



HAL
open science

Grounded and global: water infrastructure development and policymaking in the Ayeyarwady Delta, Myanmar

B. Ivars, Jean-Philippe Venot

► To cite this version:

B. Ivars, Jean-Philippe Venot. Grounded and global: water infrastructure development and policymaking in the Ayeyarwady Delta, Myanmar. *Water alternatives*, 2019, 12 (3), p. 1038-1063. hal-03510438

HAL Id: hal-03510438

<https://hal.science/hal-03510438>

Submitted on 21 Dec 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Ivars, B. and Venot, J.-P. 2019. Grounded and global: Water infrastructure development and policymaking in the Ayeyarwady Delta, Myanmar. *Water Alternatives* 12(3): 1038-1063



Grounded and Global: Water Infrastructure Development and Policymaking in the Ayeyarwady Delta, Myanmar

Benoit Ivars

University of Köln, Germany; benoit.ivars@uni-koeln.de

Jean-Philippe Venot

UMR G-EAU, IRD, Univ Montpellier, France; and Royal University of Agriculture, Phnom Penh, Cambodia; jean-philippe.venot@ird.fr

ABSTRACT: Seen as hotspots of vulnerability in the face of external pressures such as sea level rise, upstream water development, and extreme weather events but also of in situ dynamics such as increasing water use by local residents and demographic growth, deltas are high on the international science and development agenda. What emerges in the literature is the image of a 'global delta' that lends itself to global research and policy initiatives and their critique. We use the concept of 'boundary object' to critically reflect on the emergence of this global delta. We analyse the global delta in terms of its underpinning discourses, narratives, and knowledge generation dynamics, and through examining the politics of delta-oriented development and aid interventions. We elaborate this analytical argument on the basis of a 150-year historical analysis of water infrastructure development and policymaking in the Ayeyarwady Delta, paying specific attention to recent attempts at developing an Integrated Ayeyarwady Delta Strategy (IADS) and the role that the development of this strategy has played in the 'making' of the Ayeyarwady Delta as a global delta. This lays the groundwork for a broader critique of recent efforts to promote a 'Dutch Delta Approach' internationally, which we contend not only contributes to, but also aims at, making this global delta a boundary object. Such efforts play a key role in structuring an ever-expanding actor network supporting delta research and (sustainable/integrated) development. However, the making of a boundary object such as the global delta also hinges on depoliticising (delta) development. This, we consider to be problematic notably in the context of Myanmar where land and water politics have strongly shaped the changes the Ayeyarwady Delta has and will continue to witness.

KEYWORDS: Boundary object, actor network, knowledge production, discourse, Ayeyarwady Delta, Myanmar

INTRODUCTION: SITUATING OUR ENQUIRY IN AN EXPANDING GLOBAL KNOWLEDGE LANDSCAPE

Over the last decade, deltas have been the object of significant attention from a wide range of actors. This was also the case in the 1960s when the agricultural potential of deltas, and the threats to that potential that floods represented, came to the fore (UNESCO, 1966). There is, for instance, an active epistemic community generating knowledge about deltas at the global level; the members of this community particularly aim at identifying, comparing and ranking how different deltas across the world react to specific global biophysical and anthropogenic processes (Syvitski et al., 2009; Renaud et al., 2016).

In the late 2000s, this community was largely US-centred and grounded in the geosciences, and it stressed the fact that deltas were economic and environmental hotspots. Home to nearly half a billion people and rapidly urbanising, deltas were described as particularly vulnerable to climate change as well as to upstream and in situ water development. These scholars further highlighted that deltas were sinking due to lower rates of sedimentation and coastline erosion, and that this was a global issue to be dealt

with urgency (Syvitski et al., 2009). In the mid-2010s, this community further expanded to other disciplines, universities in Europe, and select countries where large deltas are found (Brazil, India, Bangladesh, Vietnam and China). This happened primarily through a Belmont Forum project that aimed at developing a common analytical framework and global indices to assess delta vulnerability and to devise related policy recommendations (Renaud et al., 2016).¹ Of specific interest for our analysis is the fact that, alongside research, these scholars also attempted to put deltas on the global policy agenda. They, for instance, called for an *International Year of Deltas 2013* in *Eos*, the journal of the American Geophysical Union (Foufoula-Georgiou et al., 2011), and published a later comment in *Nature*, calling for "the United Nations to establish an international body of experts to coordinate delta-maintenance initiatives worldwide" (Giosan et al., 2014: 31). These calls did not yield results but the *Sustainable Deltas 2015* initiative that these scholars elaborated was nonetheless endorsed by the International Council for Science (ICSU), an organisation devoted to international cooperation in the advancement of science (ICSU, 2014). The Sustainable Deltas 2015 initiative is "a statement of urgency for global cooperation and a call to arms to the global community of citizens, scientists, policy makers and funders to work together towards accelerating the understanding and sustainable solutions of these critical systems [i.e. Deltas]" (Foufoula-Georgiou, 2014).

These research efforts and policy-oriented calls start from the basic premise that deltas across the world display many similarities and face the same (global) pressures; they are presented as economic and environmental hotspots threatened by climate change (see above). On this basis, scholars argue that it is possible but also necessary to work towards a "standardization of research methodologies for delta environments" (Giosan et al., 2014). Through such standardisation, what is sought is a certain type of (generic and transferable) delta knowledge, one that could lay the groundwork for a "global strategy for protecting deltas" (ibid).

One such global strategy is already at play, spearheaded by the Government of the Netherlands. Over the last decade, the Dutch government has indeed promoted Dutch water actors as potential providers of knowledge and expertise in the water sector worldwide. The promotion of Dutch water expertise is encapsulated in the so-called 'International Water Ambition' that puts forth the goal "to increase the water safety and water security of urban deltas"; it states that "as an urban delta, the Netherlands has a lot of knowledge and experience of these subjects" (Ministry of Infrastructure and the Environment of the Netherlands, 2016: 7).² The Dutch Delta Programme (also known as the Dutch Delta Approach when targeting an international audience; NWP, 2014) is indeed used as evidence that the Netherlands' success in dealing with challenges faced at home makes them able to deal with the challenges faced by deltas worldwide.³ To quote from the website of the Delta Programme Commissioner, the Netherlands:

the Delta Programme approach has already become an export product itself: has now become an export product in itself: the 'Dutch Delta Approach' is attracting a great deal of interest worldwide. Various countries have called upon the Dutch government and business community to help them implement the Delta Programme approach to address their own taskings (Delta Programme Commissioner, nd).

