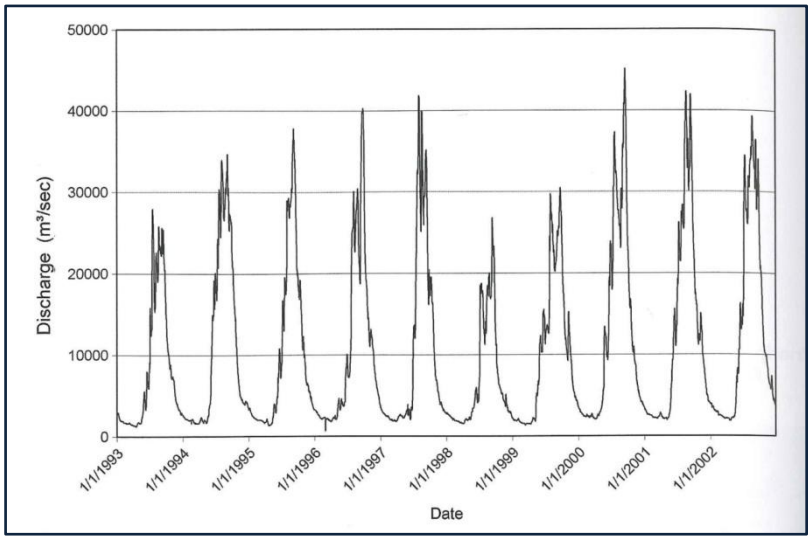
PL. 4C



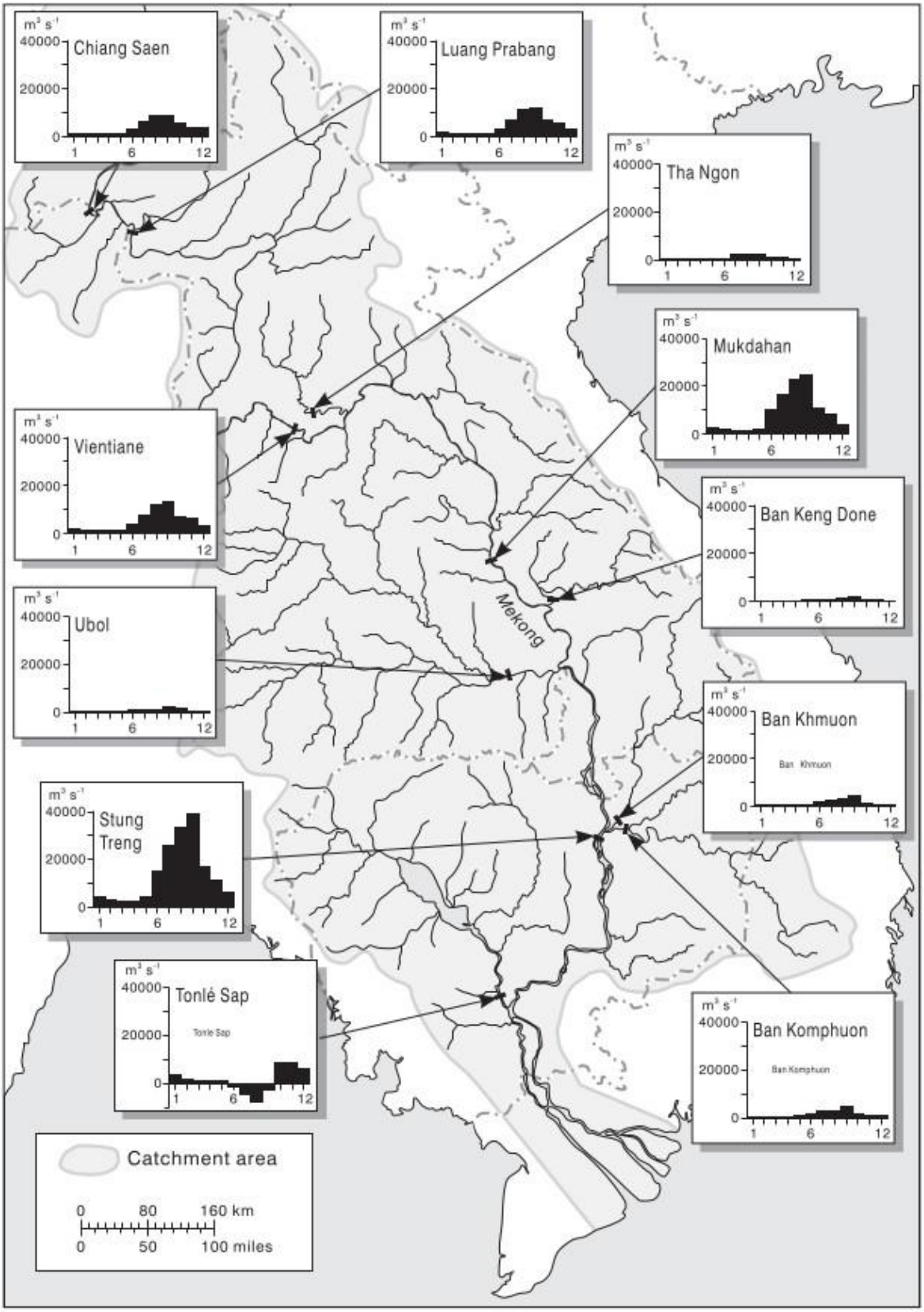
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PL. 5: The Mekong River basin and its geology. Source: Gupta, 2005.



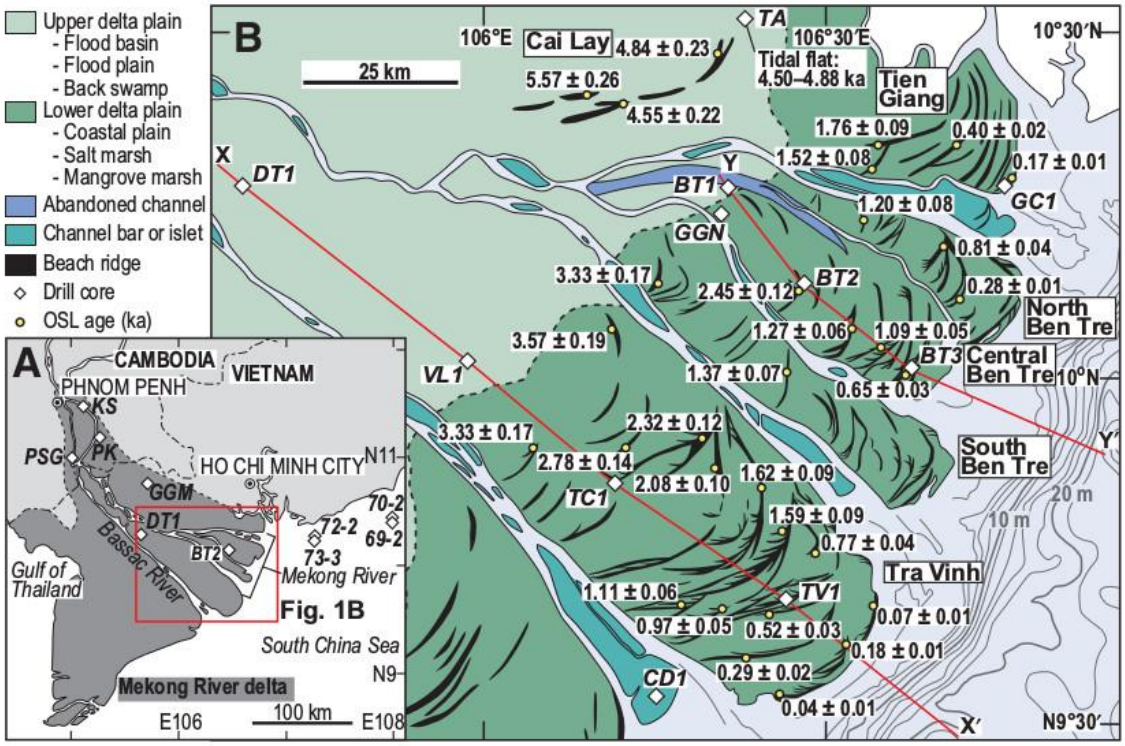
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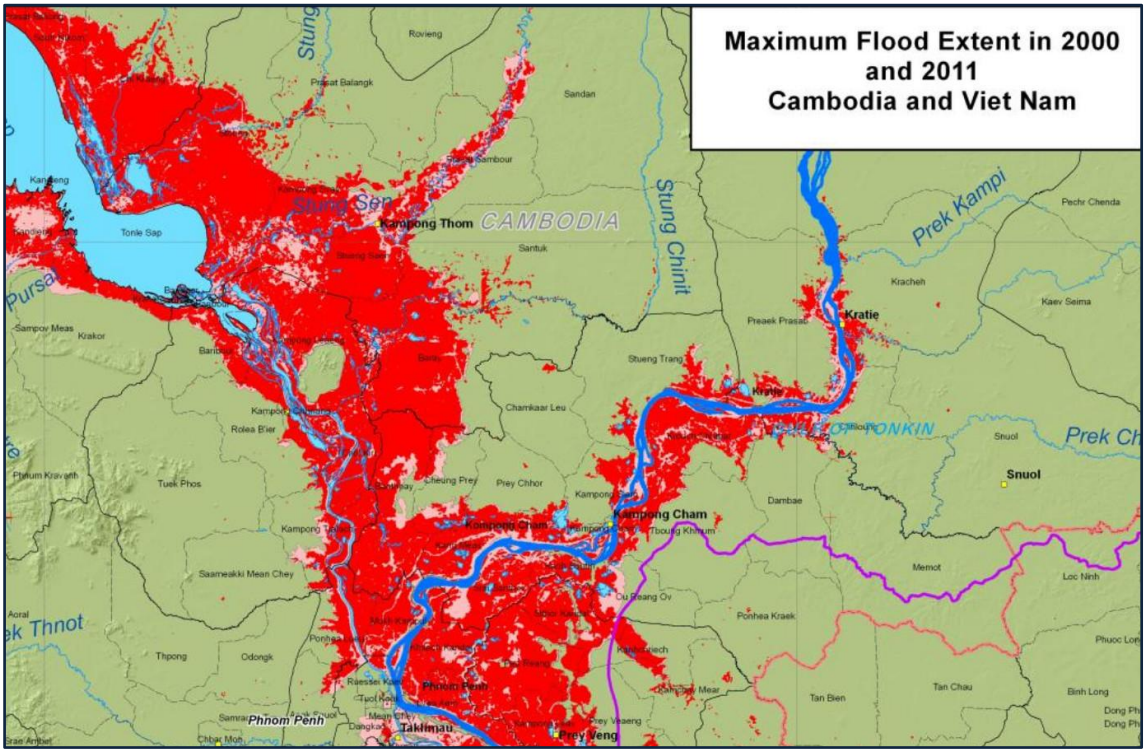
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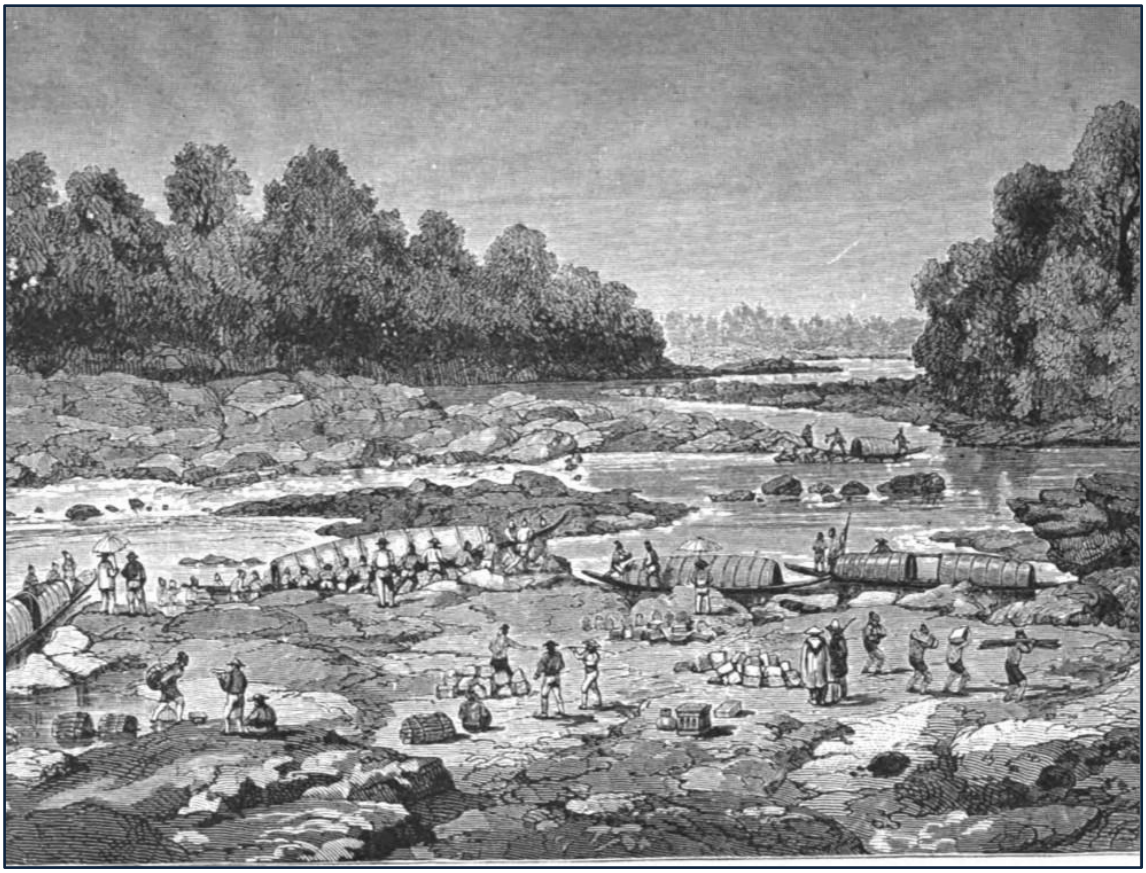
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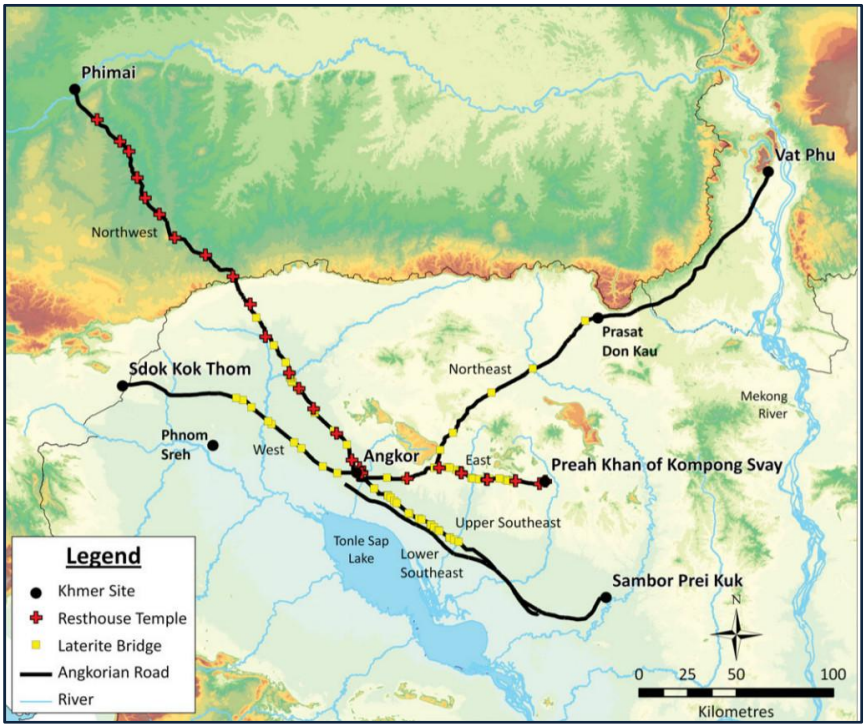
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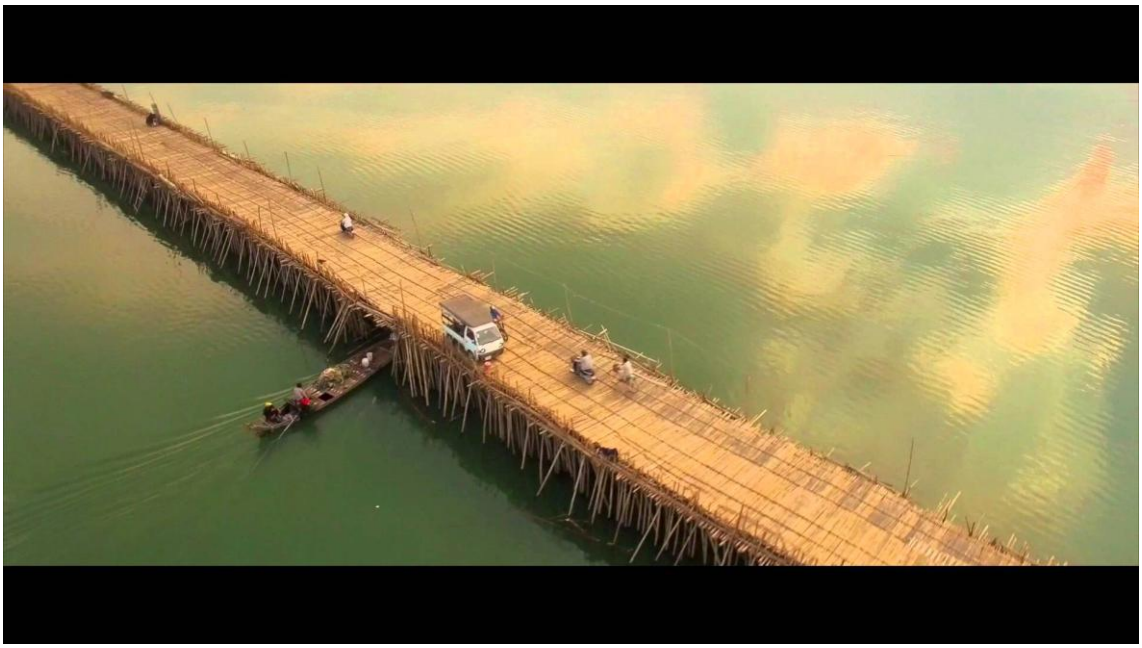
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PL. 16: Spean Praptos blocks the waterway during the rainy season. Source: A. Brouwer.



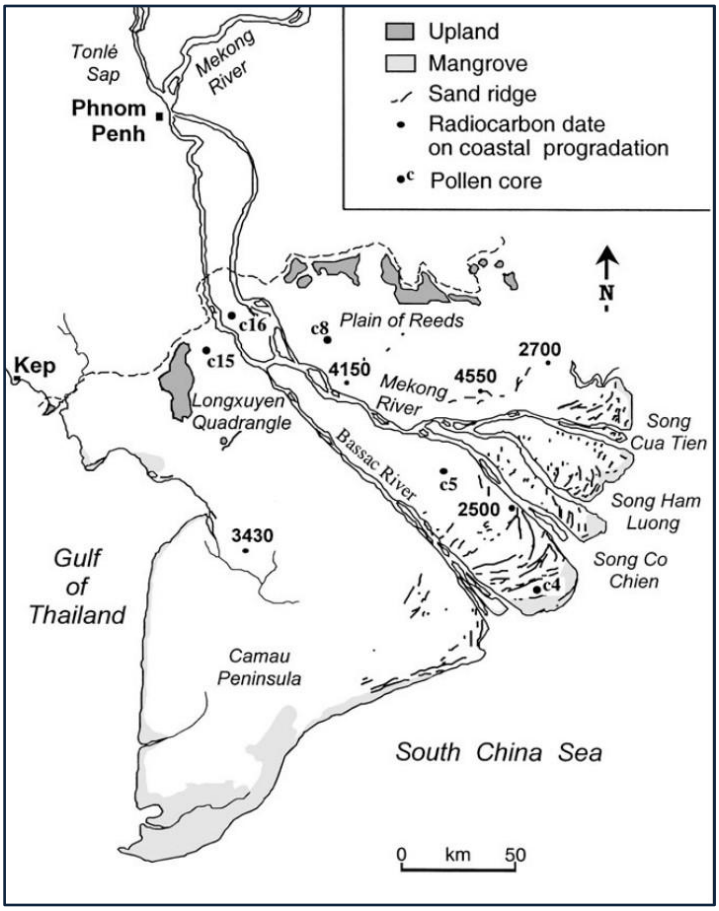
PL. 17: Bamboo Bridge in Kompong Cham area. Source: video capture from video Bamboo bridge to Koh Paen Island by drone by Kimlong Meng. Online resource: https://www.youtube.com/watch?v=DKTmgPog8Jk visited on the 18/09/2016.



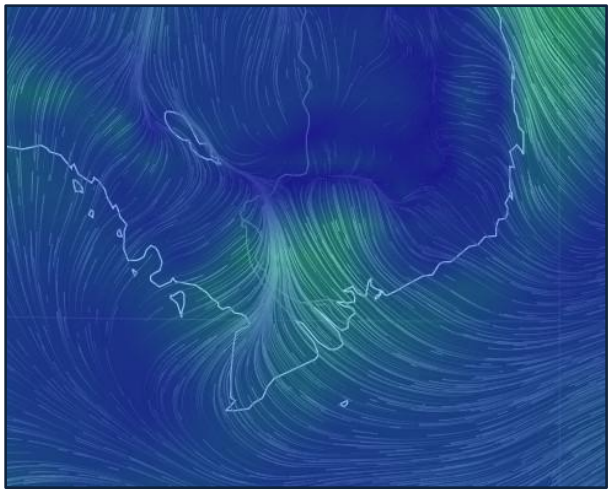
PL. 18A-B: Bamboo pontoon bridge and raft in Kratie. Full view and close up. Source: K. Katfin.



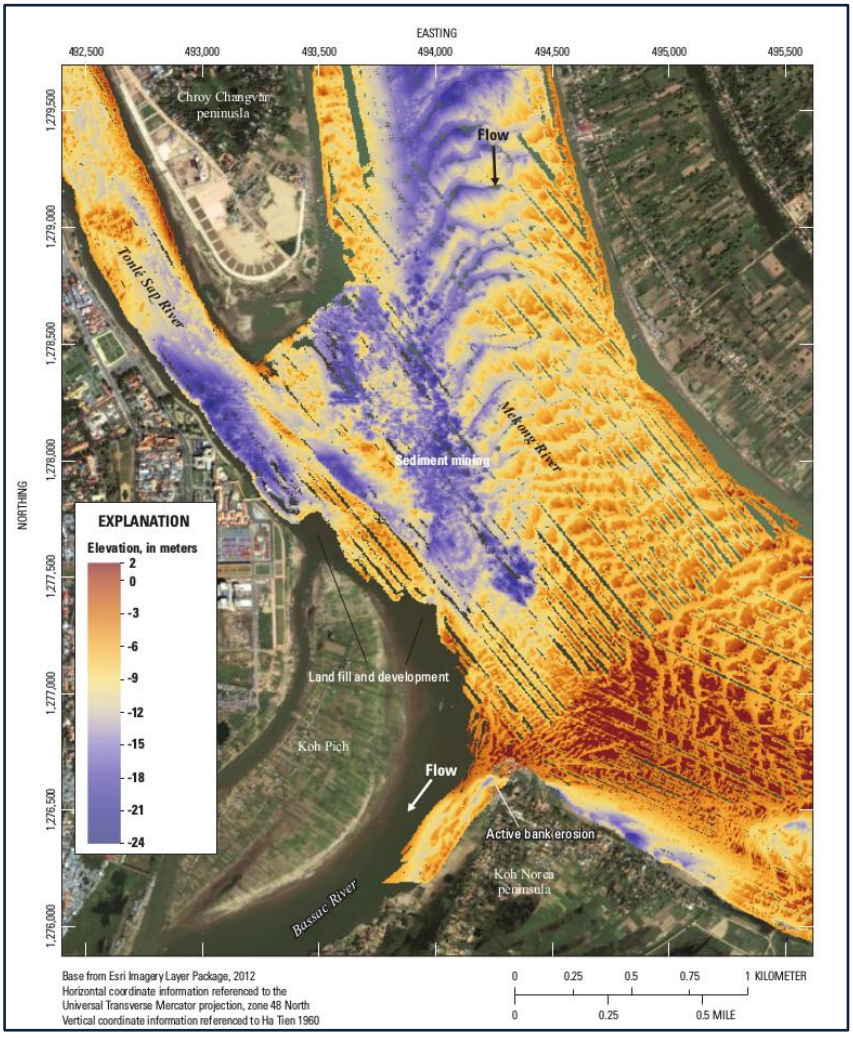
PL. 19: Boat in dry dock in the Tonle Sap. Source: A. Tovsen.



PL. 20: Mekong delta and its estuaries. Source: Gupta, 2005.

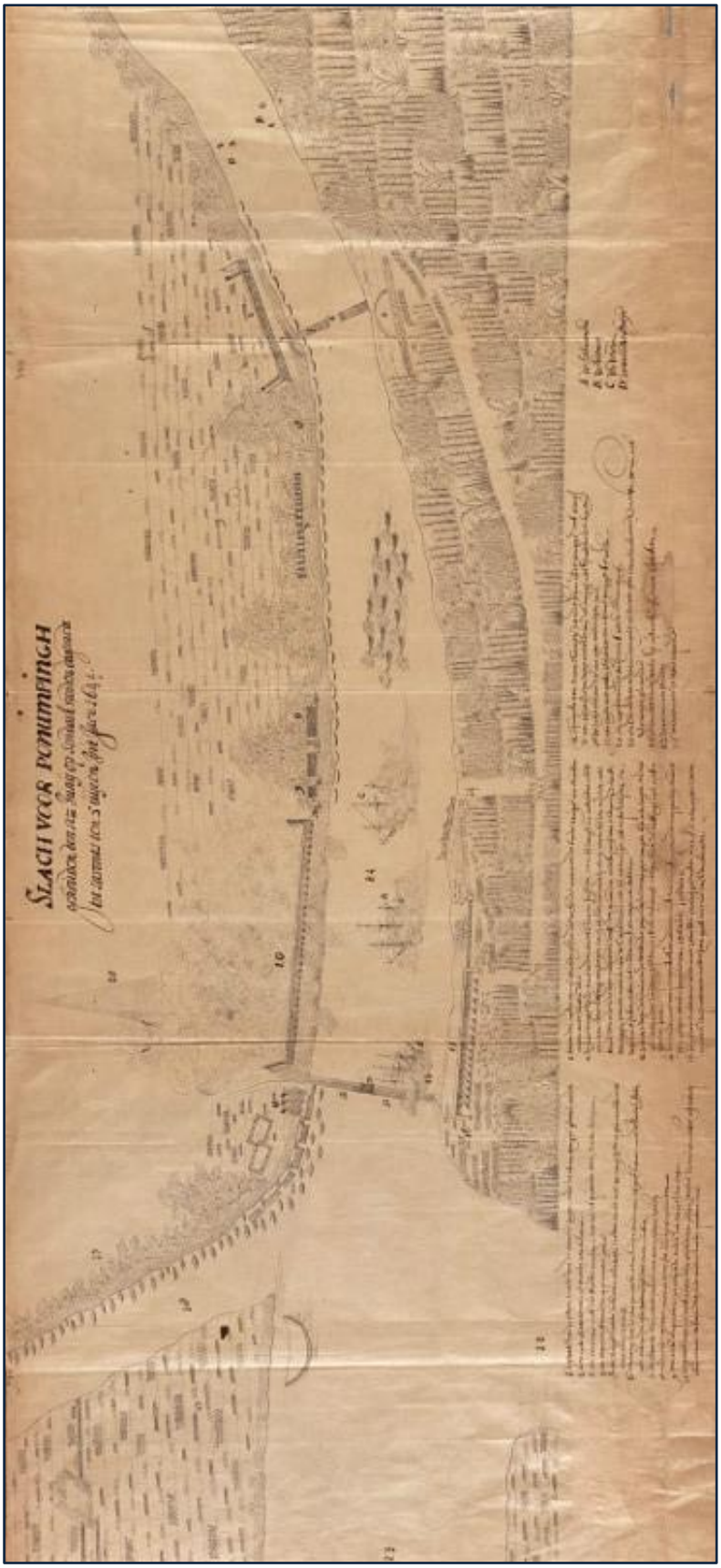


PL. 21: Winds blowing into the Mekong River from the South China Sea during the dry monsoon. Source: Earth Wind Map.[1]



PL. 22: Bathimetry of the Chaktomuk area. Source: Dietsch, DEnsmore and Wilson, 2014.

[1] Online resource: https://earth.nullschool.net/#current/wind/surface/level/orthographic=103.89,9.50,2274/loc=106.595,9.503 visited on 18/09/2016.



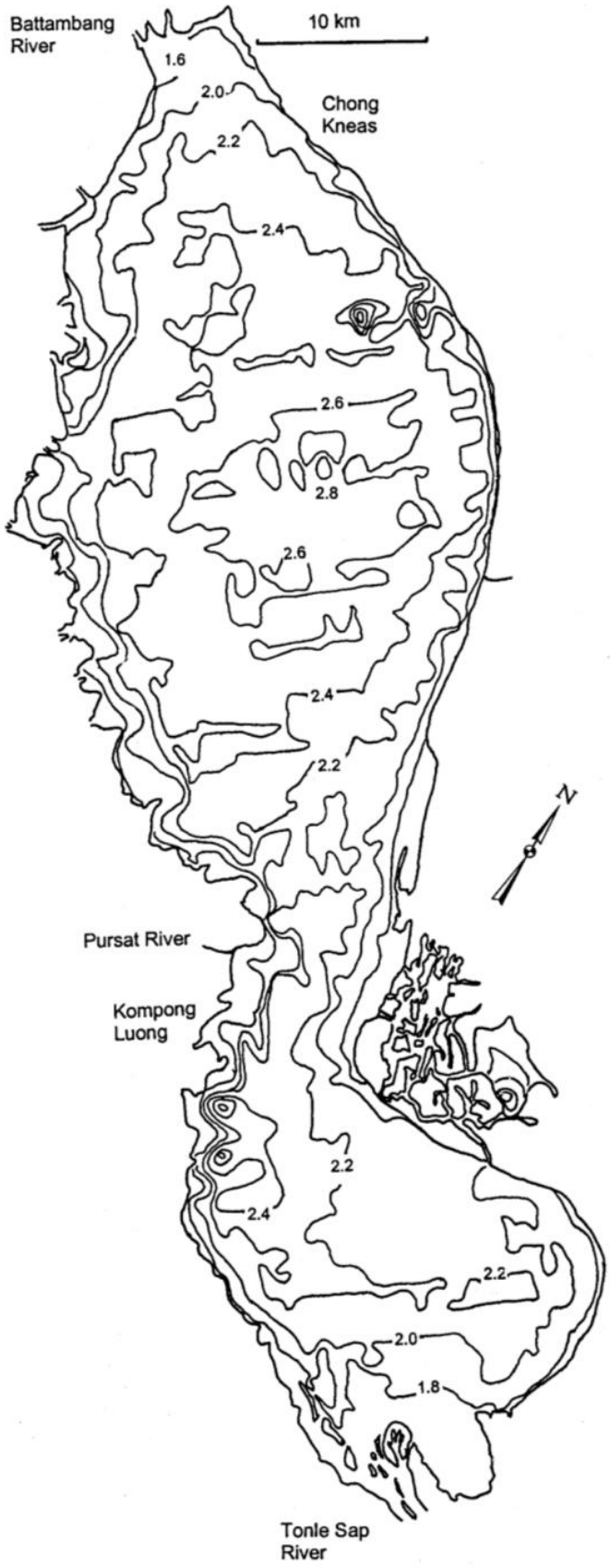
PL. 23: Dutch engraving of the battle of Phnom Penh between the Dutch and the Cambodians in 1644. Source: Van der Kraan, 2009.



PL. 24: Map of Phnom Penh in 1867. Source: Archives Generales de l'Indochine.



PL. 25: Satellite image of the Chaktomuk area with Phnom Penh on the left section. Souce: Google Earth.



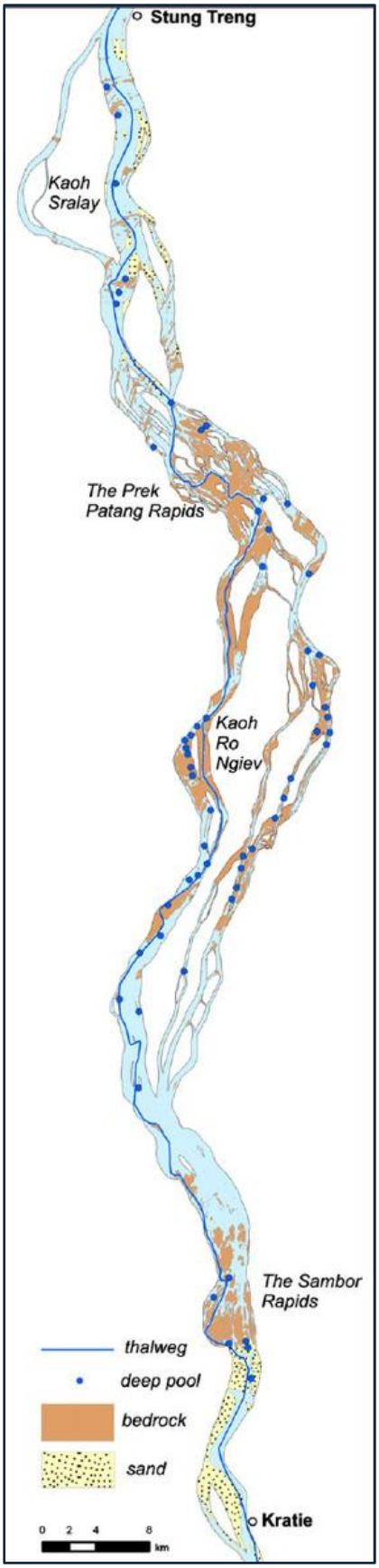
PL. 26: Bathymetry of the Tonle Sap Lake during the dry season. Source: Campbell, 2006.



PL. 27: View from a local boat of the shoreline of the Tonle Sap Lake. Source: V. Walker.



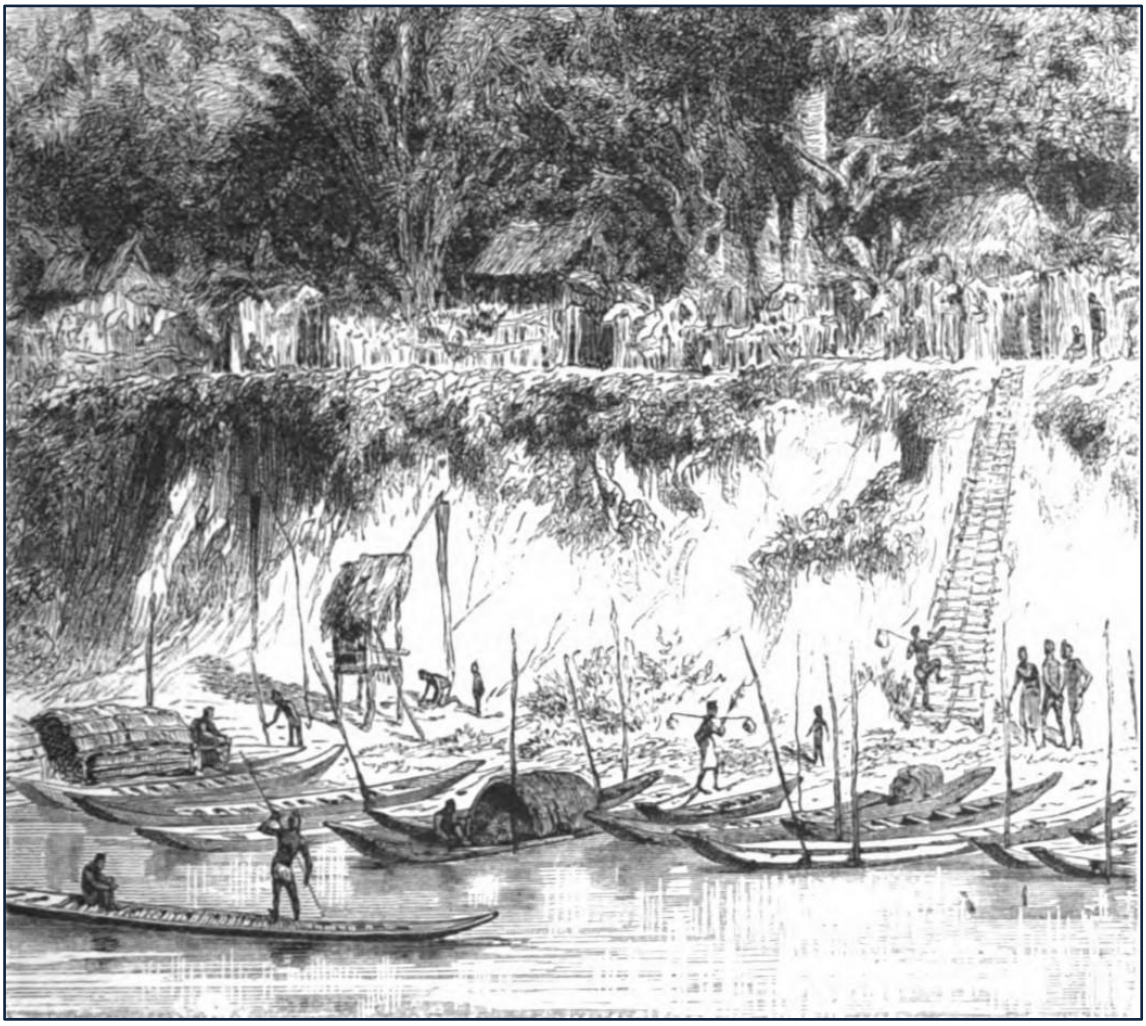
PL. 28: Colourful boats of the Tonle Sap Lake. Source: V. Walker.



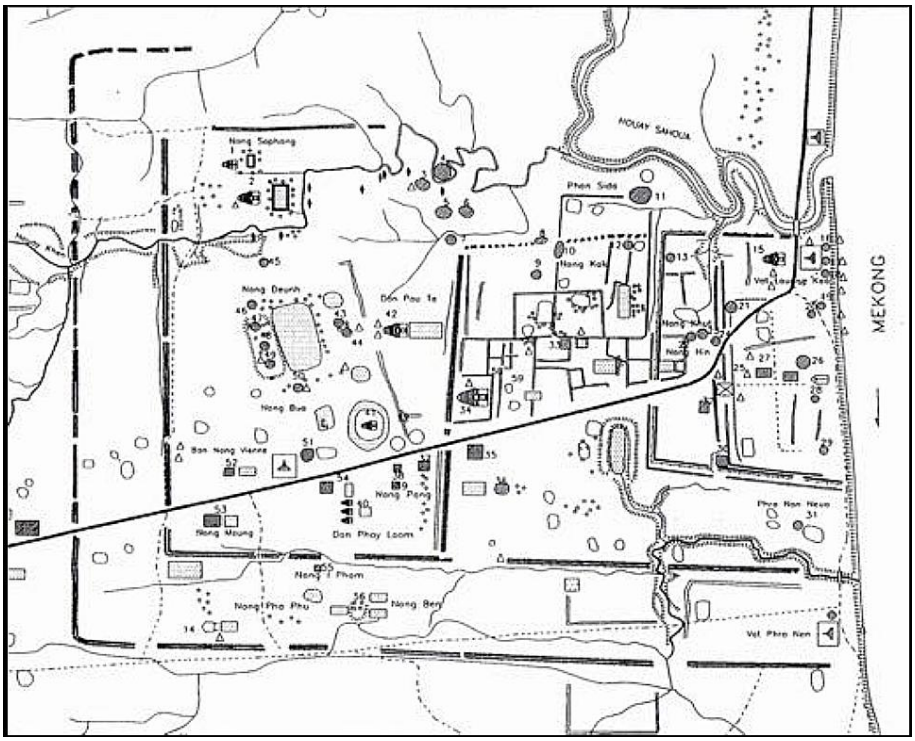
PL. 29: The Preapatang and the Sambor rapids in the Mekong River. Source: Meshkova, 2012.



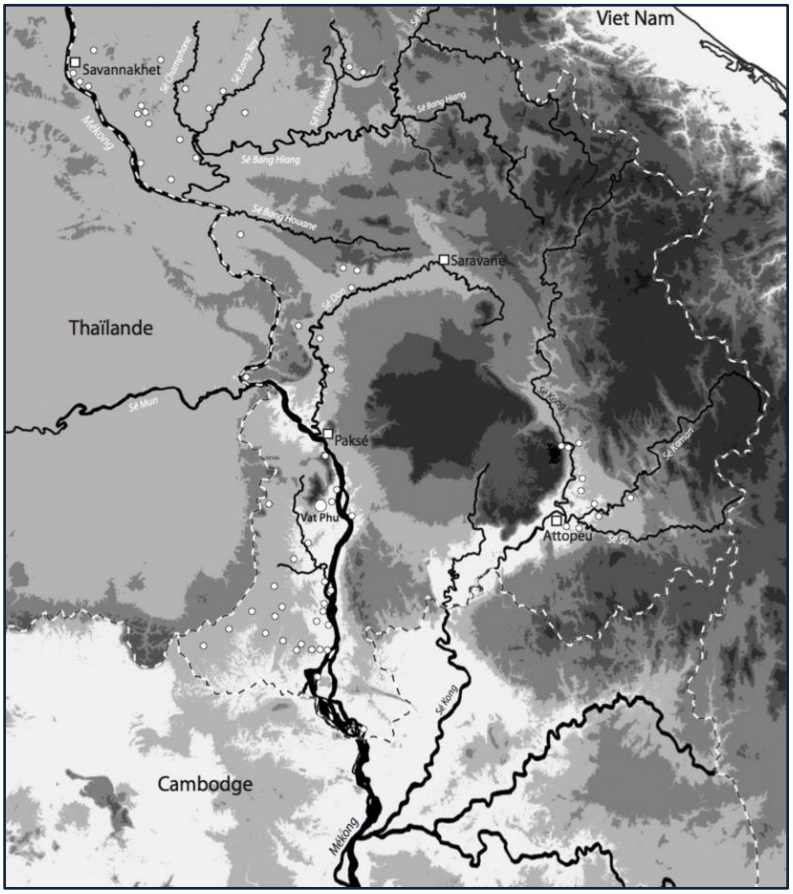
PL. 30: Local dugouts with bamboo scaffolding in Kratie-Stung Treng area. Source: Garnier, 1885.



PL. 31: Tall riverbanks above the Phapheng-Khone Falls. Source: Garnier, 1885.



PL. 32: Map of the site of Sresthapura in the vicinity of Wat Phu with the Mekong river on the right side. Source: Lerici, 2001.



PL. 33: Map of archaeological sites around the Wat Phu area. Source: Lorrillard, 2014b.



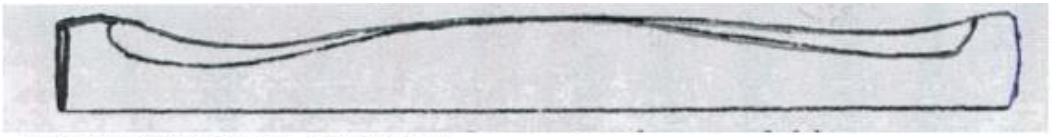
PL. 34: Dugout found in Angkor Thom province. See Appendic5 for more images. Source: APSARA Authority.



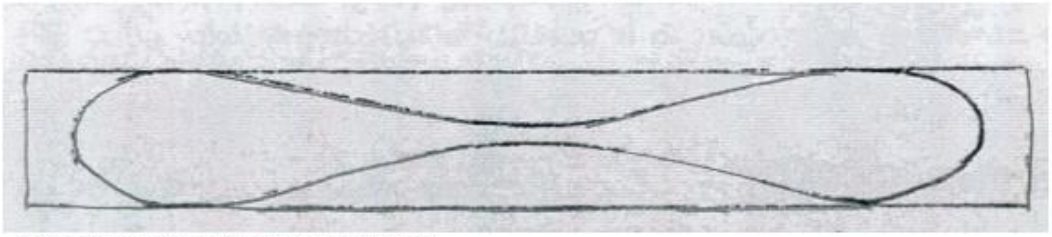
PL. 35: The Kra Raleung boat found in the Siem Reap River area in 2010 when it was taken out of the moat to extract samples for dating. See Appendix 5 for more images. Source: C.Pham.



