A Cyborg Delta:

The Interplay of Infrastructures in the Amphibious Space in the Lower Chao Phraya River Basin in Thailand

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Abstract

The 2011 Thailand floods revealed the vulnerability of modern infrastructures in the Chao Phraya Delta in the central part of Thailand. At the same time, this and other recurrent floods have demonstrated the adaptability of traditional infrastructures such as houses on stilts or rafts and town planning focusing on rivers and canals. These two forms of infrastructure reflect distinctive ways of seeing and enacting the delta, an intermediary place between sea and land. Along with other traditional Southeast Asian states sometimes referred to as "port polities", the traditional kingdoms of Siam saw the amphibious delta space as an extension of the sea into land. As such, deltas were crucially important for the overseas trade upon which these polities depended. This *aquatic* infrastructure has gradually been transformed by modern irrigation project initiated in the early 20th century. At the present day, modern infrastructures consisting of irrigation and drainage system and road network has become predominant. However, this *terrestrial* infrastructure has not completely replaced the older one. Presently, terrestrial and the aquatic infrastructures coexist in the landscape of the delta. This coexistence is now being transformed as part of a new flood protection regime, which focuses on controlled inundation rather than perfect protection of the terrestrial infrastructure and is introducing new politics of flooding.

Introduction

As a landform shaped by silt deposited by a river at its estuary, a delta is a meeting place between land and sea and thus takes on a unique intermediary quality. A deltaic landform is shaped by sedimentation of soil transported by the river, which in turn is significantly influenced by sea tide. This interaction of river and sea often results in complex geomorphological and hydrological features particular to deltas.

One of these features is their harsh environment. Deltas are prone to flooding caused by both the swollen river and high tide. Controlling this unruly environment has long been a central focus of modern infrastructure building, and, as recent huge disasters such as the Hurricane Katrina and the 2011 Thailand floods revealed, it is still a huge challenge for civil engineering and modern states.

This paper considers the historical transformation of the Chao Phraya Delta in Thailand, the inundated area of the 2011 floods, and explores changes in the infrastructures organizing this unruly environment. Doing so the paper focuses on the interplay between modern and traditional infrastructures and it elucidates the contrasting ontologies of the delta that these infrastructures embody.

In particular, the paper examines a particular arrangement of canals, dams, dikes, forms of architecture, land use, town planning, roads, boats, paddy fields and rice varieties *as an infrastructure* that organizes the landscape of the delta. As I discuss in the following section, the notion of infrastructure denotes an arrangement of artifacts and natural entities created in order to support a specific activity. For instance, irrigation network is an arrangement of rivers, canals, dikes, sluice gates, discharge gauges, and operation offices. These artifacts, natural entities and organizations are arranged in order to supply water to paddy fields and support rice cultivation. Since it denotes not a single entity but a set of related entities, infrastructure is an inherently relational term.

In the Chao Phraya Delta, there used to exist and still partially exist an *aquatic* infrastructure characterized by canal transport and flood adaptive housing and agriculture. Because of the delta's flood prone environment, the traditional infrastructure consists of canal-centered town planning and houses on stilts, well adapted to seasonal flooding. The introduction of new means of transportation, particularly cars, transformed the landscape of the delta profoundly and resulted in the formation of a new infrastructure consisting of road networks, land-based urban planning and Western style buildings. Because this new infrastructure depends on the creation and protection of dry land, I refer to it as *terrestrial* infrastructure. Although terrestrial infrastructure is predominant now, one should not assume that it has completely replaced the aquatic one. The construction of floodwalls and roads has not eliminated old canals and amphibious villages along them, just as new urban planning did not immediately convert traditional houses on stilts to Western ones. In addition, some elements of the aquatic infrastructure also function as a part of the new infrastructure: for example, old canals often serve as drainage channels in order to create and maintain dry land for terrestrial cities. In this sense, the old and the new infrastructures coexist or even overlap.

By focusing on the transformation of the delta and the complex interplay between the aquatic and terrestrial infrastructures, this paper elucidates how engineers, the ruling class of the traditional polity, and urbanites and farmers saw and organized the amphibious space of the delta. Thus, I argue, infrastructures embody particular ways of seeing the environment. Because deltas are intermediary place between sea and land, it is possible to see such watery spaces both as potential land tracts and as extensions of the sea. The development of infrastructure based on either of these views reorganizes and remakes the landscape accordingly -- thus making the landscape more terrestrial or aquatic. Such material and epistemic interventions entail distinct forms of politics. The contested modern politics of flood protection is a telling example (Lebel 2009). In the following sections, I trace the changing politics of the deltaic space and its entanglements with terrestrial and aquatic infrastructures.

Analytical Perspectives

As the pioneer scholar in the studies of infrastructure Paul Edwards (Edwards 2003) noted, infrastructure is "a slippery term" because it can "mean essentially any important, widely shared, human constructed resources" (186-7). It is thus important to make explicit the notion in order to clarify the present argument. One relevant aspect of infrastructure is its role in controlling the flow of materials necessary for sustaining the society (Larkin 2013). Edwards pays attention to this aspect by citing the following definition by the U.S. President's Commission on Critical Infrastructure Protection (PCCIP):

> "By *infrastructure* ... we mean a network of independent, mostly privately-owned, man-made systems and processes that function collaboratively and synergistically to produce and distribute a continuous flow of essential goods and services". (President's Commission on Critical Infrastructure Protection 1997: 3 sited in Edwards 2003: 187)

This notion of flow control relates to another important aspect of infrastructure, which is the mediation of geographically and temporally dispersed activities (Star and Ruhleder 1996; Bowker and Star 1999). Infrastructure controlling water flows such as waterworks that connects treatment plants, pipes and individual households mediates divergent activities such as the operation of the plants and cooking in a kitchen (Star 1999).