The Dutch Delta Approach is presented as knowledge intensive, which lays the groundwork for the establishment of initiatives and networks that have strong ties to Dutch academic and development organisations displaying 'delta expertise'. These notably include the Delta Alliance, established in 2013 as

¹ The project is called DELTAS and is led by the University of Minnesota (<http://delta.umn.edu>). The Belmont Forum was established in 2009 as "a partnership of funding organizations, international science councils, and regional consortia committed to the advancement of interdisciplinary and transdisciplinary science" (www.belmontforum.org/). By the close of 2017, the Belmont Forum had committed over US\$75 million in research activities, and 'Belmont projects' are sought after by researchers working on environmental issues worldwide.

² A 'sequel' is currently being examined by the lower house of the Dutch parliament (NWP, 2019).

³ For a critical analysis of the knowledge claims in the Dutch Delta Approach, see Hasan et al., 2019 and Zegwaard et al., 2019.

an international knowledge-driven network aiming at "increasing [delta's] resilience to changing conditions";⁴ also included is the International Delta Coalition, launched in 2016 and presented as "the first international coalition of governments created to get things done to increase the resilience of urban deltas".⁵

In relation and intrigued by the emergence and structuring of interdisciplinary academic networks that take deltas as objects of research, and of policy initiatives that promote specific approaches to delta management, social science scholars have also engaged in delta research. While some anthropologists call for an 'anthropology of deltas' – an in-depth understanding of the lived experience of delta inhabitants (Krause, 2017) – or stress the hybrid nature of deltas (Lahiri-Dutt, 2014), water governance scholars highlight that the vulnerability of today's deltas is not a given but largely results from politics and an engineering approach to water control that has dominated delta management over the last 150 years (Wesselink et al., 2015). Other social science scholars appear less interested in the delta dynamics per se than in the knowledge claims that are made about them and in the networks in which these claims are articulated. There is, for instance, an emerging critical literature investigating the making of 'delta plans' in the context of bilateral cooperation between different countries and the Netherlands (Hasan et al., 2019; Minkman and van Buuren, 2019; Zegwaard et al., 2019). Finally, drawing from the field of Science and Technology Studies (STS), a last group of scholars engage with deltas at a more conceptual level and talk of infrastructures as "ontological experiments (...) [that] produce novel configurations of the world" (Jensen and Morita, 2015). They put forth the argument that different infrastructures and governance attempts that coexist in the same space actually give rise to multiple deltas, and they then talk of 'ontological politics' to stress the tensions that may exist between these different deltas (Zegwaard, 2016; Morita and Jensen, 2017). These authors go beyond the recognition that there are multiple perceptions of deltas, and argue that multiple deltas coexist per se, including in the same space and time; they consider that the ways deltas are known are intrinsically related to what deltas are.

We argue that these policy and knowledge generation dynamics create a specific delta, which we call the 'global delta': an entity of worldwide relevance that would lend itself – and even require – generic research and governance approaches and their critique. We see this global delta to be a 'boundary object'. The concept of boundary object has been widely used in the field of Science and Technology Studies (STS) to refer to "[things] that have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of 'translation'" (Star and Griesemer, 1989: 393). They continue to exist in the face of – and perhaps because of – interpretative flexibility. Narratives and discourses around the urgency to act and the vulnerability of deltas are what holds the 'global delta' together, while interpretative flexibility – especially on what ought to be done – is allowed by the diversity of land and water management practices and infrastructures found in any single delta, and the sheer complexity of knowing/understanding the functioning of deltas.

We posit that the boundary object concept allows for investigating discourses, narratives and knowledge generation dynamics, as well as for an examination of the politics of delta-oriented development and aid interventions which till now have been studied independently. These are elements that we investigate for the Ayeyarwady Delta in Myanmar, describing the multiple processes by which it has progressively become a global delta. It is a particularly interesting case to document. First, there is relatively little academic literature on the Ayeyarwady Delta when compared to other large deltas of Southeast Asia such as the Mekong and the Chao Phraya.⁶ Second, and maybe more importantly, the

⁴ The Delta Alliance has 18 'wings' (nodes in the network) including Myanmar. See www.delta-alliance.org/ for further information.

⁵ See Delta Coalition, www.deltacoalition.net/

⁶ One of the objectives of the paper is to provide an English language knowledge base on the agricultural and water development in the Ayeyarwady Delta over the last 150 years and an extended reference list on the topic.

recent political-economic history of Myanmar has contributed to a broadly shared perception of the Ayeyarwady Delta as a 'virgin territory', isolated until only recently from the dominant water governance paradigms and infrastructure interventions. Classified as a 'delta in peril', due to rapid relative sea level rise, by scholars who adopt comparative geophysical approaches to studying deltas (Syvitski et al., 2009), the Ayeyarwady Delta is said to be characterised by a unique conjunction of 'natural' ecosystems, extreme vulnerability (that came dramatically to the fore in 2008 during Cyclone Nargis), little-developed (water) infrastructures, and foreseen rapid economic growth in a country that recently re-entered the international community (see, for instance, IADS, 2018).