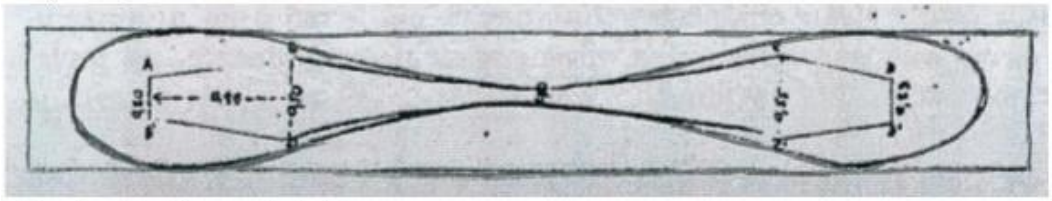
PL. 36: A traditional Cambodian boat in the Mekong River, Kandal province. Source: V. Walker.



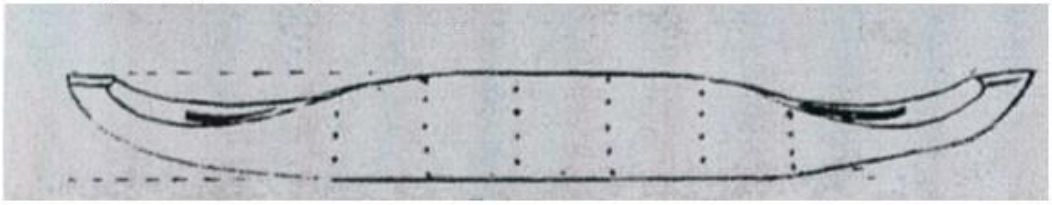
Squaring of the trunk, lateral view



Squaring of the trunk, aerial view



Tracing the figure of eight



Chak Bansak

PL. 37: Figure of eight design followed to hollow out the dugout in Cambodian traditional boat building. Source: Hoc (2001).



PL. 38: Chiselling tools used in traditional boat building in Cambodia (Sen River). Source: courtesy of Living With Heritage Project.



PL. 39: Detail of the hull with curved walls from the Angkor Thom boat (13th century). Source: APSARA Authority.



PL. 40: Unfinished dugout kept in the precinct of a *wat* in Chong Khneas. Source: V. Walker.



PL. 41: The process of expanding a dugout in the Sen River involves the use of wooden pins and logs to weight the walls down. Source: Living With Heritage Project.



PL. 42: The pin is used to hold the walls and a rope is tied to a log. Source: Living With Heritage Project.



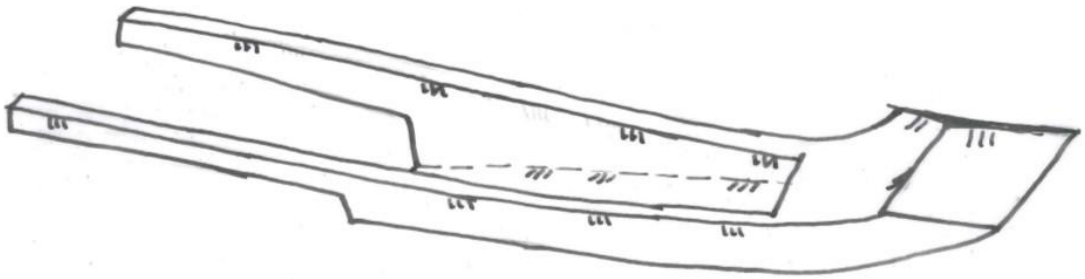
PL. 43: A similar technique was documented among the CauMa in southern Vietnam in the 1960s. Source: Boulbet (1965).



PL. 44: Some of the boats of Angkor are very large, like this one with rowers and three lines of soldiers (Bayon temple). Source: V. Walker.



PL. 45: In Cambodian traditional boat building larger boats are made by expanding the dugout. Here the dugout keel is made with a hard angle and the stempost is added later. Source: Living With Heritage Project.



PL. 45-B: Drawing of the stempost. Source: V. Walker.



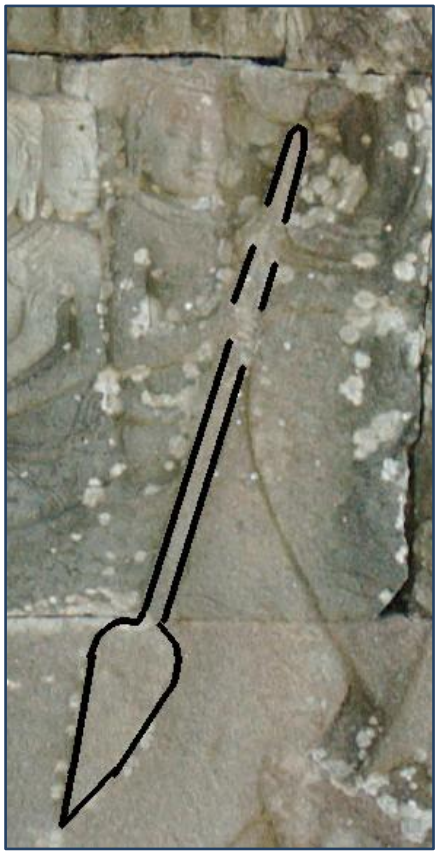
PL. 46: Once the stempost has been attached with a rabbet joing the boat appears to be seamless. Source: Living With Heritage Project.



PL. 47: The planks and the stempost are joined to the dugout keel using iron nails and pocket-hole incisions. Source: Living With Heritage Project.



PL. 48: The admiral's war boat in Banteay Chmar is another example of large expanded dugouts in Angkorian nautical iconography. Source: courtesy of N.H. Tan.





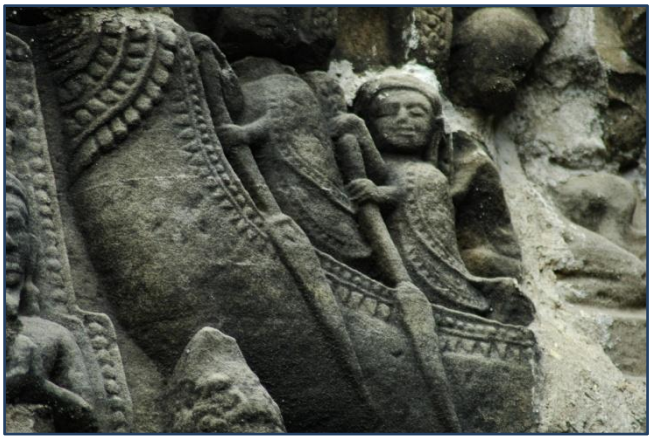
PL. 49 A-B: Paddlers of Angkor. Left (A) corresponds to BY-IG.IV and above (B) corresponds to BY-IG.VI. Source: V. Walker.



PL. 49 C: Another set of paddlers from the Royal pools (North wall). Source: V. Walker.



PL. 49 D: Another set of paddlers from the Royal pools (South wall). Source: V. Walker.



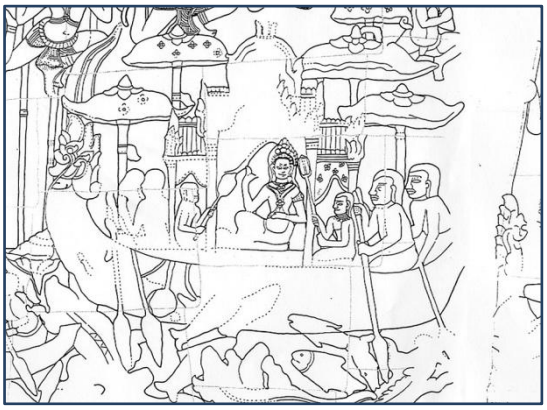
PL. 50: Detail of paddlers. They appear to be made in two parts. Source: V. Walker.



PL. 51: Modern paddles are made from a single piece of wood and have a flared tip. Source: V. Walker.



PL. 52: Line of paddlers in Angkorian boats. Source: V. Walker.



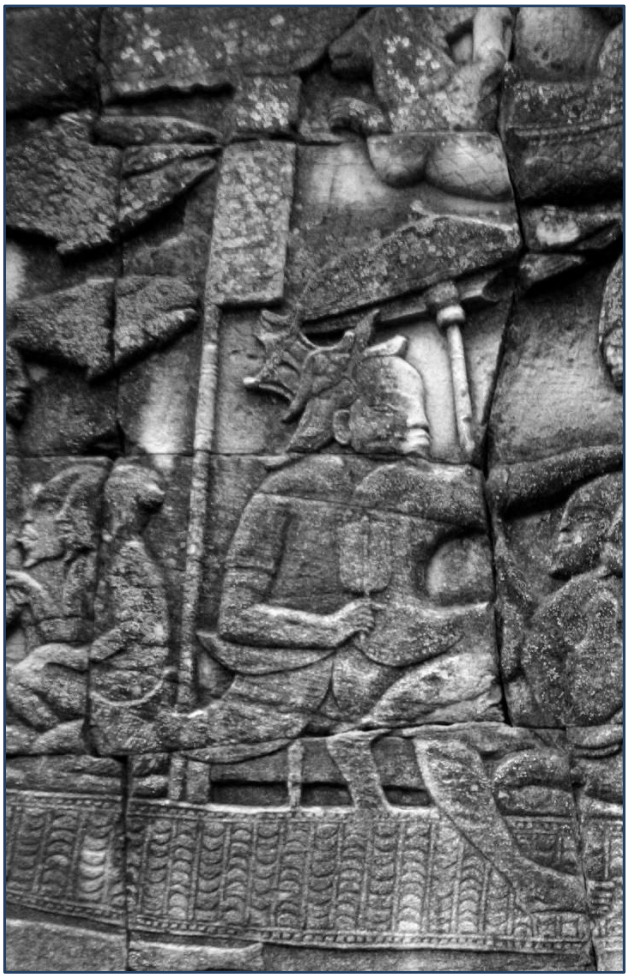
PL. 53: Most decorated boats have pairs of paddlers at the fore and the aft. Source: JSA (2003).



PL. 54: Some oars have ridges in the blade. Source: V. Walker.



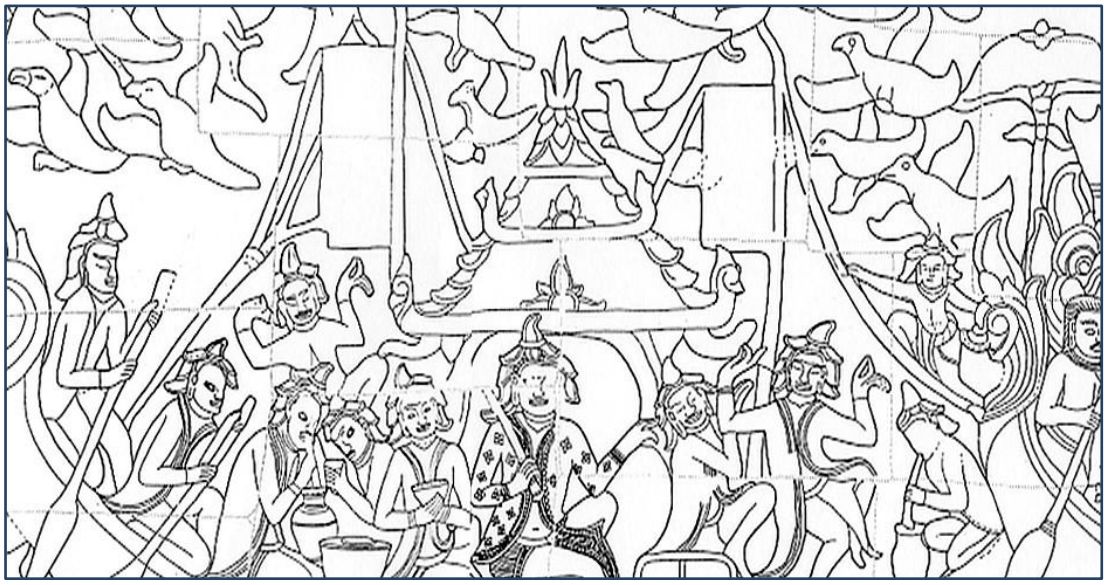
PL. 55 A: The sails of the plank vessel in Bayon are very clearly depicted with the riggings. Source: V.Walker.



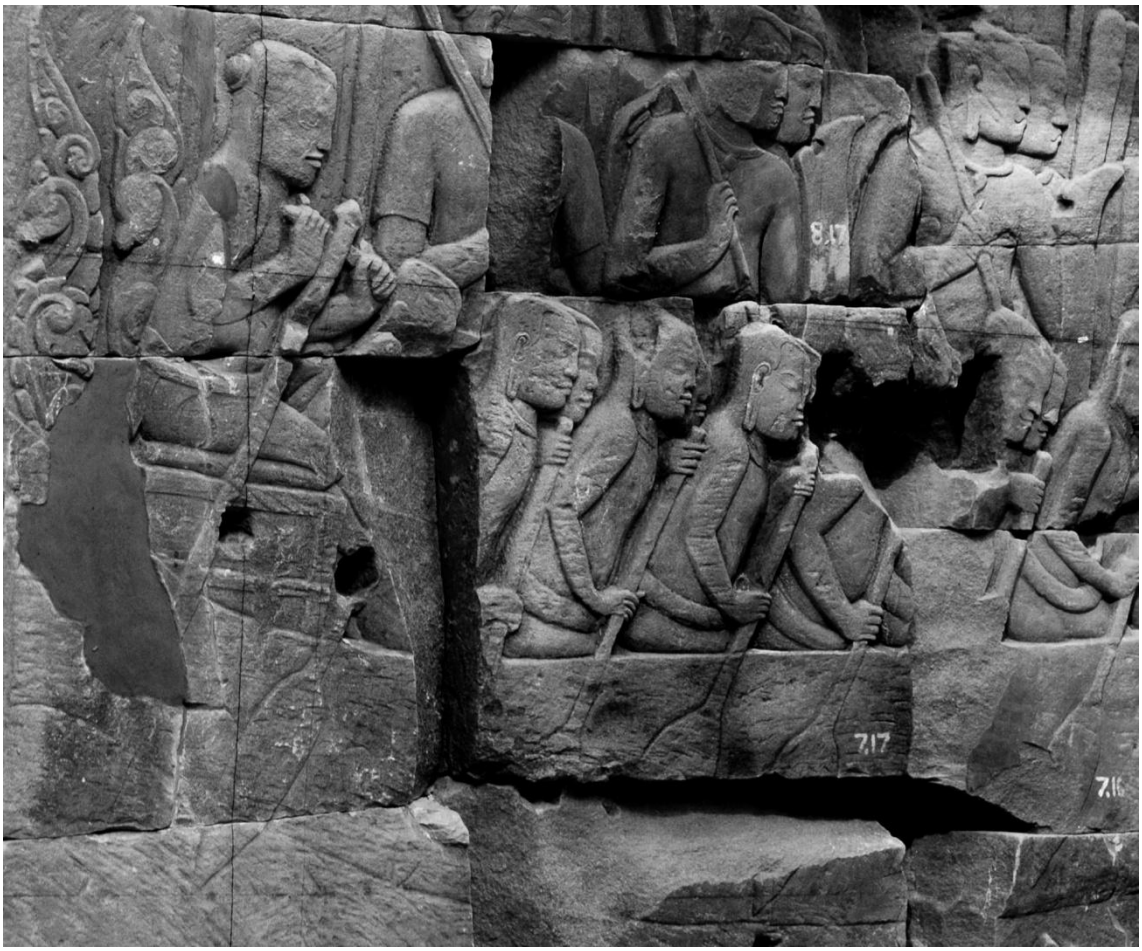
PL 55 B: The rectangular shape on the left of the main figure in the medium-sized vessel under the plank ship has also been identified as a sail. Source: V. Walker.



PL 55 C: The rectangular shape on the left of the main figure in the plank boat of Banteay Chmar is one of the two sails visible on this ship. Source: V. Walker.



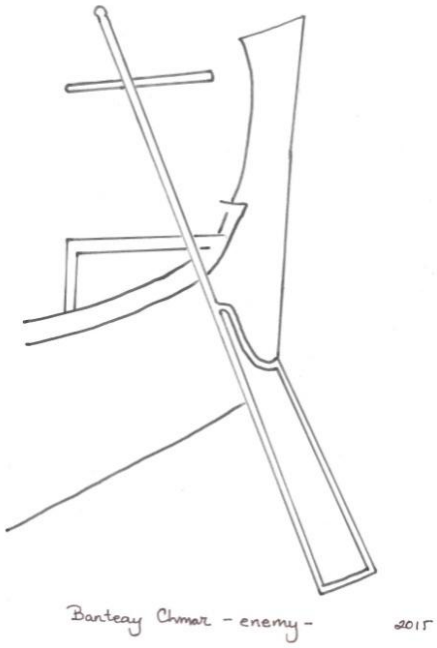
PL 55 D: The rectangular shapes on the three ships in BY-IG.IV have been interpreted as sails with riggings. Source: V. Walker.



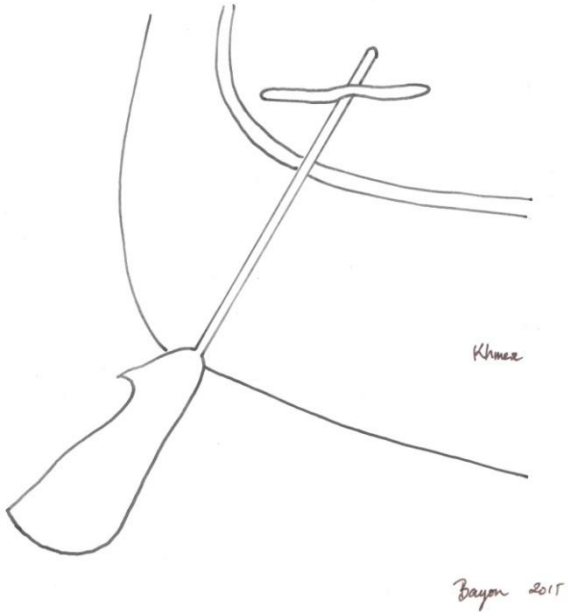
PL. 56: Line of paddlers with a helmsman and rudder in BY-SW.VI. Source: V. Walker.



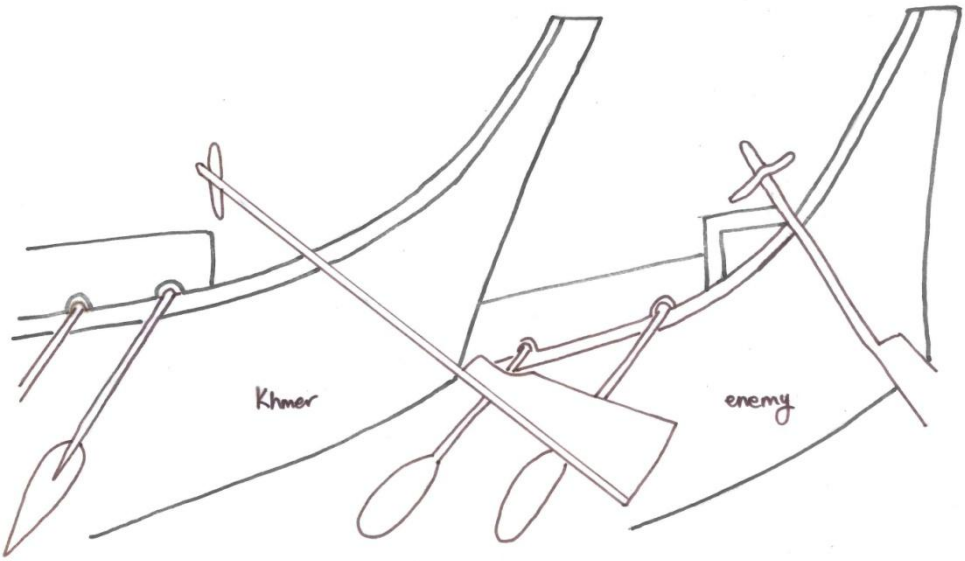
PL. 57: Rowed war boat with helmsman and rudder in the naval battle of Bayon. Source: V. Walker.



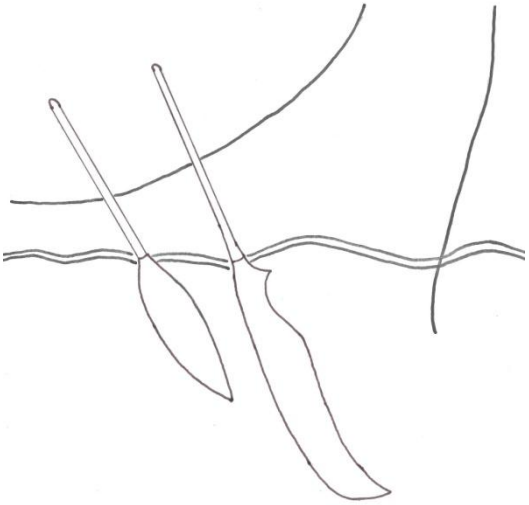
PL. 58 A: Stern of an enemy vessel in BC-EG-SW.I. Source: V. Walker.



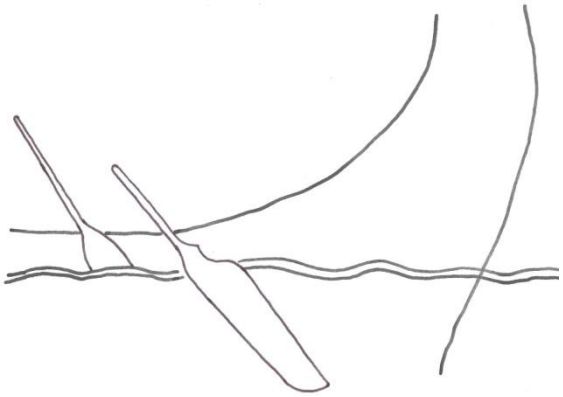
PL. 58 B: Stern of a Khmer vessel in the naval battle of Bayon temple, scene BY-SG.VI. Source: V. Walker.



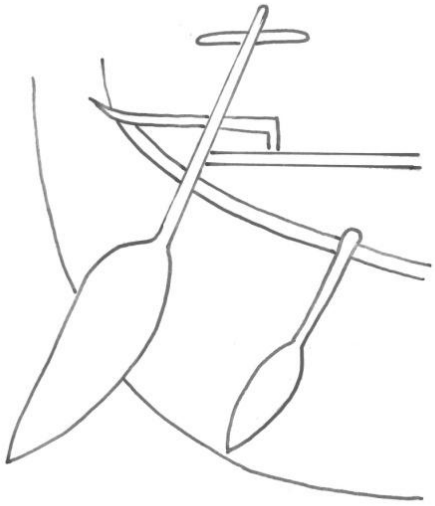
PL. 58 C: Sterns of a Khmer and an enemy vessel in the naval battle of Bayon, scene BY-SG-IV. Source: V. Walker.



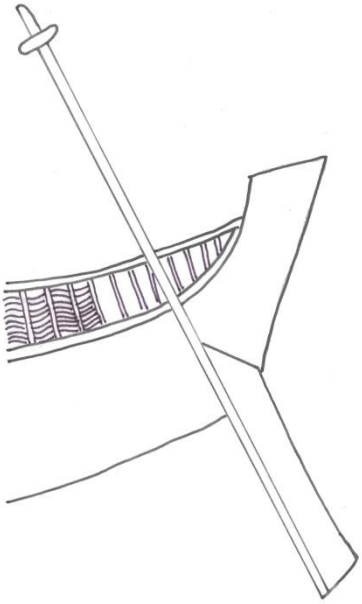
PL. 59 A: Angkor Wat, long paddle used to steer in the lower vessel of AW-CP.I. Source: V.Walker.



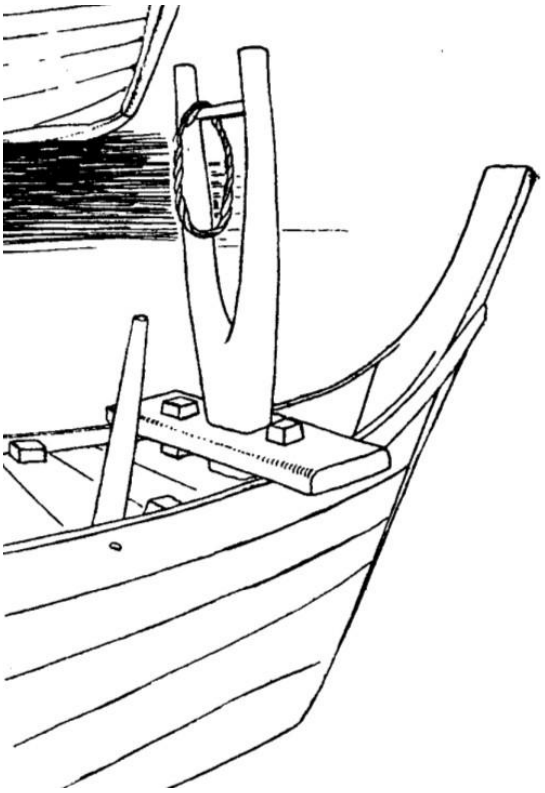
PL. 59 B: Angkor Wat, long paddle with different design used to steer in the upper vessel of AW-CP.I. Source: V. Walker.



PL. 60 A: Stern of a Khmer war boat, scene BY-SW.IV. Source: V. walker



PL. 60 B: Rudder of the medium size boat used by foreigners in BY-SW.III. Source: V. Walker



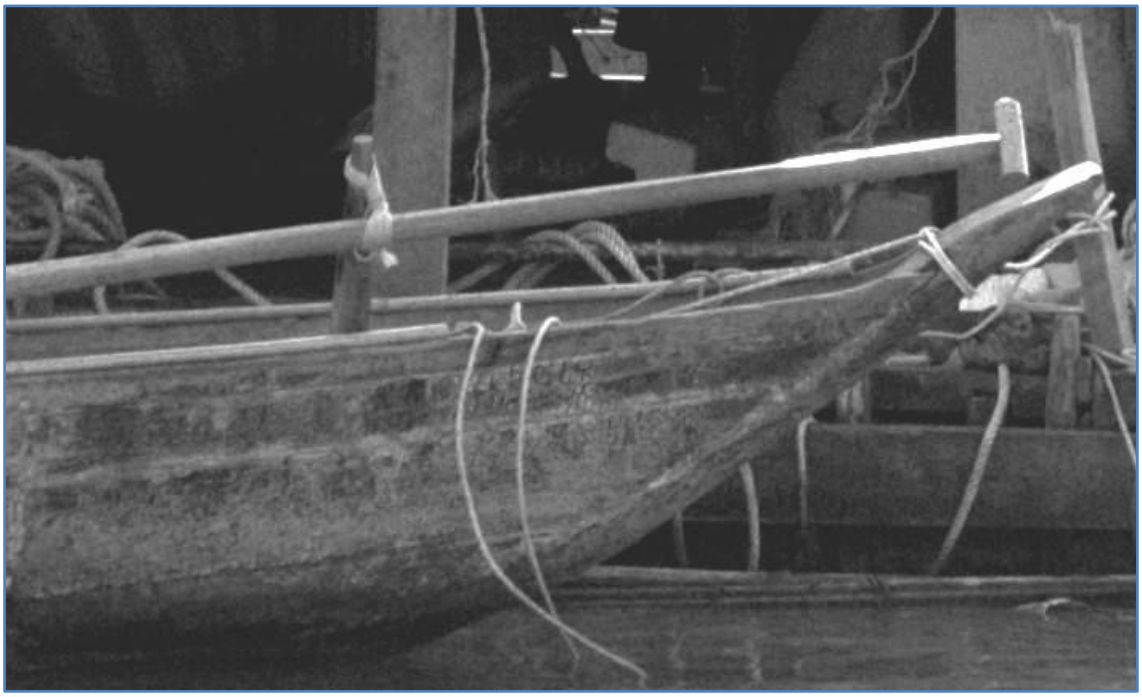
PL. 61: Rudder mechanism proposed by Paris and Gibson-Hill. Source: Gibson-Hill (1952).



PL. 62: Axial rudder used nowadays in the Cambodian Mekong River. Source: V. Walker.



PL. 63: In the Tonle Sap basin boats have a small retractable rudder attached to a side pin (right). Source: V. Walker.



PL. 64: A paddle used for stirring is placed on a pin in this boat from the Cambodian Mekong River. Source: V. Walker.



PL. 65: Double lateral rudders in the royal barges. Source: Khunkurt.



PL. 66 A: Standing helmsman in BY-SW.III. Source: V. Walker.



PL. 66 B: Standing helmsman in Banteay Samre. Source: V. Walker.



PL. 67: Decoration on the topsides, the bow, and the stern (BY-IG.VI). Source: V. Walker.



PL. 68: Iron clamps are used to attach wood extension in the Thai royal barges, Thai royal Barges, Thai Navy dockyard, Bangkok. Source: V. Walker.



PL. 69: Sternposts with tangs to be placed on the stern, Thai royal Barges Museum. Source: V. Walker.



PL. 70: Sheets of carved wood are attached to the hull using iron nails in the royal barges of Thailand, Thai Navy dockyard. Source: V. Walker.



PL. 71: Gilded decoration with encrusted crystals of the Thai Royal Barges, Thai Royal Barges Museum. Source: V. Walker.



PL. 72: The dais on which the boat pavilions are raised have similar design and decoration as the platforms used in Angkorian temples (below, Angkor Wat). Source: V. Walker.





PL. 73: Light canopy covered with silk in the Thai Royal Barges. Source: Khunkurt.



PL. 74 A:: Historical throne from the late 19th century, National Museum of Phnom Penh. Source: V. Walker.



PL. 74 B: Historical throne from the late 19th century, National Museum of Phnom Penh. Source: V. Walker.



PL. 75: Common awning in a traditional boat from Laos in the 19th century. Source: EFEO.



PL. 76: Forecastle in enemy vessel, Bayon's naval battle. Source: V. Walker.



PL. 77 A: Stern structure in the admiral's vessel in the Bayon temple. Source: Jacq-Hercoualg'h (2007).



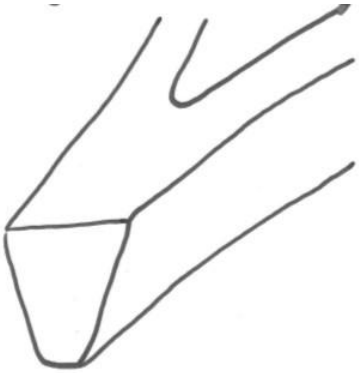
PL. 77 B: Stern structure in the flagship of the state progress by water in BY-SW.V. Source: V. Walker.



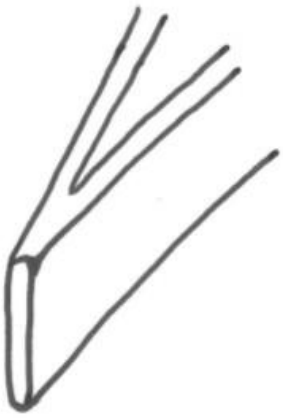
PL. 78: Hard keel dugouts in the naval battle of Bayon. Source: V. Walker.



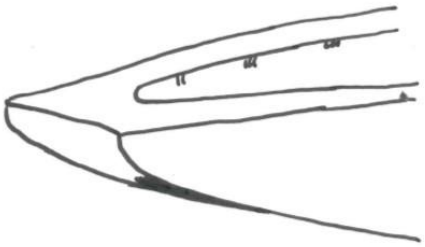
PL. 79 A: Dugouts currently being produced traditionally in Estonia show the hard angle that can be achieved. Source: SOMAA.



PL 79 B: One of the sides of both the Angkor Thom and the Kra Raleung boat has this triangular shape with a vertical end. Source: V. Walker.



PL 79 C: One of the sides of the Kra Raleung boat has this narrow shape with a vertical end. Source: V. Walker.



PL 79 D: One of the sides of the Angkor Thom boat has this flat end. Source: V. Walker.



PL. 80: Kaladan River boats in Burma. Source: J. Raptor.



PL. 81: Burmese paddy boat from the 19th century. Source: P. Klier.



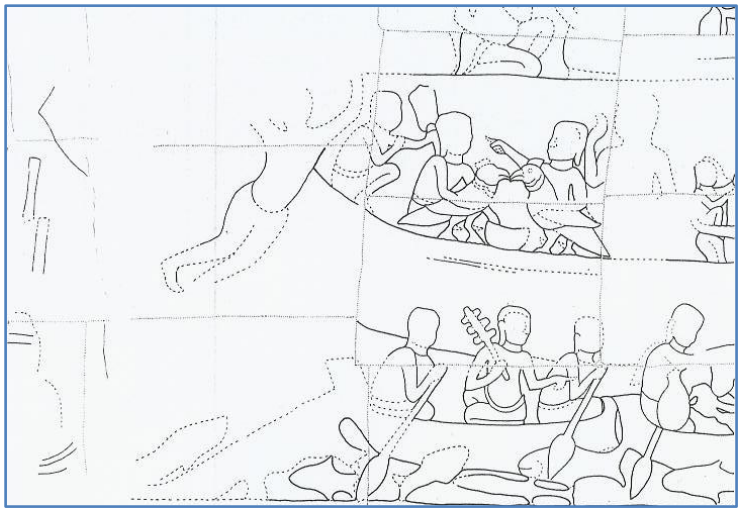
PL. 81 B: Burmese paddy boat. had a remarkable shallow draft when unloaded (pictures). Source: Jackson.



PL. 82: Transom stern with horse-shoe structure. Source: J. Raptor.



PL. 83: Fishing boat in Banteay Chmar. Source: Roveda (2005).



PL. 84: Commoners taking part in a festivity or celebration (the multi-headed naga flagship is in the foreground). Source: JSA (2003).



PL. 85: Court lady picking a lotus flower (PK-CL.I). Source: courtesy of P. Dara.



PL. 86: Above, unfinished contemporary dugout, below, the Angkor Thom boat dated to the 13th century. Source: Above: V. Walker. Below: APSARA Authority.





PL. 87: many of the traditional boats of Cambodia are now made of planks and can be seen to have been amended extensively. This boat is from the Cambodian Mekong River in Kandal province. Source: V. Walker.



PL. 88: A spirit house with old bows places next to it. Inside the shrine there is one of the eyes of a boat. Source: Living With Heritage Project.



PL. 89: Ribbons are tied to the bow and offerings are placed inside this racing boat. Source: Living With Heritage Project.



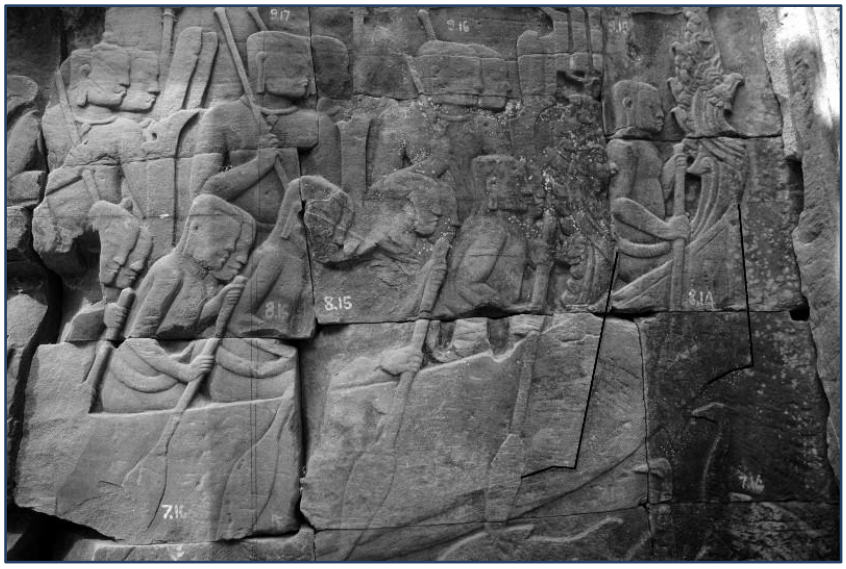
PL. 90: Makara only decoration in BY-IG.VI. Source : V. Walker.



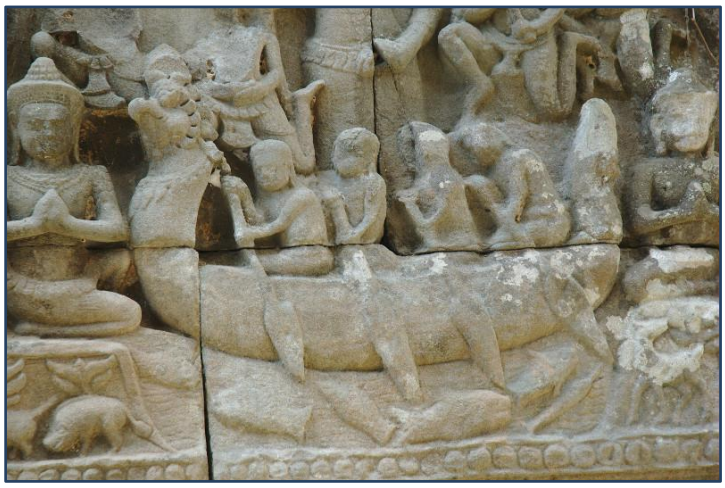
PL. 91: Reachisey decoration with goatee in the Royal Pools of Phimeanakas. Source: V. Walker.



PL. 92: Makara + garuda decoration on a round keel of the first boat in BY-IG.IV. Source: V. Walker.



PL. 93: Garuda decoration in the boats of the king's guards in BY-SW.V. Source: V. Walker.



PL. 94: Garuda decoration in Ta Nei's central sanctuary. Source: V. Walker.



PL. 95: Hihgly stylized garuda decoration in BY-IG.II. Source: JSA (2003).



PL. 96: A reachisey decoration in one of the boats of the Royal Pools of Phimeanakas. Source: V. Walker.



PL. 97: The reachisey decoration of a badly preserved boat in the central sanctuary of Banteay Samre. Source: V. Walker.



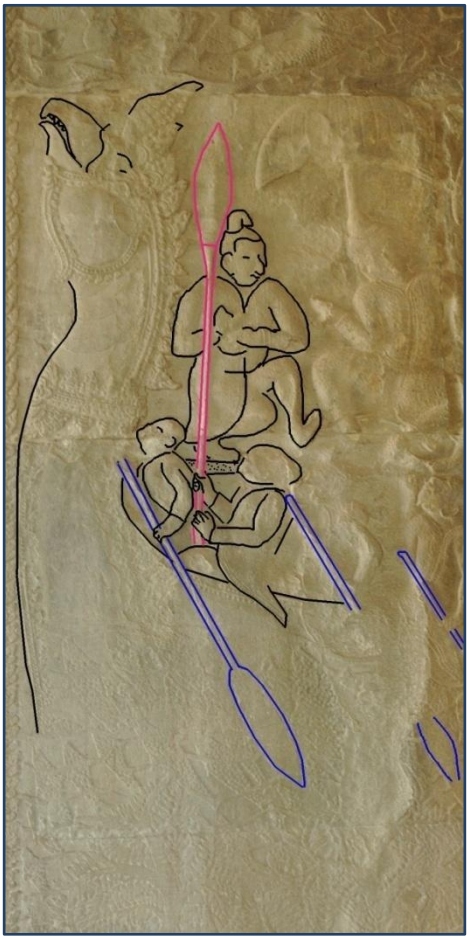
PL. 98: Decoration of one of the small vessels in BY-IG.II. Source: V. Walker.

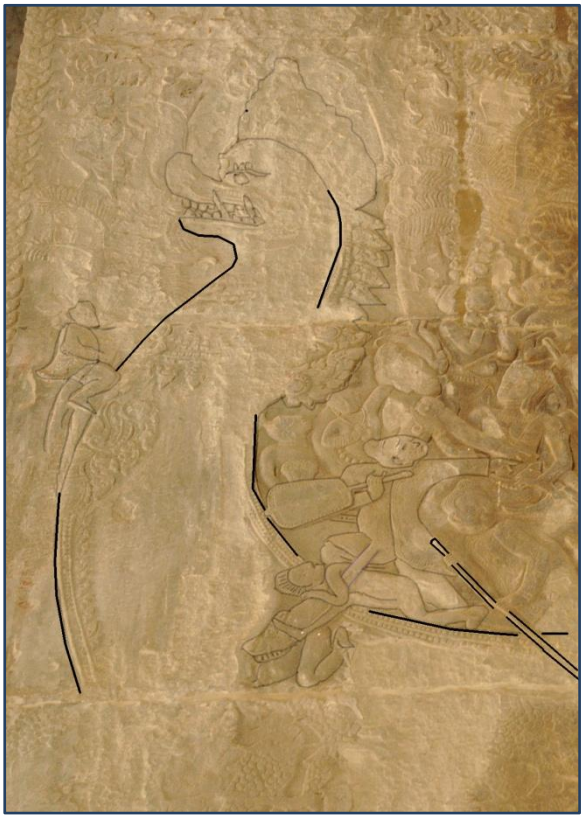


PL. 99: Decoration of the scene known as the Chess Game. Source: V. Walker.

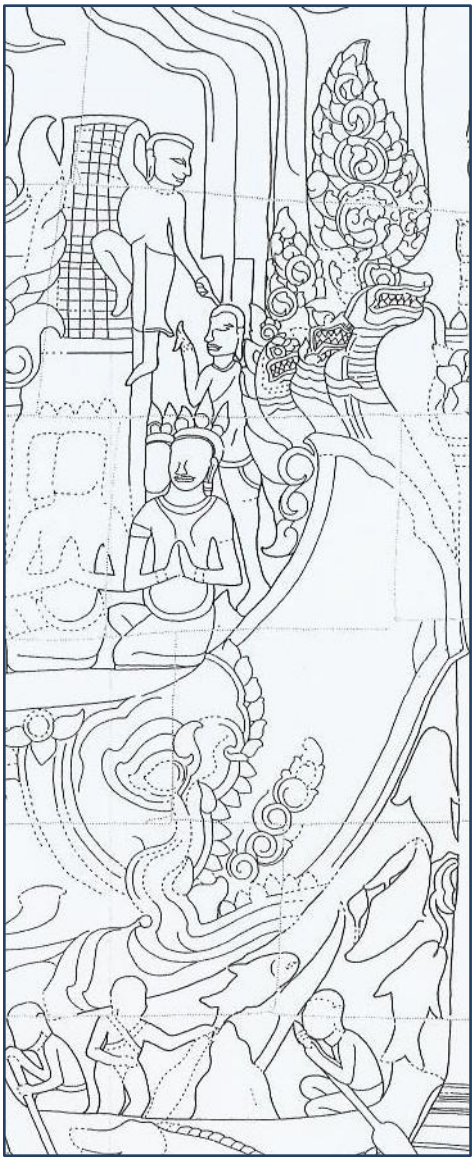


PL. 100: Garuda decoration in one of the bows of the northern wall of the western causeway in Preah Khan. Source: V. Walker.





PL. 101: Decoration of the large boat in the Angkor Wat southwest corner pavilion. Left, Hamsa decoration in the lower boat. Above, nâga decoration in the upper boat. Source: V. Walker.



PL. 102: Flagship decoration in BY-IG.V. Source: V. Walker.



PL. 103: The decoration of the flagship in BY-SW.V is barely visible. Source: V. Walker.



PL. 104: The Royal barge Anantanagaraj in the late 19th century. Source: BOSCH (1995).



PL. 105: Racing boats for the Water Festival are often kept in a shed. Source: Living With Heritage Project.



PL. 106: The bows of old racing boats are left beside a shrine or spirt house. Source: Living With Heritage Project.



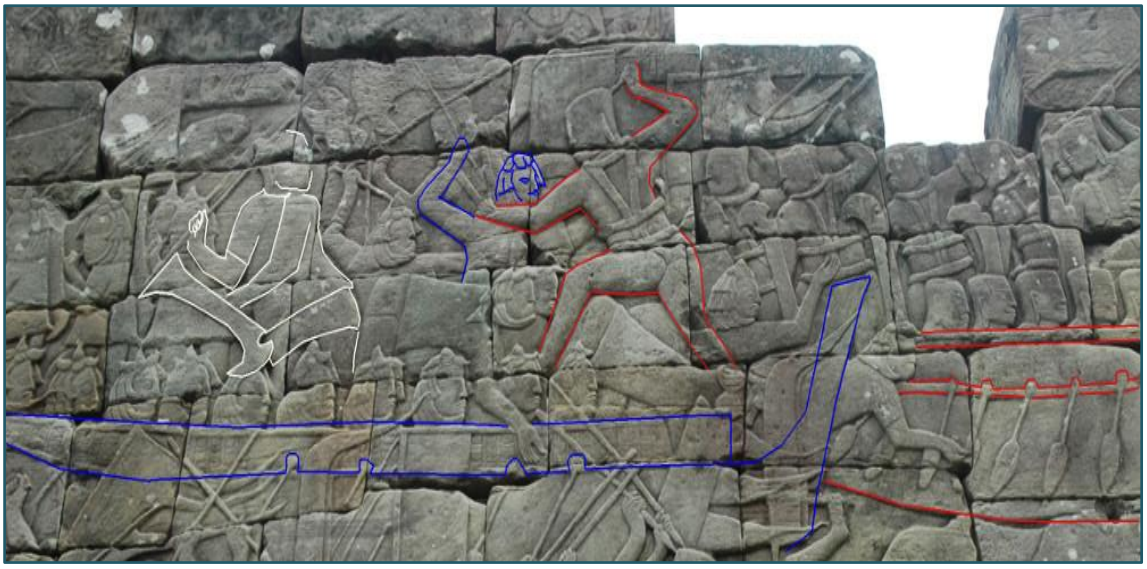
PL. 107: In the decommissioned royal barges at the Thai Navy dockyard in Bangkok offerings are placed inside the boat. Source: V. Walker.