In the STS literature, this mediating role is often viewed as a sociotechnical condition for infrastructure: A technical system becomes

infrastructure when it successfully connects geographically, temporally, socially, and technically diverse activities and establishes smooth coordination among them (Bowker and Star 1999; Bowker 2005; Carse 2012; Jensen and Winthereik 2013). As this is achieved, infrastructure may eventually become the quiet background of everyday life. For example, few scholars collaborating online with colleagues today care about data transfer protocols, though they used to be a central matter of concern for people using the Internet (Star and Ruhleder 1996). This also applies to the modern infrastructures of the Chao Phraya Delta. The network of drainages, dams and dikes that keep water away from this low-lying land became invisible soon after their completion. People take the newly created dry land for granted and usually do not pay attention to how complicated works are being done in order to keep the tract dry (Lebel 2009).

In the Chao Phraya Delta there is a complex interplay between different invisible flows in these infrastructures. Water flow is here related to other flows. On the one hand, the region's road system controls flows of land transport and connect various economic activities. On the other hand, in order to sustain this terrestrial flow it is necessary to keep the flow of floodwater at bay. Thus, it is crucial for the protection of the terrestrial infrastructure to drain excessive water and extensive drainage networks serve this purpose. These drainage networks significantly overlap with older aquatic infrastructure, originally designed to facilitate waterway traffic. The entanglement between terrestrial and aquatic infrastructure plays a crucial role in stabilizing both flows of water and of traffic and maintaining the present landscape of the Chao Phraya Delta full of highways, concrete buildings, factories and condominiums. In order to understand this complex interplay, it is necessary to understand the historical transformation of the delta. As we shall see, this is a process in which terrestrial infrastructure was layered upon the older aquatic one.

Recent works in environmental history and anthropology reveal that even seemingly pristine landscapes are often transformed by various human interventions from treading footpaths to modifying river channels (Cronon 1995; Raffles 2002). This also applies to the Chao Phraya Delta. As we will see in the following sections, the traditional kingdoms of Ayutthaya and the early Bangkok dynasty constructed extensive canal networks on the delta (Tanabe 1994). Likewise, recent archeological and geographic studies have found myriad of remains suggesting the modification of water courses by primitive dams called *tamnop*, traditionally constructed by farming communities (Fukui and Hoshikawa 2009). In this sense, the present landscape is built upon another infrastructure

rather than upon nature. One way of characterizing this situation is by conceiving of the landscape of the Chao Phraya Delta as a cyborg (Haraway 1991); that is, as a hybrid of the natural and the artificial, where the artificial goes all the way down. There is no natural substratum underneath these cyborg surfaces (cf. Carse 2012). This has an important political corollary.

If the landscape is hybrid all the way down, the answer to the question of what causes disasters such as the 2011 flood is not found in the cultural degradation of nature. Instead it must be sought by understanding how specific forms of cyborg infrastructure fit and embody the interests of particular groups and their ways of seeing the world. It is important to note the dual nature of this question. On the one hand, it is question about how infrastructural interventions are entangled with the often-conflicting interests between groups of people. The politics of flood prevention concerning which areas to protect and which to leave vulnerable is a typical case for this (Lebel 2009). On the other hand, this question also concerns the struggle between the aquatic and terrestrial infrastructures themselves, since they enact the delta landscape in radically different ways. In this 'second politics', we can no longer view politics exclusively as a struggle between people that basically stand on shared ground (that of nature). Rather we need to think of how the ground is itself already multiple, and how infrastructural grounds themselves struggle with each other. Thus we are in the realm of ontological politics (Mol 2002; Pickering and Guzik 2008, Jensen 2013).

As we shall see, the controversies brought about by the Chao Phraya flood in the 2011 provides a good entry point for such an exploration of the politics of the state and flooding.

Shared Community and Tricky Relatedness

From September to December 2011, Central Thailand experienced a historic flood that caused devastating human and economic damages in the Chao Phraya Delta region. The direct cause of the flood was unusually heavy rainfall, estimated by hydrologists as once in 50 years probability (Komori et al. 2012). The flood hit major cities in the delta including the world heritage city Ayutthaya as well as industrial estates packed with hundreds of factories operated by multinational corporations. 815 people died of floods in this year, and the World Bank estimated 1,425 billion baht (US$ 45.7 billion) in economic damages.

This huge flood was not only a natural disaster. Rather, as the Japanese political scientist Tamada Yoshifumi (2012) vividly illustrates, it was an unusual

political drama characterized by a multiplicity of conflicts between the pro-Thaksin government and the unti-Thaksin opposition party, Bangkok and rural provinces, haves and have-nots, elected parliamentary members and bureaucratic machinery, urbanites and farmers, and so on. This extraordinary story of multiple confrontations partly stemmed from the political struggles since the coup d'etat that threw away the popular Thaksin Sinawatra administration in 2006. Since then, Thai politics has been characterized by ceaseless conflicts between the anti-Thaksin group, the People's Alliance for Democracy (PAD), also called the Yellow Shirts, and the pro-Thaksin group, the United Front of Democracy against Dictatorship (UDD), the so-called the Red Shirts. The extraordinary flood hit the country in August 2011, just a month after the formation of the pro-Thaksin administration led by Yingluck Sinawatra, Thaksin's younger sister. The huge damage caused by the flood were thus inflected by still simmering political struggles. In particular, the new Yingluck government and the opposing Democratic Party, which had led the government until August, blamed each other for their inabilities in preventing damages. Even more, some Red Shirts activists alleged a conspiracy, by blaming the former government and high-ranked bureaucrats for having caused the flooding by purposeful mismanagement of the huge dams on the upper stream of the Chao Phraya River (Tamada 2012).