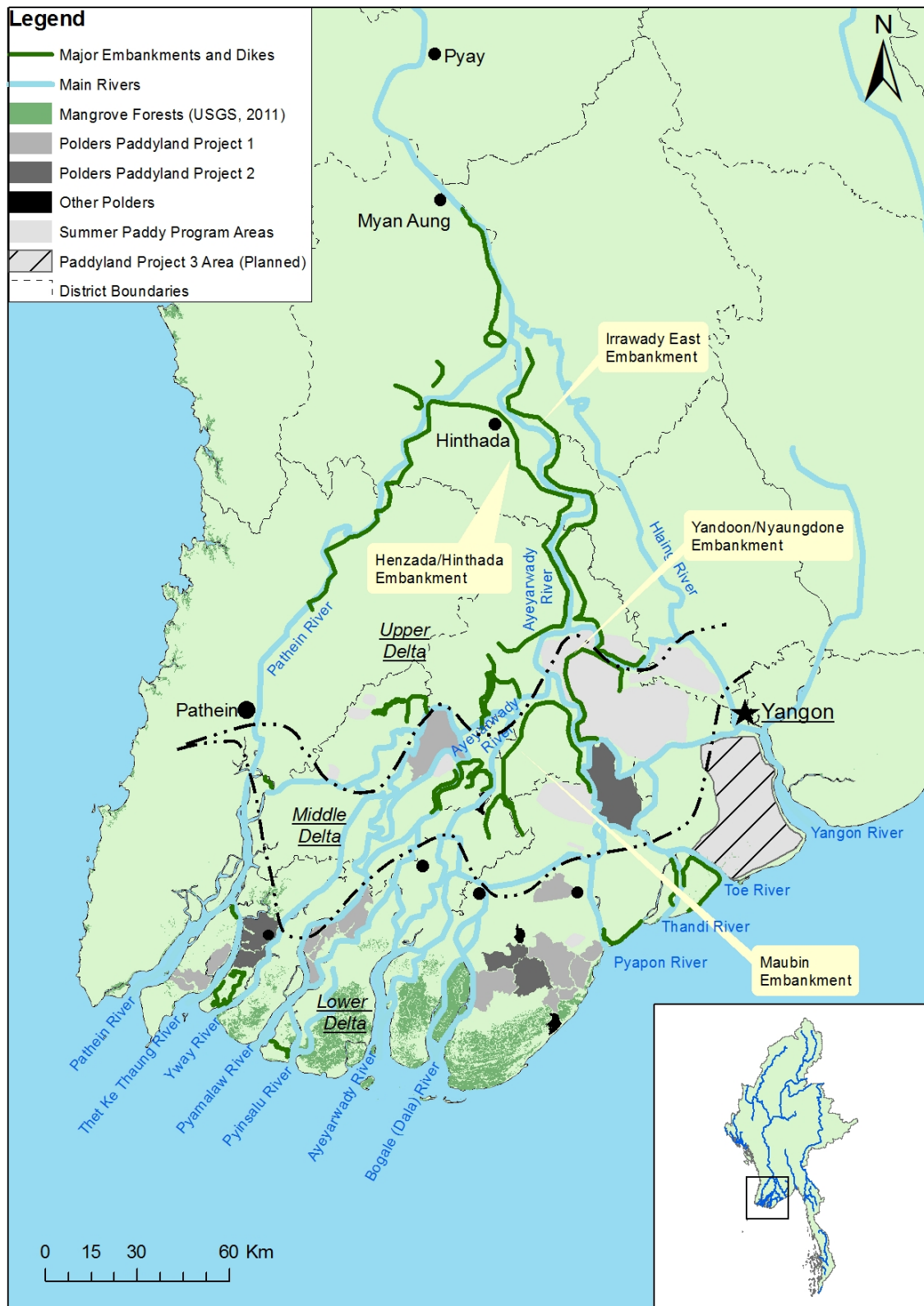
As such, the Ayeyarwady Delta displays some of the main characteristics of the global delta that we have described above. Our objective is to understand how this happened over time and we pay special attention to the recent attempt at devising an integrated approach to delta management supported by the Dutch government, specifically the Integrated Ayeyarwady Development Strategy (IADS). We indeed see the IADS as playing a key role in establishing the Ayeyarwady Delta as a global delta, and posit that the IADS also works as a boundary object in its own right, in the sense that its primary aim is to attract resources and investment for multiple actors to further shape the delta. We adopt an historical perspective that starts in the mid-19th century when lower Burma was annexed by the British Empire; we pay specific attention to continuities and shifts in delta narratives and the actors who articulated them. We chiefly rely on an extensive review of the literature on the Ayeyarwady Delta and on Burma/Myanmar; we include colonial archives and unpublished material such as project reports and official communication between the Government of Burma/Myanmar and international development agencies; we also draw from the ethnographic PhD research conducted in the delta since 2016 by this paper's first author and from interviews with selected key individuals, some of whom are currently involved in research and policy initiatives that contribute to shaping how the Ayeyarwady Delta is understood internationally today.

We start with a short biophysical description of the Ayeyarwady Delta which, we argue, lays the groundwork for the existence of a boundary object. We then describe in more detail how agriculture and water infrastructures that can be seen in the delta today came into being. We identify five distinct periods in the recent history of the Ayeyarwady Delta: 1) the British period during which the priority was to control floods in the upper delta; 2) a transition period of about two decades after World War II when little development took place; 3) the 1970s and 1980s, which were characterised by large-scale land reclamation in the form of polders in the lower and middle delta; 4) the 1990s and 2000s, when the government, isolated from the international community, engaged in large-scale land reclamation and land (re)distribution reforms to support dry season irrigation; and 5) the post-Nargis (2008) period during which the Ayeyarwady Delta has become a (paper) policy object closely aligned to the global delta. Our analysis is supported by Figures 2 and 3, below. Figure 2 presents the main development projects, the discursive lenses through which the delta was discussed, and the water control infrastructures built over time. Figure 3 presents the main studies and international knowledge brokers who have had a bearing on the Ayeyarwady Delta over the last 150 years.

LAYING THE GROUND FOR A BOUNDARY OBJECT: THE BIOPHYSICAL AYEYARWADY DELTA

The Ayeyarwady Delta is located in the southwest of Myanmar (see Figure 1). Though a precise delineation of deltas is a challenging task due to complex interactions between multiple river channels, the Ayeyarwady Delta is said to spread over 35,000 square kilometres (km²) between its apex in Pyay and the Bay of Bengal (Rodolfo, 1975; IADS, 2018). Furuichi et al. (2009) estimated an average annual flow of

Figure 1. Land, water and large-scale infrastructures in the Ayeyarwady Delta, Myanmar (Other infrastructures such as pumping schemes and sluice gates dot the landscape of the delta but are not represented in the map due to lack of publicly available data).