PL. 108: Three Cham people identified by their coiffure are inside an Angkorian vessel in Banteay Chmar. Source: V. Walker.



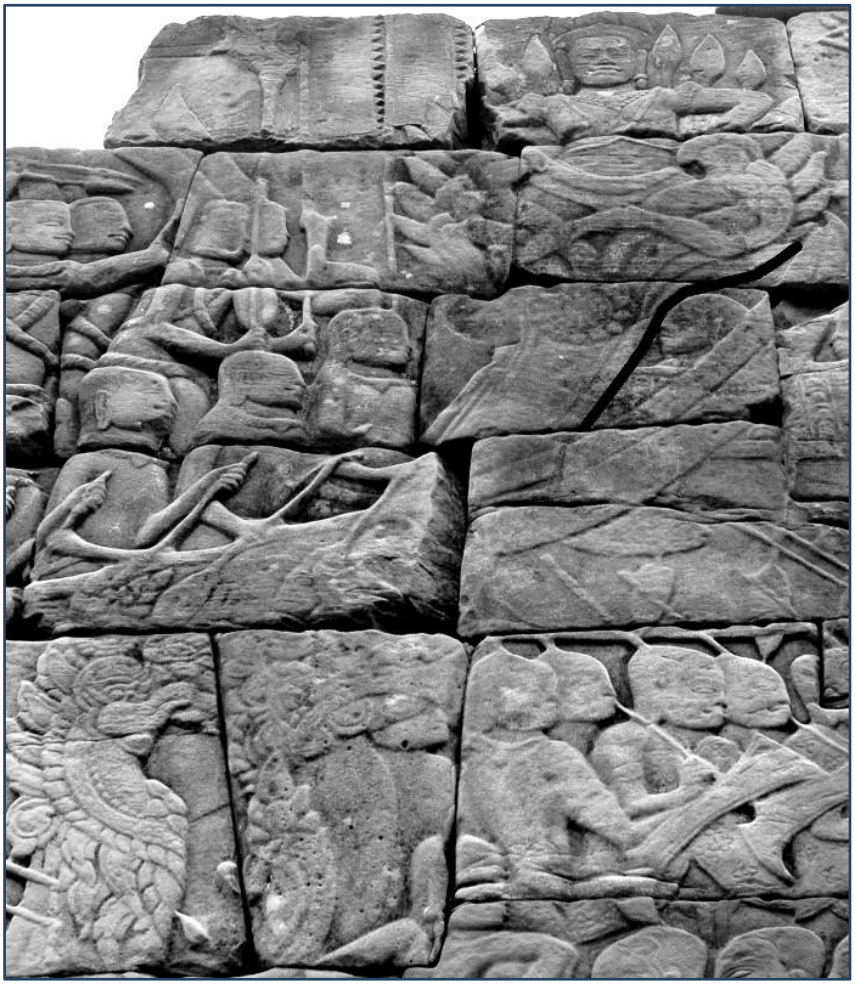
PL. 109: This boat with a garuda stempost is used by a leader, who is holding a Pkak axe at the aft of the boat. The makara decoration is out of sight but confirmed. Source: courtesy of N.H. Tan.



PL. 110: Enemy leader in the Bayon turning his head toward Angkorian soldiers boarding his boat. The Enemy is from Angkor. Source: V. Walker.



PL. 111: The boats decorated with makara + garuda bows may not have leaders but alternatively have special units like these archiers wearing jackets. Source: V. Walker.



PL. 112: The flagship of the Bayon's admiral has a figure that resembles a Brahma. Source: V. Walker.



PL. 113: The admiral's war boat in Banteay Chmar is decorated with an apsara and a makara. Source: courtesy of N.H. Tan.



PL. 114: Double paddlers in the Admiral's vessel in Banteay Chmar. Source: courtesy of N.H. Tan.



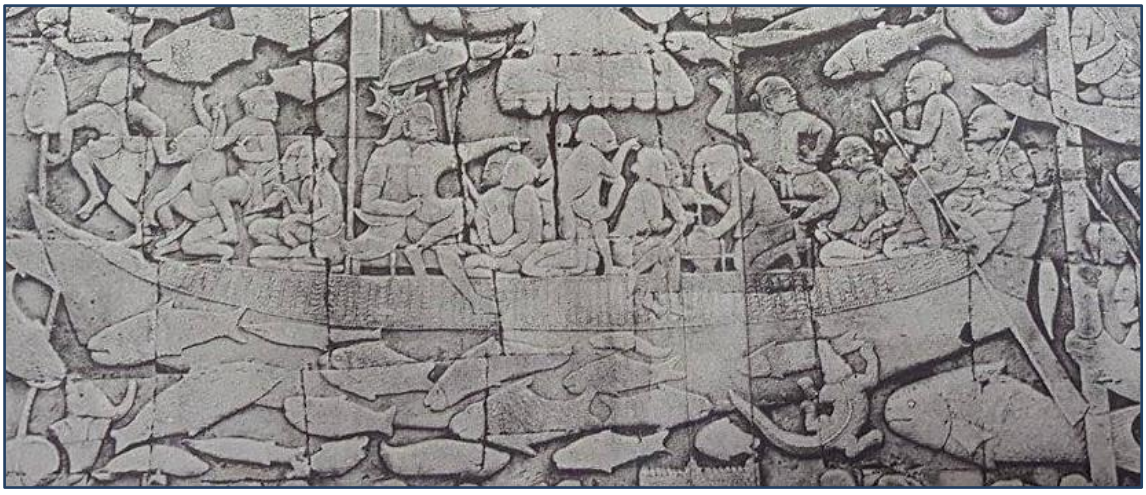
PL. 115: Sailing ship with makara decoration on the left side of the naval battle of Banteay Chmar. Source: V. Walker.



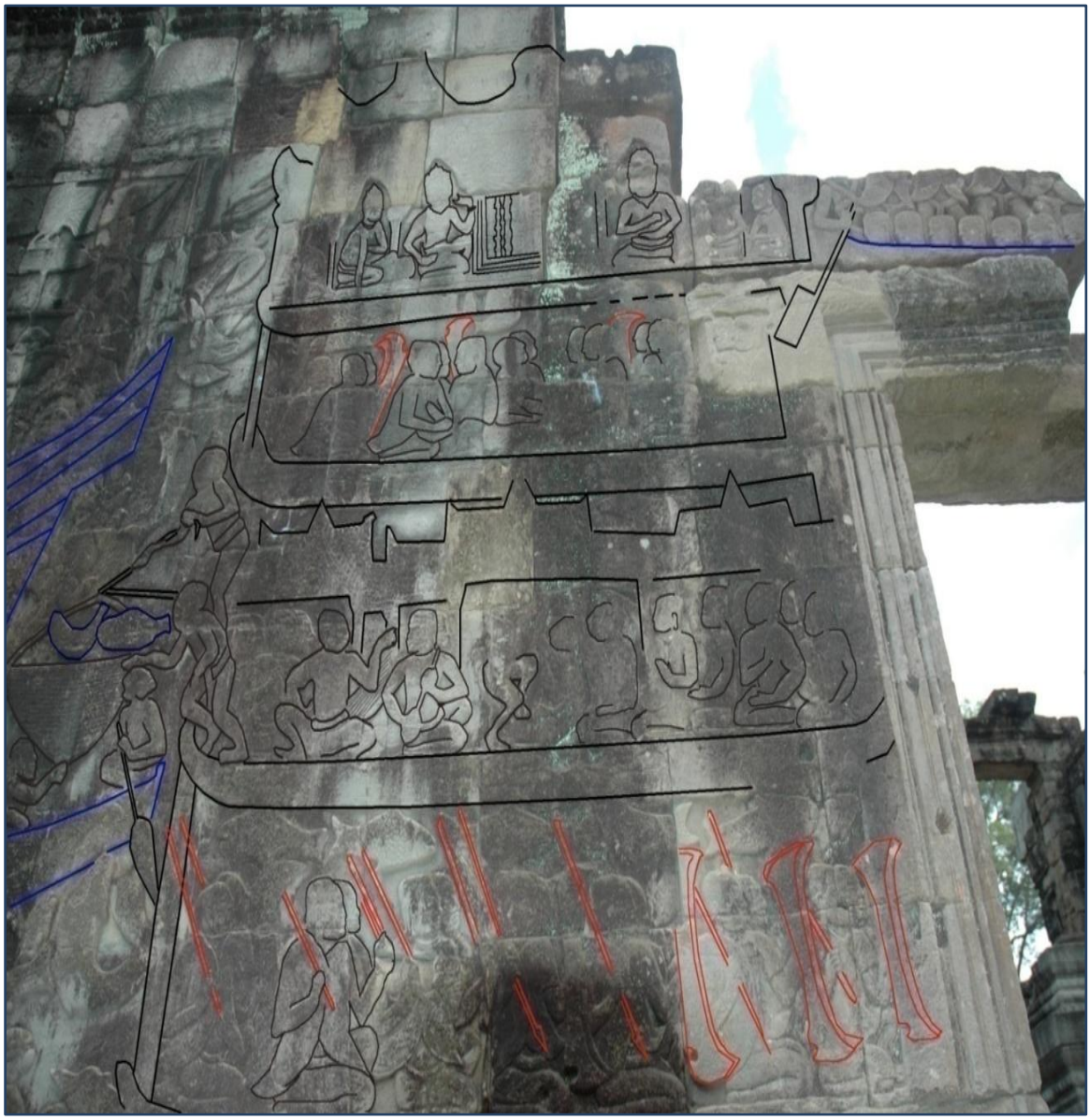
PL. 116: Inside the circle two people from the shoreline are seen interacting with the fishing boat on the right. Source: V. Walker.



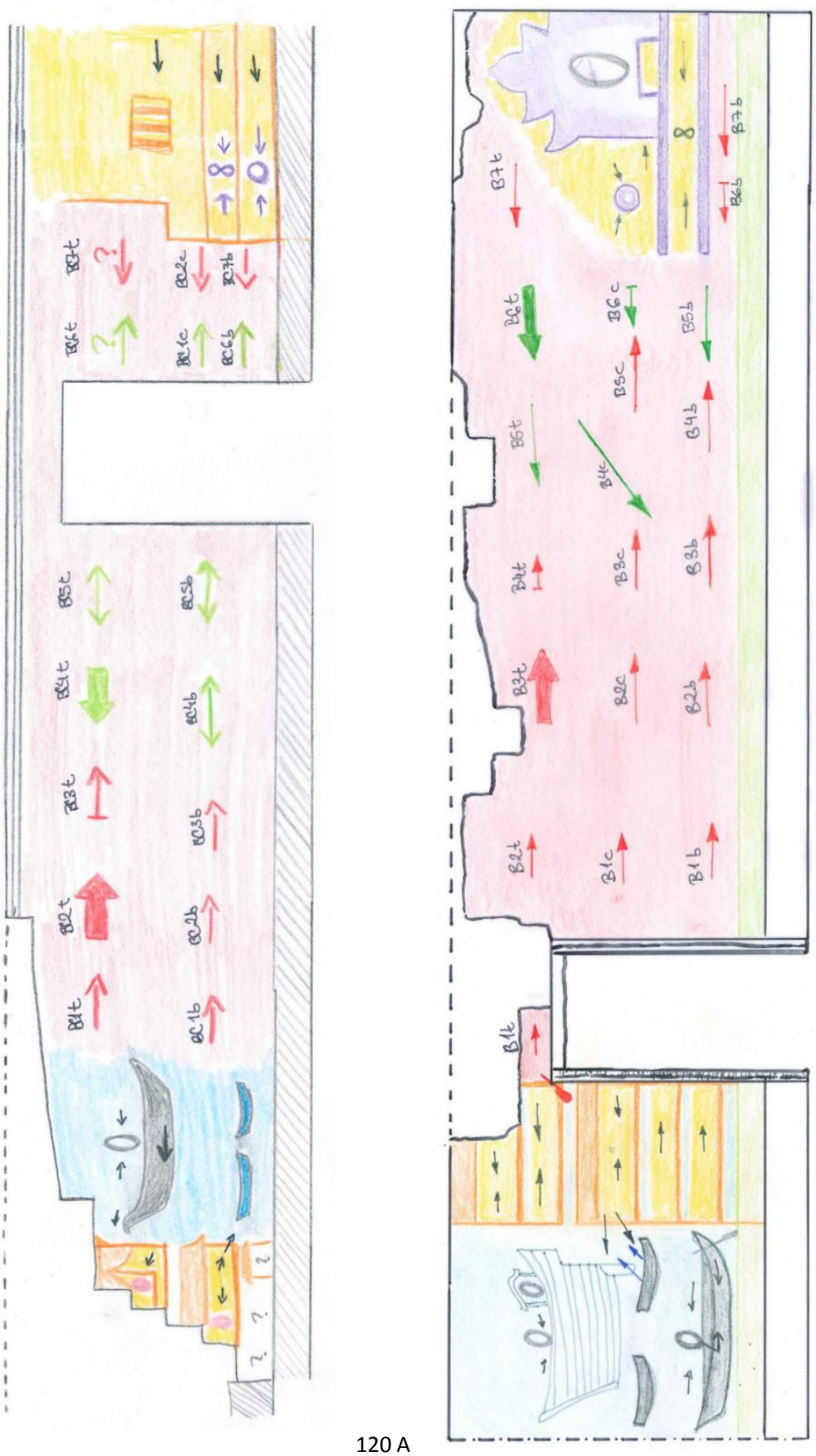
PL. 117: Shoreline scene with training fights and people observing. Source: courtesy of N.H. Tan.



PL. 118: People on board the undecorated vessel underneath the plank ship have been identified as Chinese. Source: EFEO.



PL. 119: The tracing of the relief shows two buildings with roofs, and people on the lower building engaged in activities with fishermen on the left. Source: V. Walker.



PL 120: Sketches of Banteay Chmar (A) and Bayon (B). The green arrows are enemy war boats, red arrows are from Angkor and the indicate direction of travel. Think arrows point to admirals. Source: V. Walker



PL. 1201: Scene on board the sailing ship of Banteay Chmar. Source: EFEO.



PL. 1212: Scene on board the sailing vessel in Bayon. Source: EFEO.

Appendix 2: Tables

Table 1 Scenes with individual boats

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Temple	ID	Start date	Finish date	King	Scene ID	Type of boats	Scene type	Location	Controlled	Boat ID	Decoration	Pavilion	Quarter Rudder	Propulsion	Hull shape	Size	Construction	Users
2	Angkor Wat	AW	12	12	Suryavarman II	AW-CP.I	Ritual	Festival	SW	Y	AW-CP.I.1	Reachisey	Y	Y	Paddling	Round	Large	Dugout	Angkorian
3	Angkor Wat	AW	12	12	Suryavarman II	AW-CP.I	Ritual	Festival	SW	Y	AW-CP.I.2	Hamsa	Y	Y	Paddling	Round	Large	Dugout	Angkorian
4	Bayon	BY	12	13	Jayavarman VII	BY-IG.I	Utilitarian	Fishing-Uncertain	SE	Y	BY-IG.I.1	Undecorated	N	N	Paddling	Round	Small	Dugout	Angkorian
5	Bayon	BY	12	13	Jayavarman VII	BY-IG.I	Ritual	Fishing-Uncertain	SE	Y	BY-IG.I.2	Garuda	Y	N	Paddling	Round	Medium	Dugout	Angkorian
6	Bayon	BY	12	13	Jayavarman VII	BY-IG.II	Ritual	Uncertain	SW	Y	BY-IG.II.1	Naga-reachisey	Y	N	Paddling	Hard	Small	Dugout	Angkorian
7	Bayon	BY	12	13	Jayavarman VII	BY-IG.II	Ritual	Uncertain	SW	Y	BY-IG.II.2	Naga-reachisey	Y	N	Paddling	Hard	Small	Dugout	Angkorian
8	Bayon	BY	12	13	Jayavarman VII	BY-IG.III	Utilitarian	Lotus picking	SW	Y	BY-IG.III.1	Undecorated	N	N	Paddling	Hard	Small	Dugout	Angkorian
9	Bayon	BY	12	13	Jayavarman VII	BY-IG.IV	Ritual	Festival	WS	Y	BY-IG.IV.1	Makara + multi-headed naga	Y	N	?	Round	Large	Dugout	Angkorian
10	Bayon	BY	12	13	Jayavarman VII	BY-IG.IV	Utilitarian	Festival	WS	Y	BY-IG.IV.2	Undecorated	N	?	?	Hard	Medium	Dugout	Angkorian
11	Bayon	BY	12	13	Jayavarman VII	BY-IG.IV	Utilitarian	Festival	WS	Y	BY-IG.IV.3	Undecorated	N	N	Paddling	Hard	Small	Dugout	Angkorian
12	Bayon	BY	12	13	Jayavarman VII	BY-IG.IV	Utilitarian	Festival	WS	Y	BY-IG.IV.4	Undecorated	N	N	Paddling	Hard	Small	Dugout	Angkorian
13	Bayon	BY	12	13	Jayavarman VII	BY-IG.IV	Utilitarian	Festival	WS	Y	BY-IG.IV.5	Undecorated	N	N	Paddling	Hard	Small	Dugout	Angkorian
14	Bayon	BY	12	13	Jayavarman VII	BY-IG.V	Ritual	Procession	NW	Y	BY-IG.V.1	Makara + garuda	Y	N	Paddling	Round	Medium	Dugout	Angkorian
15	Bayon	BY	12	13	Jayavarman VII	BY-IG.V	Ritual	Procession	NW	Y	BY-IG.V.2	Makara + garuda	Y	N	Paddling	Round	Medium	Dugout	Angkorian
16	Bayon	BY	12	13	Jayavarman VII	BY-IG.V	Ritual	Procession	NW	Y	BY-IG.V.3	Makara + garuda	Y	N	Paddling	Round	Medium	Dugout	Angkorian
17	Bayon	BY	12	13	Jayavarman VII	BY-IG.VI	Ritual	Uncertain	EN	Y	BY-IG.VI.1	Makara	N	N	Paddling	Round	Medium	Dugout	Angkorian
18	Bayon	BY	12	13	Jayavarman VII	BY-IG.VI	Ritual	Uncertain	EN	Y	BY-IG.VI.2	Makara	N	N	Paddling	Round	Medium	Dugout	Angkorian
19	Bayon	BY	12	13	Jayavarman VII	BY-SG.I	Military	Warfare	S	N	BY-SG.I.1	undecorated	N/A	N/A	N/A	N/A	Large	Raft	Angkorian
20	Bayon	BY	12	13	Jayavarman VII	BY-SG.II	Military	Warfare	S	N	BY-SG.II.1	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Enemy
21	Bayon	BY	12	13	Jayavarman VII	BY-SG.II	Military	Warfare	S	N	BY-SG.II.2	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Enemy
22	Bayon	BY	12	13	Jayavarman VII	BY-SG.II	Military	Warfare	S	N	BY-SG.II.3	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Enemy
23	Bayon	BY	12	13	Jayavarman VII	BY-SG.III	Sailing	Fishing-Festival	SE	N	BY-SG.III.1	Undecorated	N	N	Sailing	Hard	Large	Planked	Foreign
24	Bayon	BY	12	13	Jayavarman VII	BY-SG.III	Utilitarian	Fishing-Festival	SE	N	BY-SG.III.2	Undecorated	N	N	Paddling	Hard	Small	Dugout	Foreign
25	Bayon	BY	12	13	Jayavarman VII	BY-SG.III	Utilitarian	Fishing-Festival	SE	N	BY-SG.III.3	Undecorated	N	N	Paddling	Hard	Small	Dugout	Foreign
26	Bayon	BY	12	13	Jayavarman VII	BY-SG.III	Utilitarian	Fishing-Festival	SE	N	BY-SG.III.4	Undecorated	N	Y	Single oar/rudder	Hard	Medium	Dugout	Foreign
27	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.1t	?	N	Y	Rowing	?	Medium	Dugout	Angkorian
28	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.2t	Makara + ?	N	Y	Rowing	?	Medium	Dugout	Angkorian
29	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.3t	Makara + Brahma	N	Y	Paddling	Hard	Large	Dugout	Angkorian
30	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.4t	Makara + garuda	N	?	Rowing	?	Medium	Dugout	Angkorian

Table 1 Scenes with individual boats

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Temple	ID	Start date	Finish date	King	Scene ID	Type of boats	Scene type	Location	Controlled	Boat ID	Decoration	Pavilion	Quarter Rudder	Propulsion	Hull shape	Size	Construction	Users
31	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.5t	Makara	N	Y	Rowing	Hard	Medium	Dugout	Enemy
32	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.6t	Undecorated	N	Y	Rowing	Hard	Medium	Dugout	Enemy
33	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.7t	?	N	N	Rowing	Hard	Medium	Dugout	Angkorian
34	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.1c	?	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
35	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.2c	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
36	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.3c	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
37	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.4c	?	N	?	Rowing	Hard	Medium	Dugout	Enemy
38	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.5c	Undecorated	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
39	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.6c	?	N	Y	Rowing	Hard	Medium	Dugout	Enemy
40	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.1b	?	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
41	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.2b	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
42	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.3b	Makara + garuda	N	N	Rowing	Hard	Medium	Dugout	Angkorian
43	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.4b	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
44	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.5b	Makara	N	Y	Rowing	Hard	Medium	Dugout	Enemy
45	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.6b	Undecorated	N	?	Rowing	Hard	Medium	Dugout	Angkorian
46	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.7b	Makara	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
47	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.1	Garuda	N	?	Paddling	Hard	Medium	Dugout	Angkorian
48	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.2	Garuda	Y	N	Paddling	Hard	Medium	Dugout	Angkorian
49	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.3	Apsara	Y	Y	Paddling	Hard	Large	Dugout	Angkorian
50	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.4	Garuda	N	?	Paddling	Hard	Medium	Dugout	Angkorian
51	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.5	Garuda	N	?	Paddling	Hard	Medium	Dugout	Angkorian
52	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.6	Garuda	N	?	Paddling	Hard	Medium	Dugout	Angkorian
53	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.7	Garuda	N	?	Paddling	Hard	Medium	Dugout	Angkorian
54	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.8	Garuda	N	?	Paddling	Hard	Medium	Dugout	Angkorian
55	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.9	Garuda	N	Y	Paddling	Hard	Medium	Dugout	Angkorian
56	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.10	Garuda	N	?	Paddling	Hard	Medium	Dugout	Angkorian
57	Bayon	BY	12	13	Jayavarman VII	BY-SEQ.I	Utilitarian	Fishing	SE	Y	BY-SEQ.I.1	?	N	N	Paddling	?	Medium	Dugout	Angkorian
58	Bayon	BY	12	13	Jayavarman VII	BY-SEQ.I	Ritual	Fishing	SE	Y	BY-SEQ.I.2	?	N	N	Paddling	?	Medium	Dugout	Angkorian
59	Royal Pools	RP	13	14?	Jayavarman VII or Jayavarman VIII	RP-WW.I	Ritual	Procession	W	Y	RP-WW.I.1	Reachisey + scales	N	N	Paddling	Round	Medium	Dugout	Angkorian
60	Royal Pools	RP	12	13	Jayavarman VII or Jayavarman VIII	RP-WW.I	Ritual	Procession	W	Y	RP-WW.I.2	? + scales	N	N	Paddling	Round	Medium	Dugout	Angkorian
61	Royal Pools	RP	12	13	Jayavarman VII or Jayavarman VIII	RP-WW.I	Ritual	Procession	W	Y	RP-WW.I.3	? + makara + scales	N	N	Paddling	Round	Medium	Dugout	Angkorian
62	Royal Pools	RP	12	13	Jayavarman VII or Jayavarman VIII	RP-WW.I	Ritual	Procession	W	Y	RP-WW.I.4	Reachisey + scales	N	N	Paddling	Round	Medium	Dugout	Angkorian
63	Royal Pools	RP	12	13	Jayavarman VII or Jayavarman VIII	RP-WW.I	Ritual	Procession	W	Y	RP-WW.I.5	Reachisey + scales	N	N	Paddling	Hard	Medium	Dugout	Angkorian
64	Royal Pools	RP	12	13	Jayavarman VII or Jayavarman VIII	RP-WW.I	Ritual	Procession	W	Y	RP-WW.I.6	Reachisey + scales	N	N	Paddling	Hard	Medium	Dugout	Angkorian
65	Royal Pools	RP	12	13	Jayavarman VII or Jayavarman VIII	RP-WW.I	Ritual	Procession	W	Y	RP-WW.I.7	Reachisey + scales	N	N	Paddling	?	Medium	Dugout	Angkorian
66	Ta Nei	TN	13	13	Jayavarman VII	TN-CS.I	Ritual	Ind. Trans.	N	Y	TN-CS.I.1	Garuda	N	N	Paddling	Round	Medium	Dugout	Angkorian
67	Banteay Samre	BR	12	12	Yashovarman II or Dharanindravarman ?	BS-CS.I	Ritual	Ind. Trans.	N	Y	BS-CS.I.1	Reachisey	?	Y	Single oar/rudder	Round	Medium	Dugout	Angkorian

Table 1 Scenes with individual boats

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Temple	ID	Start date	Finish date	King	Scene ID	Type of boats	Scene type	Location	Controlled	Boat ID	Decoration	Pavilion	Quarter Rudder	Propulsion	Hull shape	Size	Construction	Users
68	Preah Khan	PK	13	13	Jayavarman VII	PK-CS.I	Ritual	Ind. Trans.	WS	Y	PK-CS.I.1	?	N	N	Paddling	?	Small	Dugout	Angkorian
69	Preah Khan	PK	13	13	Jayavarman VII	PK-IE.I	Ritual	Chess game	W	Y	PK-IE.I.1	Naga	Y	N	Paddling	Round	Medium	Dugout	Angkorian
70	Preah Khan	PK	13	13	Jayavarman VII	PK-WG.I	Ritual	Uncertain	W	N	PK-WG.I.1	Makara + Naga-Reachisey+scales	N	N	Paddling	Round	Medium	Dugout	Angkorian
71	Preah Khan	PK	13	13	Jayavarman VII	PK-WG.I	Ritual	Uncertain	W	N	PK-WG.I.2	Makara + Naga-Reachisey+scales	N	N	Paddling	Round	Medium	Dugout	Angkorian
72	Preah Khan	PK	13	13	Jayavarman VII	PK-WG.II	Ritual	Uncertain	W	N	PK-WG.II.1	?	N	N	Paddling	Round	Medium	Dugout	Angkorian
73	Preah Khan	PK	13	13	Jayavarman VII	PK-WG.II	Ritual	Uncertain	W	N	PK-WG.II.2	?	N	N	Paddling	Round	Medium	Dugout	Angkorian
74	Preah Khan	PK	13	13	Jayavarman VII	PK-CL.I	Utilitarian	Fishing-Lotus picking	N	Y	PK-CL.I.1	Undecorated	N	N	Paddling	Round	Small	Dugout	Angkorian
75	Preah Khan	PK	13	13	Jayavarman VII	PK-EC.N	Ritual	Procession	E	N	PK-EC-N.?	?	Y	?	Paddling	?	Medium	?	Multiple
76	Preah Khan	PK	13	13	Jayavarman VII	PK-EC.S	Ritual	Procession	E	N	PK-EC-S.?	?	Y	?	Paddling	?	Medium	?	Multiple
77	Preah Khan	PK	13	13	Jayavarman VII	PK-NC.E	Ritual	Procession	N	N	PK-NC.E.?	?	Y	?	Paddling	?	Medium	?	Multiple
78	Preah Khan	PK	13	13	Jayavarman VII	PK-NC.W	Ritual	Procession	N	N	PK-NC.W.?	?	Y	?	Paddling	?	Medium	?	Multiple
79	Preah Khan	PK	13	13	Jayavarman VII	PK-WC.N	Ritual	Procession	W	N	PK-WC.N.?	?	Y	?	Paddling	?	Medium	?	Multiple
80	Preah Khan	PK	13	13	Jayavarman VII	PK-WC.S	Ritual	Procession	W	N	PK-WC.S.?	?	Y	?	Paddling	?	Medium	?	Multiple
81	Neak Pean	NP	13	13	Jayavarman VII	NP-CS.I	Ritual	Uncertain	N	Y	NP-CS.I.1	?	N	N	Paddling	?	Small	Dugout	Angkorian
82	Neak Pean	NP	13	13	Jayavarman VII	NP-CS.I	Ritual	Uncertain	N	Y	NP-CS.I.2	?	?	?	?	?	?	?	?
83	Phimai	PI	11	12	jayavarman VI or Dharanindravarman I ?	PI-CS.I	Ritual	Ind. Trans.	E	Y	PI-CS.I.1	?	N	N	Paddling	Round	Medium	Dugout	Angkorian
84	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Sailing	Fishing-Festival	ES	N	BC-EG-SW.I.1	Makara	N	Y	Sailing	Hard	Medium	Planked	Foreign
85	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Utilitarian	Fishing-Festival	ES	N	BC-EG-SW.I.2	Undecorated	N	N	Paddling	Hard	Small	Dugout	Angkorian
86	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Utilitarian	Fishing-Festival	ES	N	BC-EG-SW.I.3	Undecorated	N	N	Paddling	Hard	Small	Dugout	Angkorian
87	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.1t	?	N	Y	Rowing	?	Medium	Dugout	Angkorian
88	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.2t	Makara + Apsara	N	Y	Paddling	Hard	Large	Dugout	Angkorian
89	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.3t	Makara + ?	N	?	Rowing	?	Medium	Dugout	Angkorian
90	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.4t	Makara	N	Y	Rowing	Hard	Medium	Dugout	Enemy
91	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.5t	Makara	N	Y	Rowing	Hard	Medium	Dugout	Enemy
92	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.6t	?	N	?	?	?	Medium	Dugout	Enemy
93	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.7t	?	N	?	?	?	Medium	Dugout	Angkorian
94	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.1c	?	N	Y	Rowing	Hard	Medium	Dugout	Enemy
95	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.2c	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
96	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.1b	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
97	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.2b	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Angkorian

Table 1 Scenes with individual boats

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Temple	ID	Start date	Finish date	King	Scene ID	Type of boats	Scene type	Location	Controlled	Boat ID	Decoration	Pavilion	Quarter Rudder	Propulsion	Hull shape	Size	Construction	Users
98	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.3b	Makara + ?	N	?	Rowing	Hard	Medium	Dugout	Angkorian
99	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.4b	Makara	N	Y	Rowing	Hard	Medium	Dugout	Enemy
100	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.5b	Makara	N	Y	Rowing	Hard	Medium	Dugout	Enemy
101	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.6b	Makara	N	Y	Rowing	Hard	Medium	Dugout	Enemy
102	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.7b	Garuda	N	?	Rowing	?	Medium	Dugout	Angkorian
103	Banteay Chmar	BC	13	13	Jayavarman VII	BC-NG-WW.I	Military	Warfare	NW	N	BC-NG-WW.I.1	Makara + ?	N	?	Rowing	Hard	Medium	Dugout	Enemy ?
104	Banteay Chmar	BC	13	13	Jayavarman VII	BC-SG-EW.I	Military	Warfare	SE	N	BC-SG-EW.I.1	?	N	Y	Rowing	?	Medium	Dugout	Angkorian
105	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-NW.I	Military	Warfare	SE	N	BC-EG-NW.I.1	Undecorated	N/A	N/A	N/A	N/A	Large	Raft	Angkorian
106	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-NW.I	Utilitarian	fishing-warfare	SE	N	BC-EG-NW.I.2	Undecorated	N	N	Paddling	Hard	Small	Dugout	Angkorian
107	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-NW.I	Utilitarian	fishing-warfare	SE	N	BC-EG-NW.I.3	Undecorated	N	N	Paddling	Hard	Small	Dugout	Angkorian

Table 2 Scenes with type of boats

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Temple	ID	Start date	Finish date	King	Scene ID	Type of boats	Scene type	Location	Controlled	Boat ID	Decoration	Pavilion	Quarter Rudder	Propulsion	Hull shape	Size	Construction	Users
2	Bayon	BY	12	13	Jayavarman VII	BY-SG.I	Military	Warfare	S	N	BY-SG.I.1	undecorated	N/A	N/A	N/A	N/A	Large	Raft	Angkorian
3	Bayon	BY	12	13	Jayavarman VII	BY-SG.II	Military	Warfare	S	N	BY-SG.II.1	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Enemy
4	Bayon	BY	12	13	Jayavarman VII	BY-SG.II	Military	Warfare	S	N	BY-SG.II.2	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Enemy
5	Bayon	BY	12	13	Jayavarman VII	BY-SG.II	Military	Warfare	S	N	BY-SG.II.3	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Enemy
6	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.1t	?	N	Y	Rowing	?	Medium	Dugout	Angkorian
7	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.2t	Makara + ?	N	Y	Rowing	?	Medium	Dugout	Angkorian
8	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.3t	Makara + Brahma	N	Y	Paddling	Hard	Large	Dugout	Angkorian
9	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.4t	Makara + garuda	N	?	Rowing	?	Medium	Dugout	Angkorian
10	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.5t	Makara	N	Y	Rowing	Hard	Medium	Dugout	Enemy
11	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.6t	Undecorated	N	Y	Rowing	Hard	Medium	Dugout	Enemy
12	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.7t	?	N	N	Rowing	Hard	Medium	Dugout	Angkorian
13	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.1c	?	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
14	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.2c	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
15	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.3c	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
16	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.4c	?	N	?	Rowing	Hard	Medium	Dugout	Enemy
17	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.5c	Undecorated	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
18	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.6c	?	N	Y	Rowing	Hard	Medium	Dugout	Enemy
19	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.1b	?	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
20	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.2b	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
21	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.3b	Makara + garuda	N	N	Rowing	Hard	Medium	Dugout	Angkorian
22	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.4b	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
23	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.5b	Makara	N	Y	Rowing	Hard	Medium	Dugout	Enemy
24	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.6b	Undecorated	N	?	Rowing	Hard	Medium	Dugout	Angkorian
25	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.7b	Makara	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
26	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.1t	?	N	Y	Rowing	?	Medium	Dugout	Angkorian
27	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.2t	Makara + Apsara	N	Y	Paddling	Hard	Large	Dugout	Angkorian
28	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.3t	Makara + ?	N	?	Rowing	?	Medium	Dugout	Angkorian
29	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.4t	Makara	N	Y	Rowing	Hard	Medium	Dugout	Enemy
30	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.5t	Makara	N	Y	Rowing	Hard	Medium	Dugout	Enemy
31	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.6t	?	N	?	?	?	Medium	Dugout	Enemy
32	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.7t	?	N	?	?	?	Medium	Dugout	Angkorian
33	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.1c	?	N	Y	Rowing	Hard	Medium	Dugout	Enemy

Table 2 Scenes with type of boats

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Temple	ID	Start date	Finish date	King	Scene ID	Type of boats	Scene type	Location	Controlled	Boat ID	Decoration	Pavilion	Quarter Rudder	Propulsion	Hull shape	Size	Construction	Users
34	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.2c	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
35	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.1b	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
36	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.2b	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
37	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.3b	Makara + ?	N	?	Rowing	Hard	Medium	Dugout	Angkorian
38	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.4b	Makara	N	Y	Rowing	Hard	Medium	Dugout	Enemy
39	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.5b	Makara	N	Y	Rowing	Hard	Medium	Dugout	Enemy
40	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.6b	Makara	N	Y	Rowing	Hard	Medium	Dugout	Enemy
41	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.7b	Garuda	N	?	Rowing	?	Medium	Dugout	Angkorian
42	Banteay Chmar	BC	13	13	Jayavarman VII	BC-NG-WW.I	Military	Warfare	NW	N	BC-NG-WW.I.1	Makara + ?	N	?	Rowing	Hard	Medium	Dugout	Enemy ?
43	Banteay Chmar	BC	13	13	Jayavarman VII	BC-SG-EW.I	Military	Warfare	SE	N	BC-SG-EW.I.1	?	N	Y	Rowing	?	Medium	Dugout	Angkorian
44	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-NW.I	Military	Warfare	SE	N	BC-EG-NW.I.1	Undecorated	N/A	N/A	N/A	N/A	Large	Raft	Angkorian
45	Angkor Wat	AW	12	12	Suryavarman II	AW-CP.I	Ritual	Festival	SW	Y	AW-CP.I.1	Reachisey	Y	Y	Paddling	Round	Large	Dugout	Angkorian
46	Angkor Wat	AW	12	12	Suryavarman II	AW-CP.I	Ritual	Festival	SW	Y	AW-CP.I.2	Hamsa	Y	Y	Paddling	Round	Large	Dugout	Angkorian
47	Bayon	BY	12	13	Jayavarman VII	BY-IG.I	Ritual	Fishing-Uncertain	SE	Y	BY-IG.I.2	Garuda	Y	N	Paddling	Round	Medium	Dugout	Angkorian
48	Bayon	BY	12	13	Jayavarman VII	BY-IG.II	Ritual	Uncertain	SW	Y	BY-IG.II.1	Naga-reachisey	Y	N	Paddling	Hard	Small	Dugout	Angkorian
49	Bayon	BY	12	13	Jayavarman VII	BY-IG.II	Ritual	Uncertain	SW	Y	BY-IG.II.2	Naga-reachisey	Y	N	Paddling	Hard	Small	Dugout	Angkorian
50	Bayon	BY	12	13	Jayavarman VII	BY-IG.IV	Ritual	Festival	WS	Y	BY-IG.IV.1	Makara + multi-headed naga	Y	N	?	Round	Large	Dugout	Angkorian
51	Bayon	BY	12	13	Jayavarman VII	BY-IG.V	Ritual	Procession	NW	Y	BY-IG.V.1	Makara + garuda	Y	N	Paddling	Round	Medium	Dugout	Angkorian
52	Bayon	BY	12	13	Jayavarman VII	BY-IG.V	Ritual	Procession	NW	Y	BY-IG.V.2	Makara + garuda	Y	N	Paddling	Round	Medium	Dugout	Angkorian
53	Bayon	BY	12	13	Jayavarman VII	BY-IG.V	Ritual	Procession	NW	Y	BY-IG.V.3	Makara + garuda	Y	N	Paddling	Round	Medium	Dugout	Angkorian
54	Bayon	BY	12	13	Jayavarman VII	BY-IG.VI	Ritual	Uncertain	EN	Y	BY-IG.VI.1	Makara	N	N	Paddling	Round	Medium	Dugout	Angkorian
55	Bayon	BY	12	13	Jayavarman VII	BY-IG.VI	Ritual	Uncertain	EN	Y	BY-IG.VI.2	Makara	N	N	Paddling	Round	Medium	Dugout	Angkorian
56	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.1	Garuda	N	?	Paddling	Hard	Medium	Dugout	Angkorian
57	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.2	Garuda	Y	N	Paddling	Hard	Medium	Dugout	Angkorian
58	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.3	Apsara	Y	Y	Paddling	Hard	Large	Dugout	Angkorian
59	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.4	Garuda	N	?	Paddling	Hard	Medium	Dugout	Angkorian
60	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.5	Garuda	N	?	Paddling	Hard	Medium	Dugout	Angkorian
61	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.6	Garuda	N	?	Paddling	Hard	Medium	Dugout	Angkorian
62	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.7	Garuda	N	?	Paddling	Hard	Medium	Dugout	Angkorian
63	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.8	Garuda	N	?	Paddling	Hard	Medium	Dugout	Angkorian
64	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.9	Garuda	N	Y	Paddling	Hard	Medium	Dugout	Angkorian
65	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.10	Garuda	N	?	Paddling	Hard	Medium	Dugout	Angkorian
66	Bayon	BY	12	13	Jayavarman VII	BY-SEQ.I	Ritual	Fishing	SE	Y	BY-SEQ.I.2	?	N	N	Paddling	?	Medium	Dugout	Angkorian

Table 2 Scenes with type of boats

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Temple	ID	Start date	Finish date	King	Scene ID	Type of boats	Scene type	Location	Controlled	Boat ID	Decoration	Pavilion	Quarter Rudder	Propulsion	Hull shape	Size	Construction	Users
67	Royal Pools	RP	13	14?	Jayavarman VII or Jayavarman VIII	RP-WW.I	Ritual	Procession	W	Y	RP-WW.I.1	Reachisey + scales	N	N	Paddling	Round	Medium	Dugout	Angkorian
68	Royal Pools	RP	12	13	Jayavarman VII or Jayavarman VIII	RP-WW.I	Ritual	Procession	W	Y	RP-WW.I.2	? + scales	N	N	Paddling	Round	Medium	Dugout	Angkorian
69	Royal Pools	RP	12	13	Jayavarman VII or Jayavarman VIII	RP-WW.I	Ritual	Procession	W	Y	RP-WW.I.3	? + makara + scales	N	N	Paddling	Round	Medium	Dugout	Angkorian
70	Royal Pools	RP	12	13	Jayavarman VII or Jayavarman VIII	RP-WW.I	Ritual	Procession	W	Y	RP-WW.I.4	Reachisey + scales	N	N	Paddling	Round	Medium	Dugout	Angkorian
71	Royal Pools	RP	12	13	Jayavarman VII or Jayavarman VIII	RP-WW.I	Ritual	Procession	W	Y	RP-WW.I.5	Reachisey + scales	N	N	Paddling	Hard	Medium	Dugout	Angkorian
72	Royal Pools	RP	12	13	Jayavarman VII or Jayavarman VIII	RP-WW.I	Ritual	Procession	W	Y	RP-WW.I.6	Reachisey + scales	N	N	Paddling	Hard	Medium	Dugout	Angkorian
73	Royal Pools	RP	12	13	Jayavarman VII or Jayavarman VIII	RP-WW.I	Ritual	Procession	W	Y	RP-WW.I.7	Reachisey + scales	N	N	Paddling	?	Medium	Dugout	Angkorian
74	Ta Nei	TN	13	13	Jayavarman VII	TN-CS.I	Ritual	Ind. Trans.	N	Y	TN-CS.I.1	Garuda	N	N	Paddling	Round	Medium	Dugout	Angkorian
75	Banteay Samre	BR	12	12	Yashovarman II or Dharanindravarman ?	BS-CS.I	Ritual	Ind. Trans.	N	Y	BS-CS.I.1	Reachisey	?	Y	Single oar/rudder	Round	Medium	Dugout	Angkorian
76	Preah Khan	PK	13	13	Jayavarman VII	PK-CS.I	Ritual	Ind. Trans.	WS	Y	PK-CS.I.1	?	N	N	Paddling	?	Small	Dugout	Angkorian
77	Preah Khan	PK	13	13	Jayavarman VII	PK-IE.I	Ritual	Chess game	W	Y	PK-IE.I.1	Naga	Y	N	Paddling	Round	Medium	Dugout	Angkorian
78	Preah Khan	PK	13	13	Jayavarman VII	PK-WG.I	Ritual	Uncertain	W	N	PK-WG.I.1	Makara + Naga-Reachisey+scales	N	N	Paddling	Round	Medium	Dugout	Angkorian
79	Preah Khan	PK	13	13	Jayavarman VII	PK-WG.I	Ritual	Uncertain	W	N	PK-WG.I.2	Makara + Naga-Reachisey+scales	N	N	Paddling	Round	Medium	Dugout	Angkorian
80	Preah Khan	PK	13	13	Jayavarman VII	PK-WG.II	Ritual	Uncertain	W	N	PK-WG.II.1	?	N	N	Paddling	Round	Medium	Dugout	Angkorian
81	Preah Khan	PK	13	13	Jayavarman VII	PK-WG.II	Ritual	Uncertain	W	N	PK-WG.II.2	?	N	N	Paddling	Round	Medium	Dugout	Angkorian
82	Preah Khan	PK	13	13	Jayavarman VII	PK-EC.N	Ritual	Procession	E	N	PK-EC-N.?	?	Y	?	Paddling	?	Medium	?	Multiple
83	Preah Khan	PK	13	13	Jayavarman VII	PK-EC.S	Ritual	Procession	E	N	PK-EC-S.?	?	Y	?	Paddling	?	Medium	?	Multiple
84	Preah Khan	PK	13	13	Jayavarman VII	PK-NC.E	Ritual	Procession	N	N	PK-NC.E.?	?	Y	?	Paddling	?	Medium	?	Multiple
85	Preah Khan	PK	13	13	Jayavarman VII	PK-NC.W	Ritual	Procession	N	N	PK-NC.W.?	?	Y	?	Paddling	?	Medium	?	Multiple
86	Preah Khan	PK	13	13	Jayavarman VII	PK-WC.N	Ritual	Procession	W	N	PK-WC.N.?	?	Y	?	Paddling	?	Medium	?	Multiple
87	Preah Khan	PK	13	13	Jayavarman VII	PK-WC.S	Ritual	Procession	W	N	PK-WC.S.?	?	Y	?	Paddling	?	Medium	?	Multiple
88	Neak Pean	NP	13	13	Jayavarman VII	NP-CS.I	Ritual	Uncertain	N	Y	NP-CS.I.1	?	N	N	Paddling	?	Small	Dugout	Angkorian
89	Neak Pean	NP	13	13	Jayavarman VII	NP-CS.I	Ritual	Uncertain	N	Y	NP-CS.I.2	?	?	?	?	?	?	?	?
90	Phimai	PI	11	12	jayavarman VI or Dharanindravarman I ?	PI-CS.I	Ritual	Ind. Trans.	E	Y	PI-CS.I.1	?	N	N	Paddling	Round	Medium	Dugout	Angkorian
91	Bayon	BY	12	13	Jayavarman VII	BY-SG.III	Sailing	Fishing-Festival	SE	N	BY-SG.III.1	Undecorated	N	N	Sailing	Hard	Large	Planked	Foreign
92	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Sailing	Fishing-Festival	ES	N	BC-EG-SW.I.1	Makara	N	Y	Sailing	Hard	Medium	Planked	Foreign
93	Bayon	BY	12	13	Jayavarman VII	BY-IG.I	Utilitarian	Fishing-Uncertain	SE	Y	BY-IG.I.1	Undecorated	N	N	Paddling	Round	Small	Dugout	Angkorian
94	Bayon	BY	12	13	Jayavarman VII	BY-IG.III	Utilitarian	Lotus picking	SW	Y	BY-IG.III.1	Undecorated	N	N	Paddling	Hard	Small	Dugout	Angkorian
95	Bayon	BY	12	13	Jayavarman VII	BY-IG.IV	Utilitarian	Festival	WS	Y	BY-IG.IV.2	Undecorated	N	?	?	Hard	Medium	Dugout	Angkorian
96	Bayon	BY	12	13	Jayavarman VII	BY-IG.IV	Utilitarian	Festival	WS	Y	BY-IG.IV.3	Undecorated	N	N	Paddling	Hard	Small	Dugout	Angkorian