Even so, these conflicts cannot be reduced solely to the opposition between the pro and anti-Thaksin groups. A variety of issues suggest deep and complicated fault lines in the Thai society at large. People in Bangkok's neighboring provinces blamed the Bangkok Metropolitan Administration (BMA)'s protection measures, which, they alleged, had caused water retention and exacerbated damage in the neighboring areas. At the same time, many Bangkok residents seemed to take for granted that the capital should be protected at all cost. Given the strong support from its constituency, BMA made little effort to harmonize its protection measures with the neighboring provinces. And there were further percussions. Several social critics argued that this epitomized inequality in Thailand where 'haves' such as Bangkokians take their privilege for granted and the government tends to protect their privileged at the cost of 'have-nots' (Tamada 2012).

While one might well be astonished by the diversity of conflicts, it is possible to identify two shared assumptions behind these serious disagreements. First, all shared the assumption that Thailand, though comprised of diverse communities, is shaped by the myriad interrelations between them. This formed a strong basis for the call for equal treatment in the government's flood protection

measures.

Of course much has been said about the formation of nations as imagined communities, an argument that itself originated from Southeast Asian studies (Anderson 1983; Thongchai 1994). However, only relatively recently has scholars started to pay attention to how material entities such as water, land and vegetation and their transformation by science and technology contribute to nation building (Carroll 2006). In an important contribution to this line of argument, the environmental historian David Biggs analyzes the historical transformation of the Mekong delta. In *Quagmire*, Biggs depicts the intricate relations between canal building, reclamation and the construction of colonial and postcolonial states in the Mekong delta (Biggs 2010). As we will see later, canal digging in the Chao Phraya Delta has also significantly contributed to the modernization of the Thai state. The present landscape of the central plain is the product of extensive excavation of canals that drain marshy places in the lower delta region (Takaya 1987). But this transformation did not affect people as uniformly as might be imagined from the surrounding discourses of shared nationhood. Indeed, the conflict over Bangkok's flood protection revealed that the residents living on the two sides of the capital's flood barrier were not only members of the imagined community who should *ideally* be treated equally. They were also connected by complex, sometimes invisible, water flows that made it *practica*lly difficult to treat them equally. This unevenness related to the elusive materiality of water and the resultant trade off in managing floodwater in the delta. It is indeed difficult to control a huge amount of water on the extremely flat spaces of delta, where water can flow in almost any direction. In such places, the protection of one place inevitably retards drainage in neighboring areas and thus causes or exacerbates flooding there. This tricky relatedness elicits the inevitably tricky political nature of infrastructure. As Wiebe Bijker has argued, dikes, dams and flood forecast are thick with politics (Bijker 2007).

Aquatic and Terrestrial Infrastructures

While arguing over the politics of flood prevention, some commentators and critics also related the flood damage to the troublesome history of Thai modernization that had converted the traditional amphibious lifestyle into a modern terrestrial one. In flood narratives one often finds starkly depicted contrasts between lifestyles adaptive to flooding and the modern terrestrial infrastructure vulnerable to it. For example, after the flood, the newspaper *the Guardian* reported that

> In monsoon seasons past, villagers in Pa Mok would quietly embark on their annual vertical migration as the Chao Phraya river swelled and spilled over its banks, inundating rice paddies and neighbourhoods of this low-lying community in central Thailand. They moved to the upper level of their homes, which were built on three-metre high stilts.[1]
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> Then change rolled into town, around 45 years ago in the forms of cars, roads and a bridge […] "Now they park their cars under the house, and they add an extra floor [of living space] under their homes," said Klanarong Chuaboonmee, 69, [...] "As someone working for the city, I get people asking me, 'Why don't you make it so we don't flood?'"

As exemplified in this article, houses on stilts are often seen to epitomize the aquatic character of traditional infrastructure. Before the 2011 floods, Chutayaves Sinthuphanone, an inventive architect, clearly articulated the relationship between architectural changes and the transformation of town planning from being canal centered one to road centered. The resultant was the vulnerability of present infrastructures to flooding:

> When we look back at the history of settlements of Siam (former name of Thailand), we see that all of the settlements were situated along the rivers. Both Ayutthaya and Bangkok were called 'Venice of the East' by western merchants. How did they cope with flood in the past?
>
> The obvious answer was that houses were built on stilts. Another obvious answer was that some of the homes were built as rafts. Building homes with stilts or as rafts was fine when the communities were focused along the river. But since the modern communities are now focused on the roads, how would an architect design a house that sits on the ground and can survive the flood?[2]

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[1] "Floating buildings could help Thais tackle the flooding crisis." *The Guardian* February 14, 2012.

[2] From his home page "A Site-Specific Experiment": http://asitespecificexperiment.wordpress.com/2011/05/12/amphibious-house/

As indicated by these excerpts, architectural and infrastructural designs in Thailand have indeed changed drastically over the past 100 years and this has certainly impacted on Thai cities' adaptability to floods. But it is not only the built environments that have changed. The "natural" environment of the delta has also changed due to the extensive construction of water management facilities, particularly irrigation dams and canals.

Homan van der Heide, the architect of the current irrigation system in Chao Phraya River Basin, described the delta at the turn of the century as follows:

> The plain, where not cultivated, is chiefly covered with jungle grass, where herds of elefants [sic] feed upon, brushwood and bamboo. Extensive forests do not exist. Except in the highest tracts along the rivers, even clumps of trees are scarce, apparently in consequence of occasional floods and want of proper drainage. (Homan van der Heide 1903: 3)

Before the completion of the irrigation system, which Homan van der Heide designed in 1903 (but which remained only partly materialized until 1957), the lower part of the delta was unpopulated marshland. Without an extensive and well-organized network of canals and sluice gates, the early 20th Century delta was quite an inhospitable place for agriculture and human settlements. Since the delta is extremely flat, most of its parts, except ridges along the river created by river deposit, were annually flooded. Thus the lower part of the delta became a gigantic water zone directly connected to the sea. Because inundation drowned all the young trees in the rainy season, the lower part of the delta was almost entirely deforested. Simultaneously, the inland areas not adjunct to the rivers became extremely arid in the dry season. Accordingly, in most of the delta it was extremely difficult to even get drinking water not to mention water for agriculture. These severe hydrological conditions practically prohibited human settlements except on natural levees along the river (Takaya 1987).