Source: the Authors

about 13,000 cubic metres per second (m^3/s) (410 billion cubic metres per year) at Pyay, which is then distributed among 11 major channels (Figure 1). The river discharges are at their lowest during the dry season, from January to April; they start increasing in April/May due to snowmelts in the Himalayas where the Ayeyarwady River originates, and they reach their peak in July/August during the monsoon (Volker, 1983; IADS, 2018).

With average rainfall of 1500 to 2000 mm at the apex, increasing to 2500 mm in the southeast and 3500 mm in the southwest, the Ayeyarwady Delta experiences the highest rainfall intensities of all Southeast Asian deltas and is said to be increasingly prone to flooding due to shorter but more intensive rain events (CUR, 1993; van Driel and Nauta, 2014; IADS, 2018). It is also characterised by some of the greatest tidal ranges among all Southeast Asian deltas, with tidal influence felt in Myan Aung, 300 km inland (Volker, 1983). Like in many other deltas, tidal influence has laid the groundwork for scholars to elaborate a 'rough zoning' according to salinity levels and dynamics (see the dotted lines in Figure 1). First elaborated in the 1960s (Volker, 1964), the image that the delta is made of three zones with distinct vulnerabilities still pervades today: 1) the upper delta, where freshwater dominates and which is particularly prone to riverine flooding; 2) the middle delta, which is under the combined influence of fresh and sea water depending on the season, and is prone to inundation; and 3) the lower delta, which is characterised by coastal islands, degraded mangroves and the permanent presence of brackish water, and is vulnerable to flash floods and storm surges and affected by coastal erosion. A fourth zone that is also commonly delineated – though not on the basis of salinity levels – is the urbanised and fast-developing area around Yangon facing issues strikingly different from those affecting the rural landscapes of the delta (van Driel and Nauta, 2014; Arcadis, 2016a; IADS, 2018).

The following sections make reference to such zoning, highlighting that this understanding of the delta has shaped, but also been reinforced by, choices of infrastructural development over the last 150 years. For the sake of length and due to our own expertise, we focus on water and agricultural development, policy making and discourses. We largely leave aside issues of navigation and transport, though they have played an important role in shaping the Ayeyarwady Delta and will continue to do so as highlighted by the fact that recent strategic delta studies (such as the IADS) have been conducted under the umbrella of the Ministry of Transport of Myanmar.

CONTROLLING FLOODS IN THE UPPER DELTA: THE INFLUENCE OF BRITISH ENGINEERS

Apart from a few minor embankments and dikes which were built south of Hinthada in the late-18th and 19th centuries, the Ayeyarwady Delta was largely free from infrastructures until the second half of the 19th century when the annexure of Lower Myanmar by the British in 1852 led to an influx of settlers in the region (Adas, 2011; van Schendel, 1991). From then on, under British rule, the delta would be mostly seen through the prism of flood protection; infrastructure development would focus on the upper delta as it was considered to have the highest agricultural potential.

The British administration indeed aimed at transforming what it saw as the neglected resources of the delta (swamps, marshes, lakes and vast areas of seasonally inundated plains) into an intensive and commercially oriented rice landscape that could support permanent settlements (Hedley et al., 2010). With this as their goal, the necessity of building flood protection works came to the fore as early as 1861 when flooding caused significant damage to the few existing embankments. The necessity to build further embankments would be continuously stressed due to ever more intense floods between 1869 and 1875 (ECAFE, 1950) (see Figure 2).

At first, and to protect existing settlements, the British administration (through the Public Works Department, or PWD) started consolidating small-scale embankments on the west bank of the Ayeyarwady mainstream and its river branches. It also passed several pieces of legislation to control such activities (Gordon, 1893; Samuelson, 1917). Embankments were also used as communication channels and would come to be known as horseshoe, open or U-shape embankments (Volker, 1964; see Box 1).

Box 1. An iconic infrastructure from the British period: the horseshoe or U-shape embankment

The term 'horseshoe' was first used by Gordon (1893) to describe the shape of the delta's streams and consequently the land lying between these streams (then known as horseshoe islands). The first instance of the term 'horseshoe' we found is in Barnett (1913) and the term is used to designate the embankments themselves; the term may also have been used by British officers of the Public Works Department. Much later, Adriaan Volker (1964) popularised the term, as well as the term 'U-shape embankments'. In regions where elevation differences are still relatively marked, such as the upper delta, U-shape embankments allow for the upper portions of the interdistributary areas to be protected from floods; in the event of extreme floods the lower portions of the 'compartment' can also act as a flood retention area. This reduces both the risk of breaching/overtopping embankments and flood peaks further downstream and allows for draining the interdistributary area without pumping, which would be costly. The rationale for building such infrastructure in the upper delta – as opposed to building fully closed polders – is not totally clear. Volker (1964: 8) stated that these "open embankments should be considered as a compromise in the controversy between advocates and antagonists of flood protections by diking, a problem which is encountered in many deltaic areas". Such an explanation, however, might be an instance of reinterpretation related to the debates that characterised delta management in the 1960s. There might be a more down-to-earth explanation for the existence of such embankments: that of the need for decreasing construction costs even if this meant only partial flood protection. A World Bank irrigation sector review published in 1983 for instance, highlights that empoldering the islands in the upper reaches of the delta would involve "evacuation of rainfall by pumping [and] is effectively ruled out on the ground of costs" (World Bank, 1983: 40). This echoes statements made in 1913 by Mr. Clendening, executive engineer of the PWD, about the prohibitive costs of closed embankments compared to open horseshoes (Barnett, 1913).

Talking about the U-shape embankments about a century after they were built, the engineering firm of Sir William Halcrow & Partners (1982, Volume 4: 16) stated that "[t]he construction of the four great embankments of Henzada, Irrawaddy East, Yandoon and Maubin and the others has transformed the delta from the mangrove swamps of the 1860s to the present widespread paddylands".