Table 2 Scenes with type of boats

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Temple	ID	Start date	Finish date	King	Scene ID	Type of boats	Scene type	Location	Controlled	Boat ID	Decoration	Pavilion	Quarter Rudder	Propulsion	Hull shape	Size	Construction	Users
97	Bayon	BY	12	13	Jayavarman VII	BY-IG.IV	Utilitarian	Festival	WS	Y	BY-IG.IV.4	Undecorated	N	N	Paddling	Hard	Small	Dugout	Angkorian
98	Bayon	BY	12	13	Jayavarman VII	BY-IG.IV	Utilitarian	Festival	WS	Y	BY-IG.IV.5	Undecorated	N	N	Paddling	Hard	Small	Dugout	Angkorian
99	Bayon	BY	12	13	Jayavarman VII	BY-SG.III	Utilitarian	Fishing-Festival	SE	N	BY-SG.III.2	Undecorated	N	N	Paddling	Hard	Small	Dugout	Foreign
100	Bayon	BY	12	13	Jayavarman VII	BY-SG.III	Utilitarian	Fishing-Festival	SE	N	BY-SG.III.3	Undecorated	N	N	Paddling	Hard	Small	Dugout	Foreign
101	Bayon	BY	12	13	Jayavarman VII	BY-SG.III	Utilitarian	Fishing-Festival	SE	N	BY-SG.III.4	Undecorated	N	Y	Single oar/rudder	Hard	Medium	Dugout	Foreign
102	Bayon	BY	12	13	Jayavarman VII	BY-SEQ.I	Utilitarian	Fishing	SE	Y	BY-SEQ.I.1	?	N	N	Paddling	?	Medium	Dugout	Angkorian
103	Preah Khan	PK	13	13	Jayavarman VII	PK-CL.I	Utilitarian	Fishing-Lotus picking	N	Y	PK-CL.I.1	Undecorated	N	N	Paddling	Round	Small	Dugout	Angkorian
104	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Utilitarian	Fishing-Festival	ES	N	BC-EG-SW.I.2	Undecorated	N	N	Paddling	Hard	Small	Dugout	Angkorian
105	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Utilitarian	Fishing-Festival	ES	N	BC-EG-SW.I.3	Undecorated	N	N	Paddling	Hard	Small	Dugout	Angkorian
106	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-NW.I	Utilitarian	fishing-warfare	SE	N	BC-EG-NW.I.2	Undecorated	N	N	Paddling	Hard	Small	Dugout	Angkorian
107	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-NW.I	Utilitarian	fishing-warfare	SE	N	BC-EG-NW.I.3	Undecorated	N	N	Paddling	Hard	Small	Dugout	Angkorian

Table 3: Utilitarian vessels

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Temple	ID	Start date	Finish date	King	Scene ID	Type of boats	Scene type	Location	Controlled access	Boat ID	Decoration	Pavilion	Quarter Rudder	Propulsion	Hull shape	Size	Construction	Users
2	Bayon	BY	12	13	Jayavarman VII	BY-IG.I	Utilitarian	Fishing-Uncertain	SE	Y	BY-IG.I.1	Undecorated	N	N	Paddling	Round	Small	Dugout	Angkorian
3	Bayon	BY	12	13	Jayavarman VII	BY-IG.III	Utilitarian	Lotus picking	SW	Y	BY-IG.III.1	Undecorated	N	N	Paddling	Hard	Small	Dugout	Angkorian
4	Bayon	BY	12	13	Jayavarman VII	BY-IG.IV	Utilitarian	Festival	WS	Y	BY-IG.IV.2	Undecorated	N	?	?	Hard	Medium	Dugout	Angkorian
5	Bayon	BY	12	13	Jayavarman VII	BY-IG.IV	Utilitarian	Festival	WS	Y	BY-IG.IV.3	Undecorated	N	N	Paddling	Hard	Small	Dugout	Angkorian
6	Bayon	BY	12	13	Jayavarman VII	BY-IG.IV	Utilitarian	Festival	WS	Y	BY-IG.IV.4	Undecorated	N	N	Paddling	Hard	Small	Dugout	Angkorian
7	Bayon	BY	12	13	Jayavarman VII	BY-IG.IV	Utilitarian	Festival	WS	Y	BY-IG.IV.5	Undecorated	N	N	Paddling	Hard	Small	Dugout	Angkorian
8	Bayon	BY	12	13	Jayavarman VII	BY-SG.III	Utilitarian	Fishing-Festival	SE	N	BY-SG.III.2	Undecorated	N	N	Paddling	Hard	Small	Dugout	Foreign
9	Bayon	BY	12	13	Jayavarman VII	BY-SG.III	Utilitarian	Fishing-Festival	SE	N	BY-SG.III.3	Undecorated	N	N	Paddling	Hard	Small	Dugout	Foreign
10	Bayon	BY	12	13	Jayavarman VII	BY-SG.III	Utilitarian	Fishing-Festival	SE	N	BY-SG.III.4	Undecorated	N	Y	Single oar/rudder	Hard	Medium	Dugout	Foreign
11	Bayon	BY	12	13	Jayavarman VII	BY-SEQ.I	Utilitarian	Fishing	SE	Y	BY-SEQ.I.1	?	N	N	Paddling	?	Medium	Dugout	Angkorian
12	Preah Khan	PK	13	13	Jayavarman VII	PK-CL.I	Utilitarian	Fishing-Lotus picking	N	Y	PK-CL.I.1	Undecorated	N	N	Paddling	Round	Small	Dugout	Angkorian
13	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Utilitarian	Fishing-Festival	ES	N	BC-EG-SW.I.2	Undecorated	N	N	Paddling	Hard	Small	Dugout	Angkorian
14	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Utilitarian	Fishing-Festival	ES	N	BC-EG-SW.I.3	Undecorated	N	N	Paddling	Hard	Small	Dugout	Angkorian
15	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-NW.I	Utilitarian	fishing-warfare	SE	N	BC-EG-NW.I.2	Undecorated	N	N	Paddling	Hard	Small	Dugout	Angkorian
16	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-NW.I	Utilitarian	fishing-warfare	SE	N	BC-EG-NW.I.3	Undecorated	N	N	Paddling	Hard	Small	Dugout	Angkorian

Table 4: Boats used in ritual activities

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Temple	ID	Start date	Finish date	King	Scene ID	Type of boats	Scene type	Location	Controlled access	Boat ID	Decoration	Pavilion	Quarter Rudder	Propulsion	Hull shape	Size	Construction	Users
2	Angkor Wat	AW	12	12	Suryavarman II	AW-CP.I	Ritual	Festival	SW	Y	AW-CP.I.1	Reachisey	Y	Y	Paddling	Round	Large	Dugout	Angkorian
3	Angkor Wat	AW	12	12	Suryavarman II	AW-CP.I	Ritual	Festival	SW	Y	AW-CP.I.2	Hamsa	Y	Y	Paddling	Round	Large	Dugout	Angkorian
4	Bayon	BY	12	13	Jayavarman VII	BY-IG.I	Ritual	Fishing-Uncertain	SE	Y	BY-IG.I.2	Garuda	Y	N	Paddling	Round	Medium	Dugout	Angkorian
5	Bayon	BY	12	13	Jayavarman VII	BY-IG.II	Ritual	Uncertain	SW	Y	BY-IG.II.1	Naga-reachisey	Y	N	Paddling	Hard	Small	Dugout	Angkorian
6	Bayon	BY	12	13	Jayavarman VII	BY-IG.II	Ritual	Uncertain	SW	Y	BY-IG.II.2	Naga-reachisey	Y	N	Paddling	Hard	Small	Dugout	Angkorian
7	Bayon	BY	12	13	Jayavarman VII	BY-IG.IV	Ritual	Festival	WS	Y	BY-IG.IV.1	Makara + multi-headed naga	Y	N	?	Round	Large	Dugout	Angkorian
8	Bayon	BY	12	13	Jayavarman VII	BY-IG.V	Ritual	Procession	NW	Y	BY-IG.V.1	Makara + garuda	Y	N	Paddling	Round	Medium	Dugout	Angkorian
9	Bayon	BY	12	13	Jayavarman VII	BY-IG.V	Ritual	Procession	NW	Y	BY-IG.V.2	Makara + garuda	Y	N	Paddling	Round	Medium	Dugout	Angkorian
10	Bayon	BY	12	13	Jayavarman VII	BY-IG.V	Ritual	Procession	NW	Y	BY-IG.V.3	Makara + garuda	Y	N	Paddling	Round	Medium	Dugout	Angkorian
11	Bayon	BY	12	13	Jayavarman VII	BY-IG.VI	Ritual	Uncertain	EN	Y	BY-IG.VI.1	Makara	N	N	Paddling	Round	Medium	Dugout	Angkorian
12	Bayon	BY	12	13	Jayavarman VII	BY-IG.VI	Ritual	Uncertain	EN	Y	BY-IG.VI.2	Makara	N	N	Paddling	Round	Medium	Dugout	Angkorian
13	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.1	Garuda	N	?	Paddling	Hard	Medium	Dugout	Angkorian
14	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.2	Garuda	Y	N	Paddling	Hard	Medium	Dugout	Angkorian
15	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.3	Apsara	Y	Y	Paddling	Hard	Large	Dugout	Angkorian
16	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.4	Garuda	N	?	Paddling	Hard	Medium	Dugout	Angkorian
17	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.5	Garuda	N	?	Paddling	Hard	Medium	Dugout	Angkorian
18	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.6	Garuda	N	?	Paddling	Hard	Medium	Dugout	Angkorian
19	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.7	Garuda	N	?	Paddling	Hard	Medium	Dugout	Angkorian
20	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.8	Garuda	N	?	Paddling	Hard	Medium	Dugout	Angkorian
21	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.9	Garuda	N	Y	Paddling	Hard	Medium	Dugout	Angkorian
22	Bayon	BY	12	13	Jayavarman VII	BY-SG.V	Ritual	Procession	SE	Y	BY-SG.V.10	Garuda	N	?	Paddling	Hard	Medium	Dugout	Angkorian
23	Bayon	BY	12	13	Jayavarman VII	BY-SEQ.I	Ritual	Fishing	SE	Y	BY-SEQ.I.2	?	N	N	Paddling	?	Medium	Dugout	Angkorian
24	Royal Pools	RP	13	14?	Jayavarman VII or Jayavarman VIII	RP-WW.I	Ritual	Procession	W	Y	RP-WW.I.1	Reachisey + scales	N	N	Paddling	Round	Medium	Dugout	Angkorian
25	Royal Pools	RP	12	13	Jayavarman VII or Jayavarman VIII	RP-WW.I	Ritual	Procession	W	Y	RP-WW.I.2	? + scales	N	N	Paddling	Round	Medium	Dugout	Angkorian
26	Royal Pools	RP	12	13	Jayavarman VII or Jayavarman VIII	RP-WW.I	Ritual	Procession	W	Y	RP-WW.I.3	? + makara + scales	N	N	Paddling	Round	Medium	Dugout	Angkorian

Table 4: Boats used in ritual activities

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
27	Royal Pools	RP	12	13	Jayavarman VII or Jayavarman VIII	RP-WW.I	Ritual	Procession	W	Y	RP-WW.I.4	Reachisey + scales	N	N	Paddling	Round	Medium	Dugout	Angkorian
28	Royal Pools	RP	12	13	Jayavarman VII or Jayavarman VIII	RP-WW.I	Ritual	Procession	W	Y	RP-WW.I.5	Reachisey + scales	N	N	Paddling	Hard	Medium	Dugout	Angkorian
29	Royal Pools	RP	12	13	Jayavarman VII or Jayavarman VIII	RP-WW.I	Ritual	Procession	W	Y	RP-WW.I.6	Reachisey + scales	N	N	Paddling	Hard	Medium	Dugout	Angkorian
30	Royal Pools	RP	12	13	Jayavarman VII or Jayavarman VIII	RP-WW.I	Ritual	Procession	W	Y	RP-WW.I.7	Reachisey + scales	N	N	Paddling	?	Medium	Dugout	Angkorian
31	Ta Nei	TN	13	13	Jayavarman VII	TN-CS.I	Ritual	Ind. Trans.	N	Y	TN-CS.I.1	Garuda	N	N	Paddling	Round	Medium	Dugout	Angkorian
32	Banteay Samre	BR	12	12	Yashovarman II or Dharanindravarman ?	BS-CS.I	Ritual	Ind. Trans.	N	Y	BS-CS.I.1	Reachisey	?	Y	Single oar/rudder	Round	Medium	Dugout	Angkorian
33	Preah Khan	PK	13	13	Jayavarman VII	PK-CS.I	Ritual	Ind. Trans.	WS	Y	PK-CS.I.1	?	N	N	Paddling	?	Small	Dugout	Angkorian
34	Preah Khan	PK	13	13	Jayavarman VII	PK-IE.I	Ritual	Chess game	W	Y	PK-IE.I.1	Naga	Y	N	Paddling	Round	Medium	Dugout	Angkorian
35	Preah Khan	PK	13	13	Jayavarman VII	PK-WG.I	Ritual	Uncertain	W	N	PK-WG.I.1	Makara + Naga-Reachisey+scales	N	N	Paddling	Round	Medium	Dugout	Angkorian
36	Preah Khan	PK	13	13	Jayavarman VII	PK-WG.I	Ritual	Uncertain	W	N	PK-WG.I.2	Makara + Naga-Reachisey+scales	N	N	Paddling	Round	Medium	Dugout	Angkorian
37	Preah Khan	PK	13	13	Jayavarman VII	PK-WG.II	Ritual	Uncertain	W	N	PK-WG.II.1	?	N	N	Paddling	Round	Medium	Dugout	Angkorian
38	Preah Khan	PK	13	13	Jayavarman VII	PK-WG.II	Ritual	Uncertain	W	N	PK-WG.II.2	?	N	N	Paddling	Round	Medium	Dugout	Angkorian
39	Preah Khan	PK	13	13	Jayavarman VII	PK-EC.N	Ritual	Procession	E	N	PK-EC-N.?	?	Y	?	Paddling	?	Medium	?	Multiple
40	Preah Khan	PK	13	13	Jayavarman VII	PK-EC.S	Ritual	Procession	E	N	PK-EC-S.?	?	Y	?	Paddling	?	Medium	?	Multiple
41	Preah Khan	PK	13	13	Jayavarman VII	PK-NC.E	Ritual	Procession	N	N	PK-NC.E.?	?	Y	?	Paddling	?	Medium	?	Multiple
42	Preah Khan	PK	13	13	Jayavarman VII	PK-NC.W	Ritual	Procession	N	N	PK-NC.W.?	?	Y	?	Paddling	?	Medium	?	Multiple
43	Preah Khan	PK	13	13	Jayavarman VII	PK-WC.N	Ritual	Procession	W	N	PK-WC.N.?	?	Y	?	Paddling	?	Medium	?	Multiple
44	Preah Khan	PK	13	13	Jayavarman VII	PK-WC.S	Ritual	Procession	W	N	PK-WC.S.?	?	Y	?	Paddling	?	Medium	?	Multiple
45	Neak Pean	NP	13	13	Jayavarman VII	NP-CS.I	Ritual	Uncertain	N	Y	NP-CS.I.1	?	N	N	Paddling	?	Small	Dugout	Angkorian
46	Neak Pean	NP	13	13	Jayavarman VII	NP-CS.I	Ritual	Uncertain	N	Y	NP-CS.I.2	?	?	?	?	?	?	?	?
47	Phimai	PI	11	12	jayavarman VI or Dharanindravarman I ?	PI-CS.I	Ritual	Ind. Trans.	E	Y	PI-CS.I.1	?	N	N	Paddling	Round	Medium	Dugout	Angkorian

Table 5: Vessels of War

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Temple	ID	Start date	Finish date	King	Scene ID	Type of boats	Scene type	Location	Controlled access	Boat ID	Decoration	Pavilion	Quarter Rudder	Propulsion	Hull shape	Size	Construction	Users
2	Bayon	BY	12	13	Jayavarman VII	BY-SG.I	Military	Warfare	S	N	BY-SG.I.1	undecorated	N/A	N/A	N/A	N/A	Large	Raft	Angkorian
3	Bayon	BY	12	13	Jayavarman VII	BY-SG.II	Military	Warfare	S	N	BY-SG.II.1	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Enemy
4	Bayon	BY	12	13	Jayavarman VII	BY-SG.II	Military	Warfare	S	N	BY-SG.II.2	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Enemy
5	Bayon	BY	12	13	Jayavarman VII	BY-SG.II	Military	Warfare	S	N	BY-SG.II.3	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Enemy
6	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.1t	?	N	Y	Rowing	?	Medium	Dugout	Angkorian
7	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.2t	Makara + ?	N	Y	Rowing	?	Medium	Dugout	Angkorian
8	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.3t	Makara + Brahma	N	Y	Paddling	Hard	Large	Dugout	Angkorian
9	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.4t	Makara + garuda	N	?	Rowing	?	Medium	Dugout	Angkorian
10	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.5t	Makara	N	Y	Rowing	Hard	Medium	Dugout	Enemy
11	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.6t	Undecorated	N	Y	Rowing	Hard	Medium	Dugout	Enemy
12	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.7t	?	N	N	Rowing	Hard	Medium	Dugout	Angkorian
13	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.1c	?	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
14	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.2c	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
15	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.3c	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
16	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.4c	?	N	?	Rowing	Hard	Medium	Dugout	Enemy
17	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.5c	Undecorated	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
18	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.6c	?	N	Y	Rowing	Hard	Medium	Dugout	Enemy
19	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.1b	?	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
20	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.2b	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
21	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.3b	Makara + garuda	N	N	Rowing	Hard	Medium	Dugout	Angkorian
22	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.4b	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
23	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.5b	Makara	N	Y	Rowing	Hard	Medium	Dugout	Enemy
24	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.6b	Undecorated	N	?	Rowing	Hard	Medium	Dugout	Angkorian
25	Bayon	BY	12	13	Jayavarman VII	BY-SG.IV	Military	Warfare	SE	N	BY-SG.IV.7b	Makara	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
26	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.1t	?	N	Y	Rowing	?	Medium	Dugout	Angkorian
27	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.2t	Makara + Apsara	N	Y	Paddling	Hard	Large	Dugout	Angkorian
28	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.3t	Makara + ?	N	?	Rowing	?	Medium	Dugout	Angkorian

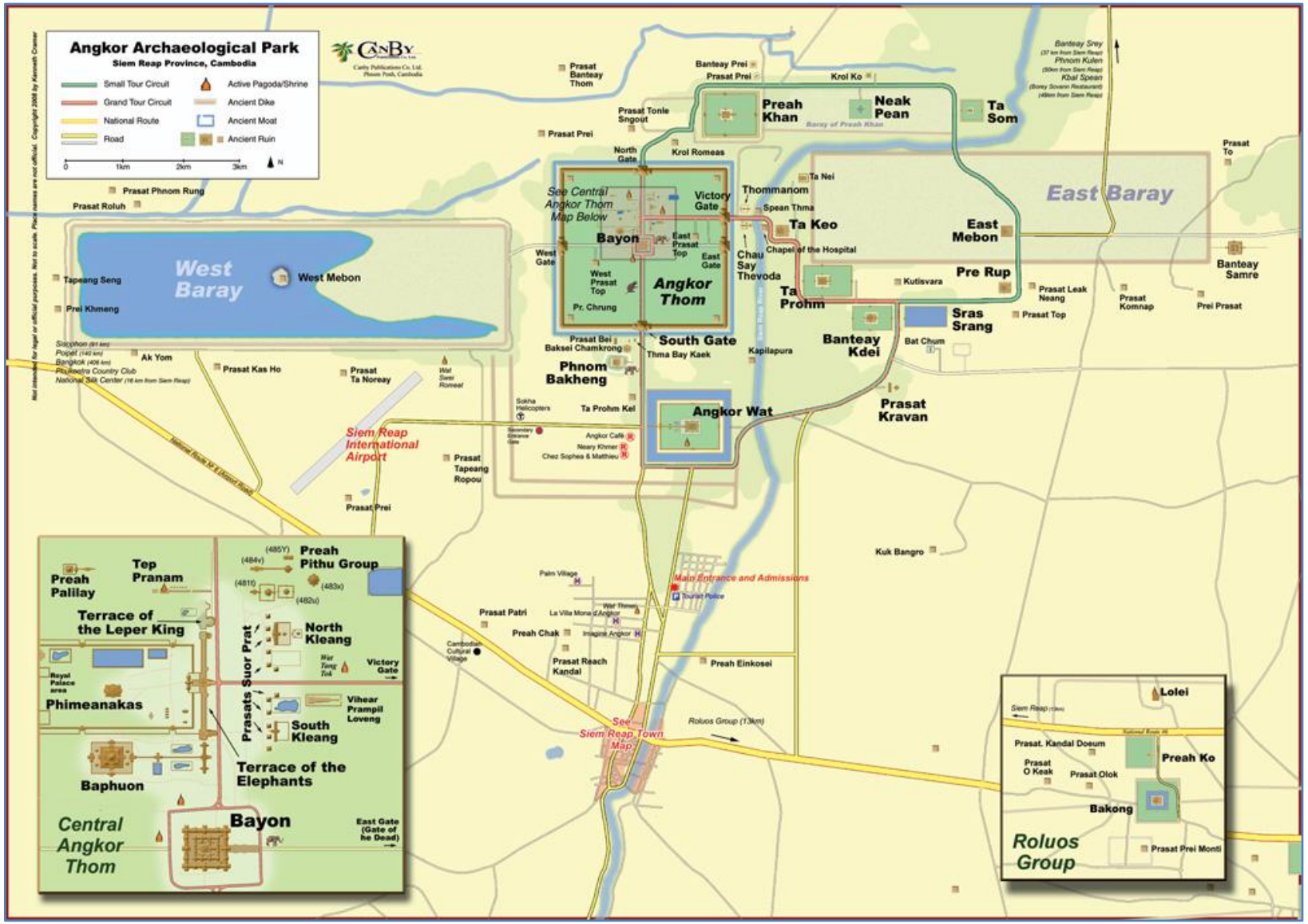
Table 5: Vessels of War

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Temple	ID	Start date	Finish date	King	Scene ID	Type of boats	Scene type	Location	Controlled access	Boat ID	Decoration	Pavilion	Quarter Rudder	Propulsion	Hull shape	Size	Construction	Users
29	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.4t	Makara	N	Y	Rowing	Hard	Medium	Dugout	Enemy
30	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.5t	Makara	N	Y	Rowing	Hard	Medium	Dugout	Enemy
31	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.6t	?	N	?	?	?	Medium	Dugout	Enemy
32	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.7t	?	N	?	?	?	Medium	Dugout	Angkorian
33	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.1c	?	N	Y	Rowing	Hard	Medium	Dugout	Enemy
34	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.2c	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
35	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.1b	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
36	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.2b	Makara + garuda	N	Y	Rowing	Hard	Medium	Dugout	Angkorian
37	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.3b	Makara + ?	N	?	Rowing	Hard	Medium	Dugout	Angkorian
38	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.4b	Makara	N	Y	Rowing	Hard	Medium	Dugout	Enemy
39	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.5b	Makara	N	Y	Rowing	Hard	Medium	Dugout	Enemy
40	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.6b	Makara	N	Y	Rowing	Hard	Medium	Dugout	Enemy
41	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Military	Warfare	ES	N	BC-EG-SW.II.7b	Garuda	N	?	Rowing	?	Medium	Dugout	Angkorian
42	Banteay Chmar	BC	13	13	Jayavarman VII	BC-NG-WW.I	Military	Warfare	NW	N	BC-NG-WW.I.1	Makara + ?	N	?	Rowing	Hard	Medium	Dugout	Enemy ?
43	Banteay Chmar	BC	13	13	Jayavarman VII	BC-SG-EW.I	Military	Warfare	SE	N	BC-SG-EW.I.1	?	N	Y	Rowing	?	Medium	Dugout	Angkorian
44	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-NW.I	Military	Warfare	SE	N	BC-EG-NW.I.1	Undecorated	N/A	N/A	N/A	N/A	Large	Raft	Angkorian

Table 6: Sailing Ships

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Temple	ID	Start date	Finish date	King	Scene ID	Type of boats	Scene type	Location	Controlled access	Boat ID	Decoration	Pavilion	Quarter Rudder	Propulsion	Hull shape	Size	Construction	Users
2	Bayon	BY	12	13	Jayavarman VII	BY-SG.III	Sailing	Fishing-Festival	SE	N	BY-SG.III.1	Undecorated	N	N	Sailing	Hard	Large	Planked	Foreign
3	Banteay Chmar	BC	13	13	Jayavarman VII	BC-EG-SW.I	Sailing	Fishing-Festival	ES	N	BC-EG-SW.I.1	Makara	N	Y	Sailing	Hard	Medium	Planked	Foreign

Appendix 3: Iconographic corpus



IC. 1: Angkor Archaeological Park with detail of Angkor Thom. Source: http://www.worldofmaps.net.



IC. 2: Geographic location of Khmer sites with nautical iconography. Source: V. Walker.

TEMPLES SURVEYED					
Name of the Temple	**Last Visit**	**Ships y / n**	**Nº of Scenes (Nº of ships)**	**King(s)**	**Date**
Central Angkor					
Angkor Wat[1]	2014	Y	1 (2)	Suryavarman II (c. 1113-1150 CE)	Early 12th c. with later add.
Ta Prohm Kel	2013	N	-	Jayavarman VII (1181-c. 1220 CE)	12th c.(dedicated in 1186)
Bakheng	2013	N	-	Yasovarman I (c. 1150-1165 CE)	late 9th- e. 10th c. (dedicated in 907)
Baksei Chamkrong	2013	N	-	Harshavarman I, c. 915-923 CE (restored by Rajendravarman)	early-mid 10th c. (re-dedicated 948)
Prasat Bei	2013	N	-	Yasovarman I (c. 1150-1165 CE)	10th century
Thma Bay Kaek	2013	N	-	Yasovarman I (c. 1150-1165 CE)	10th century
Angkor Thom[2]	2014	Y	-	Jayavarman VII (1181-c. 1220 CE)and successors	Late 12th c. and later (excluding some earlier monuments)
Bayon	2014	Y	11 (c. 41)	Jayavarman VII (1181-c. 1220 CE) to Jayavarman VIII (c. 1243-1295)	Late 12th c. to late 13th c. (started c. 1200 CE)
Bapuon	2013	N	-	Udayadityavarman II (1050-1066)	Mid. 11Th c. (dedicated in 1060)
Elephant Terrace	2013	N	-	Jayavarman VII (1181-c. 1220 CE) and Jayavarman VIII (c. 1243-1295)	Late 12th c. with later 13th c. add.
Leper King Terrace	2014	N	-	Jayavarman VII (1181-c. 1220 CE) and Jayavarman VIII (c. 1243-1295)	13th century
Phimeanakas and the Royal Palace[3]	2014	Y	1 or 2 (7)	Jayavarman V (968-c. 1000) and Udayadityavarman I (1001-1002 CE)	Phimeanakas: Late 10th-ear. 11th c., other: 12th to 13th c.
Tep Pranam	2013	N	-	Unknown	c. 16th c.

[1] Angkor Wat has a large number of painted vessels, but they have not been included here because they are post-Angkorian.
[2] The enclosure that forms Angkor Thom includes several temples that predate it, and other buildings that are studied separately. Those with nautical scenes are the Bayon and the ponds outside the Royal Palace.
[3] The nautical scenes are located **outside** the north wall of the Royal Palace, not inside its enclosure. Its date is unknown.

TEMPLES SURVEYED					
Name of the Temple	**Last Visit**	**Ships y / n**	**Nº of Scenes (Nº of ships)**	**King(s)**	**Date**
Preah Palilay	2013	N	-	? Jayavarman VII (1181-c. 1220 CE)	13th or 14th c.
Preah Pithu	2013	N	-	Suryavarman IIc. 1113-1150 CE Jayavarman VIIIc. 1243-1295 CE	13th c.
Suor Prat Towers	2013	N	-	Indravarman II (c.1220-1243 CE)	Early 13th c.
Mangalartha	2013	N	-	Jayavarman VIII (c. 1243-1295 CE)	Late 13th c. (dedicated in 1295)
The Khleangs	2013	N	-	(North) Jayavirvarman (1002-1010 CE) (South) Suryavarman I (1002-1049 CE)	Late 10th-ear. 11th c.
Eastern Angkor					
Thommanon	2013	N	-	Suryavarman II (c. 1113-1150 CE)	Early 12th c.
Chao Say Tevoda	2013	N	-	Suryavarman II (c. 1113-1150 CE) (with add. Yasovarman II, Jayavarman VIII)	Mid. 12Th c.
Spean Thma	2013	N	-	Unknown	16th c.
Ta Nei	2013	Y	1 (1)	Jayavarman VII (1181-c. 1220 CE)(enlarged by Indravarman II)	Late 12th c.
Hospital Chapel	2013	N	-	Jayavarman VII (1181-c. 1220 CE)	Late 12th c.
Ta Keo	2013	N	-	Jayavarman V (Jayaviravarman	Late 10th-ear. 11Th c.
Ta Prohm	2014	N	-	Jayavarman VII (1181-c. 1220 CE) (enlarged by Indravarman II)	Late 12th c. - 13th c.
Kutisvara	2013	N	-	Jayavarman II (790-835) (Rajendravarman)	Early 9th - mid.10th c.

TEMPLES SURVEYED					
Name of the Temple	**Last Visit**	**Ships y / n**	**Nº of Scenes (Nº of ships)**	**King(s)**	**Date**
Banteay Kdei	2013	N	-	Jayavarman VII (1181-c. 1220 CE) (enlarged by Indravarman II)	Late 12th- ear.13th c.
Srah Srang	2013	N	-	Rajendravarman (944-968 CE) (Jayavarman VII)	Mid. 10Th c. (remodeled late c.12th c.)
Prasat Kravan	2013	N	-	Harshavarman I (c. 915-923 CE)	Early 10th c. (dedicated in 921)
Bat Chum	2013	N	-	Rajendravarman (944-968 CE)	Mid. 10Th c.
The East Baray					
Pre Rup	2013	N	-	Rajendravarman (944-968 CE)	Mid. 10Th c. (dedicated in 961)
East Mebon	2014	N	-	Rajendravarman (944-968 CE)	Mid. 10Th c. (dedicated in 953)
Banteay Samré	2014	Y	1 (1)	Suryavarman II (c. 1113-1150 CE) (continued Yasovarman II)	Early 12th c.
Northeastern Angkor					
Preah Khan[4]	2014	Y	11 (+13)	Jayavarman VII (1181-c. 1220 CE) (modified Jayavarman VIII)	Late 12th c. (dedicated in 1191)
Neak Pean	2013	Y	2 (2)	Jayavarman VII (1181-c. 1220 CE)	Late 12th c.
Krol Ko	2013	N	-	Jayavarman VII (1181-c. 1220 CE)	Late 12th c. to early 13th c.

[4] The nautical iconography of the causeways (6 scenes) are too deteriorated so the exact number of boats is unknown, so one boat per scene has been included to reflect the nautical scenes although there are probably more.

TEMPLES SURVEYED					
Name of the Temple	**Last Visit**	**Ships y / n**	**Nº of Scenes (Nº of ships)**	**King(s)**	**Date**
Ta Som	2013	N	-	Jayavarman VII(1181-c. 1220 CE) (enlarged by Indravarman II)	Late 12th c. to 13th c.
The West Baray					
West Mebon	2014	N	-	Udayadityavarman I (1001-1002 CE)	Mid. 11Th c.
Ak Yum	2013	N	-	Unknown	2nd half of 8th c.
Phnom Krom	2013	N	-	Yasovarman I (889-c. 915 CE)	Late 9th- ear. 10Th c.
Roluos Group					
Preah Kô	2013	N	-	Indravarman I (877- c. 886 CE)	Late 9th c. (dedicated in 880)
Bakong	2013	N	-	Indravarman I (877- c. 886 CE)	Late 9th c. (dedicated in 881)
Lolei	2014	N	-	Yasovarman I (889-c. 915 CE)	Late 9th c. (dedicated in 893)
Banteay Srei and Beyond					
Banteay Srei	2014	N	-	Rajendravarman (944-968 CE)	Mid. 10Th c. (consecrated 22 April 967)
Kbal Spean	2014	N	-	Udayadityavarman II (1050-1066 CE)	? 11th to 12th c.
Beng Mealea	2013	N	-	Suryavarman II (c. 1113-1150 CE)	Mid. 12th c. with later add.
Koh Ker	N/S	-	-	Jayavarman IV (c. 928-c. 941 CE)	Mid. 10Th c.
Banteay Chhmar[5]	2010	Y	5 (24)	Jayavarman VII (1181-c. 1220 CE)	Late 12th- ear.13th c.

[5] Many sections of bas-reliefs in Banteay Chmar are scattered on the floor, thus it is possible that more nautical scenes may appear after the restoration of the temple (currently underway).

TEMPLES SURVEYED					
Name of the Temple	**Last Visit**	**Ships y / n**	**Nº of Scenes (Nº of ships)**	**King(s)**	**Date**
Preah Vihear	N/S	-	-	Suryavarman I (1002-1049 CE) and Suryavarman II (c. 1113-1150 CE)	11th to 12th c.
Phimai[6]	N/S	Y	1 (1)	Suryavarman I (1002-1049 CE)	11th and 12th c.
Unknown provenance					
Phimai National Museum	N/S	Y	1 (1)	Unknown	unknown

N/S= not surveyed, data found on desk-based research.

[6] Published in 1976 (Pichard).

Description of the images

The images of boats in Angkorian temples are unevenly distributed. Some temples have large nautical scenes, like in the case of the Bayon or Banteay Chmar, while others like Neak Pean or Ta Nei have isolated images. The images have been named using the initials of the temple where they are located (i.e. BY for Bayon, AW for Angkor Wat, BC for Banteay Chmar, etc.) followed by the initials of the location within the temple (i.e. IG for Innger Gallery) and a Roman number in the order of their appearance (i.e. BY-SG.V).

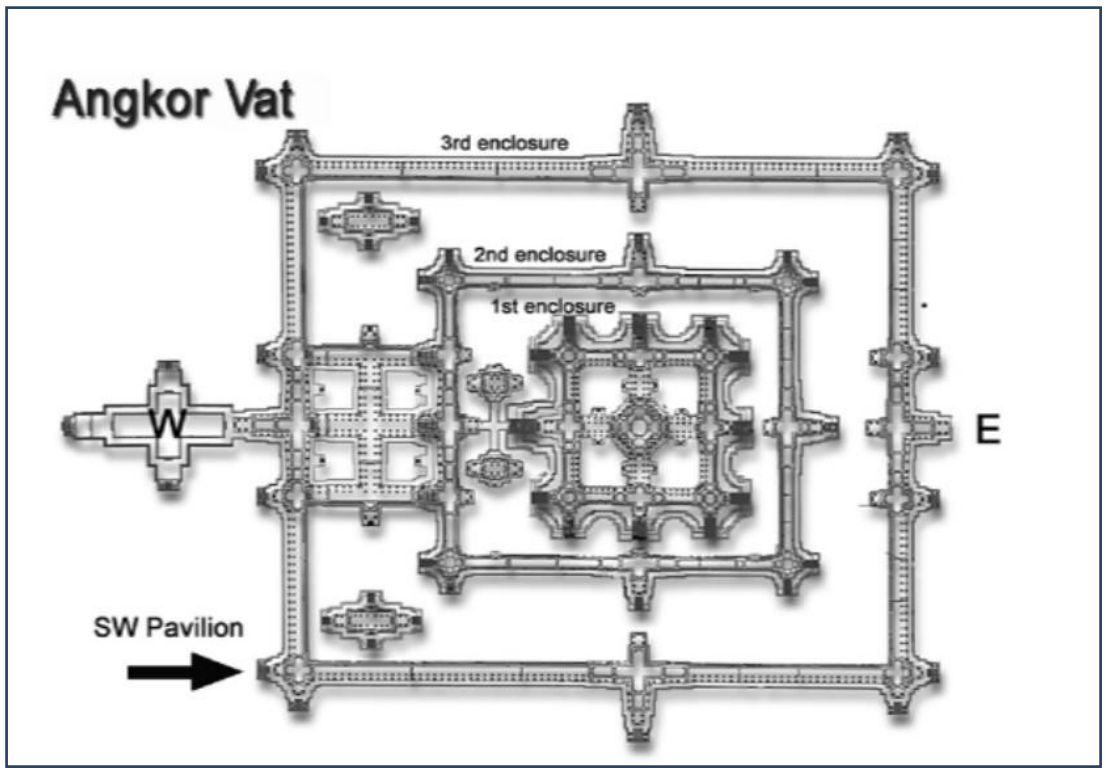
Following the system commonly used by scholars (Roveda, 2007: 284-285), the temples will be divided into eastern, southern, western and northern galleries. In turn, each is sub-divided into wings following the cardinal points (i.e. southern gallery, eastern wing). The direction of the description will be specified for each gallery, unless there is only one single image or scene.

Angkor Archaeological Park

Angkor Wat (AW)

The temple of Angkor Wat was commissioned by king Suryavarman II (1002-1049 CE) during the first half of the 12th century (IC. 3). Originally dedicated to Vishnu, there is great controversy as to its functions and symbolic status (Higham, 2001: 114-121: Freeman and Jacques, 2003, pp. 48-49: Higham, 1989: 332-335). There is a single nautical bas-relief located in the west corner pavilion of the third enclosure. The entire enclosure contains around 600 meters of bas-reliefs, most of them illustrating scenes from the *Ramayana* and *Mahabarata* epics (Freeman and Jacques, 2003: 54-55). Apart from this scene, boat paintings were found in the west *gopura* (Walker-Vadillo, 2009), and in the galleries of the four enclosures (Tan, Sokrithy and Chan, 2014). Most of the paintings represent local watercraft, but there are also foreign vessels. In the west gopura there is a European-rigged vessel that may be a VOC ship (Walker-Vadillo, 2009) and in the second enclosure part of the rigging of another European

vessel can be discerned. Preliminary analyses suggest a date of early 17th century for these paintings based on the nautical features of the European ships. Since the paintings do not seem to correspond to the Angkorian period, they will be studied in the future.



IC. 3: Plan of Angkor Wat with the location of the south-west corner pavilion where the nautical scene is located.

Third enclosure, outer gallery, South-West corner pavilion

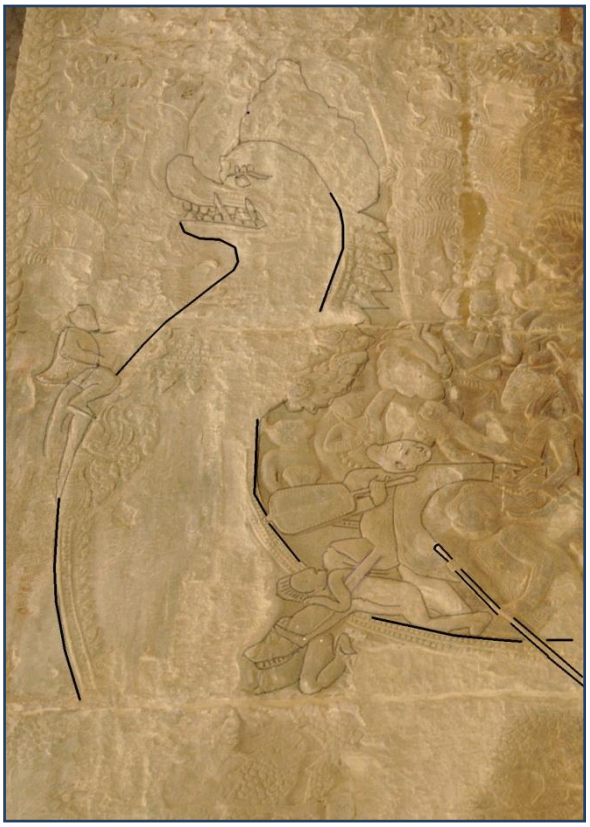
AW-CP.I The nautical bas-relief is located in the south-west corner pavilion of the third enclosure. Two heavily decorated barges are carved with exquisite detail. The scene has been identified as the water festival at Dvaravati[7] and it shows groups of courtiers enjoying a celebration. The image is deteriorated, but the outlines of the boats are quite clear. The stem and stern post of the lower ship are decorated with a garuda and its tail, while the ship on top has a nāga decoration. The ship in the upper register (IC. 4) is propelled by paddlers located all along the ship, while in the vessel of the lower register (IC. 5) they are located in the fore and aft areas, leaving the section amidships (centre of the boat) clear. It appears that both ships

[7] The identification of this scene with the Dvaravati water festival is widely extended (see for example Roveda, 2005, pp. 382: Paris, 1941., pp. 352-353) but there is no indication as to the meaning of this festival or the reason for such association between the nautical scene and the festival. The ships shown in the scene have the same type of decoration seen in other Khmer ships from Angkorian temples, indicating a likely Khmer origin.

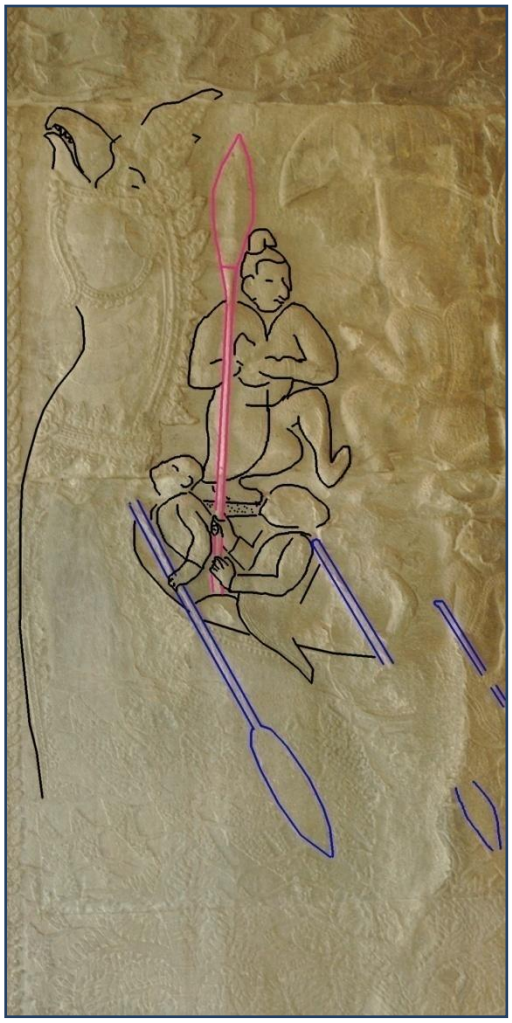
are using quarter rudders; the design of the rudders is similar to the paddles, in the form of a leaf. In this bas-relief we can see wavy lines that indicate water, which shows that the waterline of the vessels is very close to the sheer line.