The drastic changes of both the urban and rural landscapes were the result from extensive efforts to build new infrastructures, in particular irrigation systems, over the past 60 years. The transformation of marshy lowlands into productive paddy fields and the transformation of urban planning from canal- to road-centered, have proceeded simultaneously, hand in hand. Given this history, it is not surprising that some flood discourses assume modernization itself as the

major cause of flood damages.

The Delta as Reclaimable Land

The stark contrast between the terrestrial and the aquatic infrastructures derives from some basic contrasts in how infrastructure makers conceive of the marshy delta lands. Specifically, the amphibious space of deltas has been seen as both reclaimable land or as the extension of sea into the land. Depending on which view was adopted different potentials of delta space for human use could be imagined. Different infrastructures have been built to realize those potentials. In both Europe and its colonies in the tropics, the terrestrial view of reclamation has been predominant. One can trace this Western terrestrial view back to the origin of the term "delta".

The word delta itself is of Greek origin. Greeks used this designation on the basis of the similarity of the shapes between the letter Δ (delta) and the estuary landform of the Nile River.[3] It was originally the proper name given to the Nile Delta by the ancient Greeks. As a proper name, delta was already in use when Herodotus wrote his *History* in the 5th century B.C. But the word did not acquire the generic meaning before the Alexander the Great's invasion to India where the Greeks found similar landforms at large river mouths. Strabo, the well-known Roman geographer, cites several Greek writers comparing the Nile Delta and the newly visited Indian alluvial areas. Francis Celoria has argued that the term gradually gained generic meaning through those comparisons (Celoria 1966).

Herodotus well-known phrase "Egypt is the gift of the Nile", suggests that the soil of the delta is transported by the river, particularly during seasonal inundation (Herodotus 1890). In the dynamic hydrological condition of the Nile, the relationship between flooding and deposit of fertile soil is quite visible: seasonal flooding reached the delta around the particular period of a year, and the recession of water left a visible new layer of soil upon the field (Nagasawa 2013). While we cannot assume any direct linkage between Herodotus and modern European science and technology, there are interesting commonalities between the observations of this mythical father of geography and those of modern geo-morphologists. Both view rivers as the central forces that make of landscapes (Leopold, Miller, and Wolman 1964).

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[3] Thai, Chinese and Japanese do not have this sort of handy word, and the landform is commonly called something like "triangular landform at estuary".

Modern infrastructural interventions in European deltas date back to the early Middle Ages, particularly to the Dutch lowlands. Settlers in the coastal areas reclaimed fenlands by constructing dikes and drainage channels. The invention of windmills significantly contributed to the improvement of drainage and the Dutch continued to expand their farmlands into the sea and seashore lakes. Dutch technology eventually spread to many European countries and reclamation of swampy land became one the focus of much land development in Europe (Danner 2005).

But though the Chao Phraya delta's present terrestrial landscape was actually designed by a Dutch engineer, it was not this technology that created it. The irrigation technology applied to the Chao Phraya Delta was instead a hybrid and colonial technology developed in the tropical colonies of the Dutch and British empires (Ertsen 2010; Headrick 1988). Irrigation was indeed unnecessary for the Netherlands and Britain, where farmers could count on year-round rainfall. Britain, the master of modern irrigation in the early 20th century, developed its irrigation technology in colonial India. Their technologies developed as part of effort to reconstruct deteriorated irrigation canals dug by the Mughal Empire. Eventually, the British constructed their own irrigation schemes both in the deltas and in highland regions (Headrick 1988). They were eventually transferred to other British semi-colonies such as Egypt and Mesopotamia (Nagasawa 2013). On the Nile, the introduction of new irrigation systems were accompanied by the construction of the Aswan Low Dam, the largest hydro-engineering construction in the world upon its completion in 1902. The dam and irrigation made year-around cultivation possible in the Nile delta and completely remade the landscape and the agrarian society (Mitchell 2002). As it happens, the irrigation project of the Chao Phraya Delta was inspired by and visibly modeled after this impressive accomplishment (Homan van der Heide 1903).

Indeed, the colonial origin of irrigation also applies to the case of Dutch technology. Although widely known for their mastery of delta water management in Europe, Dutch engineers initially had nothing to add to the existing irrigation in the Indonesian archipelago. Their initial involvement was mostly limited to the maintenance of existing irrigation works. But after the introduction of the forced cultivation of sugarcane, Dutch engineers were required to construct new irrigation system suitable for this lucrative crop. Because sugarcane was cultivated on Balinese paddy fields as a second crop, sugarcane irrigation also deeply involved Dutch engineers in paddy field irrigation -- in which Thailand in the early twenty century had a growing interest (Ertsen, 2010).

The Delta as an Extension of the Sea

The terrestrial conception of deltas as reclaimable land is almost completely lacking in most of the kingdoms in coastal Southeast Asia. Before the mid 19th century, the polities in Southeast Asia viewed rivers and the amphibious landscape of deltas mostly as the extension of sea. Because these countries' prosperity depended almost exclusively with long distance trade with China, Japan, India and the Middle East, rivers' function as traffic routes were far more important than their potential to irrigate adjunct lands. Their function was to connect coastal and inland areas, which produced lucrative exports such as sapanwood, camphor, pepper, and ivory.