While the PWD focused on building dikes on the west bank of the mainstream, local district officers started diverting the road construction budget to build embankments on the east bank of the river, and private entrepreneurs engaged in building their own embankments. Construction mimicked settlement patterns and was in response to the local population on the east bank attributing acute flooding to the PWD projects on the other side of the river (Candy, 1931). This happened in an ad hoc way, often against the official policy and recommendations of the PWD.

By the 1920s, several hundred kilometres of embankments protecting hundreds of thousands of hectares had been built (CUR, 1993). As a result of large-scale inflows of labour and capital, the area under rainfed cultivation in the Ayeyarwady Delta increased from 240,000 hectares (ha) in 1852/1853 to 3.6 million ha in 1922/1923 (Mya Than, 2000). The expansion of rice cultivation took place at the expense of inland fisheries, and came alongside significant land concentration that benefitted absentee landowners through processes of land taxation and the extension of (agricultural) credit. Following the 1930s worldwide economic crisis and the related drop in rice prices, this would eventually lay the groundwork for peasant rebellions (Adas, 2011; van Schendel, 1991).

Anticipating contemporary debates (see, for instance, the discussion on hurricane Katrina and related floods in New Orleans, and Wesselink, 2007), the desirability of building embankments came under scrutiny in 1926 due to the large-scale floods that affected both the Ayeyarwady and the Mississippi. In the case of the Mississippi, the dramatic impact of the floods was attributed to the double embanking of the river; this led to questioning the relevance of the embankments on the east bank of the Ayeyarwady, especially as these were lower than those on the west bank and had been built in a largely uncoordinated

way. There was even a proposal to destroy them, but this never happened due to the costs of compensation and land acquisition that doing so would have entailed (Volker, 1964).

Despite the debates in the mid-1920s about the desirability of building embankments on both sides of the Ayeyarwady River, the 1930s and 1940s were indeed a period when the British administration focused its effort on maintaining existing dikes and elevating the height of those built by local authorities. This was done in response to ever more acute flood events such as those recorded in 1939 and 1947 (ECAFE, 1950). If infrastructure development focused on the upper delta during most of the British period, the 1930s and 1940s also saw the construction of sea dikes in the lower delta to limit sea water intrusion and land salinisation (Volker, 1964). These dikes would later provide the basis for the polders built from the 1970s onwards (see below).

FROM WORLD WAR II TO THE 1960S: FROM FLOOD PROTECTION TO LAND RECLAMATION 'ON PAPER'

Efforts towards flood control and infrastructure development came to a halt during World War II, during which Myanmar was a battleground. This was followed by two decades during which existing flood control infrastructures deteriorated and cultivated areas significantly decreased (World Bank, 1983). The limited investments supported by the Government of Myanmar in the 1950s – rehabilitation of damaged infrastructures and building of low embankments in the lower delta to protect it from seawater intrusion (World Bank, 1974) – were made obsolete by the 1962 military coup and by the "Burmese Way to Socialism" that marked a focus on industrial development (Information Department, 1962). In the delta, land nationalisation led to the departure of the large landowners who had assumed a significant role in building and maintaining embankments; this, in turn, was followed by stagnation in the agricultural sector for most of the 1960s (World Bank, 1983).

Though the 1950s and the 1960s are characterised by little infrastructure development, the period appears still to be pivotal as the Ayeyarwady Delta started to be seen not only through the prism of flood protection but also through that of land reclamation. Several large-scale national-level planning studies were indeed conducted in the 1950s with support from US-based engineering companies (see Figure 3). The report by Knappen Tippetts Abbett Engineering Company (KTA, 1953), for instance, is a study for the "economic and engineering development of Burma" commissioned by the government to investigate the feasibility of developing dry season irrigation. Among other things, it identified opportunities to develop pump irrigation systems in the upper part of the delta and proposed closing some of the existing U-shape embankments, effectively creating polders. This study informed projects implemented from the 1970s onwards, namely the Paddyland I and II projects funded by the World Bank, and the Nyaungdone reclamation project of the 1990s (see below). In the 1960s, global knowledge networks on Southeast Asian deltas further structured themselves under the initiative of the UNESCO Humid Tropics Research Program (UNESCO, 1966) and in relation to discussions around flood control and the management of deltaic areas held under the auspices of ECAFE (United Nations Economic Mission for Asia and the Far East; now ESCAP)⁷ (see Figure 3). These discussions took the form of a series of symposiums in 1963, 1969 and 1979, which brought together researchers from the Netherlands, China and Japan and provided the natural science and engineering knowledge background that would underpin later interventions in Southeast Asian deltas, including the Ayeyarwady.

The shift from a purely 'flood control' to a 'land reclamation' narrative appeared clearly in 1969, when ECAFE presented the objectives of the regional deltas symposiums as being "to advance the principles of modern large-scale reclamation; to stimulate thought as to what could be done in the way of reclamation (...); and to stir thought into action" (ECAFE, 1969: 4), a call that was heard by major development agencies, notably the World Bank, in the 1970s and 1980s.

⁷ United Nations Economic and Social Commission for Asia and the Pacific.

THE ERA OF POLDERS IN THE LOWER AND MIDDLE DELTA: THE WORLD BANK'S INFLUENCE IN THE 1970S AND 1980s

The image of the Ayeyarwady Delta as the 'rice bowl' of Myanmar, which still pervades today (MoALI, 2015), and the objective of the government to rejuvenate it after two decades of decay, underpinned many transformations that the delta went through in the 1970s and 1980s. Agricultural stagnation in the delta had indeed led to dwindling government revenues in the 1960s (Cheng, 1968), which triggered a renewed interest in the agricultural sector in the 1970s. This 'return to agriculture' was enshrined in successive 4-year plans and in the 20-year plan entitled *Long Term and Short Term Economic Policies of the Burma Socialist Program Party* published by the Government of Burma in September 1972 (World Bank, 1983).