In the upper register, amidships, we can see an ornate structure protecting two central figures. This construction seems to have a single room with tied curtains and flower garlands. The two central figures are playing a board game, possibly *ouk*, and the detail is so exquisite that the outlines of each piece of the game can be seen (Finot, Goloubew, and Coèdes, 1932: pl. 295). There is hectic movement depicted in the fore and aft sections of the ship; courtiers appear to be sitting on a raised deck engaged in various activities. In the fore, a figure is holding another person who appears to be overboard, in the water. Someone appears to be climbing the prow, whilst on board there is an elevated platform where court ladies and other people are sitting down. In the aft, an unidentifiable structure in the form of an inverted parasol is set against a decorated beam resting against the sternpost. If this is a seat, it could be a vantage point, perhaps for navigation. In this section there is also an elevated platform where people are engaged in activities. Roveda has identified one of the actions as people hunting with a blow pipe (2005: 382). The background is set by a tree line, and *apsaras* are flying in the sky. The upper tier is separated from the lower by a large number of fish, snake, and crocodiles depicted amidst wavy lines. The depiction of the ship in the lower tier shows the same kind of hectic movement in the fore; where people seem to be dancing on a platform under two parasols. A man is holding a pole that ends in a leaf-shape which could be a paddle, since it has a similar form. The ship also has a central pavilion with three rooms. The room on the left is occupied by two women in an embrace and a man kneeling down. The central room is occupied by noble women playing with children, and the left room has a kneeling figure, a child, and a figure of large size looking toward the aft, where a cock fight is taking place on top of a platform. The men surrounding the event appear to be betting, while another two men are holding roosters (IC. 6). Two parasols can be seen in the background. The scene is framed

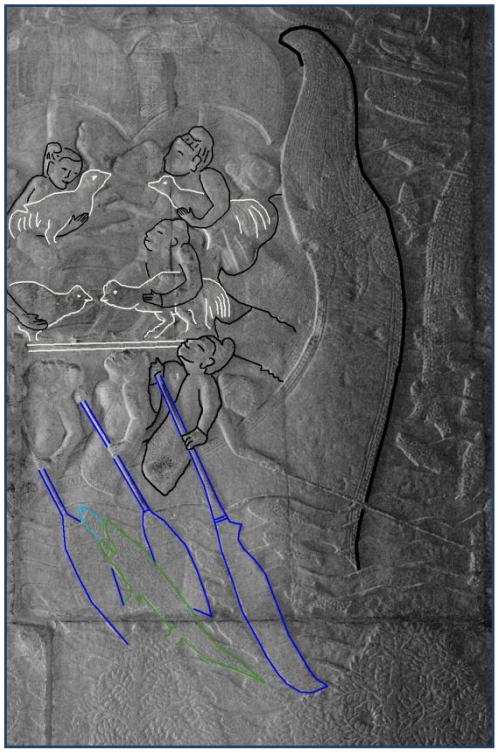
in the lowest section by water, fish, and vegetation. The scene has been linked to the epic Harivamsha, II, 43-46 where the Dvaravati Water Festival is described (Roveda, 2003: 122-126).



IC. 4: Detail of the boat in the upper register of AW.CP.I. Source: V. Walker.



IC. 5: Detail of the boat in the lower register. Source: V. Walker.



IC. 6: Stern detail of the boat in the lower register. Four roosters can be seen on a platform. Source: V. Walker.



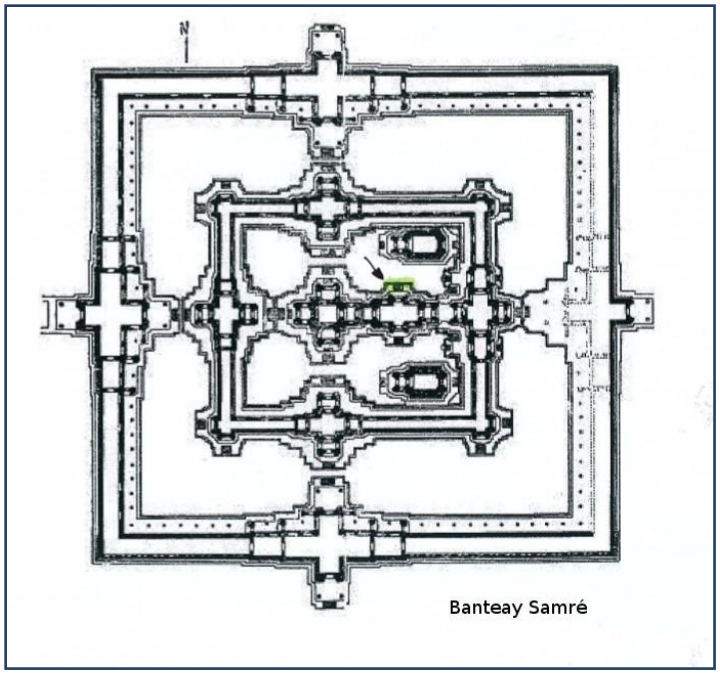
IC. 7: Stern of the barge in the upper register. Source: V. Walker.

Banteay Samré (BR)

The temple of Banteay Samré was constructed in the first half of the 12th century during the reign of Suryavarman II, and has some similarities in style with the temple of Phimai, located in the Khorat Plateau (Freeman and Jacques, 2006: p. 164), where there is another nautical scene in the central sanctuary (IC. 8).

Central sanctuary

BR-CS.1 In the pediment of the East door of the north wall of the mandapa[8] next to the central sanctuary there is a deteriorated image of a ship (IC. 9). The scene is divided into three tiers; in the upper section most of the image has disappeared. An apsara dances in the sky. On the central tier there seems to be a procession where four figures walk in front of two men who are carrying a giant fish hanging from a rod. In the lower section, the bow and the stern of a ship are visible, although the centre of the image appears to have been defaced[9]. The lower section of the hull is also lost. The bow is pointing towards the East and is decorated with the head of a *nāga* or a *garuda*. A person is kneeling right behind the decoration, carrying a pole. The pole does not seem to be the shaft of a paddle, since the lower section bends downward and appears to have something attached to it.



IC. 8: plan of the temple of Banteay Samré with the location of the nautical scene.

Another figure is facing the stern and appears to be holding something amidships that has disappeared. At the stern, the decoration seems to be that of a tail. Two figures can be seen in this section, one of them with a raised arm. Behind them, at the furthermost part of the boat, a standing helmsman is governing a quarter rudder of great length. The shaft of the rudder is between his legs. The rudder appears to be the means of propulsion of the ship; there are no paddlers at the front nor aft, and there are no apparent remains of paddles in the central

[8] Elevated outdoor pavilion destined for public rituals.
[9] The temple of Banteay Samre suffered an iconoclastic attack after the death of Jayavarman VII, and all Buddhist images were destroyed by Shaivites (Roveda, 2004, p.34).

section. This image seems to share similarities with stories from the *Jataka*[10] (Roveda 2005: 395-396).

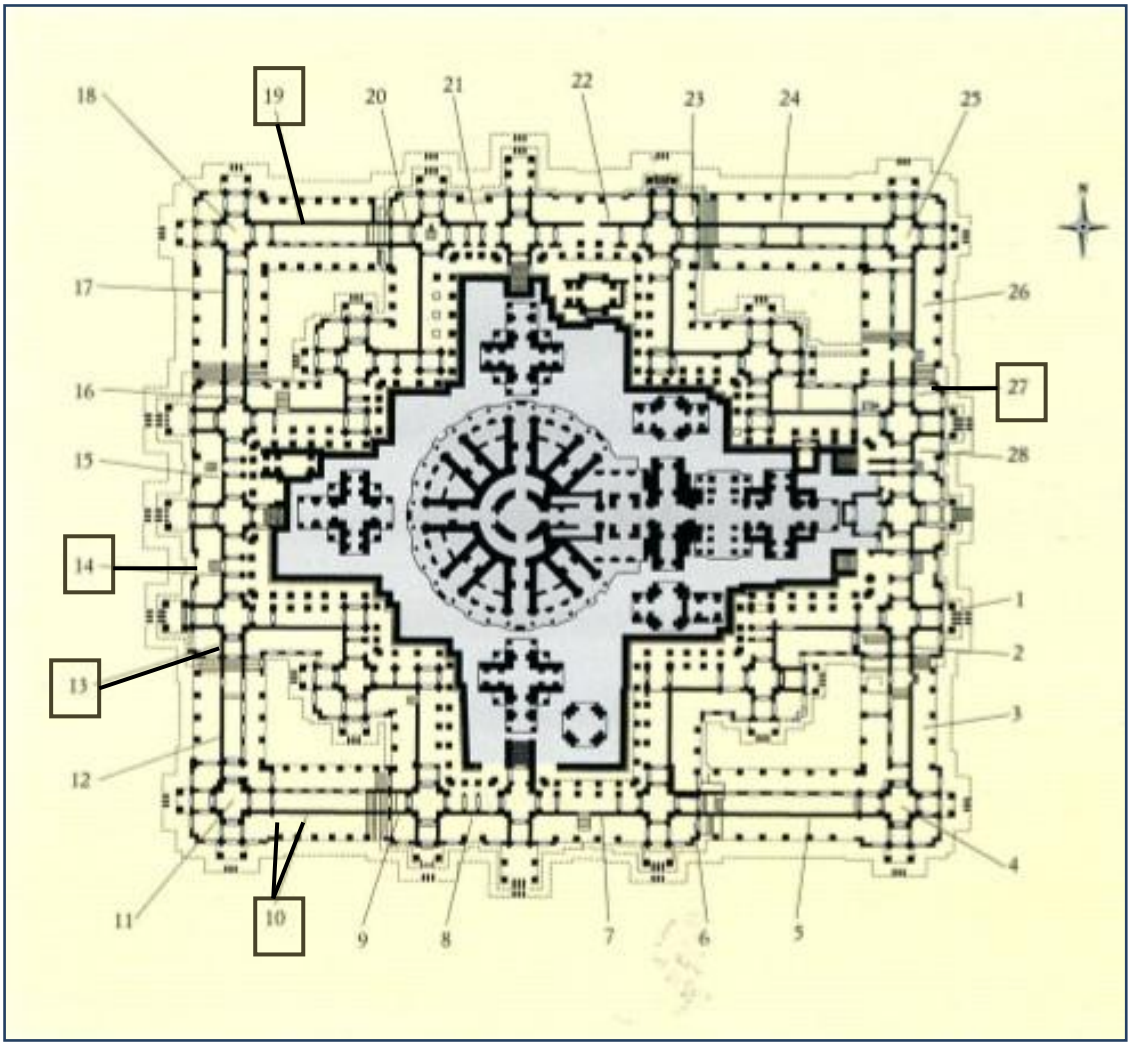


IC. 9: Only the bow and the stern are visible in this boat. Source: V.Walker.

Bayon of Angkor Thom (BY)

The Bayon is the central temple of Angkor Thom, the capital city constructed by king Jayavarman VII between the late 12th and late 13th century (IC. 10). There are some issues regarding the dating of the carving; the outer gallery is thought to have been carved during the life of Jayavarman VII (1181-c. 1220 CE), while the dating of the inner gallery is still a matter of debate. Some of the carvings of this section could have been carved while Jayavarman VII was still alive. However, other sections could have been carved during the reign of Jayavarman VIII (c. 1243-1295), when the temple was converted to Hinduism (Roveda, 2007: 284-285).

[10] Indian stories that narrate the previous lives of the Buddha.



IC. 10: Plan of Bayon's first enclosure with the location of the nautical scenes. Legend: 10: BY-IG.1 and BY-IG.2; 13: BY-IG.3; 14: BY-IG.4; 19: BY-IG.5; 27: BY-IG.6. Source: Freeman and Jacques 2003.

First enclosure

Located in the first enclosure, the inner gallery expands approximately 76 meters from north to south, and around 87 from east to west. The scenes in this area represent mostly mythological or religious themes associated with Hinduism (Roveda, 2007: 286).

Southern gallery, eastern section



IC. 11: detail of the decorated vessel in BY-IG.I. Source: Japanese team for Safeguarding Angkor (JSA) 2003.

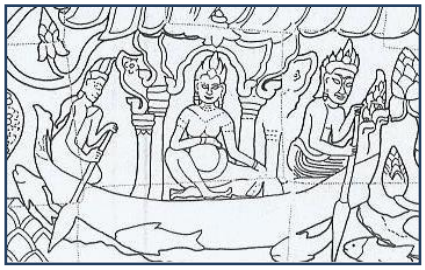
BY-IG.I. The first nautical scene in the inner gallery is the story of *Pradyumna,*[11] in the central-east section of the southern gallery, between towers 25 and 26 (Roveda, 2007: 291; Freeman and Jacques, 2003: 96). A large vessel filled with parasols and heavily decorated at its bow and stern is being propelled by four paddlers (IC. 11-12). The direction of the bow is toward the west. An ornate pagoda protects a central female figure surrounded by her courtiers. In the sky, a large number of apsaras fly above the boat carrying parasols and flower garlands. On the shore, a group of court ladies are depositing *Pradyumna* in a decorated chest, which will be thrown into the water. In the lake, close to the aforementioned large ship, a humble undecorated fishing boat rests in the water. A paddler is in the aft. The fisherman in the fore is throwing his net and, according to the story, he will catch the fish that swallowed little *Pradyumna*. The small boat's bow is looking westward. The scene has been identified by Roveda as a mythological theme from the *Vaishnava* tradition (2007: 360-361).



IC. 12: Fishing boat in BY-IG.I. Source: V. Walker.

[11] Pradyumna was born to Krishna and Rukmini. He was stolen by the demon Sambara when he was six years old, and thrown into the ocean. Praduymna was then eaten by a fish that was later caught by a fisherman and taken to the house of Sambara.

Southern gallery, western section



IC. 13: detail of the ship on the left of the scene in BY-FE.2. Source: JSA, 2003.

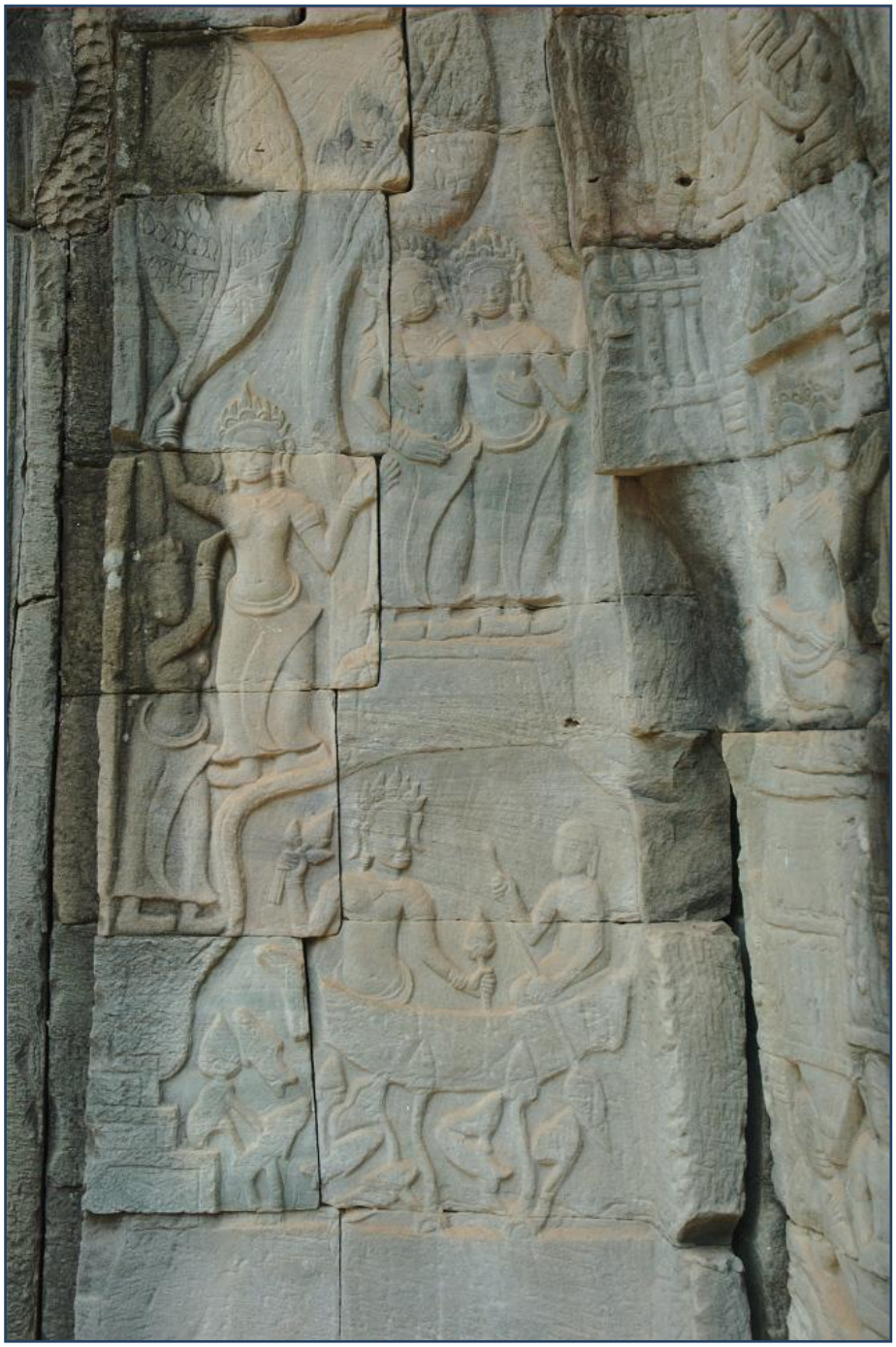
BY-IG.II Between towers 27 and 28, in the lower gallery, a nautical scene can be seen under a magnificent temple identified as Shaivite (Roveda 2007: 296; Freeman and Jacques 2003: 96). The temple seems to be floating on the water. In the lower register, two ships that are nearly identical are carrying court ladies and their courtiers (Fig. 19). The noble figures are protected by an elaborated structure. Each of the vessels is propelled by one paddler at the bow and another one at the stern. The bows are decorated with a multi-headed *nāga*, and the sterns seem to be mimicking the tail of the mythological being. Both ships are facing each other. In the centre, three *apsaras* are dancing on the water.



IC. 14: scene with two boats and what has been identified as a floating palace. Source: V. Walker.

BY-IG.III In the far left corner of the same wall, a boat can be seen in what could be identified as a man-made pond due to the stepped shoreline (Freeman and Jacques, 2003: 101). The undecorated vessel carries a court lady picking lotus flowers while an attendant paddles at the

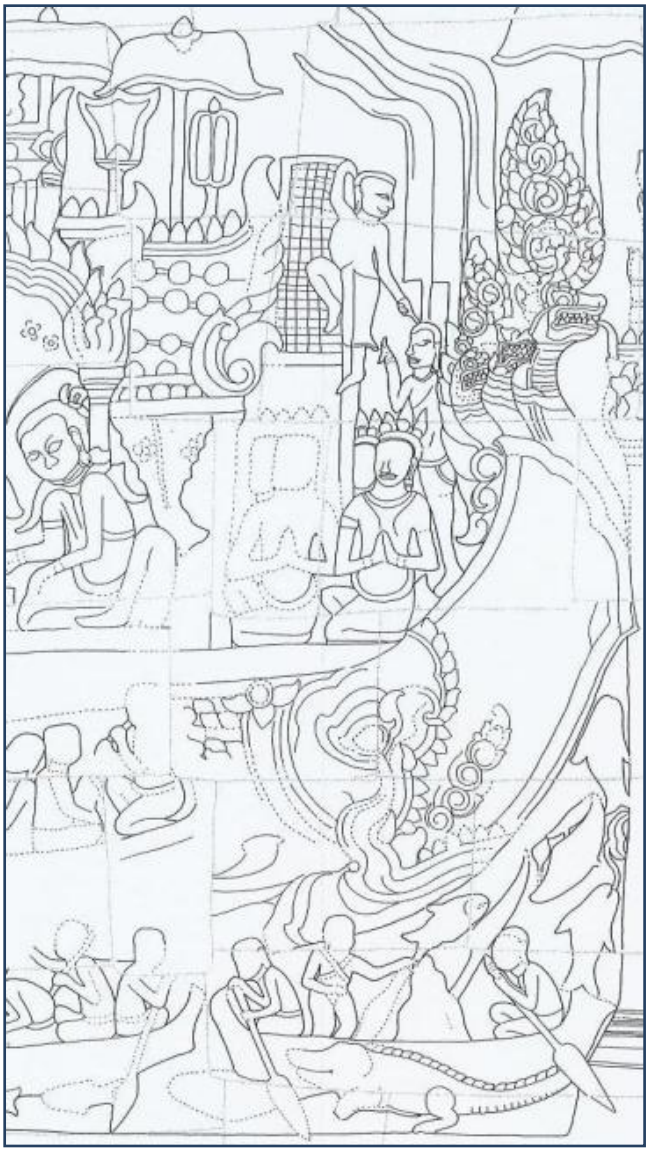
stern. The bow points toward the west. The hull appears to be shallow. As we can see in IC. 15, the paddler is kneeling on a platform, while the court lady is represented from the waist up.



IC. 15: court lady picking lotus flowers. Source: V. Walker.

Western gallery, southern section

BY-IG.IV The gallery between the towers 29 and 30 contains an extremely damaged bas-relief that shows a lavish celebration on water. The bas-relief could not be properly photographed due to the amount of erosion (IC. 16-17), nevertheless the Japanese Government Team for Safeguarding Angkor (JSA) made excellent drawings of this scene (IC. 16). The nautical depiction presents an ornate ship of considerable size located in the upper registry with its bow pointing to the east.



IC. 16: this detail of BY-FE.4 shows the intricate decoration of the main ship. Source: JSA, 2003.

An elaborated structure with several parasols and banners shelter what could potentially be an important person, but the image is too faded to give additional details. A group of courtiers are part of his or her entourage. A rectangular banner or sail can be seen on the right, with a servant climbing on top of it. The bow of the ship is heavily decorated with a *makara* and a protruding multi-headed *nāga*. It is very likely that the stern would have been originally decorated with the tail of the mythical animal, but the image is eroded in the aft section. In the central section of the scene, a medium-size vessel can be seen. The bow and stern are eroded; thus the direction of the ship is unknown. A figure of considerable size is amidships, although there is no awning on board. To the left of the central figure, three men

are enjoying a cock fight, whilst to the right, a person holds a child and other people are eating or drinking from a pot. The lower register shows three small undecorated vessels carrying three or four people. The boats use paddlers at bow and stern. The two ships on the left are moving to the east, while the ship on the right has its bow pointing toward the west. This has been identified as a secular theme by Roveda (2007: 360-361), whilst Freeman and Jacques point to similarities to the nautical scene in Angkor Wat, since both depict a festival scene (2003: 97).



IC. 17: this is one of the most deteriorated nautical scenes. However, the in JSA 2003 there is a very useful drawing with further details of the decoration. Source: V. Walker.

Northern gallery, western section

BY-IG.V This scene depicts three richly decorated ships heading west towards land (IC. 18-20). According to Roveda, the vessel closing the parade is smaller and different from the other two (2007: 302). However, from a nautical perspective it could be argued that the hulls are almost identical. For once, the decorations of the stem and stern posts of all three ships show a

similar depiction of a *garuda* and its tail (IC. 20). Also, the three ships also have parallel lines to the sheer line, which might be an indication of planking. The impression of the first ship being different relates to the fact that the structure in the first vessel is made in a different style than the other two. This vessel is occupied by what seems to be a foreign entourage, with a relevant figure sitting amidships under the structure. The dress of the foreign entourage has often been identified with Cham[12] people (Roveda, 2007: 302). The courtiers are dancing and cooking, and at the bow there is a juggler or sailor on a rope. The ship is propelled from the stern by two paddlers in our line of vision. It has been suggested that the small rectangular shapes at both sides of the structure could be sails (Paris, 1941: 350; Roveda, 2007: 302), although they are very small. The other two vessels also have similar rectangular objects in the stern of the ship. The central ship partially covers the bow of the previous ship, blocking the view of the bow. A big figure sits amidships holding a commanding stick. An ornate structure shelters him, while parasols populate the bow and banners can be seen undulating on board the ship. The courtiers surrounding this central figure are holding containers in their arms. From their dressing and hair style it could be said that they are Khmer (Roveda, 2007: 302). The ship is moved by a paddler at the stern and another one at the bow. The stern of the third ship is visible as it covers the bow of the previous vessel. This scene also represents a Khmer important figure surrounded by his entourage. The structure is of the same style as the other Khmer boat and it is also propelled by a paddler at the bow and at the stern. The decoration of a *makara* in the lower part of the bow is clearly visible.

[12] The Cham originate from Champa, in meridional Vietnam and have traditionally challenged the power of Angkor in the region (Hall, 1985, pp.169-230: Vickery, 2004).



IC. 18: The vessel closing the parade (left) has been identified as foreign, but the hulls are identical. Source: JSA, 2003.



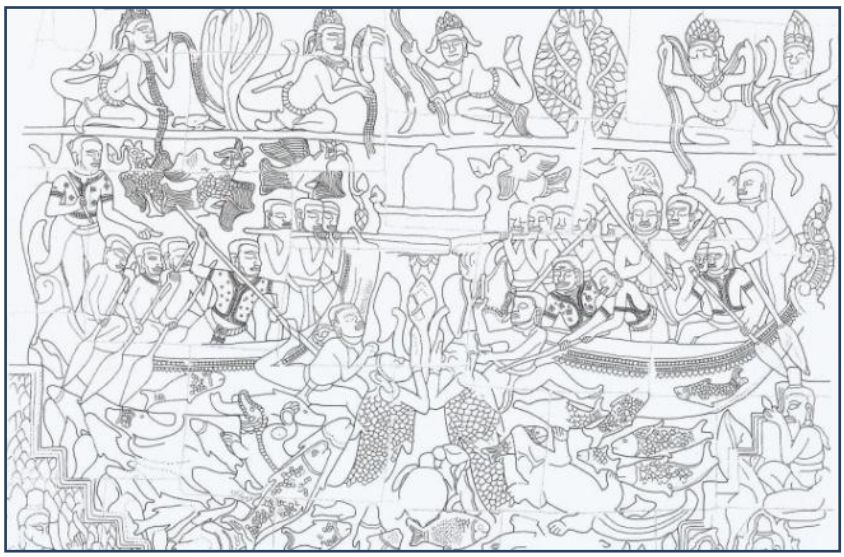
IC. 19: this scene is deteriorated, but the outline of the boats are visible, as well as the structures in the center of the boat. Source: V. Walker.



IC. 20: Detail bow decoration in one of the boats; a makara is regurgitaring a garuda. Source: V. Walker.

Eastern gallery, northern section

BY-IG.VI Between the towers 36 and 37, in the lower section, a nautical scene can be seen among a large number of fish and crocodiles (IC. 21-22). The stepped shore line suggests a man-made pond or *baray*. In the upper register, *apsaras* are flying over the scene carrying flower garlands. A group of men carrying a palanquin can be seen in the background. The object they are carrying has been defaced, but it could have been a *linga* (Roveda, 2007: 310). In the centre, two ships are facing each other and a complex scene is taking place on board. Standing figures at the stern of both ships appear to be coxswains, while paddlers move the ship from the aft. On the left side ship, a relevant figure amidships holds a rod and is either pushing or pulling someone in the water. On the right side ship a similar scene is taking place, with three figures holding rods. In the centre of the scene, in the water, there are two figures that are half-men and half-fish. The bows of the vessels are partially covered by human figures, but a few details of what could be a *makara* decoration can be perceived.[13] The upper side of both ships is decorated with symmetric patterns, and the stern is carved like the tail of the *makara*. The scene has been identified as a local legend (Roveda, 2007: 360-361).



IC. 21: in this drawing of BY-FE.6 we can see *apsaras* flying in the sky, and the scene unravelling in the pond. Source: JSA, 2003.

[13] In the left boat, above the shoulder of the person in the water, there is something that looks like an eye.



IC. 22: this scene shows two boats in a pond where two men are being thrown into or pulled from the water. Source: V. Walker.

Second enclosure

The outer gallery located in the second enclosure comprises an area of around 130 meters from north to south and 140 meters from east to west. The gallery was originally covered by a vault with a semi-corbelled gallery resting on square pillars. The themes represented in this section are connected to historical accounts (Roveda 2007; Freeman and Jacques 2003). The boat images are clustered in a section of the gallery, and they will be described in the counter-clockwise direction suggested by Roveda (2007: 312).

Southern gallery, eastern wing

BY-SG.I The nautical scene depicted in this section depicts a raft or pontoon bridge being crossed by soldiers and elephants (IC. 23). The construction of the raft follows the bundle technique, which can be seen in the cross-section.



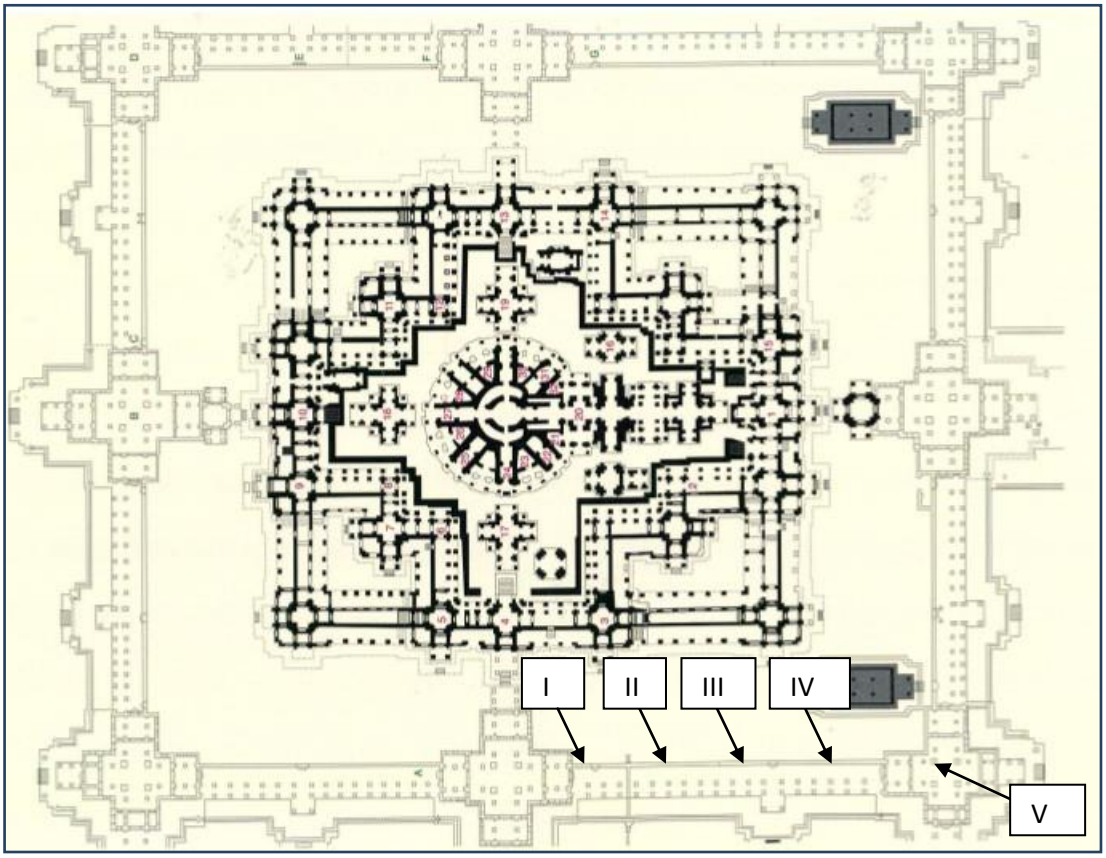
IC. 23: Raft or pontoon bridge with mooring pole used by soldiers and elephants. Source: EFEO.

BY-SG.II The nautical scene unravels just as we step out of the central axial pavilion (see location in IC. 24). Three identical ships can be seen coming from the east. The bows of the vessels are decorated with a *makara* regurgitating a *garuda*, while the stern shows the common tail ending (IC. 25-26). Khmer oarsmen are rowing, while helmsmen wearing a different coiffure and clothing steer the ships with a square-shaped quarter rudder.[14] The ships are loaded with two lines of enemy soldiers ready for battle. The first vessel is being beached and tied by an enemy soldier. On the shore, Khmer and their enemies can be seen engaged in combat. In the lake there are abundant fish and crocodile, and soldiers can be seen drowning or dead in the water.

The scene represents a naval invasion by a mixed navy, perhaps showing an alliance between the enemies and a rival Khmer faction (Roveda, 2007: 320). It has been suggested that the

[14] The interpretation of nationalities or ethnicities of the people depicted in Angkor has been contested by researchers like Paris (1941), Roveda identifies the enemies as Cham (2007: 319); the enemies carry a distinctive coiffure or helmet and are represented in nautical scenes battling with Khmer forces. Given the lack of consensus over this matter, in this paper we will use the term enemies.

small number of boats involved in this scuffle may suggest a scouting operation and not a large-scale invasion (Ibid.). The enemy soldiers on land are fighting the Khmer in the shoreline. In the upper register the enemies are seen as loosing the fight under the scrutiny of the king, who has ordered to prepare a banquet (Freeman and Jacques, 2003: 88).



IC. 24: plank of the Bayon with the location of the scenes in the second enclosure. I: BY-SG.I; II: BY-SG.II: III: BY-SG.III; IV: BY-SG.IV; V: BY-SG.V. Source: Freeman and Jacques, 2003.



IC. 25: first boat in the invasion sequence represented in this scene. Source: V. Walker.



IC. 26: Last boat involved in the naval invasion. Source: V. Walker.

BY-SG.III Separated from the previous scene by a strip that has been carved to this purpose, the next nautical scene represents a puzzling portrait of what is commonly described as Chinese people enjoying a day in the lake or river (IC. 27-31).[15] The upper register shows a vessel of considerable size, made using planks, with a large rudder at the stern and a sophisticated anchor at the bow (Fig. 36). At least two masts can be seen, with sails that seem to be made from rattan or bamboo (Roveda, 2007: 320). The ship is sailing in a westerly direction. Everyone on board seems to have small pointed beards. A figure of considerable size

[15] The ethnicity of the people depicted in this scene has been attributed to their pointed beards, coiffure, and short lobes (Roveda 2007: 320; Freeman and Jacques 2003: 87).

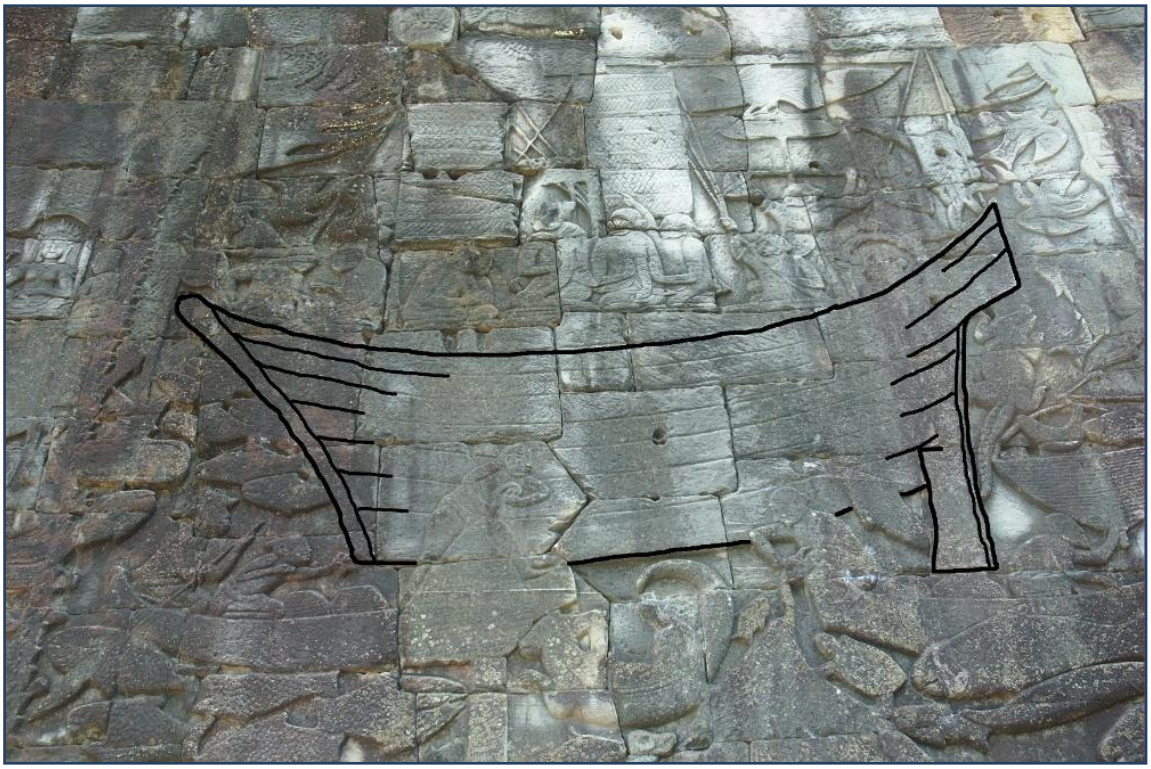
can be identified in the centre. Furthermore, a number of people seem to be paying respects to this central figure. Another group of people is playing a board game. In the aft, there is a parasol and an ornate pavilion with windows from where a bearded man peers out. Around the pavilion, a man is holding the rope of the sails and another sailor is holding what looks like a mop to work probably on the sails.

At the viewer's eye level, a middle-sized undecorated ship can be seen with a large number of people on board (IC. 30). The boat seems to be heading toward the west and it is propelled by a fixed quarter rudder with a tiller for handling. At the bow, a sailor is taking care of a rock anchor in the form of a tear drop that could be tied to a pole on board (the features are in line, but it is possible that they are not related at all). A bearded figure of considerable size sits amidships under a parasol. He is pointing to the stern as if he were giving an order. Behind him there is a mast or a pole from where a rectangular banner is set. Aft wards, a person seems to be dancing, while a group of people is gathered around a container. A decoration or protective panel made of rattan or bamboo can be seen in the topside.

Two small undecorated fishing boats can be seen under the planked vessel. In both boats there seems to be a mixture of Khmer and bearded crew or fishermen, and their bows are pointing at each other. In the left boat, a fisherman at the bow is throwing a soft net, while another person sits in the aft holding something in his hand (IC. 31). A person with an exotic hat is paddling in the stern. Hard nets or cages can be seen on board. On the right boat, a fisherman is throwing a soft net from the bow, while a bearded figure amidships holds a basket full of fish and is interacting with two men standing on a platform (IC. 28).

A Khmer paddler is moving the boat from the stern and discussing something with the same men. These men are part of a section of a bas-relief that has been identified as a separate scene (Roveda, 2007: 320) or as part of a wider nautical scene (Freeman and Jacques, 2003: 87). Given the interaction between the four men in IC. 31, this report supports the latter

interpretation. Thus, on the right side of the nautical leisure scene there are five platforms that have been previously identified as long boats tied to a pole at the stern. However, there seems to be a grouping of the first three "long boats", with and the two upper boats (IC. 31). In both cases the uppermost platform is covered by a roof. Given the traditional construction techniques that are still in use in Cambodia, I propose that these platforms are indeed two separate buildings –either raised on stilts or floating, though the extended pole in the lower building suggests stilts– and topped with an elaborated roof. The lower building has three levels; on the first and second stages there are armed soldiers, while on the third level there is a dancer in the centre, musicians on the left and an audience on the right. At the far left there are the two men interacting with the men on the boat, seemingly purchasing fish from a basket that is being raised between a men on the building and a men on the boat. The other man on the building seems to be discussing a matter with the man holding the paddle at the stern of the boat (Fig. 38). In the building at the top there are soldiers on the lower level and in the upper level there are rooms occupied by princesses and their courtiers.



IC. 27: upper register of the scene where a plank vessel can be seen. Source: V. Walker.



IC. 28: fishing boat in the middle register, left section. Source: V. Walker.



IC. 29: fishing boat in the middle register, rigth section. Source: V. Walker.



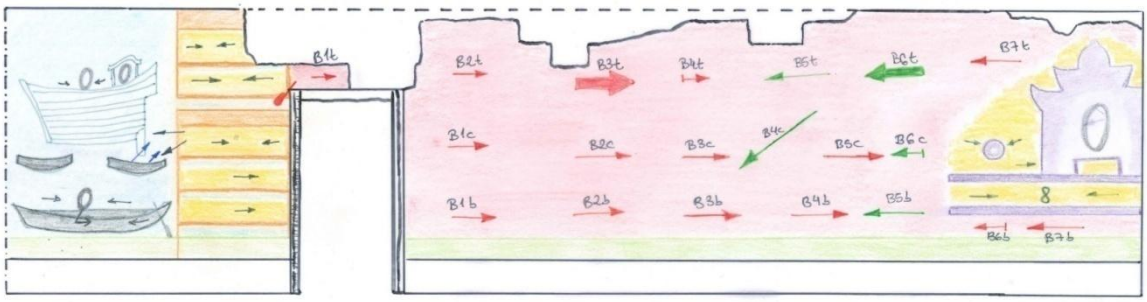
IC. 30: large leisure vessel in the lower register. Source: V. Walker.



IC. 31: Stilted buildings between the sailing ship scene and the naval battle. On the left side there is interaction between people in the lover building and people on a boat. The roof of the lower building is clearly depicted and separated from the upper building. On the right side the rudder of a war boat is partly depicted in the area of the stilted building. Source: V. Walker.

BY-SG.IV To the east of the wall, the great naval battle scene is revealed (IC. 32-38). The fight is between two parties that have been identified as Khmer and Cham due to the hair style or hats (ibid.: 321-322), nevertheless the parties will be identified here as Khmer and enemies. The enemy vessels are arriving from the east, but in the midst of battle, Khmer ships have surrounded them (see sketch in IC. 32). The enemies are outnumbered, by five ships to eleven.[16] The uppermost part of the wall supporting this depiction has collapsed, and although there are other three or four ships, it is difficult to determine their affiliation. Nevertheless, the Khmer seem to be winning, with their soldiers shown as having sunk an enemy vessel and are about to board another ship using hooks to secure the bows.

[16] The upper section of the panel is deteriorated and incomplete, so there might have been more ships originally.



IC. 32: Sketch of the Bayon naval battle and adjacent nautical scene BY-SG.III. Arrows point the direction of interaction of the people on board. Red arrows depict Angkorian vessels, green arrows enemy war boats. Red arrows indicate Angkorian boats and green arrows enemy boats. Source: V. Walker.

On the right side of the panel, amidships, a large vessel carries a figure of great size that has been identified as the admiral of the Khmer navy (Jacq-Hergoualc'h, 1979: 129-131). His boat is heavily decorated and has a castle in the aft. The bow has a *makara* with protruding tusks that could have been used for ramming. The *makara* is regurgitating a *multi-headed nada*, although the image is not very clear. The ship is propelled by paddlers, with a helmsman sitting just below the castle. The rest of the Khmer warships have similar hull shapes; however, they all use rowers.

The enemies are depicted as having similar ships to the Khmer. The only substantially different hull carrying enemy soldiers is located in the lower right section of the bas-relief, which has its sternpost leaning toward the inside of the ship. Rowing is also used as the primary method of propulsion among the enemy's warships. The topsides of the ship have been increased using what looks like a reed panel, possibly made with rattan or bamboo (Roveda, 2007: 322); it is difficult to determine if this section protrudes from the hull. The reed panel has oar ports where the oars are fixed, oarlocks are not represented in the depiction. The decoration of Khmer and enemy boats is very similar. As the battle ensues, many soldiers have fallen in the water, where crocodiles await. The naval war scene is being observed by the Khmer king from the right side of the panel (Roveda, 2007: 322). His entourage surrounds him while he participates in the victory. An acrobat performs to the music of a harpist. The lower section of the bas-relief depicts festive scenes on the shore. The platform on which the king and his

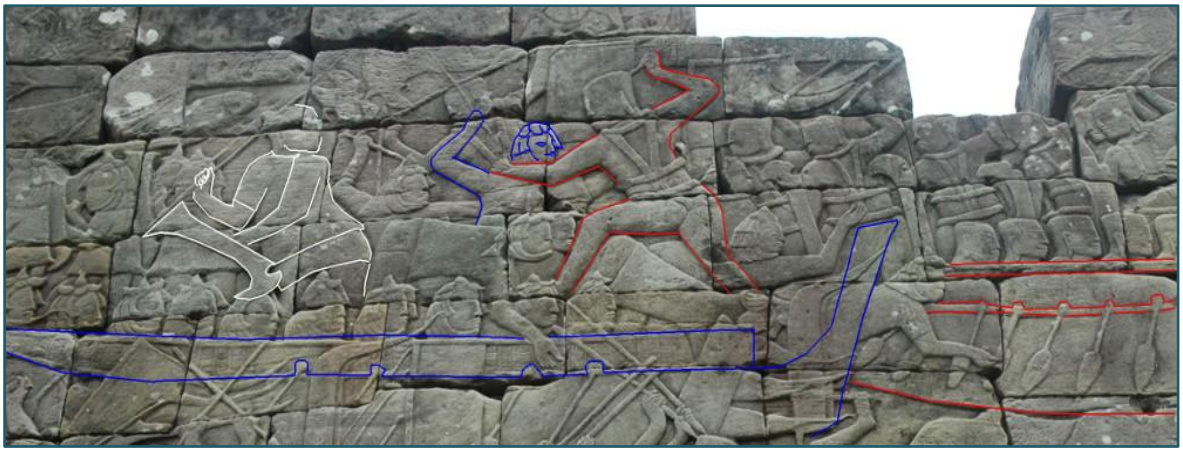
entourage are located has been identified as a raft similar to the one in BC-EG.SW.I in Banteay Chmar (Roveda, 2005: 435), but it could also be a stilted house.