The rulers of the important ports in the region gained huge profits by exporting highly valued tropical forest produce collected from their hinterlands. Scholars in Southeast Asian area studies refer to those traditional states as "port polities" to emphasize their trade-centered political economy and their close relationship with world trade (Kathirithamby-Wells and Villiers 1990; Hirosue 2004). For port polities, rivers were important routes to access the hinterlands providing lucrative forest produce. John Gullick describes the relationship between rivers and port polities as follows:

> The territory comprised in a State was related to […] the use of rivers as the main lines of communication and trade. A State was typically the basin of a large river or (less often) of a group of adjacent rivers, forming a block of land extending from the coast inland to the central watershed. The capital of the State was the point at which the main river ran into the sea. At this point the ruler of the State could control the movement of all persons who entered or left his State […] (Gullick 1958: 21 sited in Tambiah 1977: 87)

In case of the Chao Phraya Delta, the lack of state interest in agriculture also stemmed from the hydrological condition of the delta. Yoneo Ishii has written that in the time of the Ayutthaya and early Bangkok dynasties (from 14th to 19th century), the lower Chao Phraya Delta was "a belt of mud stretching between the continent and the sea, which, under natural conditions, is unsuitable inhabitation." (p.28) Given this amphibious character of the delta, the ancient capital of Ayutthaya, located 100 kilometers from the coastal line, was actually the outlet

port of the Chao Phraya River (Ishii 1978).[4]

The hydrological conditions of the delta made the Ayutthaya and the early Bangkok dynasties relationship to water management distinctive from other traditional polities of Tai peoples, who share cultural and linguistic traits and have historical relations with the Siamese people in the central part of Thailand. Most of the lowland people in Thailand, Laos and Northwest Vietnam, the Shan State in Burma, and part of Yunnan in China and Assam in India speak related languages and form similar political systems based on wet rice production. The principalities located in intermountain basins developed relatively small-scale irrigation systems, which are usually collectively run by farmers (Ishii 1978; Tanabe 1994).[5] This type of water management was impossible in the delta, where Siamese immigrated from the north before the 13th century.

Given this condition Siamese developed different approaches to water management. First, farmers resorted to completely different measures from the traditional Tai small-scale irrigation to adapt the environment because they were unable to control the water flows in the delta. In particular, rather than the engineering effort to construct hydraulic infrastructures, they began capitalizing on specific biological features of certain rice varieties. Until recently, farmers in the delta thus used floating rice varieties, which rapidly grow their stems to keep pace with the rise of the water level and can therefore survive in a water depth of more than 4 meters. Following Ishii, who refers to agriculture using floating rice as "agronomic adaptation" to the environment and contrasted this with the mode of adaptation by building irrigation, one can say that rice variety became a key biological means for infrastructuring the amphibious delta space (Ishii 1978).

Meanwhile, the kings and elites of the Ayutthaya and Bangkok Dynasties treated water in quite another way. As typical port polities, they saw the delta as

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[4] The Siamese state placed its capital in Ayutthaya from 14th to 18th century.

[5] The historical evidences about the involvement of the traditional states in the irrigation management seem unclear. Anthropologists generally emphasize the grassroots and communal character of village or basin level management (Tanabe 1994). But Ishii indicates historical evidences that suggest the states' active role in the construction works for water diversion in large river basins and, following Karl Wittfogel (Wittfogel 1957), characterizes these polities "quasi-hydraulic societies" (Ishii 1978).

space for trade and extended water into this amphibious space by excavating canals. Both dynasties were enthusiastic about digging canals not for irrigation but for transport. In the Ayutthaya period, they were dug to make shortcuts in the winding natural waterways (Ishii 1978). In the early 19th century, extensive transversal canals were dug to connect rivers running parallel in the Chai Phraya Delta. These rivers, Tha Chin, Bang Pakon and Mekhlong, all served as a major access to the inland area of the respective basins, and had no direct connections to each other(Takaya 1987). The transversal canals significantly improved access to those basins from the Chao Phraya River Basin, where the center of the state had been located since the Ayutthaya period.

But canal digging was not limited to the state sponsored endeavors. In the amphibious delta environment, watercourses were primary traffic routes for everyone. Farmers and townsfolk dug small canals in order to commute to the paddy fields, to make access to the main watercourses and open up new settlements. Since human settlements were limited to the banks of canals and rivers, aquatic infrastructures exemplified by traditional architecture and town planning developed mainly in these canal banks. George Finlayson who visited the delta and Bangkok in 1820s vividly illustrates this aquatic life style:

> The Siamese may be said to be aquatic in their disposition. (…) (T)he greater number of them are floating on bamboo rafts secured close to the bank. The houses that are not so floated are built on posts driven into the mud, and raised above the bank, a precaution rendered necessary both by the diurnal flow of the tides, and the annual inundations to which the country is subject. (...) To every house, floating or not, there is attached a boat, generally very small, for the use of the family. (…) The few streets that Bankok (sic) boasts are passable on foot only in dry weather: the principal shops, however, and the most valuable merchandise, are found along the river in the floating-houses. (Finlayson 18826: 212)

Before 1861, when European residents asked the King to construct a road, there was no road passable for horse wagons in Bangkok. The existing land paths were mostly narrow footpaths, *thang chueam,* connecting houses. In this canal-centered town planning, riparian space was the most important social space where people met, traded and sometimes literary lived.

The riparian life style and the state's massive investment in transport

canals are illustrative of Thai society's exclusive interest in extending fluvial space of rivers into inland rather than creating dry land by reclamation. The drastic transformation of the type of interest taken in the canals occurred in the late 19th century when the Thai state, Siam as it was called then, encountered new political and economic conditions. At this point, Siamese elites encountered completely different ways of dealing with water– namely those irrigation techniques developed in European colonies.

The Master Plan and the Remaking of the Delta[6]

In 1902, the government of Thailand led by the King Chulalongkorn (Rama V) invited the Dutch engineer, J. Homan van der Heide from the Dutch East Indies to examine the possibilities to modernize the canal system and introducing irrigation. Homan van der Heide was enthusiastically devoted to irrigation engineering. Before his arrival to Thailand, he had traveled in Egypt, Japan and Italy and conducted a comparative study of irrigation systems (Brummelhuis 2005).