A greater willingness of the Burmese government to receive financial support from development partners (World Bank, 1983) made it possible to envision projects whose objective would be the construction of expensive irrigation infrastructures. Building on government initiatives that promoted low-lift irrigation pumps in the 1960s, the first of these donor-supported projects would be the so-called 'Irrigation Project'. Implemented between 1974 and 1980, it was the first World Bank project in Burma (Figure 2; World Bank, 1974). The project, implemented by the Agricultural Mechanization Department and the Irrigation Department of the Ministry of Agriculture and Irrigation, aimed at: 1) doubling the area under supplementary irrigation through low-lift pumps during the rainy season (up to 200,000 ha), and 2) upgrading existing small-scale embankments that had deteriorated (World Bank, 1974). As with most activities conducted in the delta up to that point, this project focused on its upper reaches.

However, as the idea of building polders replaced that of U-shape embankments, the attention of the government and its development partners progressively shifted towards the middle and lower delta. This happened partly because of costs (building polders in the upper delta would be technically more difficult and expensive due to larger floods and more pronounced topography), but also for political reasons. In 1974, after years of military intervention against communist and Karen groups that had found refuge in the lower and middle delta, the government declared the latter to be a 'white area', that is, a region under its control. Transforming the now insurgent-free delta into a government stronghold became a priority (Maung Aung Myoe, 1999), and reclaiming abandoned paddyland became a way to do so. Though we could not find documents making this explicit, we argue that it is no coincidence that the government's willingness to transform the delta into a stronghold via its post-counterinsurgency strategy was concomitant with the formulation of projects that would be implemented in regions that had not yet been targeted by foreign development agencies.⁸ We argue that infrastructure development, land reclamation and land allocation in the newly reclaimed area in the middle and lower delta was a way for the Government of Myanmar to reassert control over the region.

Partly inspired by studies that had been conducted in the 1950s (for example, KTA, 1953), and following the large-scale floods of 1974, the appraisal report of the Lower Burma Paddyland Development Project (1976-1980) of the World Bank states that

the quickest and most inexpensive way of increasing rice production in Burma is to protect farm land from flooding and salt water intrusion and reclaim the abandoned paddyland in Lower Burma by construction of low embankments around islands with drains and sluice gates (World Bank, 1976: 8).

⁸ Until 1973, official communication between the World Bank and the Government of Myanmar reveals that the latter considered the low-lying sections of the country (i.e. the delta) as 'saturated' with rice production, hence offering little scope for (agricultural) development; see, for instance, the declassified office memorandum dated 26 September 1973, which reports on a meeting between Robert McNamara (the then president of the World Bank) and the Ministry of Planning and Finance of Burma.

At the core of the project was the transformation of the 'islands' found between river streams into 'polders' by the Irrigation Department. This was to be done through the rehabilitation and closure of existing low-height embankments, the construction of drainage networks (that could also be used for low-lift irrigation and navigation within the polders) and of sluice gates at the lower reaches of the polders. To keep the project 'inexpensive',⁹ pumping rainfall out of the polders was not considered in the project's design, meaning that the project could only be implemented where river flows were lower and natural drainage possible, that is, in the lower and middle reaches of the delta (World Bank, 1983). In 1978, following the same model, the World Bank launched a *Paddyland Development II Project*, implemented between 1978 and 1988 (World Bank, 1978, 1991). A Paddyland III project was prepared in the mid-1980s but was abandoned following political turbulence (the 1988 military coup; see Figure 2), as well as because of the withdrawal of major donors and a "projected weakening of international paddy price" (see World Bank, 1991: 1). The area to be reclaimed for rice production under the Paddyland III project (see Figure 1) is still considered today to have a high development potential. What is new, however, is that the area is no longer talked about in terms of agricultural development, but rather in relation to Yangon's rapid economic and demographic growth; it is considered to be an area where the largest city of Myanmar could further extend. This discursive shift is not neutral: explicitly linking Yangon to the delta contributes to establishing the latter as an 'urban delta' and to anchoring it in global knowledge and policy initiatives (see below).

The paddyland projects were shadowed by significant issues related to land allocation, including the fact that most of the land reclaimed actually benefitted state farms and cooperatives mainly comprising government employees and not the smallholders who had been displaced by the construction work (World Bank, 1986). Further, their (secondary) objective – developing dry season cultivation through low-lift pumping from the internal drainage network of the polders – was not achieved. Despite this, the paddyland projects were evaluated as satisfactory by the World Bank (World Bank, 1991). Successive paddyland projects have left an indelible mark on the delta landscape: by the late 1980s, about 20 polders had been built, protecting about 150,000 ha (World Bank, 1976, 1978, 1991; see Figure 1). The resulting increase in rice area and the higher paddy yields are closely related to the fact that these projects were implemented parallel to another large-scale initiative of the Government of Burma – the Whole Township Rice Production Program (WTRPP) of 1978-1986 – and at the same time as other agricultural projects supported by the International Rice Research Institute (IRRI), the Food and Agriculture Organization (FAO), the United Nations Development Programme (UNDP), the Japan International Cooperation Agency (JICA), the Asian Development Bank (ADB), and the World Bank itself (through the Seeds 1, 1977-1984 and Seeds 2 1986-1992 projects) (see Figure 2).¹⁰

Infrastructure development in the 1970s and 1980s took place against the backdrop of hydrological and engineering studies that aimed at providing a knowledge base to support planning and to rationalise investment in the delta. Between 1977 and 1981, the engineering firm of Sir William Halcrow & Partners Ltd was commissioned to conduct a study of the hydrology of the delta in which the Hydraulics Research Station of Wallingford (United Kingdom) was also involved (see Figure 3). The study concluded that the approach adopted in the Paddyland I and II projects – the construction of small independent polders in the lower and middle delta, coupled with low-lift irrigation systems – was particularly adapted to the delta context and economically sound (Sir William Halcrow and Partners, 1982). It also recommended investing in medium- and large-scale pumping irrigation systems in the upper reaches of the delta. Though very much focused on engineering, this is the first study we found that mentioned that the

⁹ The project still amounted to US\$54 million, of which US\$30 million was a grant from the World Bank. The Paddyland II project had a similar budget of US\$56 million, of which US\$34.5 million was a grant from the World Bank (World Bank, 1976, 1991).