IC. 33: detail of the naval battle in three registers. This section corresponds to boats B1b, B1c, B2t of the sketch. Source: V. Walker.



IC. 34: detail of the battle toward the right. The admiral's ship can be seen in the upper register to the right. These boats correspond to boats B2b, B2c, B3t. Source: V. Walker.



IC. 35: Leader of the enemy fleet traced in white being attacked from behind by Angkorian soldiers. These boats correspond to B6t, B7t. Source: V. Walker.



IC. 36: a sinking ship in the top left and casualties in the water. These boats correspond to B4b, B5b, B4c, B5c. Source: V. Walker.



IC. 37: Low ranking boats with undecorated and makara decorated boats. These boats correspond to B6t, B7t. Source: V. Walker.



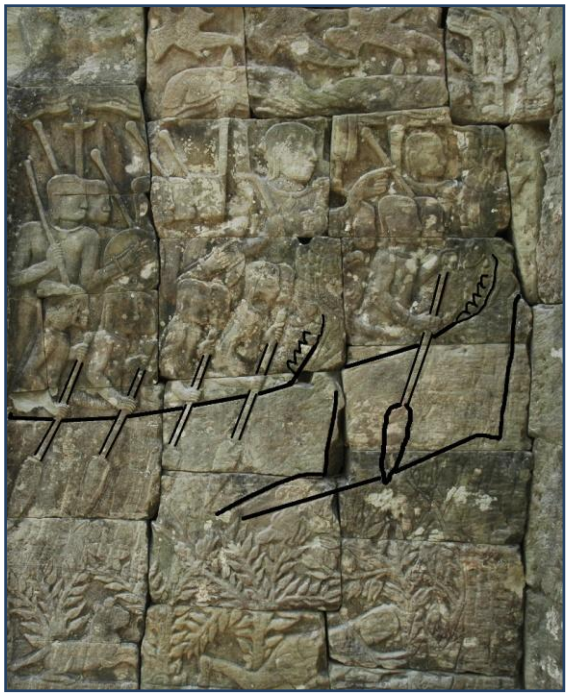
IC. 38: platform with the king observing the naval battle and a fight. Source: V. Walker.

BY-SW.V Crossing the door that leads to the tower 57, we can find an unfinished bas-relief showing several ships leading a procession or royal parade towards the east (IC. 39-44). The scene unravels along the wall, through a corner, a doorframe and a second corner (IC. 39). The rearguard is composed of two paddled boats carrying soldiers. A larger image in the centre

suggests a leader of this military division. The next wall is dominated by a single large royal barge with two court ladies attended by courtiers and an unfinished central section. The bow is only traced but the decoration of the prow is unfinished. There is a single paddler on this section. The stern has a small pavilion right on the sternpost, and underneath it there is a helmsman. The scene is sectioned off by a doorframe, and the sculptors have used this feature to adapt the image without reducing the scale of the image. Thus, four boats are represented grouped in twos and only depicted from amidships to the bow. The stem posts of the ships are decorated with garuda. Around the corner, there is a vanguard with two boats depicted side by side represented as double sterns and bows (IC. 40). A contiguous line of paddlers propels the ship, which is steered with a quarter rudder with a tiller. The vessels leading the expedition or procession are loaded with soldiers. Although armed with fighting sticks and shields, these soldiers are not displaying the readiness of the immediate battle since their sticks are resting on their shoulders. Among the soldiers, a few parasols can be seen.



IC. 39: the scene is spread over different architectural features. Source: V. Walker.



IC. 40: the scene starts in the north corner of the west wall of the south-west corner pavillion, right beside the doorframe. Two boats are closing the parade. Source: V. Walker.



IC. 41: detail of the helmsman of the vangard of the parade. Source: V. Walker.



IC. 42: the royal barge has been left unfinished. The bow of the ship is barely traced, whilst the central figure has not been marked for carving. Source: V. Walker.



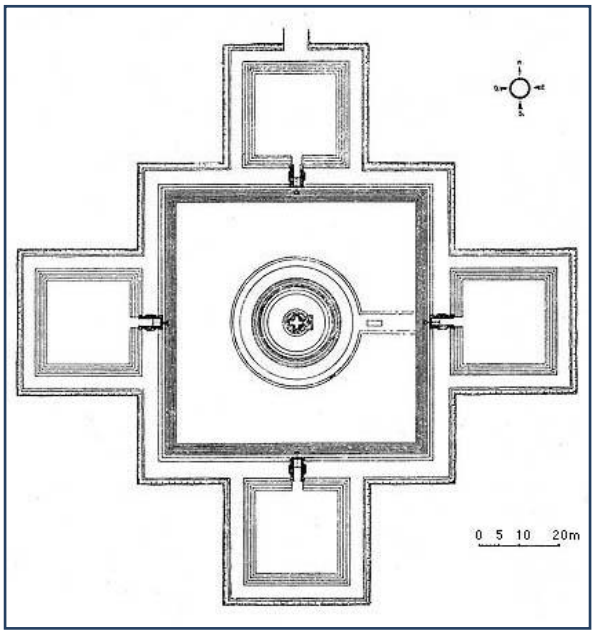
IC. 43: the royal barge is preceeded by four boats full of soldiers. Source: V. Walker.



IC. 44: vanguard of the parade with two boats. Source: V. Walker

BY-SEQ.I Two boats are depicted in another representation of the story of Pradyumna. The image can be found on the southeastern quadrant on the remains of a pediment that is not in situ (Roveda, 2005).

Neak Pean (NP)



IC. 45: IC. 45: plank of Neak Pean with the location of the nautical bas-relief.

This temple was constructed during the reign of Jayavarman VII, around the late 12th century. The outline of Neak Pean is marked by a central pond with a round structure in the centre and four surrounding ponds linked to the central pond through four satellite temples. According to the Preah Khan inscription, the temple originally contained fourteen statues of deities and a thousand lingas (Roveda 2005: 408). The temple is located at the centre of the Jayatataka *baray* of Preah Khan and was designed to be approached by water (Freeman and Jacques, 2003: 178). The scene may represent the story of the Mahajanaka *jataka* (Num. 539) according to Roveda (2005: 251).



IC. 46: Detail of the boat with a paddler clearly depicted at the stern. Source: M. A. Walker.

NP.WC.I The nautical scene is located in the north pediment (levelled with the walkway) of the western chapel (IC. 45-47).[17] The scene is divided in three tiers, all severely deteriorated. The upper section is dominated by a small pagoda with *nāga* details. The centre of the pagoda originally contained a Buddha sitting on a lotus flower, but the image has been defaced (Roveda, 2005: 408). More than half of the central and lower sections are deteriorated, except

[17] The image was found in 2010, but the location was not properly recorded. The temple was going to be surveyed in 2011 but it had to be postponed due to conservation works being carried out on the temple.

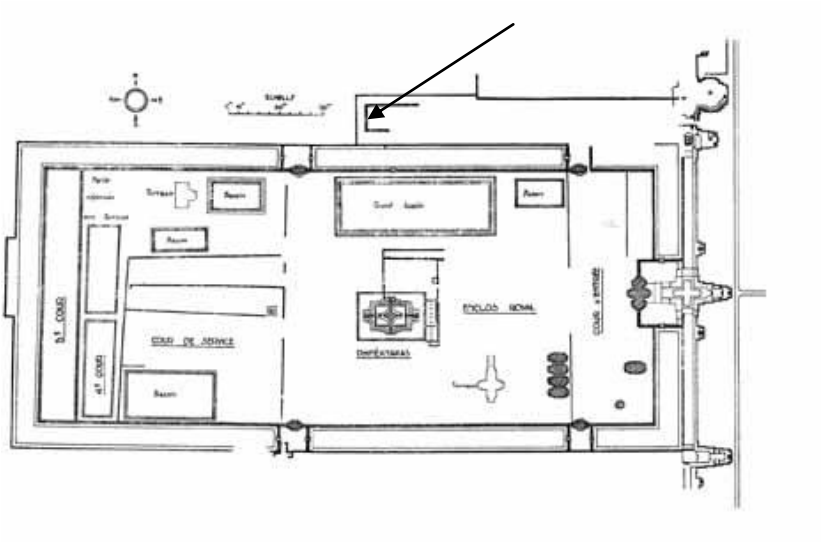
for the right side. In the central tier, only a bird (*hamsa*) remains (Ibid.), just on top of the vessel. In the lower section we can see a ship, (IC. 46), although it has been reported that there was a second ship, now eroded (Ibid.). The bow and stern are visible, but the detail of the decoration is lost. The bow is heading towards the left of the panel. The ship is carrying three figures; the two figures at the bow and amidships are kneeling down and their hands are lifted with what appears to be offerings. At the stern of the ship a half-kneeling man is paddling the ship using a paddle with a short shaft and a leaf-shaped blade. The detail of two fish close to the sheer-line indicates that the ship has a shallow draft.



IC. 47: view of the location of the image. Source: Lucy Liu (CC).

Royal Pools of Phimeanakas (RP)

The two nautical scenes are located outside the north wall of the royal palace, in what appears to be a pond of considerable size (Fig. 58). On the west wall of the pond there are two nautical scenes on the same wall, thus they may be part of the same scene although there is a gap between them. The description will start from the south to the north section of the wall.



IC. 48: map of Phimeanakas, the Royal Palace and its surroundings with the location of the nautical scene.

RP-WW.I On the south section of the west wall, the nautical scene starts on the left with carved lotus flowers (IC. 49). This part of the bas-relief is covered in soil and nothing else is visible. The scene continues two decorated boats heading to the north. The first to appear is heavily decorated; the bow and stern have a nāga decoration (head and tail), including scales carved on the hull (IC. 50-52). Three parasols are carried on board. There are two paddlers in the aft and two in the fore and their hand position on the paddle shaft can be seen clearly. A servant is holding a parasol for a central figure that is holding a rod and is wearing a necklace and arm bracelets. The next boat has not been preserved complete (Fig. 62). The gap in the centre of the wall has cut off the scene; blocks of uncarved sandstone are piled where the bow and part of the central section of the ship should be. Some blocks have a different texture from the carved panel. Only the aft of the ship can be seen up to the sheer-line, the lower section of the hull is buried under soil. A parasol is visible, and two paddlers with naked chests are holding paddles though the blades cannot be seen. The section of the hull that is exposed has been decorated with scales. The stern is lifted in the form of an elaborated tail. The wall then disappears in a heap of soil that runs for around 9 meters before the next nautical scene starts.



IC. 49: detail of the last section of the scene with lotus flowers, partially covered by soil. Source: V. Walker.



IC. 50: continuation of the image toward the north. Only the stern is visible here, but the shaft of the paddles is clearly visible. Source: V. Walker.



IC. 51: Bow of the previous boat with nada decoration. Source: V. Walker.



IC. 52: last visible portion of the nautical relief, with a clear view of the paddlers and their position in the boat. Source: V. Walker.

RP-WW.I (continuation) Passed the gap, the north section of the wall continues with another nautical scene. This one contains five ships that are heading south toward the previous scene, which suggests they could have met in the middle or a structural opening (i.e. stairs) may have

been used to separate the scene. The gap in the centre of the wall also affects this section; only the lower part of the bow is visible on the first ship, and the blocks surrounding it have been replaced or completed using uncarved blocks with a different texture and colour. However, the part of the hull that is visible shows a *makara* that was most likely regurgitating a *nāga*, as can be seen in the Bayon or Banteay Chmar temples. The hull is decorated with scales. The rest of the ships in this scene have a *nāga* decoration with the tail in the stern. At the bow of the first ship one uncompleted figure is kneeling, followed by another similar figure holding a paddle. A central figure is missing the head, and the block on top of it appears to have been wrongly placed, since it has what could be identified as part of the *nāga* decoration of the bow. A smaller figure is attending the person in the centre and a parasol can be seen behind him. At the stern, a man wearing a loin cloth has his leg overboard and is holding a paddle with a long shaft that he is using as a quarter rudder.

The second vessel also has a number of parasols (IC. 53-58). Two figures are paddling at the bow. A central figure is sitting amidships with the chest naked and wearing an elaborated cloth, a necklace, and arm bracelets. He is holding something in his right arm, while his left arm is resting on his leg, with a finger pointing to the bow. Two figures are paddling at the stern. The third ship also has two paddlers at the bow and one at the stern. There are parasols and banners on board. A central figure has one arm lifted and is being attended or heard by two kneeling figures. One is bending forward; the other one is carrying an elaborated container in his arms. The fourth ship is smaller and has a paddler at the bow and another one at the stern. Amidships, a central figure sits, attended by two other figures. One seems to be carrying a bird, while the other one has a simple container. The fifth ship is even smaller, with just one paddler at the bow. There are parasols on board, and a central figure is checking the contents of an open box that is being offered or shown to him by an attendant (Roveda, 2005: 284). The scene is partially covered by soil. The background of the scene is dominated by lotus flowers, fish, crocodiles, and birds. Most of the lower section is buried, and thus hidden from view.



IC. 53: the nautical scene starts with an incomplete boat. Instead of showing the typical tail decoration, the stern is decorated with what appears to be a garuda. Source: V. Walker.



IC. 54: Continuation of the scene. The second boat's bow is decorated with a nāga. Source: V. Walker.



IC. 55: Detail of the two paddlers at the stern holding leaf-shape paddles. Source: V. Walker.



IC. 56: bow decorated with a nāga or a makara (notice the snout), and two paddlers at the fore. Source: V. Walker.



IC. 57: detail of the courtiers attending a central figure. Source: V. Walker.

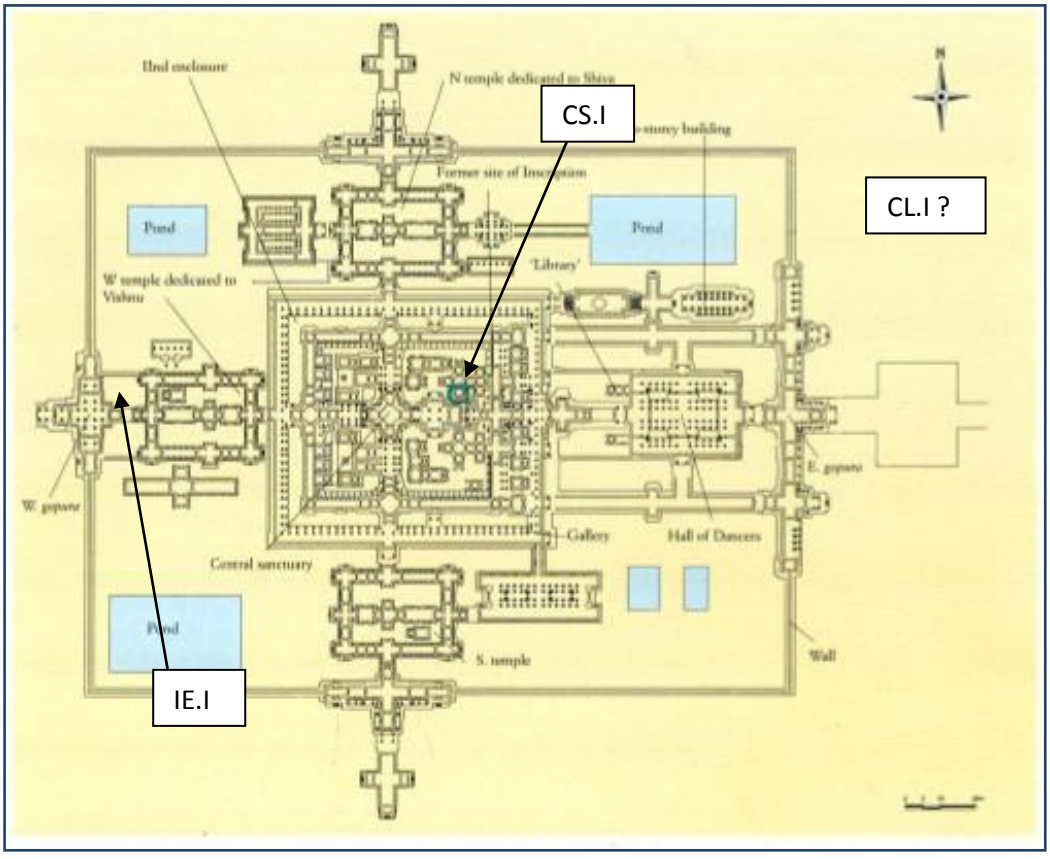


IC. 58: like in the case of the south wall, the final section of this relief is covered by soil and has not been excavated. The bow of the boat is visible, as well as the activities conducted on board. The hull and the stern are buried. Source: V. Walker.

Preah Khan (PK)

Preah Khan temple was commissioned by king Jayavarman VII and consecrated in 1191 (Roveda, 2005: 403). According to the inscriptions, this large temple was dedicated to the king's father, had over one thousand teachers, and was possibly used as a Buddhist university

(Freeman and Jacques, 2003: 170). The many bas-reliefs depicted in Preah Khan show a mix of mythological and historical narrative, like it was the case of the Bayon (Roveda, 2005: 403). At least ten of these bas-reliefs are nautical scenes, which makes Preah Khan one of the wealthiest temples in terms of maritime iconography together with Bayon, which also has ten scenes (Fig. 69 and 73). These scenes are spread around the temple; two are located around the central sanctuary, one in the second enclosure, and the rest are found in the third enclosure and the causeways of the Giants that lead to the temple. Only three of the causeways are visible; the one in the south has not been excavated and therefore it is not possible to determine whether there were boat scenes there as well. According to the local population, stones from the causeways were used to build a road in the middle of the 20th century, thus there is a chance that the bas-reliefs in the southern causeway are not complete (Roveda 2005: 284).



IC. 59: Central sanctuary and inner enclosure of Preah Khan with the location of the scenes. Source: Freeman and Jacques 2003.

PK-CS.I The nautical scene can be found in the area of the central sanctuary, in the small pediment of shrine 35 (IC. 60). A picture of the whole scene was published in 1963 (Benisti, 1963: 95-98) but nowadays the lower section of the scene has fallen and the carved block lies on the ground, with the image facing the floor. In the background of the scene there are a large number of banners, and in the centre of the boat there is a large figure standing up. The identification of this image is not unanimous; it has been identified as a Bodhisattva (Roveda 2005: 405) and as a representation of the early lives of Buddha, specifically the one narrated in the Silanimsansa jataka (Benisti, 1963: 97). The stern is decorated like a tail, thus the bow could have been decorated with the common head of an animal. A paddler can be seen at the stern. Only the short shaft of the paddle is visible. The section with the blade is lying on the ground; image taken with a mobile phone introduced under the block show that the blade has the form of a leaf. It seems that the artist was constraint by space, and the boat has been cramped into it. The bow is deteriorated and therefore it is impossible to determine how it was decorated. At the left of the boat, two kneeling figures appear to be making offerings from a platform. The lower section of this platform was depicted in the section that has fallen down; the scene in this part contains fish.



IC. 60: in this scene only the stern is visible, with a decoration of a tail. The lower half of the scene has dislodged, and is currently resting underneath the image. Source: V. Walker.

PK-CL.I The image was documented by archaeologist Phoeung Dara (IC. 61), who indicated that it is located in the area of the central sanctuary. However, the exact location needs to be confirmed. It shows a single boat with a paddler at the aft and what appears to be a court lady (indicated by the coiffure) holding a lotus flower. The figure at the bow is kneeling with his head inclined, but it is difficult to ascertain what is doing.



IC. 61: boat scene with a paddler at the aft. The central figure seems to be a court lady picking lotus flowers. Source: courtesy of D. Phoeung.

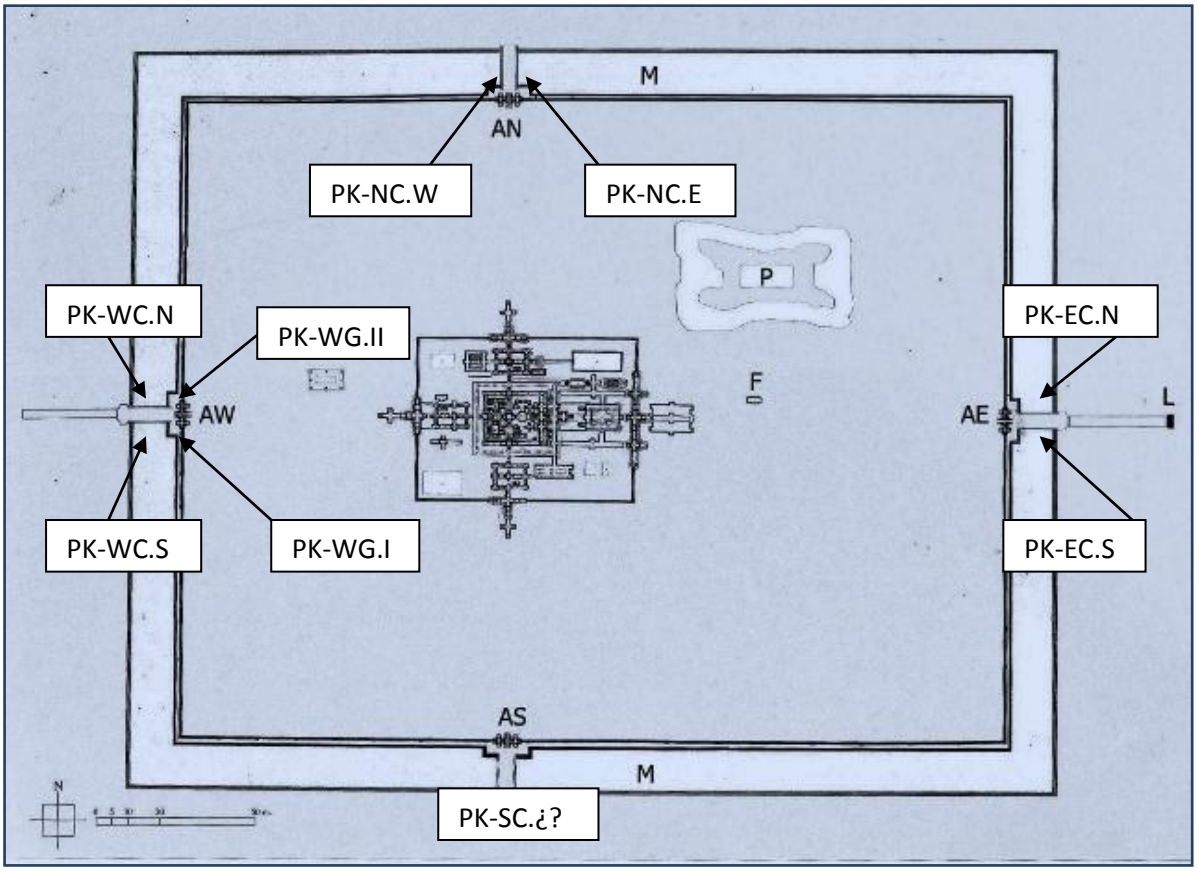
PK-IE.I The bas-relief is located in the west door of the second enclosure, specifically in the pediment of the door facing the central sanctuary (IC. 62). The image depicts a nautical scene with a single boat. The bow and stern are decorated with the shape of a nāga; the tail has an inverted S-shape. At the bow, two figures wearing full clothes are paddling. At the stern, another two figures can be seen, the one closer to the stern is deteriorated, but it is very likely that it was a paddler. The one in front has full clothes and is paddling. Most of the ship is covered by a structure with three rooms with curtains that have been tied in the centre. The central room also has a curtain. Inside, on slightly elevated platforms, two figures can be seen playing a board game (Roveda, 2005: 251). A figure is sitting on the roof of the central structure, while the remains of two other figures can be seen at the sides, also on top of the roof. The background of the scene is filled with big trees with dense foliage and what appears to be steps leading to the water, thus the scene is probably taking place in a pond, a canal or a

baray (Roveda, 2005: 251). There are two praying rishis[18] on the shoreline (ibid.). An animal with scales can be seen under the hull, but the image is deteriorated and it is difficult to interpret. Roveda has proposed that the scene may be a local version of a *jataka* story.



IC. 62: detail of the nautical scene where the central figures are represented playing a board game. Source: V. Walker.

[18] Sages or saints from the post-Vedic tradition.



IC. 63: full plan of Preah Khan with the location of the nautical scenes in the third enclosure and the causeways. Source: Freeman and Jacques, 2003.

PK-WG.I On the pediment of the south door of the west gopura there is another nautical scene, this time with two boats facing each other (IC. 64-65). The bows are decorated with a *nāga* decoration. The boats are propelled by four paddlers each. In the background of the image there is a platform where an image of a Bodhisattva rests on a plinth. On both sides of the Bodhisattva there are two kneeling figures that seem to be praying (Roveda, 2005: 251). Apsaras can be seen flying in the sky surrounded by banners. The scene has been identified as another story of the *jataka* or as a ceremony of devotion to a bodhisattva (ibid.). I propose that, if it is taken in connection with the other scenes, it may represent nautical games.



IC. 64: the two boats are facing each other, they have identical decorations and are propelled by four paddlers each. Source: V. Walker.



IC. 65: detail of the bows of the boats with the decorations marked in black. Source: V. Walker.

PK-WG.II This nautical scene appears to be the counterpart of PK-WG.I taking into account the distribution of the boats –in this case they are both facing each other– and its symmetrical position in the pediment of the north door of the west gopura (IC. 66-67). The scene is missing a big section in the centre and the sandstone is extremely eroded. Nonetheless, the outline of

the boats is clear; they both have four paddlers and the way the bows lift suggests that the boats were decorated, probably in a similar style than PK-WG.I. In the background there are two large figures; the one on the left is eroded but it seems to be mimicking the image on the right. A smaller figure is at the centre of the scene, possibly perched on the prow of the boat (IC. 67). On the right, the large figure is amidships and is holding a bow. A smaller figure appears to be assisting him by holding an object that is too faded to venture an interpretation. The symmetrical distribution of this scene and the previous scene together with the identical spatial distribution on the side pediments that provide access to the temple suggest a strong link between them. Therefore they could be interpreted together. The preliminary interpretation that I make is that these images represent nautical games celebrated in honour of an important figure (bodhisattva?) or perhaps that said figure presides over the games.



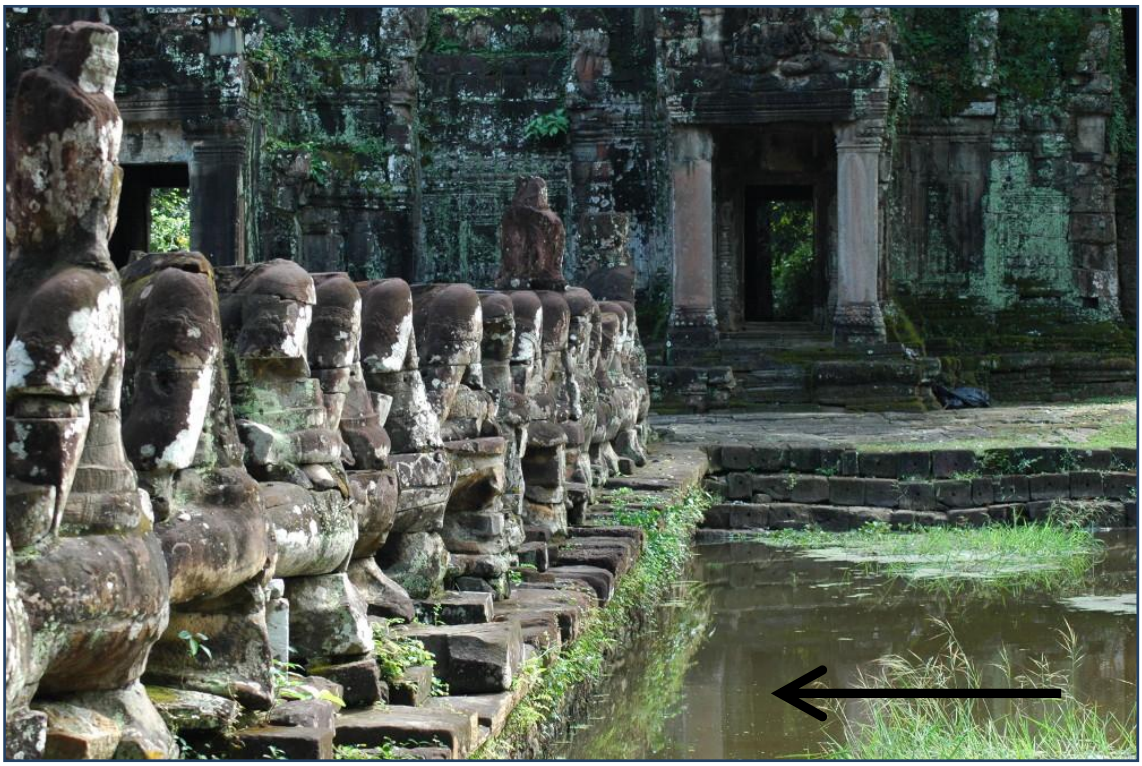
IC. 66: The nautical scene in the north door of the west *gopura* is deteriorated. Although details are hard to see, the outline of the boats and the paddlers is still visible. An archer is standing on a boat on the right side, and a similar figure is standing on the left side. Source: V. Walker.



IC. 67: the nautical scene in the north door of the west *gopura* is deteriorated. Although details are hard to see, the outline of the boats and the paddlers is still visible. Projecting the probable lines of the bows helps with the interpretation. Source: V. Walker.

The causeways of Preah Khan

Preah Khan is accessed by four causeways flanked by water. Despite being commonly called bridges, these causeways are actually solid and water does not run pass them (Roveda, 2005: 285). The causeways are similar to the bridges of Angkor Thom, and have giant statues of asuras and devas pulling from a serpent (IC. 68). During the rainy season the water covered most of the wall, and in a late visit (January 2014) the water had receded but it still covered a great part of the wall. There is no clear interpretation for these scenes, it has been suggested that they may represent a specific event, perhaps depicting people attending a festival (Roveda 2005: 406), possibly connected to the two nautical scenes in the west gopura that have been identified as possible representations of nautical games.



IC. 68: the image shows the condition of the west causeway and the location of the images, which were under water in October 2013. Source: V. Walker.

PK-WC.S The first boat scene is located in the south wall of the west causeway (Fig. 75). It contains boats loaded with people carrying javelins and parasols. The boats have one central pavilion occupied by a main figure (Roveda, 2005: 285). The procession is heading toward the

temple (IC. 69), though Roveda says that they seem to be moving away from the temple (2005: 284). This discrepancy may have been brought about because Roveda made a common description of all the nautical scenes in the causeways instead of going through them one by one. In this scene the people further from the temple are heading towards it, but the figures closest to the temple gate seem to be heading in their direction, possibly to receive them (IC. 70).



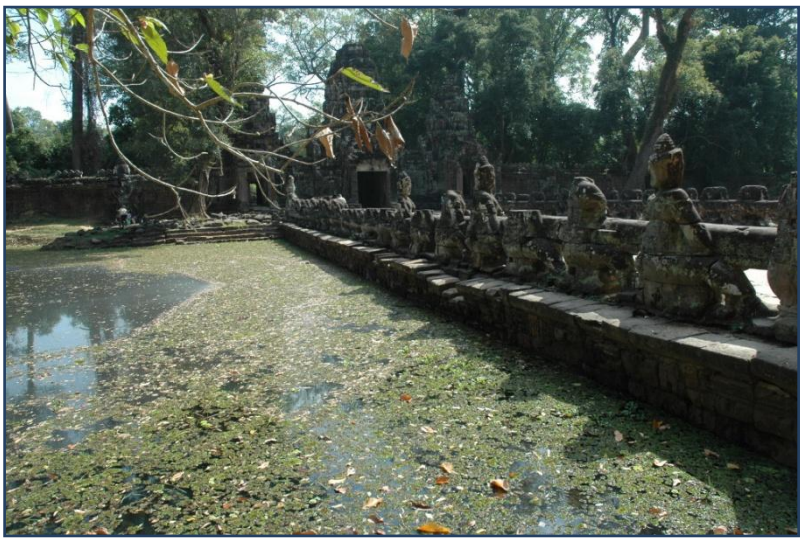
IC. 69: the procession of the south wall of the west causeway in January 2014. The people depicted seem to be heading to the temple. Source: V. Walker.



IC. 70: the figures closest to the temple gate seem to be leaving the temple, perhaps to meet the people who are heading toward the temple in the same scene. Source: V. Walker.

Fig. 77: (PK-CW.6)

PK-WC.N The scene in the north wall of the western causeway is similar to its counterpart in the south, with people on board boats filled with parasols. The scene is difficult to see in the rainy season (IC. 71) as well as in the dry season. However, the coiffure or hat of some of the attendees can be seen. The ones furthest from the gate are heading toward the temple, whilst the ones closer to it seem to be heading to meet them (IC. 72-73).



IC. 71: the carvings are underwater during the rainy season. Source: V. Walker.



IC. 72: detail of paddlers in the north wall of the west causeway heading toward the temple. Source: V. Walker.



IC. 73: detail of the boats closest to the temple that has two flying apsaras and a main figure in a pavilion. The main figure seems to have its body to the right, indicating that it is leaving the temple. Source: V. Walker.

PK-NC.E and **PK.NC.W** The north causeway contains a boat scene that includes a number of women standing on boats holding children (Roveda, 2005: 284).[19]

PK-CW.9 and **PK-CW.10** are located in the north and south wall of the eastern causeway that connects the temple to the *baray*. According to Roveda, the nautical scene is composed of small boats that are moving away from the temple toward the *baray* (Roveda, 2005: 407). Roveda mentions that the boats are being rowed (Ibid.), but he has consistently used paddling

[19] The west wall of the north causeway appears to have scenes of everyday life (Roveda 2005: 284), further observation needs to be conducted in situ to explore its connection to the east wall and the other causeways, but it will not be counted as a boat scene in this report.

and rowing indistinctively in his 2005 and 2007 publications. However, these are not synonyms; they represent different propelling techniques. Thus it is very likely that these boats are indeed paddled and not rowed, but a visit in situ to observe this is necessary.

Ta Nei (TN)

The temple of Ta Nei was constructed during the late 12th century by king Jayavarman VII; it has two narrow moats at north and south and lies about 200m west of the East *Baray*.

TN-CS.I The nautical scene can be found in the north pediment of the small cruciform pavilion that connects the central sanctuary with the north *gopura*. In the upper section, there is a large group of flying *apsaras* carrying parasols (Fig. 81). A figure of great size is standing amidships of a vessel that has been crudely made. The bow is facing east and is decorated with the head of a *garuda*. Four paddlers are propelling the ship using paddles with short shafts and leaf-shaped blades. The scene appears to be in a pond since the shoreline is depicted as a continuous line. There are fish and wild animals in the lower section of the scene. On both sides, two *rishi* are praying. All in all, the shape of the ship is less stylized and more animalistic (Fig. 82) than those of Angkor Wat or the Bayon, and shares similarities with the nautical scenes in RP-WW.1 and RP-WW.2 in the area of the Royal Palace, and PK-SE.3 in Preah Khan. In terms of composition, it is similar to the one in PK-CS.1 in Preah Khan and it has been interpreted as a possible *jataka* scene (Roveda 2005: 413).



IC. 74: Full view of the nautical scene, with a boat decorated with a garuda moved by four paddlers. Source: V. Walker.



IC. 75: detail of the boat and the shoreline of the pond. Source: V. Walker.

Temples outside the Angkor Archaeological Park

Banteay Chmar

Banteay Chmar[20] (late 12th or early 13th centuries) is located in the North-west region of Cambodia, close to the Thai border. The temple was constructed in the style of king Jayavarman VII, with the same four-face towers that are characteristic of the Bayon temple in Angkor Thom (Bacus et al. 2008: 14-24). The great naval battle is very similar to the one represented in the Bayon, except that in this case the image of the admiral is preserved (Fig. 83). Apart from this scene, it is hard to tell if there are other images of watercraft present in the temples since sections of bas-reliefs have collapsed. The temple is currently being reconstructed, but it will take some time before the final result can be observed and new surveys conducted. Another issue with this temple is that the naval battle has been covered up by wooden braces, making it difficult to see the whole scene. For this reason, we will have to rely partially on the descriptions made by previous researchers (Parmentier 1910: 209-211; Paris 1941: 335-342; Jacq-Hergoualc'h 1979: 127-138). The scene will be described from right to left.

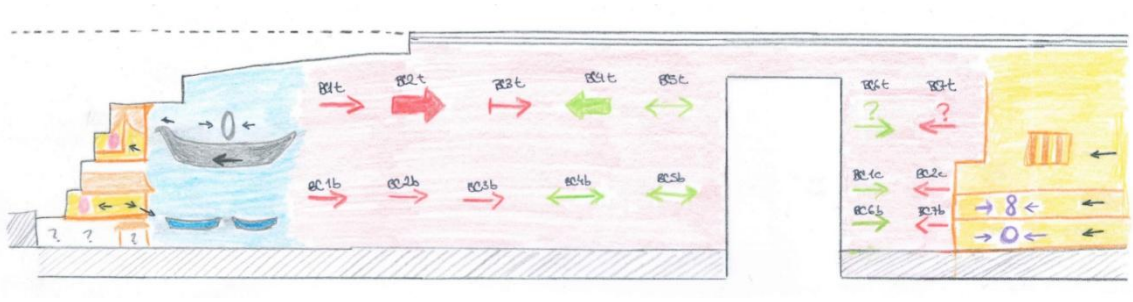
Second enclosure

Eastern gallery, southern wing

BC-EG.SW. I-II The nautical scene, which is divided into I and II to separate the military vessels on the right (II) from the sailing ship scene on the left (I), starts half way through, partially hidden by the image of a building which has been identified as a bundle raft (Roveda, 2005: 435) though it is possible that it is a house on stilts (IC. 76). The battle appears to represent the defeat of the enemy (who wear the same distinctive hat or coiffure as the enemies in the Bayon nautical battle). The vessels are not depicted completely from bow to stern, instead

[20] Also written as Banteay Chhmar.

some ships appear partially behind other ships, and lines of soldiers mix in a possible attempt by the artist to create the sense of a multitudinous battle. Although representing different armies, Khmer and enemy ships have a fairly similar hull (Fig. 84-85).

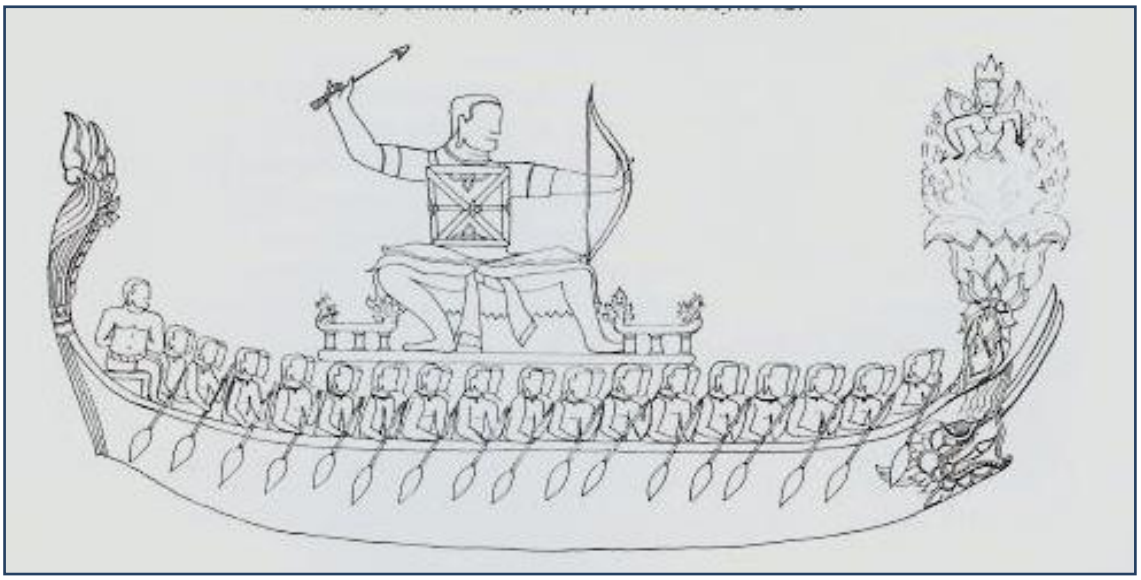


IC. 76: Sketch of the naval battle of Banteay Chmar. In the tables the scene is separated into the military section (II), and the sailing ship (I). Red arrows depict Angkorian vessels, green arrows enemy war boats. Red arrows indicate Angkorian boats and green arrows enemy boats. Source: V. Walker.

The bows of both armies have the image of a *makara.* In the case of the Khmer navy, the mythical animal is *makara* is regurgitating a *garuda*, and its tail forms the stern. However, the enemy vessels have raised undecorated stem and stern posts (IC. 79). Even though the enemy ships' bow point to the west, the rowers are facing forward, to the bow. Only an enemy vessel has its rowers facing the stern. This has often been interpreted as the enemies fleeing the scene. The Khmer are all rowing facing the stern, towards the east to face their enemies. Where the stern is visible in Khmer and enemy ships, a helmsman can be seen steering the vessel using a quarter rudder with a tiller set transversally in the shaft. On board the battle ships, at least two lines of soldiers appear with their pikes and shields ready to engage in combat. In the upper register, on the left side of the wall toward the end of the scene, the disproportionately big figure of an admiral can be seen in the same fashion as in the Bayon (IC. 77). An elevated platform can be observed amidships, where the general is sitting holding a bow. The *makara* decoration at the bow has ramming tusks and is regurgitating what initially looks like a multi-headed *nāga* but that turns out to be a small mitred feminine figure (see Jacq-Hergoulac'h, 1979: 131). The ship is propelled by a large number of paddlers. Fish abound

in the water, as well as crocodiles. Many enemy casualties lie in the water either dead or dying.

The scene finishes with a sailing ship that does not appear to be a separate event (IC. 80-82). An important figure with a peculiar hat can be seen under a large number of parasols. He or she is surrounded by courtiers who are attending to his needs. The bow of the ship is facing west, and it is also decorated with a *makara*. The wooden braces cover the aft of the boat, so it is not possible to determine the type of propulsion and rudder that is being used. Below the decorated boat, a few small undecorated fishing boats can be seen. The scene is framed by a large number of fish in the water. Further to the left, the wall is collapsed, thus casting doubt on the real extension of the nautical scene.



IC. 77: this ship in BC-SE.1 is similar to the one depicted in the Bayon (BY-SG.9). The admiral sits in the centre, and paddlers propel the ship. Source: Jac-Hergoualc'h, 1979.



IC. 78: detail of the battle (right section) with the hulls marked in black. Toward the right there is a structure with soldiers fighting. The image was taken with a fish eye lens, hence the distortion in the edges. Source: V. Walker.