Around this time, the Thai economy had become increasingly dependent on the export of rice, both to the rising demand in the neighboring European colonies and to the decline of sugar export, which had been primary in the mid 19th century (Daniels 1996), but had been almost completely destroyed by the fundamental technological change introduced by new refining methods that facilitated colonial Java's extraordinary competitiveness in the sugar industry (Yamamoto 1998). In this context further boosting of the delta rice production gained in economic importance, at least in the eyes of some.

However, although the idea of irrigation enthused King Chulalongkorn and a few key ministers, Homan van der Heide's plan to construct an irrigation network did not capture the imagination of most of the Thai elite including the Agricultural Minister himself (Brummelhuis 2005). The decision to invite Homan van der Heide was due to a mixture of the King's interest in the possibility of stimulating rice cultivation and the common recognition among Thai elites of the necessity of introducing modern hydraulics to rehabilitate the transversal canals, which had been silted up by the tidal effect and begun to give rise to salinity problem in adjacent areas. Because of the delta's slight gradient, the rivers on the

[6] The description of this section is mostly based on Brummelhuis' (2005) detailed study of the interaction between Homan van der Heide and Thai elites in the early 20th century.

delta were affected by tide up to 100km upstream from the coast. The reverse flow caused by high tide deposited silts on the transversal canals' riverbeds and made canals shallower particularly at the meeting point of the two tides, the mid point of the canals. At the end of the 19th century, the deposit problem made the canal passable only during the highest water levels and this caused huge traffic problems. At the same time, tidal intrusion through the transversal canals spread salt damages to large area along the canals. Small canals continuously dug by local people spread salinity further inland. Already a few years before the arrival of Homan van der Heide, the King had prohibited new canal digging until the arrival of a European expert (Brummelhuis 2005).

In this context, the decision to bring in a European had less to do with interest in reproducing forms of colonial irrigation than in supporting the traditional aquatic infrastructure. Carefully examining correspondences between the van der Heide, the minister of agriculture and the King, the Dutch anthropologist and historian Han ten Bruhmelhuis concluded that the Thai government at the time almost completely lacked the notion that agriculture could be developed by state intervention such as irrigation and reclamation. This was in spite of the fact that the King himself occasionally made suggestions to this effect to his ministers. As an aquatic trade-oriented kingdom, agricultural development was simply outside the state's vision; left totally in the hands of farmers endeavoring to help themselves (Tambiah 1977). Eventually this lacking interest led to the decline of Homan van der Heide's massive irrigation plan due to insufficient resources and to limiting the role of this ambitious irrigation engineer to the rehabilitation of the existing canal system (Brummelhuis 2005).

Homan van der Heide's irrigation scheme was indeed extremely ambitious, particularly in the financial and political situation of Thailand in the early 20th century. It encompassed the entire delta water system and included three natural watercourses, the Chao Phraya mainstream and its two tributaries, Tha Chin and Noi, as well as numerous canals. Just like the Egyptian Aswan Low Dam project, van der Heide's Chao Phraya scheme centered on the construction of a huge barrage across the Chao Phraya at the top of the delta. It was designed to divert water from the main stream to the Tha Chin, the Noi and a newly constructed canal, each of which would function as irrigation canals, distributing water to the entire delta. The inventiveness of Homan van der Heide's scheme has been acclaimed by a number of later-generation engineers (Brummelhuis 2005).

But the inventiveness also exhibits the traveling nature of delta knowledge. In the *General Report for Irrigation and Drainage* (Homan van der

Heide 1903), van der Heide cites a wide variety of reports on deltas, from the famous William Willcock reports on the modernization of Egyptian irrigation by the British to the *Bulletin of the College of Agriculture at the Tokyo University*. Indeed, it is through Homan van der Heide's continuous comparisons between Egypt, India, Japan, Italy and Java that he comes to characterize, diagnose and assess the potential of the Chao Phraya Delta. As an object of state-engineering interventions, the Chao Phraya Delta was thus embedded in colonial connections among numerous deltas; connections though which, engineers, reports, scientific articles and ideas all circulated.

Homan van der Heide's innovative design was not implemented by the Thai government for nearly half a century. Although the King and at least one minister seemed to recognize the innovativeness of the plan, it looked to most of the Thai ministers as a disproportionately ambitious and risky endeavor (Brummelhuis 2005). Particularly, the most costly part of the plan, the construction of the barrage across the mainstream, on which the entire system hinged, was only realized in the form of the Chao Phraya Dam in 1957, and then only with massive financial support from the World Bank and the United States (Takaya 1987).

After submitting his report, Homan van der Heide remained in Thailand with an appointment as head of the newly founded Royal Irrigation Department. In this position he was engaged in a number of canal improvement projects of more moderate ambition. Because the government agreed on the potentials of his master plan and he decided on the work undertook by his department, these canal improvement projects were designed in line with his master plan. At the same time, however, the department's activities were necessarily directed to the urgent issue of rehabilitating the existing canal systems that served as main traffic routes. While van der Heide carefully designed infrastructures, such as sluice gates, dikes and ditches, to be useful for irrigation purpose and eloquently declared their "true" purpose for irrigation, his successive and successful endeavors contributed significantly to sustaining the aquatic infrastructure rather than transforming it into a terrestrial one. The Thai name of the department *Krom Klong*, "Canal Department", neatly epitomizes this point (Brummelhuis 2005).

Terrestrializing the Delta

The completion of the Chao Phraya Dam in 1957 was a major turning point of the infrastructural history of Thailand. Aside from its main purpose, the irrigation system has significantly contributed to terrestrializing the delta landscape. In

reality its role was more important than the construction such as roads and Western style buildings since drainage by irrigation canals created the dry land upon which these terrestrial infrastructures were constructed.