¹⁰ The WTRPP was the government flagship programme of the time. Its characteristics were those of a Green Revolution programme aimed at introducing improved varieties and adapting them to local conditions, and facilitating access to fertilizers. Its extension component – framed in terms of 'production camps', 'mass participation', and 'strong leadership of people representatives' – reflects the socialist economy of the time (Agricultural Corporation, 1983).

construction of water control infrastructures could have a detrimental effect on capture fisheries, an economic sector already significantly negatively impacted by past infrastructure development.

The World Bank was not the only major development partner of the Myanmar government at the time; the latter requested JICA to conduct a study for an Irrawaddy Basin Agricultural Integrated Development Project (IBAI DP) (JICA, 1980). JICA focused on the upper Ayeyarwady Basin but also included recommendations regarding the development of pump-based irrigation for double cropping and the construction of flood control infrastructures and small reservoirs in the upper delta. These were very much in line with the recommendations of Sir William Halcrow and Partners (1982). Some of these projects would be implemented without external support by the Government of Myanmar in the 1990s (see next section).

DRY SEASON IRRIGATION AND LAND ALLOCATION: GOVERNMENT PRIORITIES IN THE 1990S

By the late 1980s, the Ayeyarwady Delta had come to be closely associated to polders and supplementary irrigation during the rainy season. In the 1990s, following the military coup of 1988 and the subsequent isolation of the country from the international community and its resources, the delta would be mostly seen through the prism of its potential for rice and pulse cultivation during the dry season. This happened as the military government exerted its power through further control over the agricultural sector, including through a monopoly on rice exports, the re-establishment of the paddy procurement system at below market price (which had been introduced under the socialist government in the 1960s), and forced labour for the construction of irrigation infrastructure (Thawngmung, 2004).

Control over the agricultural sector happened through a nationwide extension-based programme, the 'summer paddy programme' launched in 1992 and implemented until the early 2000s. It promoted new rice varieties and cropping practices, made rice cultivation in the dry season compulsory in designated areas, and was implemented alongside the development of medium-sized infrastructure, namely 1) sluice gates to be used for tidal irrigation in the middle part of the delta,¹¹ 2) small reservoirs in the upper reaches of the delta (both implemented by the Irrigation Department), and 3) collective pumping schemes, also in the upper reaches of the delta (implemented by the Water Utilization Department) (Aye Myint, 2012). Today, there are more than 200 sluice gates in the delta, as well as 17 pumping schemes in the Ayeyarwady division and another 23 in the Yangon division (interview data with officials IWUMD department).¹²

Despite the political rupture of the late 1980s, infrastructure development in the 1990s displayed strong continuity with the earlier periods. Indeed, many of the projects implemented by the military government of Myanmar had been identified in diverse studies conducted in the late 1970s and 1980s (for instance Sir William Halcrow and Partners, 1982; World Bank, 1983; Royal Haskoning DHV, 1988); many new polders were built by closing existing open embankments, and many sluice gates were built on those polders. Another illustration of this continuity is the large-scale reclamation project of the Nyaungdone Island, which epitomises the government vision of the delta (see Box 2). Rather than differences in the type of infrastructure, it is the way these were envisioned that differed. For the military government, water control and irrigation infrastructures served to open up new agricultural frontiers and were built alongside far-reaching land reforms. The Land Reclamation Policy of 1991 indeed created the conditions for private companies with close relationships to the military regime to enter the agricultural

¹¹ Tidal irrigation uses the tide to 'move' freshwater for irrigation. In the rainy season, sluice gates can be used to control floods and divert fresh water in the command area. In the dry season, at high tide, freshwater levels in the river increase and the same sluice gates can be opened to supply water to the command area. Depending on the location, major canals can be elevated (allowing for gravity irrigation) or act as drains (irrigation, then, requires low-lift pumps).

¹² The Irrigation and Water Utilization Management Department (IWUMD), under the Ministry of Agriculture, Livestock and Fisheries, was created in 2016 by merging 1) the Irrigation Department (in charge of large infrastructures – dikes and reservoirs – construction and maintenance), and 2) the Water Utilization Department (primarily in charge of overseeing pumping schemes).