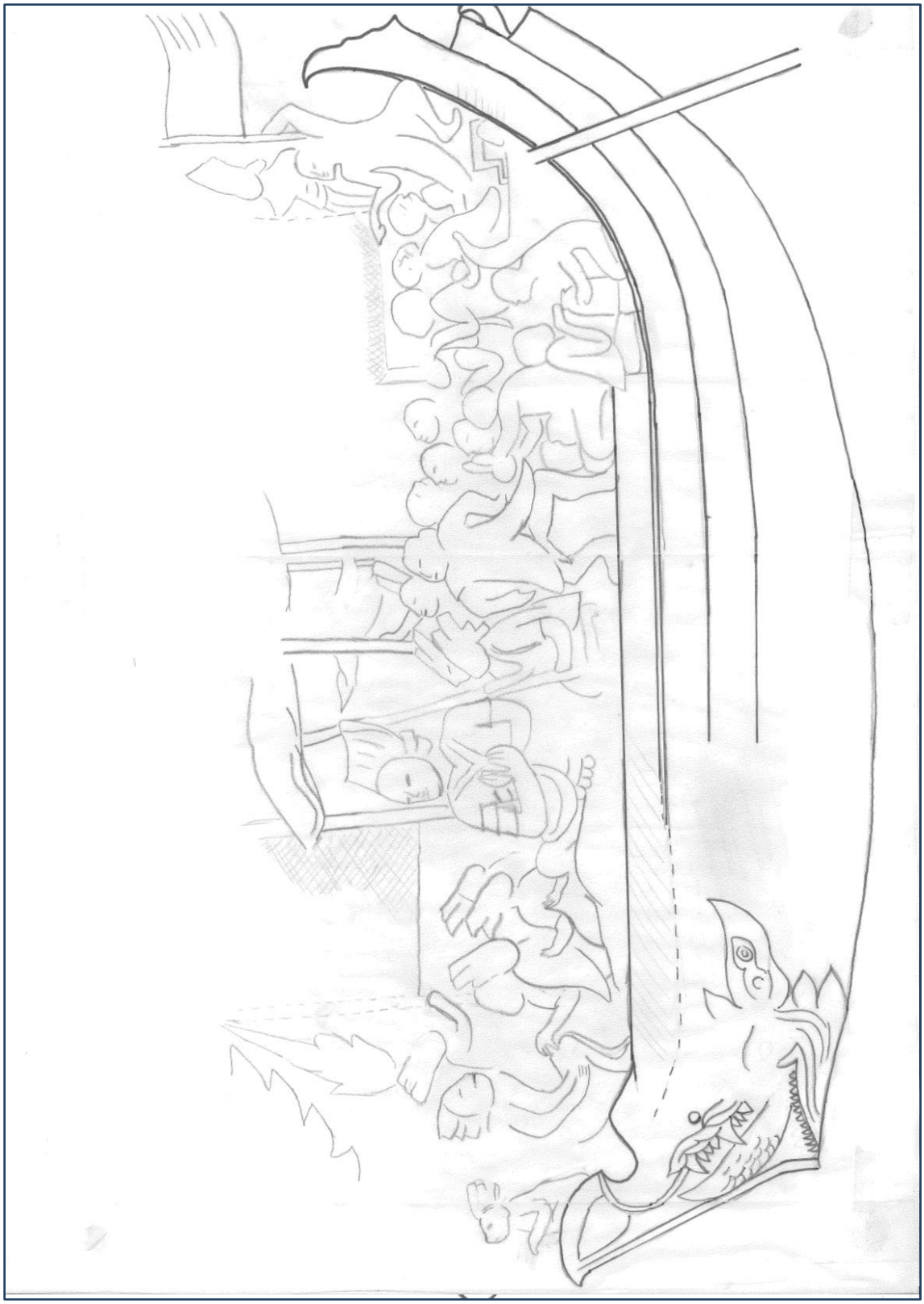
IC. 79: continuation of the nautical battle on the other side of the south door. The coiffure of these soldiers has been identified as Cham. Here there are four war boats inflicting severe damage on the Khmer soldiers. The image has been sharpened using GIMP Image software. Source: V. Walker.



IC. 80: A large figure with a coiffure can be seen as it is being tended by courtiers, who seem to be disorganized (top right of the image), in this archive image from the EFEO the scene is visible, and the sails on the top section are depicted with lines that seem to imply reed. Source: V. Walker after EFEO archive image. .



IC. 81: close-up of the fishermen under the leisure boat. Between 2008 and 2016 the scene was covered in wooden braces due to the fragility of the wall structure. Source: V. Walker.

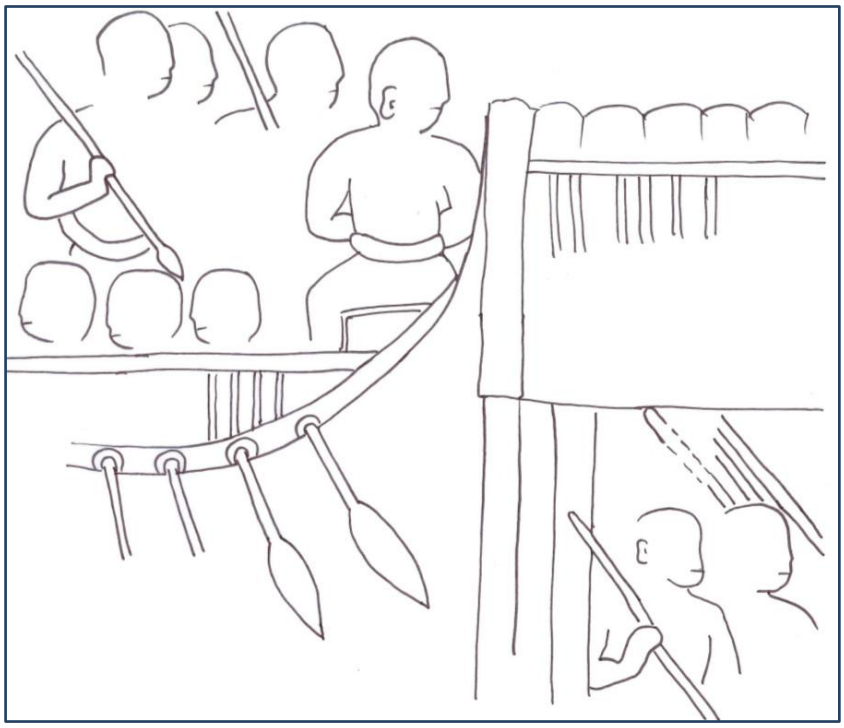


IC. 82: Drawing of the sailing ship in Banteay Chmar. Source: V. Walker.

BC-SG-EW.I : In this incomplete scene the stern section of a boat is visible against a stilted building from where soldier are departing (Roveda, 2005: 440). The head of the helmsman is turned backward toward the building and soldiers on board the vessel are heading toward the stern. The scene appears to depict a deployment scene of soldiers arriving on boats (IC. 83-84).

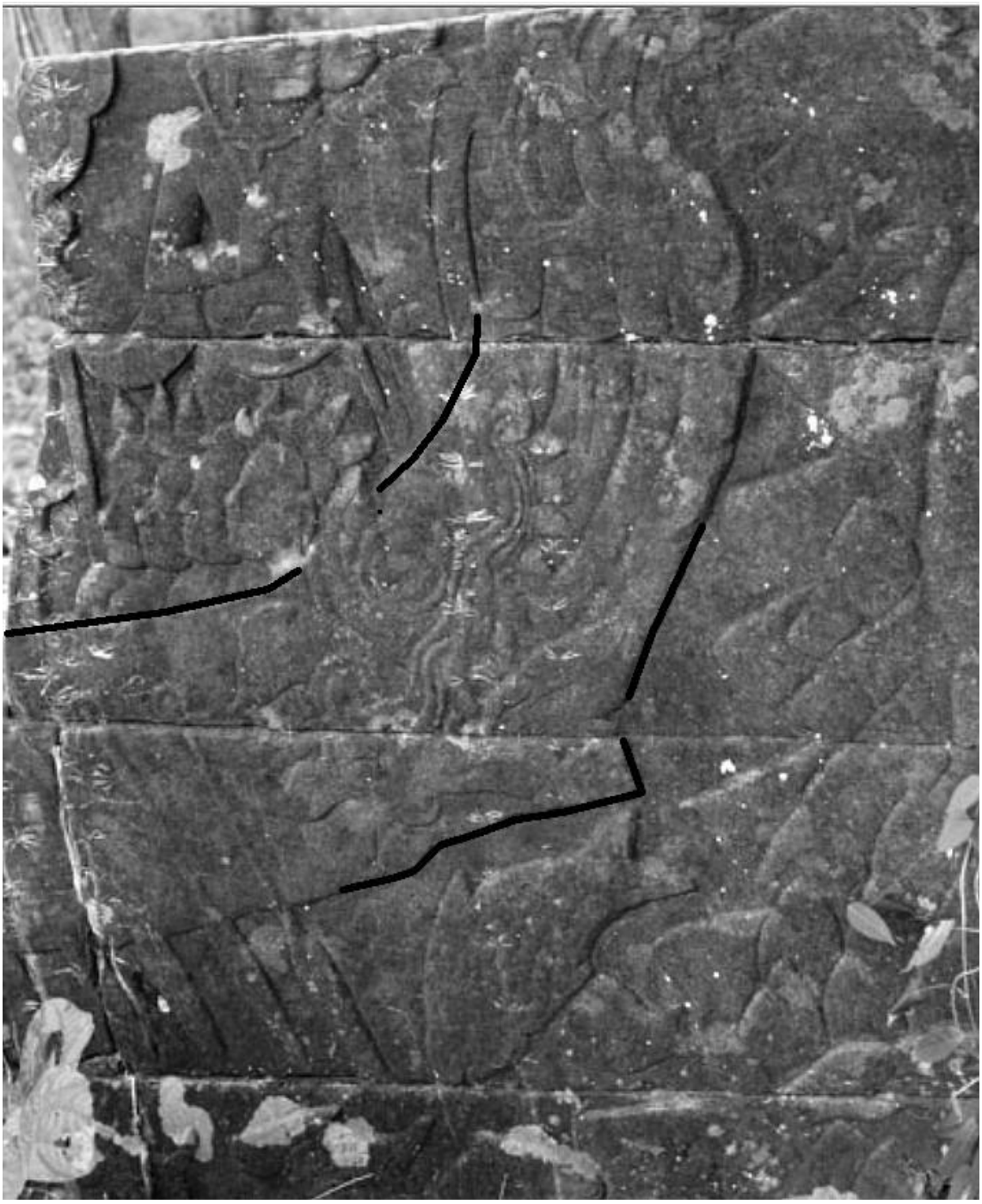


IC. 83: Stern of the boat against a building. Source: Roveda (2005).



IC. 84: Drawing of the scene. The heads of the soldiers and the helmsman are turned toward the building. Source: V. Walker.

BC-NG-WW.I In this incomplete scene a boat is apparently being used by the enemies to flee from battle against the armies of Angkor (Roveda, 2005: 436). Only the bow section of the boat is visible. It is decorated with a makara on the hull and everything seems to suggest that the stempost has some kind of decoration (IC. 85).



IC. 85: Bow of the boat with soldiers. The four figures in the lower section are not positioned as rowers. Source: Roveda (2005) with drawing by V. Walker.

BC-EG-NW.I The scene depicts a raft carrying soldiers and elephants (IC. 86-89). The raft is clearly moored to thick poles and to a jetty where there are more soldiers. The water is filled with fishes and two fishing boats (Roveda, 2005: 435).



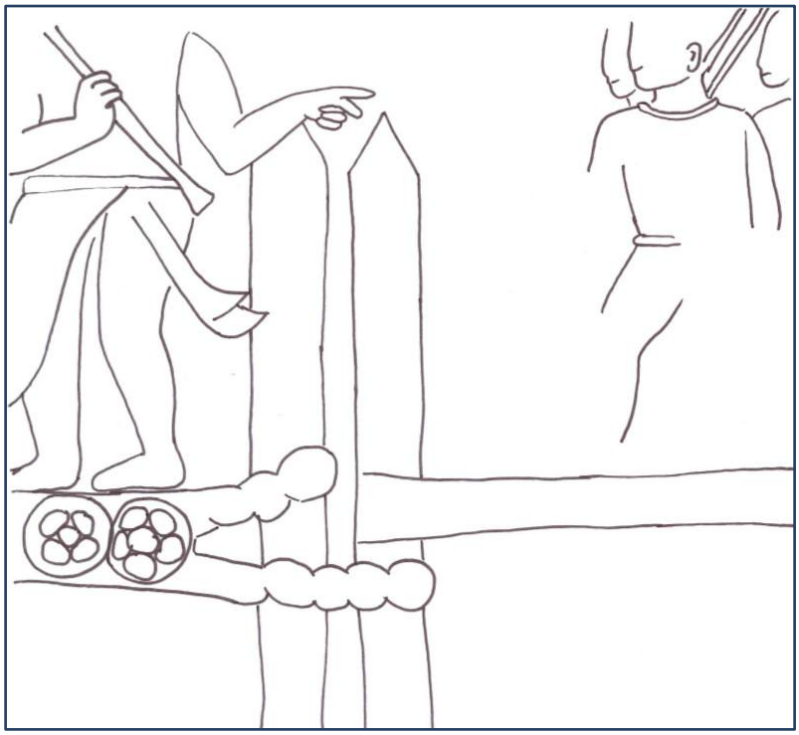
IC. 86: Leader on board the raft talking to soldiers. Elephants are seen behind. The raft is indicated by the flower-like shapes on the lower section. These are cross-section depictions of bundles. Source: Roveda (2005).



IC. 87: One of the two fisherman depicted in the raft scene. Source: Roveda (2005).



IC. 88: Detail of the mooring mechanism used with the raft or pontoon bridge. Source: Roveda (2005).

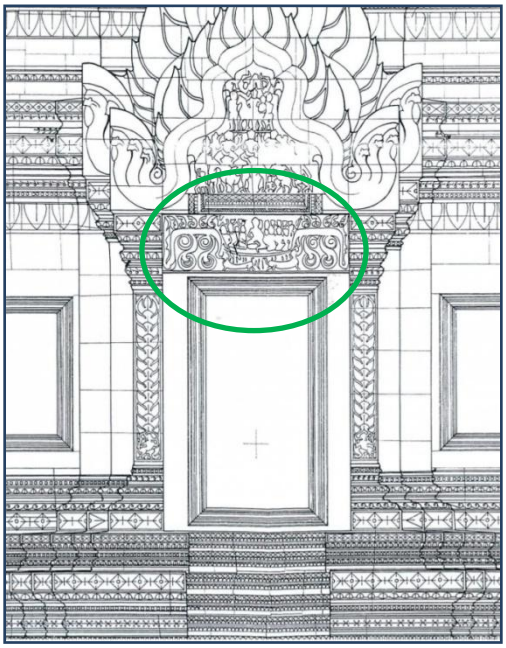


IC. 89: Drawing of the mooring mechanism. Source: V. Walker.

Phimai (PI)

Phimai lies in the Khorat plateau, in the Mun river valley in modern day Thailand. The temple was constructed by Suryavarman I (1002-1050) and was a very important for the Khmer empire as an administrative and economic outpost in the region (Hall 2011: 180-182).

PI-CS.1 The ship can be found in the frieze of the frontispiece of the East section of the central sanctuary and was found in Pierre Pichard's "Pimay: étude architecturale du temple" (1976). The photograph was taken from a considerable distance, and it is difficult to analyse the details. The sides of the image are decorated with vegetal motifs while the ship occupies a central position. The bow and stern appear to be elevated, which suggests it originally had the recurrent decoration of a mythical animal (IC. 90). Two paddlers at the bow can be seen in a kneeling position using short paddles. The ship is loaded with people, but most of the figures have eroded. There is a central figure of great size that appears to be sitting on a slightly elevated platform. The stern of the ship is barely visible; hence it is difficult to tell if the original image had paddlers or a helmsman with a quarter rudder.



IC. 90: drawing of the temple with the nautical scene. Source: Pichard (1976).

Ship iconography of unknown provenance (UP)

So far, one nautical scene from unknown provenance has been identified in the process of this research. It has been included in this paper due to its relevance in terms of nautical technology.

Phimai National Museum

UP.I In the Phimai Museum there is a carving showing part of a ship (IC. 91). The decoration of the boat is partially missing, although it presents the common decorations of a nāga or garuda (the "neck" is visible, but the "head" has disappeared at the bow). The stern of the ship is decorated with the tail of the animal, but instead of being coiled, the tail is drawing an inverted S. A helmsman is holding a quarter rudder from a half-kneeling position. The rudder has a long shaft that appears to be fixed. The blade of the rudder is very voluminous, and has a rounded shape. This appears to be the only means of propulsion. On board, a structure with seven rooms covers the vessel completely from bow to stern. The helmsman is occupying one opening. A multi-armed figure sits in the central opening. Two rooms in the aft of the ship have kneeling figures resting on slightly elevated platforms and holding offerings above their heads. The two rooms in the fore also have kneeling figures facing the central figure. Their left hand is resting on the knee while the right hand is placed on the heart. The figure at the bow, also covered by the structure, has the body toward the bow, but the head is turned towards the central figure. The right hand is placed over the heart; the left hand holds something very similar to a paddle. However, if this is a paddle, the blade is clearly inside the ship. The topsides are decorated with a double line of dots. Under the ship, fish can be seen, as well as the tail and body of a crocodile.



IC. 91: this bas-relief shows a single vessel with the interesting feature that the hull is covered by a structure from the bow to the stern. The rudder used in this boat is similar to the one used in the boat located in Angkor Wat.. Source: courtesy of N.H. Tan.

Appendix 4: Ethnographic data

Cambodian contemporary shipbuilding traditions

Dugouts

The touk meat

The most common boat found in Cambodia is called *touk meat* or *touk pilan.* It is made from a single log; it has a shallow draft, a wide beam, and a characteristic three point decoration at bow and stern. In many cases the hull is covered by a deck that sits a few centimetres bellow the topsides, though in some cases there is no deck. Paris suggested that the boats represented in the reliefs were more similar to the Siamese *rua chalom* than the contemporary Cambodian boats (1941: 346); however, while the bow and the stern are different, there are other traits in contemporary Cambodian boats, such as the use of decks, the low draft, and the position of the paddlers on board, that are nearly identical to the boats in the bas-reliefs of Angkor. The *touk meat* is a type of boat used in rivers, lakes, ponds, and inundated areas, usually for transport or fishing. Finding a *touk meat* is not that common anymore. Though the form of the hull remains the same, nowadays most of the boats in Cambodia are built using planks (Hoc, 2001: 7, also attested by the author during the course her fieldwork).[21] Hoc identified in his work two phases of construction: an initial phase in the forest – *prei* –, and a final phase in the village – *srok* – (Hoc, 2001). This division seems to be deeply rooted in the traditional fluid duality that exists in Khmer culture, which divides the world into wild forests (*prei*), the land of wild and untamed spirits, and villages (*srok*), the domesticated land (see Ang, 1986; 2004; 2007 and Forest, 1992; 1994). Though practices have changed and nowadays most of the boats are made using planks, this division still seems to be practiced to some extent. During fieldwork, the author of this article noticed that the bows and the sterns (which are carved into form and serve as stem and stern posts to which the planks are attached) were

[21] Two dugouts were found by the author in the flooded village of Kompong Khleang (Siem Reap) in 2008; one was being repaired, and had clearly a raised hull, that is, planks were added to the sides of the hull. The second one was an unfinished dugout that was apparently abandoned in the pagoda. The rest of the boats observed during fieldwork were mainly plank boats.

sold off to boat builders roughly shaped with the characteristic three point bow and stern shape. This seems to suggest that the rough carving of the wood may still be conducted in the forest and then distributed to the villages.

The logboat *touk meat* are traditionally made from the *koki* tree (*hopea odorata*), a type of tree endemic to mainland Southeast Asia that can reach a height of up to 45 meters (Jøker 2000).[22] In a documented case, the *koki* tree was felled on the premises of a pagoda, but these trees are smaller than – and not as desirable as – the larger specimens that can be found in the forest (Porée-Maspero, 1964: 371). The process of boat construction starts with the selection of a tree in the forest by the *chieng prei* – literally the "carpenter of the forest" who will be in charge of this phase of construction. The *chieng prei* has to identify the ideal tree measuring the size of the trunk to ensure that it meets the requirements of the boat (Hoc, 2001: 2).

Once a tree has been identified, the boat builder proceeds to present offerings to the spirits of the forest (*bang bat*), the spirits of the land (*neak ta*), and the spirit of the tree (*roukh tévoda*); this includes a pork face[23] and a hand of *nuon* – a type of bananas (Porée-Maspero, 1964: 371). Then a request is made, accompanied by further offerings to ask the *roukh tévoda* to leave his home (Hoc, 2001: 6; Porée-Maspero, 1964: 371). Candles and incense are lit as the *chieng prei* invokes the spirits saying: "we, your servants, request this *koki* tree to make a *touk*.[24] We pray for you to agree to our request" (Hoc 2001: 6). A letter is then placed on the trunk to inform the spirits that after seven days they will return to fell the tree, and to ask them to remain, but to stay as far away as possible (Porée-Maspero, 1964: 371; Hoc, 2001: 6). The tree is then in a state of soullessness, while its spirit prowls around the area. This state is considered to be

[8] The use of teak wood, another type of hardwood, has been mentioned by Poujade (1946: 6), but local sources questioned during fieldwork always talk about *koki* tree. Porée-Maspero (1964: 371) mentions the use of *sro lao* wood as an alternative, but further research suggests that *sro lao* is used for the topsides, not the whole boat.

[23] In a particular case where the tree was felled inside a pagoda, the offerings did not include meat (Porée-Maspero, 1964: 370-371), following the Buddhist tradition.

[24] Hoc mentions that *koki* means tree in its wild form. The sentence makes reference to the transformation of the *koki* tree from a wild tree into *touk*, which translates as wood that floats, not specifically a boat. The object is not considered yet a boat (2001: 6).

extremely dangerous for the boat builders, who have to protect themselves by requesting the help of Preah Pisnukar, the artisan god (Hoc, 2001: 6).

After the seven day wait, the boat builders return to the site (Porée-Maspero 1964: 371; Hoc 2001: 6). Prior to cutting down the tree, they wait for a few minutes before performing a mock attempt to fell the tree. Holding an adze in his hand, the *chieng prei* asks: "Have the lords conceded to give us this tree?" To which the crew responds: "Yes, they have". The *chieng prei* interpellates the spirits once more: "Is this true?" And he is answered again by his crew: "Our lords have clearly given it." (Hoc, 2001: 6). This is repeated thrice before starting to cut the tree. During this process, absolute silence is observed: talking or laughing is strictly forbidden (Porée-Maspero, 1964: 371; Hoc, 2001: 6). Before starting work on the trunk, a small offering to Preah Pisnukar is conducted.

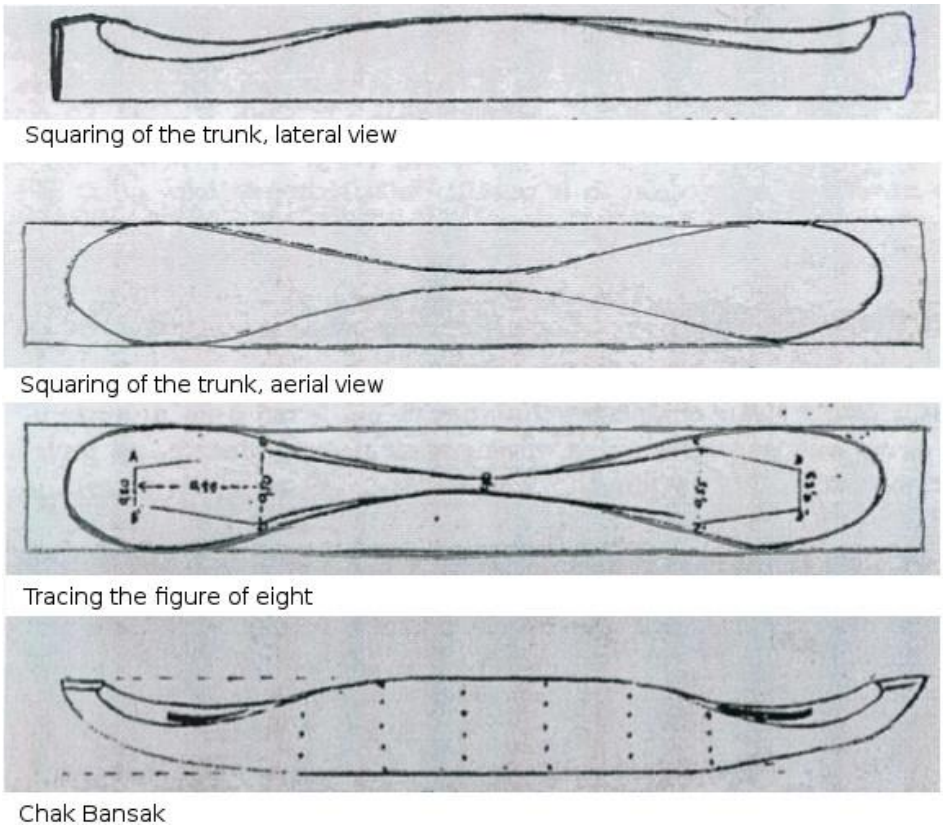


Fig. 1: Khmer nautical design for hollowing out the wood. Source: Hoc (2001).

The tree is cut on one side up to the core, and then on the other side until it falls. Once on the ground, the trunk is debarked and three equal longitudinal marks are made. The side of the trunk that will be hollowed out is squared (Hoc, 2001: 2-3). The bow will be made on the side closest to the stump. The trunk is marked in quarters, and a figure of eight is drawn to guide the carpenters when they start chiselling (Fig. 1). The opening has to be wide in the upper section, and tapering downwards in a sharp angle. The bow is yet to be given form; this form will later determine the lines of the boat.[25] The stern is always slightly higher than the bow, between 15 and 35 centimetres (Hoc, 2001: 5). Once the tree is hollowed out and given the desired form, the boat builders light a fire with the debris left from the chiselling process. The boat is then placed on top of the embers with the opening facing the sky (Hoc, 2001: 2-3; Poujade, 1946b: 6). A series of weights are placed inside the hull to force the sides open. If a section is not bending properly, it means that that part is thicker than the others, and it needs to be levelled with the adze (Hoc 2001: 2-3). If this happens, then the dugout is placed upside down over the embers. Once the sides of the dugout have been softened, beams (*khtong prey*, or forest beams) are placed inside it to keep the walls open (Hoc, 2001: 3; Poujade, 1946: 6). The dugout is then turned over and left in the woods to dry for one or two weeks. The end product at this point is called *touk kamrol*, the wild boat (Fig. 2).[26]

When the work in the forest is finished, the boat builders bid farewell to the spirits of the forest (*bang bat*) leaving offerings for them (for example, two chickens and a bottle of rice wine). The dugout is then taken to the village, where the boat builders involved in the events of the forest request protection and refuge to the *prey srok*, the guardian spirits of the village (Hoc, 2001: 6, 8). This ceremony is similar to the one celebrated for the felling of the tree, but this time the ones conducting it are the owner of the dugout and the *chieng srok*, the

[25] The most common form of the bow is the *khbal bei*, the three heads, which symbolizes the serpent of the forest or *poh prei* (Porée-Maspero, 1964: 371). Other less common forms include the *khbal sampan*e (flat), and the *meat leav*, the Laotian style square bow (Hoc, 2001: 5).
[26] The meaning of *touk* here still refers to wood that floats, not strictly a boat (Hoc 2001: 4).

carpenter of the village (Ibid.), who will be in charge of the work during this phase of construction. The dugout is thus passed on to the world of the *srok*.



Fig. 2: Abandoned unfinished dugout in the precinct of a Buddhist temple in Kompong Khleang photographed in 2008. Source: V. Walker.

Once this ceremony is conducted, the carpenter of the village proceeds to polish the wood.[27] First, the outer hull is trimmed and when this is done, the dugout is turned over and a series of holes are made in the outer part. These holes are placed one meter apart in staggered rows from the top sides to the bottom. The holes are all the same size and depth, their main aim is to guide the boat builders to even out the thickness of the hull. The dugout is then shifted, and the interior of the dugout is trimmed with an adze until all the holes are found.

When all the holes are found, the dugout is placed over embers again, but the embers do not follow all the length of the boat. Instead, they are only used where there needs to be further bending of the wood. Afterward, wooden pegs are used to cover the holes. The hull is then polished, first with a short adze and then with pumice stone or sandpaper. After the whole surface has been polished, the boat builders apply a coat of resin known as *mrak*, which is made from the resin of the *kroeul* tree (*Melanorrhéa usitata*) mixed with *choar teuk*, an oily resin from the *choeu teal* tree (*Dipterocarpus alatus*). The hull is then left to dry in the sun for three or seven days (Hoc, 2001: 4). Once it is dry, the *khtong* (thwarts) are placed inside, but the dugout is not yet finished.

[27] Based on Hoc (2001).

Though it is acknowledged by the Cambodian local population that the boat has a spirit, it is not clear in the data the moment when the spirit starts inhabiting the boat. Since there is a ceremony designed to evict the spirit before the felling of the tree, a similar ceremony to bind the spirit to the boat probably takes place at some point of the construction process. This seems to be the case of the opening of the eyes ceremony, which is conducted in the village once the boat is finished. This process is feared by the carpenters because the eyes of the boats are the eyes of the spirit that lives inside of it (Hoc, 2001: 6-7).

Boat builders take great care in not angering the chief carpenter or breaking things in front of the eyes. These are made with wood, and both ought to weight exactly the same, otherwise the boat will tilt toward one side. Before placing the eyes on the hull, mandatory offerings are made to Pisnukar: a well cooked pork face, a cooked chicken, a hand of *nuon* bananas, five candles, five incense sticks, five cigarettes, five betel leaves, two *sla thor*, a bottle of rice wine, *sambour* (holy water), and gold and silver leaves (Hoc, 2001: 6-7). After setting the offerings, the *acar* (head of the carpenters) pours water over the eyes and ties a cord around the wrists of those who have participated in the construction of the boat. During this process, he sings a song of victory named *cheyanto* in Khmer. Though this may be a problem of transliterating Khmer words into Roman alphabet, the term *acar* may be the same as *achar*, which according to Harris refers to a lay ritual specialist in Khmer culture (Harris, 2005: 66). If these words were the same, it would reinforce the ritual character of boat builders in Khmer society.

Other traditions related to the placing of the eyes have been recorded. In one of the accounts documented by Porée-Maspero, it can be read: “et on plaça sur la nouvelle pirogue les yeux de l’ancienne” (ibid.: 371). The term “ancienne” means “the oldest”, a reference to the *neak ta*, the term used by the Cambodians for the spirits, which literally means “the old ones” (Arensen, 2012: 52).

When the dugout is finalized, a baptism is organized on the date of the birth of the owner. If this date is inauspicious, then the wife's birthday is selected. Family and relatives partake in the event, where new offerings are made. A red textile weaved with magic formulas is tied around the section of the bow known as *ka* (throat in Khmer) (Hoc, 2001: 7). Three incense sticks are burnt in the bow and all the equipment of the dugout is placed inside the hull. Two large candles are lit; one is placed at the bow and the other one at the stern. Smaller candles are placed on the thwarts. When all the offerings and preparations are completed, the *acar* recites the magic formula as follows:

> *Oh! Powerful spirit protector of the village, of Preah Thorani (Earth); today we have organized this ceremony to request your permission to launch the touk on the water. Lord, deign to grant us prosperous trade, and gentle and solid fortune, to all of those gathered here today, our children, our grand-children, husband and wife. And you, touk, when you were in the forest we called you* koki*, but now you are in the village and you are a* touk *and we name you* Sok Chamroen*, "Fortune and Prosperity".*(Translated from Hoc, 2001: 7).

After reciting this incantation, the orchestra plays three songs destined to please the spirits that will protect the boat. According to a medium who was interviewed by Hoc (2001: 7), the first tune is dedicated to *Chum Teav Haira*, who will guide the ship and act as a steerswoman. The second song is to honour *Chum Teav Mao* (Black Lady),[28] the guardian of the spirits of the forest who will act as the vigil. Finally, the third piece is for the damsel *Kantong Khiev*, savior of the Earth, whose task is to float and move the boat (Hoc, 2001: 7). When the music is over, the boat is launched and the family gets on board. They navigate around the port thrice to honour and thank the spirits and with this, the process of transformation of the *koki* tree into a *touk meat* is finalized.

The analysis of the construction process indicates that the symbolic or spiritual value of boats lie at the very beginning with the selection of the material. The belief that the tree is the

[28]Also known as *Neang Khmau*.

dwelling of a spirit seems to affect the way in which the material is processed. Firstly, it seems to constrain boat construction in the way the log is processed. The evidence suggests that boat construction is a closed cycle where the majority of the material used for the boat comes from a single tree that is worked with adzes, not with saws. The by-product of hollowing out the log is used to light the fire that is later used to open the log. Though it could be suggested that the recycling of the material is prompted by a desire to maximize the use of the resources, the attribution of a spirit to the material appears to play an important role in the way the material is handled and used. And secondly, it marks the pace of the construction process through the rituals that need to be conducted to appease the spirits, and the location of the construction process. The boat thus acquires the quality of a living being, which is also reflected in Khmer nautical terminology; the bow is called *khbal* (i.e., head), the section between the bow and the first thwart is called *ka* (i.e., throat), the first thwart is known as *sma* (i.e., shoulder), the walls of the boat are called *sach* (i.e., flesh), the central section of the boat is *troung* (i.e., chest), the ribs are called *chhaeing* (i.e., skeleton), and the section between the last thwart and the stern is known as *chrak ka kansay* (i.e., heel) (see Hoc, 2001). A similar association was identified by Ivanoff among the Moken people of Southeast Asia (Ivanoff, 2001: 13). Boats are thus not simple utilitarian tools, they are perceived as living things that may have an effect on the lives of the users. An important implication of this is that boat builders are not simple craftsmen: they are the ones who have to mediate with the spirits; therefore their role could be equated to ritual specialists.

Touk Ngor (touk Prasat kdar)

The *touk ngor* or *touk prasat kdar*[29] are racing boats used in the celebrations of the *Bon Om Touk* festival, which has been popularized in the Western world as the Water Festival (see Fig. 3-8). These are the main nautical celebrations connected to the king, and have been linked to the nautical representations of Angkor due to their decorations and connections to fertility

[29] Touk Prasat Kdar means the wood or boat of the pagoda.

rites (see Hoc, 2001: 2; Jacq-Hergoualc'h, 2001: 9). The data was gathered by the author in 2008, 2010, 2012, and 2013-2014 mainly in the provinces of Siem Reap (the seat of Angkor) and Kandal (the area where the Mekong and the Tonle Sap Rivers meet).[30] Other additional sources will also be used, particularly an interview with boat builder In Phen recorded by Nou Thearint (2013).

Since the water festival boats are specifically commissioned for pagodas, it is difficult to document the construction process. Nonetheless, direct observation and interviews with relevant people suggests that these boats were probably traditionally made like the *touk meat*, but with some variations. The boats are currently made in Kompong Thom and Kratie, the only two provinces that still have large *koki* trees according to sources from the Preah Prek pagoda (Kandal province) interviewed in 2013. The felling of the tree is preceded by the same kind of ceremony as the one described for the *touk meat* (Nou Thearit, 2013: 37). In at least one occasion a *koki* tree located within the precinct of a pagoda was used to construct a racing boat, and before it was cut down the boat builders offered a pair of *sla thor*, sweets, candles and incense sticks (Porée-Maspero, 1964: 370-371). The offering does not include the meat products offered in ceremonies conducted for the dugout. It seems that this is a Buddhist alteration of the pre-Indian tradition.

In some cases, a single racing boat is made from the tree (ibid.), in other cases, three trees are required to make a single racing boat,[31] while some boat builders split the trunk in two and each part is transformed into a racing boat (Nou Thearit, 2013: 37). The bow and the stern are made using jackfruit tree wood (*Ibid*. 37); the fieldwork conducted by the author showed that some are carved in the traditional three point head, whilst others carve the wood to make it look like a serpent. The main purpose of these boats is speed; they can have a length of around

[30] The researcher had designed the 2013-2014 fieldwork to attend the *Bon Om Touk* festival in Phnom Penh but the festival was cancelled. This was the third time that the event has been cancelled.
[31] This refers to a racing boat from a pagoda in the Mekong delta (Poujade, 1946: 6), now in Vietnam but culturally linked to Cambodia.

thirty five meters and accommodate up to sixty five paddlers. In order to increase the flexibility of the boat to reach higher speeds, planks of a special wood called *sro lao* (*lagerstroemia aungustifolia*) are added to the bulwark. Once the boat is completed in its rough state, it is taken to the pagoda, where a ceremony is conducted to honour the god *Krong Peali*. The monks are then in charge of painting and decorating the hull with sacred motifs. Eyes are made in wood, like in the *touk meat*, and once the boat is finished, the Buddhist monks conduct a ceremony called *Saen Krong Peali*, the opening of the eyes ceremony. The boat can then be worshipped.

In *Bon Om Touk,* the boats are taken in front of the royal palace in Phnom Penh, where another ceremony is conducted to bless the boat and set the shrine where people can leave their offerings to the spirit that dwells in the boat. Racing boats are usually kept in shipsheds that are sometimes protected by chicken wire, and other times are open.

The purpose of the boat races has been linked to fertility rites connected to the king, and its origins have been traced to the boat representations of the Dong Son bronze drums (Loofs-Wissowa 1991: 47), and Angkorian nautical iconography (Roveda, 2007: 353). The role of the king in these events is very important, since it emphasizes his leading role in agricultural rites that are conceived to ensure the fertility of the land (Loofs-Wissowa, 1991: 49 f.22). A depiction of a boat where a figure of a naked helmsman in ithyphallic position was identified in a drum kept at the Yunnan provincial museum (ibid.). Based on this evidence, Loofs-Wissowa poses that the boat races spread throughout Southeast Asia are remnants of fertility cults and that boat were used to transport regalia (i.e. bronze drums), which appear on board the boats in some of the representations (ibid.).

The racing boats of the Bon Om Touk festival, which is celebrated toward the end of the rainy season corresponding with the change of course of the Tonle Sap River (Porée-Maspero, 1964: 369-385) are constructed in a slightly different way than the *touk meat*. These boats, called

touk ngor or *touk prasat kdar*[32] have been linked to the nautical representations of Angkor due to their decorations and connections to fertility rites (see Hoc, 2001: 2; Jacq-Hergoualc'h, 2001: 9). The boats are specifically commissioned by pagodas and paid for by sponsors; most of them are currently made in Kompong Thom and Kratie, the only two provinces that still have large koki trees according to sources from the Preah Prek pagoda (Kandal province) interviewed in 2013. The felling of the tree is preceded by the same kind of ceremony as the one described for the touk meat (Nou Thearit, 2013: 37).

On at least one occasion a *koki* tree located within the precinct of a pagoda was used to construct a racing boat, and before it was cut down the boat builders offered a pair of sla thor, sweets, candles and incense sticks (Porée-Maspero, 1964: 370-371). In some cases, a single racing boat is made from the tree (Ibid.), in other cases, three trees are required to make a single racing boat (Poujade, 1946b: 6), while some boat builders split the trunk in two and each part is transformed into a racing boat (Nou Thearit, 2013: 37). The bow and the stern are made using jackfruit tree wood (Ibid. 37); the fieldwork conducted by the author showed that some are carved in the traditional three point head, whilst others carved the wood to make the bow look like the head of a rudimentary serpent. The main purpose of these boats is speed; they can have a length of around thirty five meters and accommodate up to sixty five paddlers. In order to increase the flexibility of the boat to reach higher speeds, planks of a special wood called *sro lao* (*lagerstroemia aungustifolia*) are added to the bulwark. Once the boat is completed in its rough state, it is taken to the pagoda, where a ceremony is conducted to honour the god Krong Peali. The monks are then in charge of painting and decorating the hull with sacred motifs. Eyes are made in wood, like in the touk meat, and once the boat is finished, the Buddhist monks conduct a ceremony called Saen Krong Peali, the opening of the eyes ceremony. The boat can then be worshipped.

[32] *Touk Prasat Kdar* means the wood or boat of the pagoda.

In Bon Om Touk, the boats are taken in front of the royal palace in Phnom Penh, where another ceremony is conducted to bless the boats and set the shrine where people can leave their offerings to the spirit that dwells in the boats. When the races are over, the racing boats are usually kept in shipsheds that are sometimes protected by chicken wire, and other times are open. The purpose of the boat races has been linked to fertility rites connected to the king, and its origins have been traced to the boat representations of the Dong Son bronze drums (Loofs-Wissowa, 1991: 47), and Angkorian nautical iconography (Roveda, 2007: 353). The role of the king in these events is very important, since it emphasizes his leading role in agricultural rites that are conceived to ensure the fertility of the land (Loofs-Wissowa, 1991: 49 f.22). A depiction of a boat where a figure of a naked helmsman in ithyphallic position was identified in a drum kept at the Yunnan provincial museum (Ibid.). Based on this evidence, Loofs-Wissowa[33] posed that the boat races spread throughout Southeast Asia are remnants of fertility cults and that boats were used to transport regalia (i.e., bronze drums), which appear on board the boats in some of the representations (ibid.).

[33] The oldest iconographic evidence of boats in mainland Southeast Asia originates from the Dong Son bronze drums (Jacq-Hergoualc'h, 2001: 2). Over 400 of these drums have been found, many of which are engraved with boat scenes (ibid.: 8). The origin of the drums has been traced to the Red River (north of Vietnam), but they have been found in archaeological contexts all around mainland and island Southeast Asia, as well as in southern China (Higham, 2002: 168-179). The boats are usually represented in a single line; the hull is slightly curved and a helmsman is holding a large quarter rudder in most of the boats. The hull is decorated along the sides, and the prow and the stern have apparently decorations of the head and tail of an animal respectively. Several people are usually depicted on board, clearly standing on top of a deck; platforms are often represented, in many cases containing what looks like a bronze drum, and archers placed on top with their bows ready (Higham, 2002: 178). There appears to be vertical banners, and the people on board are wearing headdresses that could be made out of feathers (Jacq-Hergoualc'h, 2001: 8). The boats have been interpreted as dugouts involved in fertility rites (ibid.: 9). Although the iconography belongs to two different cultures in two different geographical regions, the similarities – albeit loose – in the decorations and the context in which the boats are used gives ground for comparison (Jacq-Hergoualc'h, 2001: 8-10).



Fig. 3: the racing boats are painted with bright colours, and used only for the Bon Oum Touk races. The rest of the year they are kept in dry dock. Prek Prang Pagoda, Phnom Penh province. Source: V. Walker.



Fig. 4: Detail of the hull and the thwarts. These boats are made from a single log of hardwood, and the topsides are made from a more flexible wood. Prek Prang Pagoda, Phnom Penh province. Source: V. Walker.



Fig. 5: The racing boats are very long and can accommodate around 65 paddlers. Lvea Em pagoda, Kandal province. Source: V. Walker.



Fig. 6: among these boats was the 2006 race winner. The boats are worshipped with incense and other traditional Buddhist offerings. Kompong Khleang pagoda, Siem Reap province. Source: V. Walker.



Fig. 7: The racing boats are often protected by a shipshed, and in some cases there is chicken wire that prevents people from getting close to the boat. Lvea Em pagoda, Kandal province. Source: V. Walker.



Fig. 8: In other cases, the racing boats are simply covered by a shipshed without chicken wire. Lvea Em pagoda, Kandal province. Source: V. Walker.

Water Festival dugouts in the Stung Sen River

During the summer of 2016 the Living With Heritage Project, which records living traditions surrounding archaeological remains from the Angkor era, documented the construction of a racing boat in Chhouk village near the Sambor Prei Kuk archaeological site in the Sen River basin (Fig. 9-15). The work took place during the summer months of (rainy season) and was not finished as of 29th of July 2016. The images taken by the Living With Heritage Project complement Hoc's account on boat construction, and add additional details on the tools used for boat building (Fig. 10), the system used of opening the dugout (Fig. 12-14), and the spirit house used to place offerings for the boat spirits represented in the bows kept in the premises (Fig. 16). Additionally, it provides data on the use of *khbal bei* stemposts attached with rabbet joints to the dugout-keel.



Fig. 9: carving of the dugout. The bow section is designed in a triangular shape to fit the stempost. Source: courtesy of Living With Heritage Project.



Fig. 10: Tools used to carve the wood. Source: courtesy of Living With Heritage Project.



Fig. 11: A previously carved bow can be seen on the right side. the piece will be fitted to the dugout keel using a rabbet joint. Source: courtesy of Living With Heritage Project.



Fig. 12: Detail of the mechanism used to open the dugout over the fire. The debris of the boat is used to feed the fire, as can be seen in the image. Source: courtesy of Living With Heritage Project.



Fig. 13: Close up of the expanding process. Source: courtesy of Living With Heritage Project.



Fig. 14: Detail of the pin used to act as lever in the opening process. Source: Living With Heritage Project.



Fig. 15: Shrine with offerings and old bows placed against the fence in the foreground. The red wooden object inside the spirit house is one of the eyes of the racing boats. Source: courtesy of Living with Heritage Project.



Fig. 16: The top sides are added in different wood using nails in pocket holes. Source: courtesy of Living With Heritage Project.