In 1903, Homan van der Heide had already foreseen that irrigation canals would open up new terrestrial possibilities such as permanent settlement in the inland areas, orchards and livestock (Homan van der Heide 1903). Due to the cyclical flooding and aridity, most of farmers lived near paddy fields only in rainy seasons, when drinking water and the waterway connection from the main canals to the field were available. Irrigation canals that retained water in the dry seasons made it possible for these farmers to build permanent villages near the field and thus contributed to eliminating the mobile lifestyle in the delta, which caused trouble for taxation and population surveys (Brummelhuis 2005). The irrigation system also drained excessive water from villages and adjacent areas, which meant that villagers were able to cultivate fruit trees and raise livestock. The irrigation and drainage network introduced a clear separation of water and land that remained stable throughout the year. This was obviously a great advantage for the development of terrestrial agriculture and economic activities.

Based on the year-round separation of water and land, the construction of extensive highway networks since the 1960s has dramatically altered the main transport means in the delta from boats to cars. The development of the road network brought about an overall figure-ground reversal in the delta townscapes. Specifically, roads were traditionally built parallel with but slightly distanced from rivers and thus faced the *backyards* of houses, whose main entrances faced rivers and canals. As roads became the dominant communication and transport routes, the urban space literally turned around. Now backyards became front entrances and riverside boatslips, *tha*, the traditional front entrance of the riparian houses, became backdoors. In many places, the orientation of social space was thus directly reversed from the riparian space to the roadside.

This urban transformation, which took place in Bangkok and major cities, was on the way throughout the 1970s. However, as a consequence, Thailand started began experiencing flooding problems. Since newly constructed terrestrial infrastructures were vulnerable to flooding, flood protection became a major concern of water management. In the meantime, the materialization of Homan van der Heide's plan, which brought irrigation to most of the delta created unexpected side effect since it altered the pattern of water flow in the entire delta.

The new canal network supplied water primarily to the relatively high areas near the river channels. In the furrow-like topology of the delta, higher places

are located along the rivers, and low-laying depressions are found between the rivers. Because of this topography, irrigation canals provide water to the higher riverside areas first and only subsequently to the depressed areas in between. Along with irrigation water, drainage from the higher areas also flows into lower-lying places. In this altered water flow more water concentrates in the depressed areas and thus flooding in these areas were actually exacerbated (Takaya 1987).

This inundation problem had a fractal quality, since the problem replicated across scales. Repeating the problem at the basin level, at the micro level, flooding also occurred in the relatively lower lying place within irrigation tracts, usually places where water is controlled by a sluice gate. The water level of irrigation tracts were generally controlled in order to keep sufficient water in the highest areas, and these were usually the areas closest to the river, where water first arrived. Because every tract has a gradient that runs from upper to lower stream, this water control tended to bring about much deeper inundation in the lower places, often located close to the sluice gates that controlled the drainage (Molle et al. 1999).

This system of water control brought about the coexistence of the traditional and modern forms of agriculture within the same irrigation tract. The introduction of irrigation created the conditions for agricultural change at higher elevations. In the upper lands, the irrigation department ensured a water level suitable for the short stem high yield crop varieties, which were the main technology behind the Green Revolution. The department also drained water from the fields in preparation and harvesting periods so that farmers could apply machinery. In contrast to the rapid changes brought about by the Green Revolution technologies in the upland, however, lowland farmers adapted to the increasing inundation problems by using the traditional means: floating rice varieties.

Here we are witness to a form of coexistence between aquatic and terrestrial infrastructures of agriculture. On the one hand, in the low laying places the traditional form of agriculture gained even further importance due to the diversion of drainage from the upper lands. Traditional agriculture infrastructure consisted of higher dikes around the paddy fields that kept large amounts of water *within* the field, of traditional floating rice varieties, of huge amount of human labor for harvesting, and, sometimes, of boats for cultivating on the floodwater. On the other hand, the agricultural practice in the higher areas were transformed into a new terrestrial form comprised of lower dikes that *prevented* floodwater from entering into the paddy, of high yield short stem rice varieties developed by the

International Rice Research Institute, and of mechanized harvesting, which has become popular since the 1990s (Molle et al. 1999).

This co-existence finally disappeared in the late 1990s. The productivity difference between floating rice and high yield varieties and the need for mechanization due to labor shortages strongly promoted the transformation of the deep-water paddy fields into shallower ones. This was made possible by the irrigation department's continuous effort to construct smaller sluice gates within each tract. Those minor sluice gates enabled detailed water control and thus ensured that water levels within a tract could be kept nearly constant. Yet, it was farmers rather than the irrigation department that initiated this change in water management. In the mid 1995s, village leaders in the upper delta formed an alliance to request the irrigation office to install a new water management policy that kept water levels evenly, so that everyone would be able to use high yield varieties and harvesters. After the successful petition and subsequent transformation of the lowlands, this new practice spread to irrigation offices all over the delta and significantly transformed the delta's agricultural landscape (Molle and Keawkuladya 1998).

Coexisting Infrastructures

The transformation of the landscape seemed completed by the turn of the century. However, the successive flood years of 2006, 2008 and 2011 revealed that the shift has not yet completed and maybe never will be. In 2006, the first year in which massive flooding occurred, the Royal Irrigation Department and the King were forced to divert water into a few low-laying tracts in the Ayutthaya Province in order to prevent flooding in Bangkok. At first, the King ordered the irrigation department to divert water into his private property. It became a shallow but vast retention pond used to store excess water from the Chao Phraya River. A few days later, the Royal Irrigation Department publicly announced the call for "volunteers" who would take inspiration from the King and offer their land to retain excess water. However, several farmers witnessed that soon after the call for volunteers the department diverted water to low laying lands in these areas with out sufficient caution. One farmer said, soon after he was informed about the plan the department diverted water during the night, and he found himself surrounded by water when he got up next morning (Lebel 2009).