Touk Thnaot[34]

Other traditional Khmer boat that can be found in Cambodia is the sugar palm tree dugout or *touk thnaot* (Heng, 2011: 5-6). The palm tree is felled without damaging the section of the stem closest to the roots (see Fig. 17-20); this section has a rounded shape and serves as a sitting area for a single person. The roots are cleared from the stem and the trunk is sectioned in half (in some cases, like in Fig. 19-20, the rounded section of the stem is kept). The trunk is then hollowed out, the rounded section of the stem is continuous, and no further action is

[34] This type of construction was only documented in its end result (i.e. the boat), but the construction process was not observed.

required. The stem of the coconut tree is partially hollow, hence the section furthest from the roots is hollowed out and the gap is covered by a plank attached to the hull using iron nails or clay. Some of the most elaborate ones have a small deck. These boats are not used in open waters; they are usually found in flooded areas like rice paddies, or ponds, and are used mainly as flotation devices from where to fish.

The material analysis of the boat suggests that this kind of boat is elaborated in a similar fashion as the *touk meat*. However, palm trees can be found in rice fields, which are considered part of the *srok*. This warrants further research to determine the way in which the material is selected and processed, which may be different from a *touk meat*.



Fig. 17: Dugout constructed from palm tree in Kandal province. Source: V. Walker.



Fig. 18: Detail of the palm tree dugout showing a deck. The narrowest section of the boat is sealed with mud. Source: V. Walker.



Fig. 19: Dugout constructed from palm tree in Siem Reap province. Source: V. Walker.



Fig. 20: The wider end portion of the log has been kept in the design. Source: V. Walker.

Chi Phat pirogue

A single pirogue was documented in the forest close to Chi Phat (Fig. 21-22) in the Cardamom Mountains.[35] The site had many felled trees of the same size as the boat, and the area appeared to be a shipyard or a repair site. The narrow boat was made with a single log that had been hollowed out and had a pronounced V-shape. The hull presented the same kind of marks used in the common dugout to level the thickness of the wood. One end of the boat was open and squared, and a tailor made plank was placed across to seal that section off. A long plank was added at each side to finish the boat. A similar kind of narrow boat is also used in Laos. Though this is essentially the same type of boat as the *touk meat*, the hull is very narrow if compared to the latter. This may be an adaptation to the environment or perhaps an indication of the limitations of the resources since the width of the boat is determined by the width of the three (Hoc, 2001: 2).



Fig. 21: Dugout found in Chi Phat used for river transport in the Cardamom Mountains area. Source: Sokha Tep.



Fig. 22: The dugouts in Chi Phat are narrower, similar to those found in upper Laos, with a narrow beam. Source: Sokha Tep.

Shell-built vessels

The Ca-Vom

Although in the early 20th century the dugouts were widely documented, nowadays plank vessels are more prominent in Cambodia along with other types of modern boats using fibre

[35] The site was documented in February 2014 by Tep Sokha while he was conducting fieldwork in the Cardamom Mountains jar burial sites. The construction process was not documented.

glass. In 1946 Poujade recorded the Ca-Vom, a type of plank vessel used for rice transportation in the Mekong delta (1946: 6). Poujade was of the believe that the Cambodian dugout was the basis for this type of boat, which was constructed by adding planks to a dugout that served as the keel (ibid.: 5-12). However, he attributed the design to the Chinese and specified that this type of vessel was made by the Vietnamese only (ibid.: 6). The horizon of boat construction in the Mekong delta seems to be far more complex than anticipated by Poujade, as the region has a variety of ships that range from narrow shell-built family boats to large cargo vessels of up to 20 m in length (Pham, Blue and Palmer, 2012: 268). The region seems to have been heavily influenced by the Chinese, all sharing some similarities in construction techniques: shell-built, plank-keels, and edge-nailing with triangular recesses (ibid.).

The Touk Loeuk Kdar

The Ca-Vom is used in Cambodia nowadays, but there is also a different type of plank boat currently in use, the *touk loeuk kdar* (Fig. 23-28). This type of plank boat was recorded by the author in the Tonle Sap and the Mekong River. The data was gathered by the author in fieldwork conducted in 2008, 2010, and 2013-14, when she visited a shipyard in Siem Reap belonging to a boat-builder accompanied by a local translator was used.

It was not possible to document the process of acquisition of the material beyond the fact that it was purchased by the boat builder. The planks were cut by the supplier using modern means, whilst the logs used for the bow and the stern appear to have been manufactured in a traditional way (*khbal bei*) ahead of their purchase by the boat builder. These logs –which are made from the *koki* tree, just like the dugouts– are roughly cut in a way that resembles the *touk kamrol*: an unfinished product with the basic cuts that needs to be polished by the boat builder (Fig. 23-24). Given the way in which these logs have been manufactured, it can be hypothesized that during the transition of the dugout into the plank boat the boat builders chose to continue using the same techniques for the bow and the stern. An implication of this

observation is that similar rituals to the ones used by the *chieng prei* for the dugout were possibly conducted during the sourcing and production of these logs. This issue is an intriguing one that could be usefully explored in further research. The construction process of the *touk loeuk kdar* in the village was recorded over a few seasons of fieldwork. No rituals were mentioned by the boat builder, but in this particular case, the boat builder acknowledged that he did not learn the trade from his father; he started building boats after the war (referring to Pol Pot's regime from 1975-1979). It is therefore probable that he learned the technological aspects of the trade without necessarily learning the rituals that accompanied it.

After the acquisition of the planks and the logs used for the bow and the stern, the boat builder starts working with an adze on the *koki* logs (Fig. 23-24). He first uses an adze to define the three pointed design (*khbal bei*) used in most of Khmer boats, with the stern designed to sit slightly taller than the bow. A chisel and a small hatchet are then used for more delicate work (Fig. 25). A rabbet joint is made at the end of the bow and the stern where the strakes will be placed. The first to be fitted is always the central strake, which acts like a false keel. Then the rest of the strakes are placed alternating port and starboard. The strakes are joined together in the edge to edge style and using iron nails with triangular recesses or pockets. The curvature of the boat is forced into place using chains tied around amidships. Ribs and thwarts are used to strengthen the hull and reinforce the strakes. Depending on the function of the ship, some have removable decks just a few centimetres below the bulwark. Caulking is made by introducing cord of vegetal material into the seams and covering it with *mrak,* the same type of resin used for the dugouts. The whole boat is covered in this resin and left to dry for several days. Most of these ships do not have eyes, neither painted nor carved. Though some Cambodians interviewees have reportedly made their own boats, these plank boats were not commissioned by a prospective buyer. Instead, boats were made with material purchased in advance by the boat builder, and the boats were exhibited in the workshop which is located by a busy road.

Though links to the traditional way of making boats can still be seen in the manufacture of the bow and the stern, there is a clear change not only in the way the boat is made and the material sourced, but also in the driving force behind the construction. All these changes hint toward a re-appraisal of the boat from a living thing to a utilitarian object. The plank-keel and the edge-joined planks using iron nails in triangular recesses seem to point to Chinese influence, but it is impossible at this stage to tell when this type of construction technique was first used in Cambodia and what the connection to the Ca-Vom is.



Fig. 23: Roughly chiseled logs bought in this condition by boat builder Ping Peak. Source: V. Walker.



Fig. 24: Details of the construction process of the bow. The form is given using an adze. Source: V. Walker.



Fig. 25: Finer work is made by using a chisel and a small hatchet. Modern tools, such as electrical saws, are used in the construction process. Source: V. Walker.



Fig. 26: The bow and stern are linked through planks. The first plank is the false keel (central bottom plank), then the rest of the planks are added port and starboard side alternatively. Source: V. Walker.



Fig. 27: Once the hull is finished, the boat is caulked by introducing cord between the planks and painting several layers of resin over the hull. Source: V. Walker.



Fig. 28: The workshop: displayed at the front are the tools used for boat construction. Source: V. Walker.

Appendix 5: Archaeological data

The Angkor Thom boat (13th century)

The Angkor Thom boat is a dugout found buried 7 m deep, is the only complete example of a vessel from the Angkor period found to date (Fig. 29-36). Its overall length is 12.83 m and it has been constructed from a single log, possibly from *koki* tree wood (Sen, 2016). This type of tree, called *hopea odorata*, is a type of hardwood that is endemic to Southeast Asia and is commonly used for boat building (see Hoc, 2001: 7). The inward curvature of the log suggests the boat is unfinished.

It is difficult to determine which section is the bow and which one the stern at this stage but there seem to be some differences: one appears to be flat with the post carved in the form of an inverted triangle (Fig. 34), while the other looks exactly like the bow documented in the Sen River by the Living With Heritage Project with a triangular form (Fig. 36). The former section has squared rails and a V-shaped ending. The inside of the boat and the walls are also thick, but these differences may be attributable to the unfinished state of the boat.



Fig. 29: Detail of the inside of the Angkor Thom boat. The curvature of the hull suggests the boat did not go through the expanding process. Source: APSARA Authority.



Fig. 30: The Angkor Thom boat was found buried 7 m deep during construction work in Angkor Thom province. Source: APSARA Authority.



Fig. 31: Detail of the location of the boat in the construction site. Source: APSARA Authority.



Fig. 32: The alignment between the two ends of the boat is twisted. Source: APSARA Authority.



Fig. 33: Detail of the Angkor Thom boat's interior. Source: APSARA Authority.



Fig. 34: The boat was taken to the moat of Angkor and submerged for conservation after 14C samples were taken. Source: APSARA Authority.



Fig. 35: The walls of the dugout are thick. As seen in this and the following pictures, the boat could float. Source: APSARA Authority.



Fig. 36: The triangular shape of this end of the boat is identical to the one documented by the Living With Heritage Project in the Sen River. Source: APSARA Authority.

The Kra Raleung boat (15th century)

A second boat was found ten years prior in Kra Raleung village (An, 2014). The dugout was unearthed by a farmer at a depth of 1.3 metres as he was digging a fish pond (Fig. 37-45). The village is located in the proximity of the Siem Reap River, between Siem Reap and the flooded village of Chong Khneas. A team led by archaeologists from the APSARA Authority excavated, extracted, and took the remains to Angkor Wat (Fig. 38), where they were submerged in the moat for conservation purposes. In 2010, the boat was lifted to take samples for radiocarbon dating, which have yielded a date of between the 14th and 15th century CE (An, 2014). This places the remains within the final stages of the Angkor civilization. The boat is a dugout and is preserved in three parts from bow to stern. The sides have degraded and only around 30

centimetres of the width of the hull around the keel section[36] has survived. The length of the boat is 15 metres. There are no planks or indication of planking; the section that remains was made from a single log from a *koki* tree (An, 2014).

The stern lies barely higher than the bow, and appears to have slightly more rocker than the bow. The draft is shallow and the transversal section of the hull seems to be round. The outside of the hull shows up to four rows of drilled holes at equal intervals. The last horizontal line of drilled holes at the bow and the stern seem to be grouped in two groups of two (An, 2014). The bow and the stern are narrow at the end, and in the inside they have been chiselled in an angular design following the form of the boat's wall. In the inside of the boat there is a keelson, a longitudinal beam used to strengthen the stiffness of the boat (Figure 42). This keelson may have been added, but the photographs seem to show that this section is part of the log, and has been chiselled out.



Fig. 37: The remains of the dugout were found at 1.3 m deep in Kra Raleung village in the Siem Reap River. Source: APSARA Authority.

[36]The term keel refers to the timber located lengthwise along the base of a boat. In this case the whole timber of the dugout forms the base of the boat.



Fig. 38: The remains of the boat were taken to the moat of Angkor and submerged there for conservation. Source: C. Pham.



Fig. 39: Detail of the inside of the hull with an apparent false-keel carved in the bottom of the boat. The arrow points to one of the holes documented by the APSARA Authority. Source: C. Pham.



Fig. 40: The same flat end recorded in the Angkor Thom boat can be seen on this one. Source: C. Pham.



Fig. 41: View of one section of the boat. Source: N. Gani.



Fig. 42: View of the central section of the boat. Source: N. Gani.



Fig. 43: Detail of one section of the boat with a pointed end, vertical stempost, and hard keel. Source: C. Pham.



Fig. 44: Detail of the other end of the bow. The hard keel is visible, but this end of the boat has a flat end and the vertical stempost is shaped in the form of an inverted triangle. Source: C. Pham.

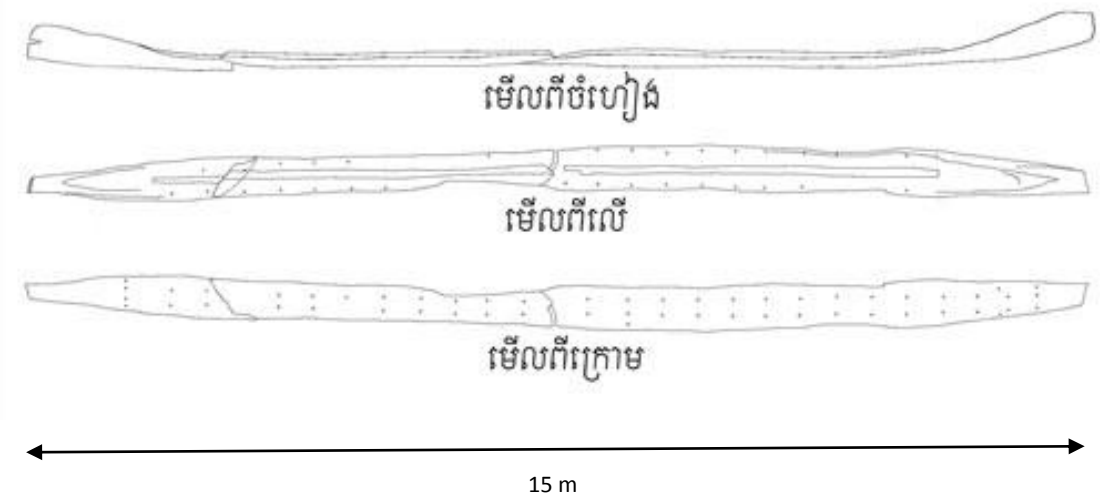


Fig. 45: Technical drawing of the Kra Raleung boat elaborated by the APSRA Authority. Source: An (2014).

Appendix 6: Terminology

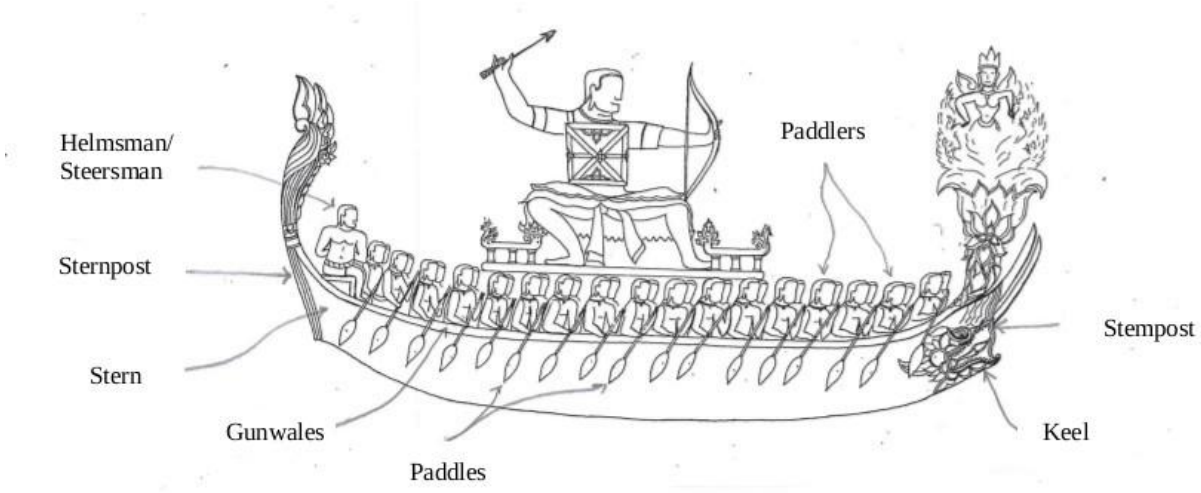


Fig. 46: Boat terminology used in this thesis for paddled boats. Drawing: Jacq-Hergoualc'h, 2007. Text: V. Walker.

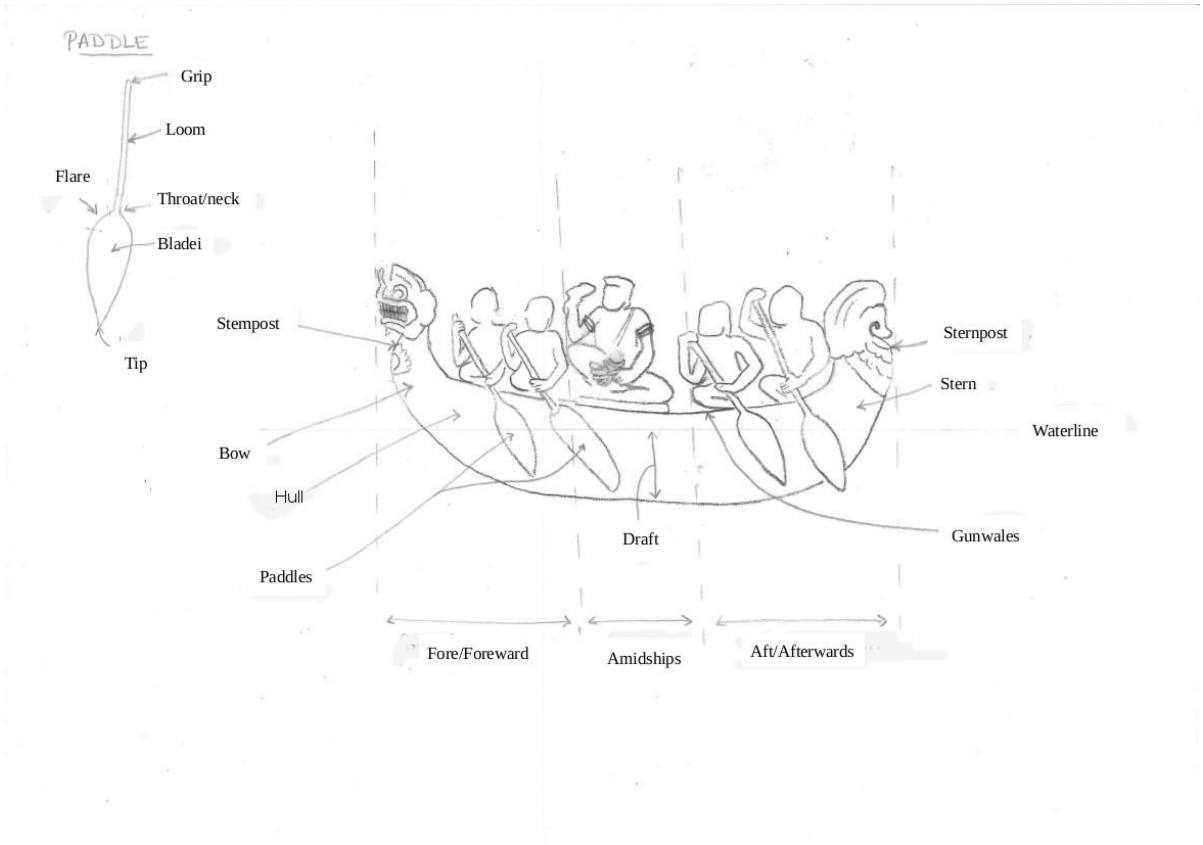


Fig. 47: Boat terminology for small and medium paddled boats and paddles. Source: V. Walker.

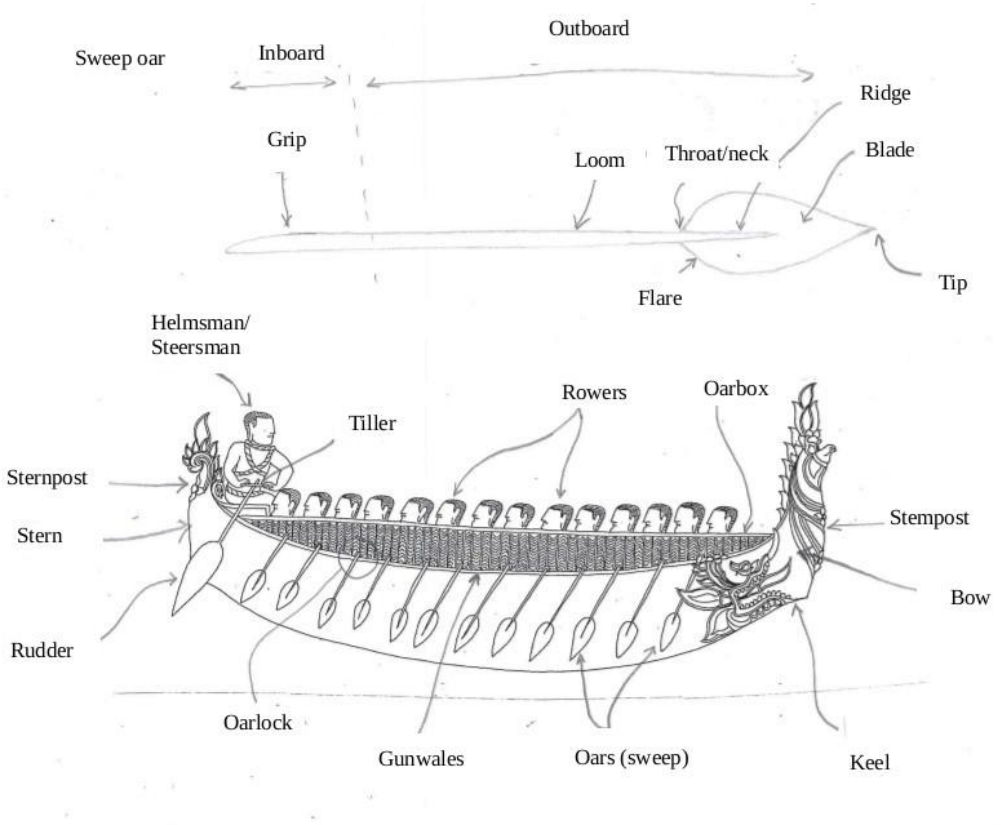


Fig. 48: Boat terminology used for rowing vessels. Drawing: JacqHergoualc'h. Text: V. Walker.

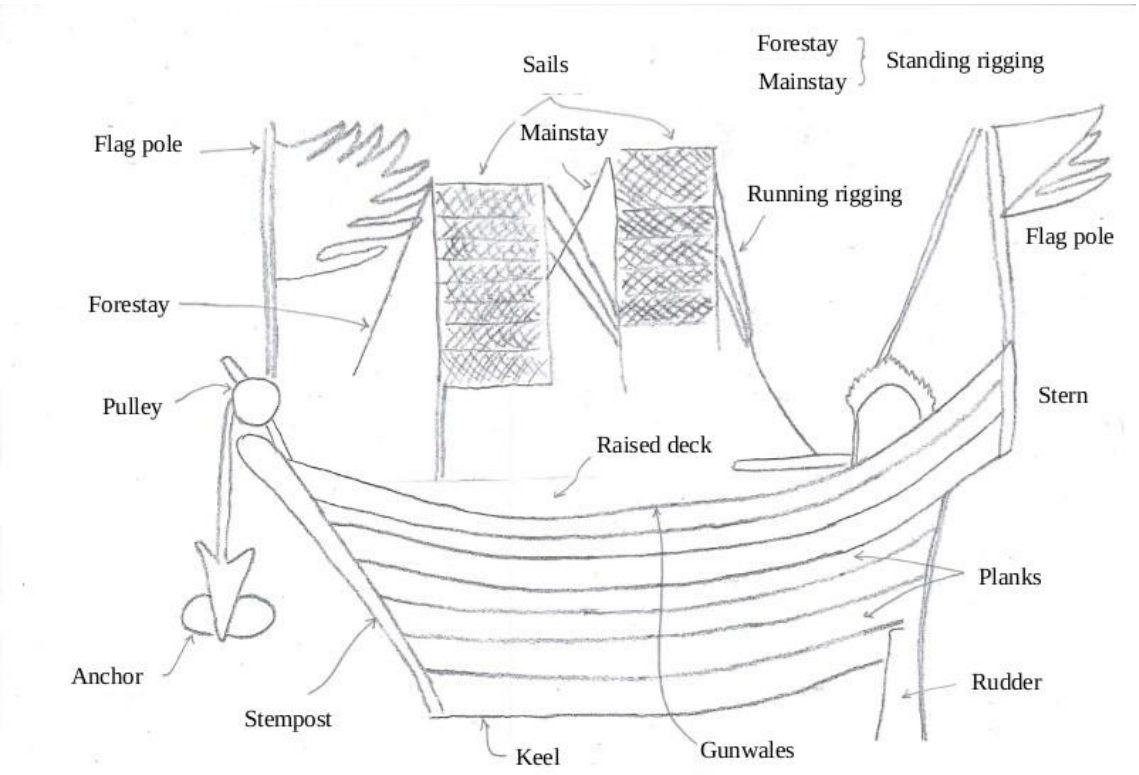


Fig. 49: Boat terminology used for sailing ships. Source: V. Walker.

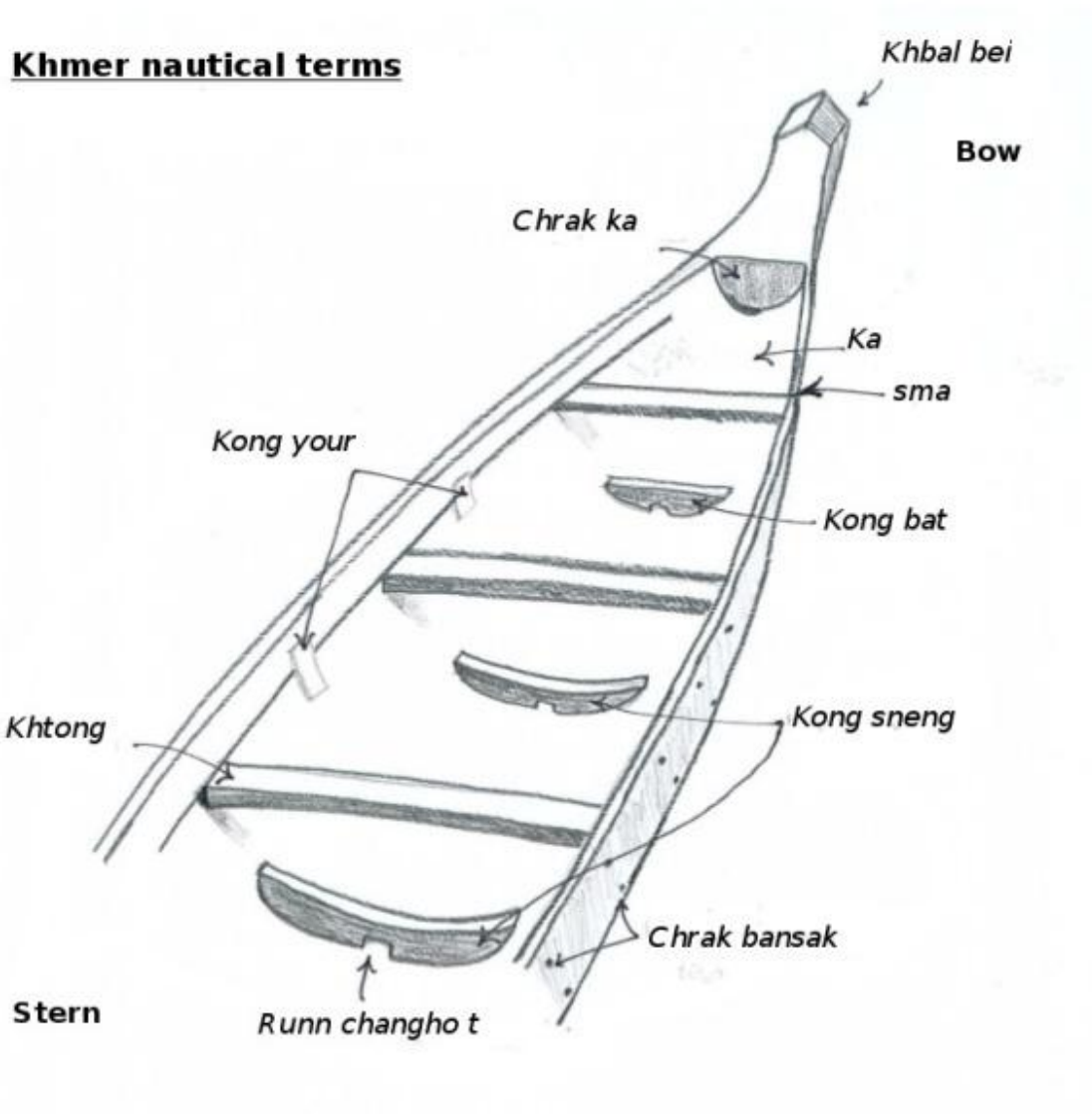


Fig. 50: Khmer terminology of modern boats. Source: after Hoc, 2001.

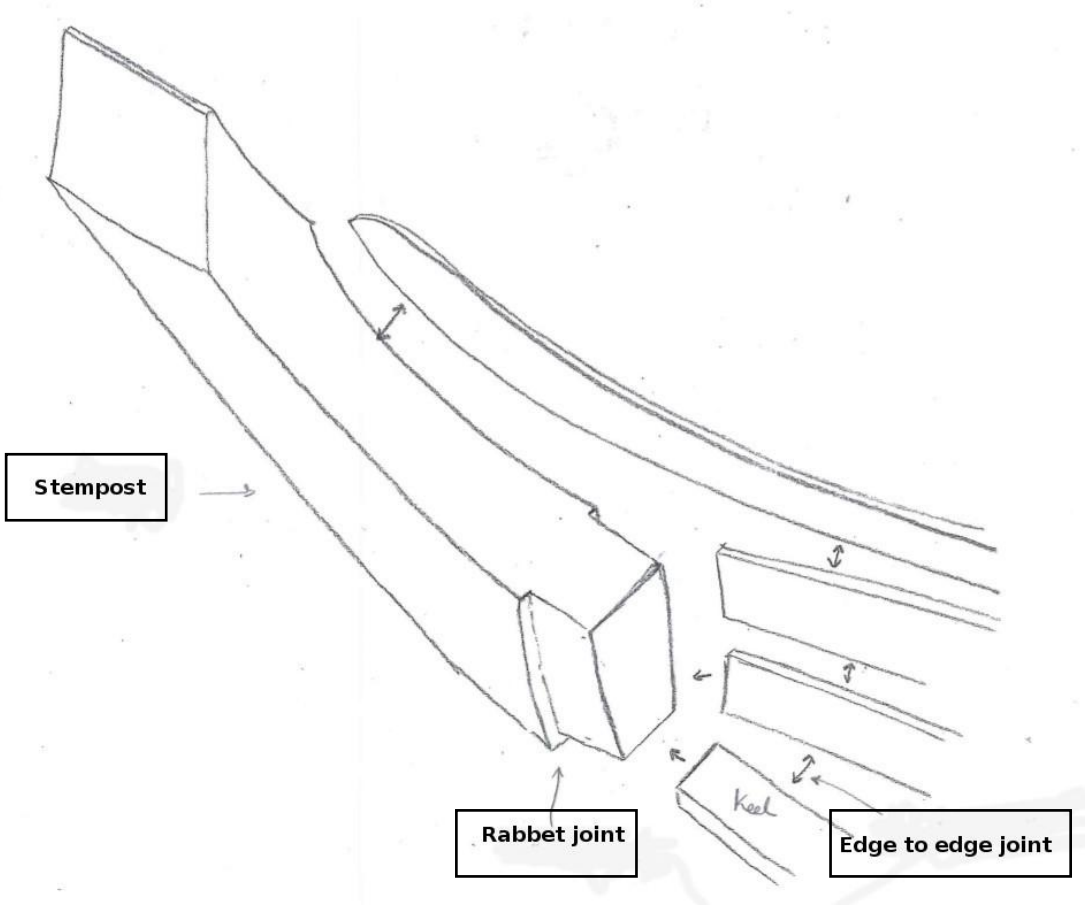


Fig. 51: PL. 48: Modern plank boat assemblage and terminology. Source: V. Walker.

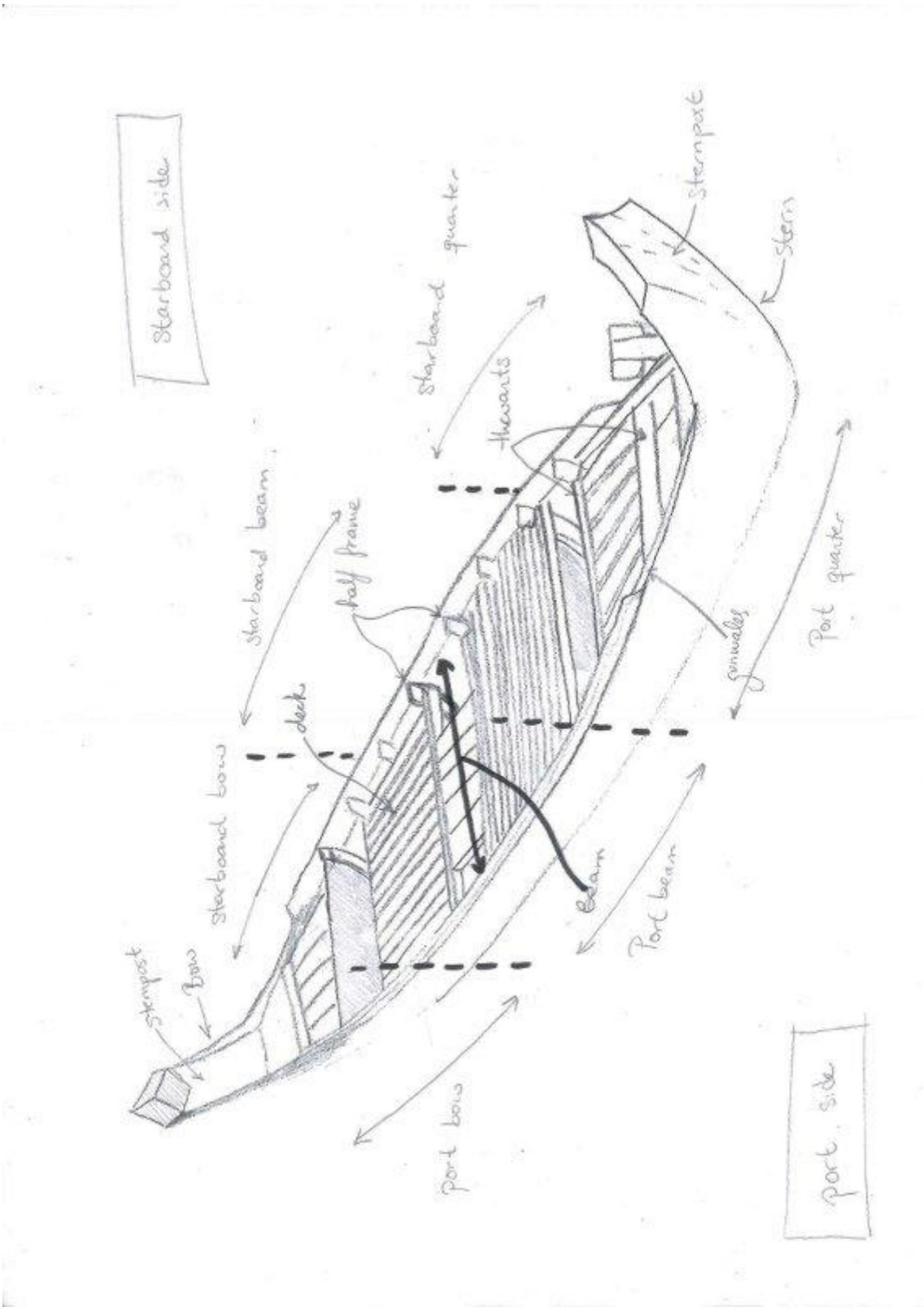


Fig. 52: Modern vessel used in Cambodia with associated terminology. Source: V. Walker.

Appendix 7: Kompong tables

Kompong/Kampong villages from the 19th and 20th century

Source legend:

L = (Lajonquière, 1901) F = Feuille A, B, C, D, etc.	P = (Pavie, 1901)	G = (Garnier, 1885)
L2 = (Lajonquière, 1911) F = Feuille A, B, C, D, Etc.	GM = Google Maps	B = (Brinkhoff, 2015)
CIWN = Cambodian Inland Waterway Navigation (Seng, 2010)	H = (Harmand, 1876)	

River (name – ends in)	Port Villages (downstream-upstream)	Notes	Source
Mekong River			
Prek Phipot – Gulf of Thailand	Kompong Sala		P (XII)
	Phipot		P (XII)
Prek Kompong/Prek Tap Cheang – Gulf of Thailand	Kompong Som		P (II), P (XII)
	Kompong Srela		P (II)
	Kompong Roun		P (II)
	Kompong Tonn		P (II)
Unknown River – Gulf of Thailand	Kompong Trach		L-FC, B
Stung Tuk Meas – Gulf of Thaiand	Kompong Nhen		L-FC
	Kompong Prah Bao		L-FC
Mekong River – South China Sea	Kompong Phnum (Mekong Branch)		CIWN
	Kompong Svay (Bassac branch)		GM
	Kompong Sambor (Bassac Branch)		CIWN
	Kompong Prean (Bassac branch)		CIWN
	Kompong Sdey/Kompong Krabey-Kamong Reab		CIWN
	Kompong Cham		L-FC , P (XIV), B
	Kompong Sleng		P (XIV)
	Kompong Treas		CIWN
	Kompong Srolao		CIWN
	Kompong Kor		CIWN
	Kratie		L-FD, P(XIII), G
	Sambok *		L-FD, P(XIII)
	Sambor *		L-FD, P(XIII), G
	Thala Borivat * - Stung Treng		L-FD, G
	Kompong Sralao Pir		GM
	Sresthapura *		

River (name – ends in)	Port Villages (downstream-upstream)	Notes	Source
Stung Sla Ku – Mekong River[37] (E)	Kompong Ompil / Krasaing[38]		GM, P, CIWN
	Kompong Youl		P (II)
	Takeo - Kompong Sleang/Krom		P (II), L-FC, CIWN
	Kompong Ompil (Ampil)		P, CIWN
	Kompong Bonlei		L-FC
	Kompong Bat Roka	next to Phnom Chisor	L-FC
Prek Ambel – Mekong River[39] (E)	Angkor Borei *		L-FC
Tonle Bati – Mekong River (E)	Kompong Ting Kok	Salt mines	L-FC
Prek Thnott – Mekong River (E)	Kompong Tul		P, L-FC
	Kompong Speu		L-FC
Tonle Touch system – Mekong River (W) Banam – K. Reang	Banam		L-FC
	Kompong Hang		L-FC
	Kompong Cham •	next to Wat Nokor	L-FC , P (XIV)
	Kompong Sleng •		P (XIV)
	Kompong Ratt (?)		P (XIV)
	Kompong Reang (?)		GM
Tonle Touch system – Mekong River (W) Banam – Boeng Kompong	Banam		L-FC
	Kompong Leav (Prey Veng)		L-FC, CIWN
Tonle Touch system – Mekong River (W) Banam – K. Preah Kiep	Banam		L-FC
	Kompong Ksach Sa		L-FC
	Kompong Snay		L-FC
	Kompong Preah Kiep		L-FC
Tonle Touch system – Vaico Occidental (South China Sea) Banam – Tamlong	Banam		L-FC
	Kompong Trabek		L-FC, CIWN
	Kompong Krang Leo		L-FC
	Kompong Cherei		L-FC
	Tamlong		L-FC
	Svay Rieng (Prek Kompong Chamlang)		CIWN
	Kompong Rou		CIWN
Tonle Touch system – Mekong River (W) Banam – Mekong	Banam		L-FC
	Kompong Sala		L-FC
	Kompong Soeng		GM
	Kompong Thum		GM
Se Kong Basin – Mekong River (E)	Thala Borivat		G, Mad, CIWN
	Attopeu		G, Mad, CIWN
Se Kong Basin – Se San - Mekong River (E)	Thala Borivat		G, Mad, CIWN
	Se San		G, Mad, CIWN
Se Kong Basin – Sre Pork - Mekong River (E)	Thala Borivat		G, Mad, CIWN
	Lumphat		G, Mad, CIWN
Tonle Repou - Mekong River (E)	Kompong Sralao Muoy		GM
	Kompong Chenang		H

[37] According to CIWN, canals have been built in this section.

[38] In Pavie the village in this area is called Kompong Ompil, while the village following Takeo is also called Kompong Ompil. In Google Maps the former appears as Kompong Kraising, so it seems likely that the name is repeated by mistake since it does not appear anywhere else under that name.

[39] According to CIWN, canals have been built in this section connecting Takeo

River (name – ends in)	Port Villages (downstream-upstream)	Notes	Source
Tonle Sap Basin (counter clockwise)			
Tonle Sap River – Mekong River (E)	Kompong Luong	next to Oudong	L-FC
	Kompong Tralach	next to Longvek	GM, CIWN
	Kompong Prasat Kang		CIWN
	Kompong Kdar		CIWN
	Kompong Hao/Hau (Bang)		P (XIII), B, L-FC
	Kompong Chhnang		L-FC, P (IV), P (XIII), B
Unknown River – Tonle Sap River (E)	Kompong Sa		L-FC
Stung Chinnit – Tonle Sap River (E)	Kompong Roung		P (XIII)
Stung Kompong Thma – Stung Chinnit – Tonle Sap River (E)	Kompong Somrong		P (XIII)
	Kompong Thma		?
Stung Sen – Tonle Sap River (E)	Kompong Svay		GM
	Phat Sanday floating port		CIWN
	Kompong Thom	next to Angkorian road	P (XIII)
	Kompong Chuteal (Tuk Angong)	next to Sambor Prei Kuk (road)	L-FD
	Kompong Babung		L-FD
	Kompong Trabek		L-FD
	Kompong Chuong		L-FD
	Kompong Pranak	Koh Ker in the vicinity and NE road	GM
	Prei Kompong * (Archaeological site)	(Stung Chenh to Prei neak Buos)	L2
	Kompong Tuc [sic]	Branch of Sen River tributary heading northeast	H
Stung Stung – Tonle Sap Lake (NE)	Kompong Chen	next to Angkorian road	L-FD
	Preah Khan of Kompong Svay *	Main archaeological site	L-FD
Stung Chikren – Tonle Sap Lake (NE)	Kompong Kdei	Angkorian road	
	Spean Praptos (bridge)	Angkor era bridge	L-FD
	Spean Ta Ong (bridge)	Angkor era bridge	L-FD
Damdek canal – Tonle Sap Lake (N)	Kompong Khleang		GM, CIWN
	Kompong Cham		L-FD
	Run		L-FD
O. Kul – Tonle Sap Lake (N)	Kompong Cham		L-FD
	Spean Dong Keo (bridge)	Angkor era bridge	L-FD
Stung Roluos – Tonle Sap Lake (N)	Kompong Phluk	Entrance to Roluos	GM, CIWN
	Roluos group *	Main archaeological site	L-FD
Stung Siem Reap – Tonle Sap Lake (NW)	Kompong Sedam / Chong Khneas	Entrance to Angkor	P (VI), CIWN
	Angkor *	Main archaeological site	L-FD, P
Stung Sreng – Stung Sangke – Tonle Sap Lake (W)	Kompong Kralanh / Kompong Thkov		L2, B
	Spean Sreng (bridge)	Angkor era bridge	L2
Stung Kompong – Stung Mongkol Borey – Stung Sangke – Tonle Sap Lake (W)	Phnom Srok *		L2
	Banteay Chhmar *	Main archaeological site	L2
O. Ta Sin – Stung Mongkol Borey – Stung Sangke – Tonle Sap Lake (W)	Spean Dach & Spean Rap (bridges)	Angkor era bridge	L2
	Banteay Chhmar *	Main archaeological site	L2
Stung Mongkol Borey – Stung Sangke – Tonle Sap Lake (W)	Mongkol Borey		L2, P (VII)
	Kompong Chhenang		P (VII)

River (name – ends in)	Port Villages (downstream-upstream)	Notes	Source
Stung Sisophon – Stung Mongkol Borey – Stung Sangke – Tonle Sap Lake (W)	Sisophon		L2, P
Stung Sangke – Tonle Sap Lake (W)	Battambang	(moved in 19th c.)	P (V), L2
	Kompong Chhlang		P (V)
	Kompong Srema		P (V)
	Banon *	Main archaeological site	P (V), L2
	Kompong Ekrom		P (V)
	Kompong Kol		P (V)
Stung Dountri	Moung Roussei		GM
Stung Kompong Prak – Tonle Sap Lake (SW)	Kompong Prak		P (V)
	Kompong Klong		P (IV), P (V)
Stung Dop Bat – Tonle Sap Lake (S)	Bakan / Preah Khan *	archaeological site	P (V), L2
Stung Pursat – Tonle Sap Lake (S)	Kompong Kassar		P (IV)
	Pursat		P (IV), L2
	Kompong Luong		P (IV), CIWN
Stung Chlea Mean – Tonle Sap Lake (S)	Kompong Kontuol		P (IV)
Stung Kompong Roca – Stung Babor – Tonle Sap Lake (S)	Babor		L2

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