This forced inundation to protect Bangkok is striking, and troubling, in many ways. But perhaps an overlooked aspect is it that, although it caused massive

crop loss in the fields where the rice was still growing, there was hardly any damage to humans. This was mainly due to flood adaptive infrastructures and lifestyle in these low laying villages, which are located completely outside modern flood protection infrastructures. In these areas villages are built along a complex network of rivers and canals that connect the mainstream of Chao Phraya and the Noi River. Because the villages were so close to watercourses, the dikes constructed in the 1980s and 1990s had been made not between the villages and the rivers but rather between the villages and the fields located inland. Strange looking to the eyes of outsiders, these villages came to be located *outside* the dike, and the dikes protect *paddy fields rather than villages*. Because of these locations, villages are subject to annual inundation and people in these villages still keep traditional houses and boats. This persistence of traditional aquatic life was the major reason that the sudden water discharge into the area did not cause serious damage at the village side. After all, it had already been flooded.

The dramatic events of 2006, year led to new discussion about flood protection and the decision to use Bang Ban and a few other areas as retention zones. The project was named after the King's water management vision "*Kaem Ling*" ("monkey cheeks"), which analogizes the areas' capacity to keep water with a monkey's cheeks, filled with bananas to be consumed when food is scarce. The project aims to keep the water during the flood seasons and recycle it for irrigation in the following dry seasons.[7]

Through the subsequent floods in 2008 and 2011, Bang Ban and the other areas were formally designated as "Natural Monkey Cheeks" by the Royal Irrigation Department. This foregrounded the resilience of the seemingly outdated traditional delta infrastructures. It also highlighted that the safety the modern terrestrial infrastructure depends on keeping traditional aquatic infrastructures in place.

Conclusion

As we have seen, the politics of flood protection involves tricky problem concerning water flow. In the extremely flat Chao Phraya Delta, protecting one place inevitably exacerbates flooding in other places. This water-mediated

[7] The idea of "monkey cheeks" itself predates the event in 2006 and originally meant the Kings project to rehabilitate urban canals in order to rehabilitate and augment their function as retention ponds and drainage canal of floodwater.

relatedness poses serious question for the politics of flood protection in contemporary Thailand. Thus, the protection of Bangkok at the cost of adjacent areas was seriously contested. However, this highly visible politics too often eclipses another politics. This ontological politics concerns the complex and layered relations between terrestrial and aquatic infrastructures.

The perspective offered in this paper makes it possible to shed lights on the entanglements of infrastructures with configurations of natural rivers, canals, dikes and sluice gates, architecture and town planning, in the shaping of water flow in the delta. From this viewpoint what is at stake is not only how to allocate water in times of flooding but also how different kind of ontological grounds for doing so are enacted by different infrastructures, which embody different versions of amphibious delta spaces.

As I have shown, the aquatic infrastructure developed due to South East Asian port polities' concern about water transportation. Transversal canals embodied this interest in promoting watercourse traffic. Along these watercourses traditional town planning centering on canals flourished. At the same time, agriculture, left solely in the farmers' hands, adapted to the flood prone deltaic environment by biological means, that is, via selection of floating rice varieties. This sharply contrasted with the solution of hydro-engineering adaptation; exemplified by the community-based irrigation of the uplands Tai peoples.

This aquatic infrastructure, however, was significantly transformed as Western irrigation was introduced in the mid 20th century. Yet, even as Europeans developed a terrestrial view of deltas as potential land for reclamation, Western irrigation itself developed through encounters with indigenous irrigation in their tropical colonies. The life history of Homan van der Heide who designed the master plan of Chao Phraya delta irrigation exhibits the travels and translations of colonial engineering. Trained in the Dutch East Indies, Homan van der Heide traveled Egypt, Italy and Japan before diagnosing the problems with the Chao Phraya delta and drawing his ambitious plan, itself modeled after the successful Aswan dam project in the Nile.

Understanding the co-existence of infrastructures is of vital importance in the present situation. The Chao Phraya irrigation network not only altered water flow in the delta but also made more complex and more invisible than ever before. In turn, the huge floods of the 2000s made visible anew the interrelations between Bangkok and its rural areas. As critics argued after 2011, urban safety is now totally dependent on rural areas, which have been forced to accept flooding. In the meantime, the flood crisis foregrounded sharp contrasts between terrestrial and

aquatic infrastructures, and enabled a positive reevaluation of the latter. Thus it has become increasingly clear that endless modernization, understood as the ongoing construction of terrestrial infrastructure, will not prevent flood damage. Instead, terrestrial infrastructure relies on aquatic infrastructure just as Bangkokians rely on rural people. This situation of dependency between the terrestrial and the aquatic infrastructures was partly instituted in the Monkey Cheeks system. Retention zones, where people still depend on the aquatic infrastructure and which are thus resilient to flooding, now serve to control the water level in Bangkok.

The Monkey Cheeks project is far from settling the Thai politics of flooding, the struggle between Bangkok and adjacent provinces, or that between terrestrial and aquatic infrastructures more generally.[8] Yet, the partial institutionalization of the relationship between these infrastructures seems to open up a new stage in the relationship between these infrastructures. As an intermediary place between sea and land, the future of the Chao Phraya Delta is captured in the constant interplay of the aquatic and terrestrial ontologies that these infrastructures embody.

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[8] The government of Thailand approved the 300billion Baht budget for water management master plan in July 2012 (http://www.mcot.net/site/content?id=4ff675610b01dabf3c047d5a#.Ut6EQv0kpn0). However, the proposed master plan and bidding process created a huge controversy about the adequacy of the plan and the procedure. http://www.bangkokpost.com/news/politics/388807/water-project-faces-risk-of-more-delays

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