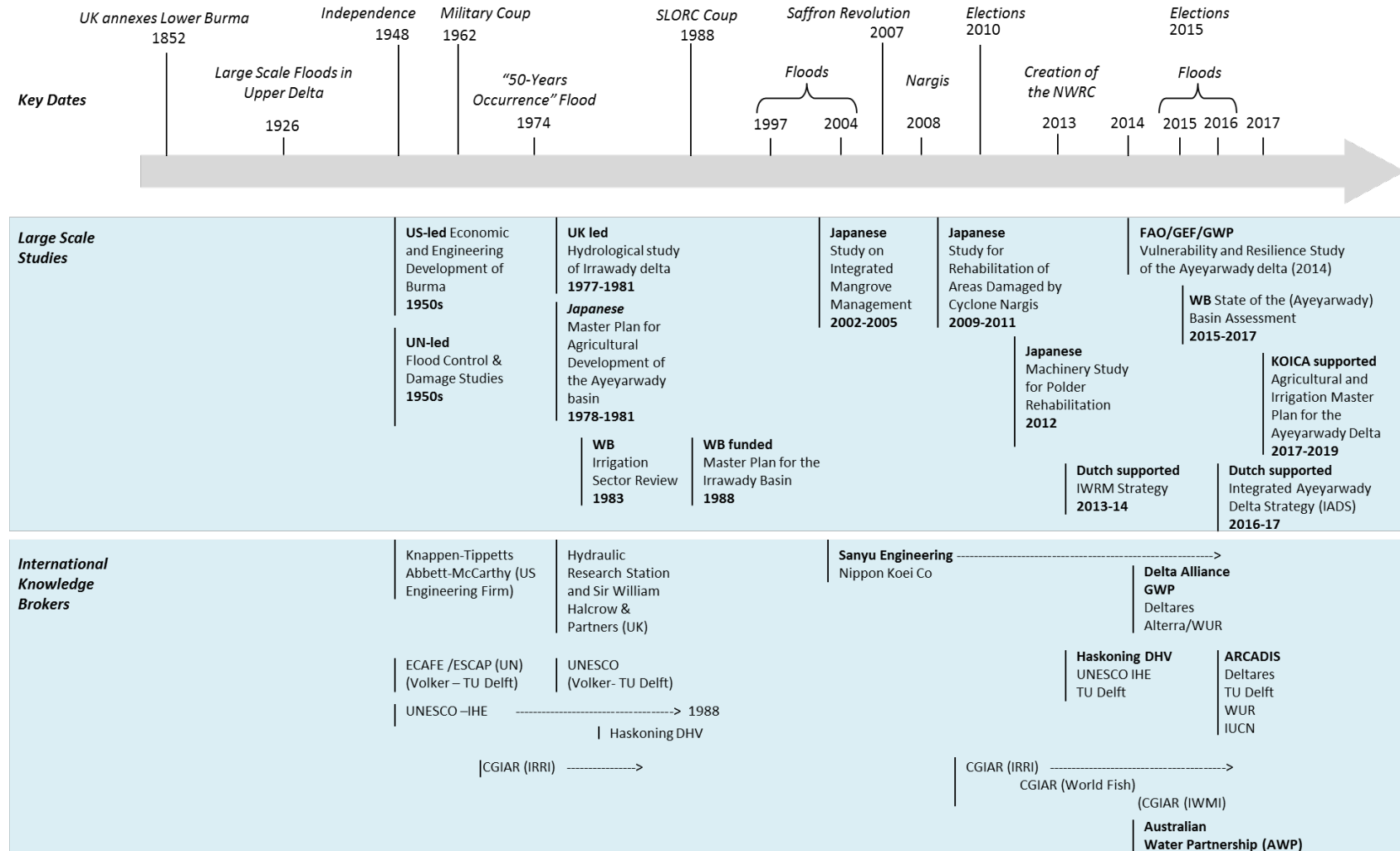
Box 2. The Nyaungdone reclamation project: Between continuity and change

Nyaungdone Island is located south of the first division of the main Ayeyarwady River in the northwest of Yangon (see Figure 1). In the late 19th century, an intense debate over the desirability of a double embankment on the Ayeyarwady River and the impact that an embankment of Nyaungdone Island would have on the productive fisheries of the area lasted several decades. In the 1920s, the British administration finally built a U-shape embankment to protect the northern part of the island. The potential to further reclaim the area was highlighted by KTA (1953) but was not taken up until the mid-1990s. In the 1970s and 1980s, the World Bank indeed considered that the costs in terms of potential losses in fisheries, wildlife habitats, and changes in the hydrological regime of the creeks were too high compared to an agricultural potential that would be, in itself, difficult to harness given the low-lying nature of the land and the presence of several metres of water, year round, on some parts of the island. The military government of Myanmar launched the Nyaungdone Island Rehabilitation Project in 1994/1995 as part of the Lower Burma Land Reclamation Project Phase II; it was framed as a tidal irrigation project (MoAI, 2002; Aye Myint, n.d.). The scale of the project (20 km of embankments, more than 250 km of drainage and irrigation canals and 100 km of roads, 10 major sluice gates, the protection and reclamation of 65,000 ha) made it one of the flagship programmes of the Irrigation Department. It was under the supervision of a senior irrigation engineer who had been the first Burmese graduate from UNESCO-IHE in the late 1950s, which shows the historical depth of the relationship at play today between Myanmar and the Netherlands.

The case of Nyaungdone illustrates many of the issues related to land reclamation and water infrastructure development in the Ayeyarwady Delta in the 1990s. It illustrates the scale of land redistribution dynamics that played out during the decade as the government promoted large-scale entrepreneurial farming. First, areas that were 'newly reclaimed' were allocated to military commercial entities, private companies, and local large-scale entrepreneurs, regardless of prior use including the fact that such land supported productive small- or medium-scale capture fisheries. In Nyaungdone, the Myanmar Billion Group (MBG), for instance, initially received 14,000 out of the 25,000 ha that had been classified as virgin land under the project (World Bank, 1999). Following this initial land distribution, and until the mid-2000s, further land reallocation took place. Reallocations were motivated by the fact that MBG did not reclaim the entire area it had been allocated; the reallocations benefitted private entrepreneurs, companies and village headmen who had strong links to the military regime. Second, in areas devoted to summer paddy cultivation (which was not subjected to the procurement system), the government established targets in terms of cultivated area and production. Where farmers did not cultivate paddy or could not reach the production targets, the government could seize the land and reallocate it to large-scale private entrepreneurs with political connections (Thawngmung, 2004; see also Warr, 2000). This happened in Nyaungdone where farmers never really engaged in double rice cultivation due to combined drainage and water availability issues; while some areas still suffered from recurrent flooding during the rainy season, others suffered from low water availability in summer even though the government had provided low-lift pumps and subsidised diesel to some farmers.

The 'failure' of smallholders to cultivate summer paddy led to further dispossession, followed by land use changes and – with or without legal backing – the construction of fish ponds by entrepreneurs, often at the expense of capture fisheries. The conversion from paddy fields and open wetlands to fishponds raised issues in terms of water management and triggered social conflicts. The 2012 election opened a window of opportunity for smallholders and small-scale fishermen to reclaim their prior rights, and some reallocations have indeed happened, though often after long and cumbersome lawsuits. The earlier patronage networks are still pervasive, however, and the local elite and entrepreneurs have often managed to use the 2012 land laws, which consists of registering and distributing land rights, to their benefit.

Figure 3. Main studies and international knowledge brokers involved in the Ayeyarwady Delta



Source: The Authors

sector. Rather than smallholders, it is these large-scale agro-entrepreneurs that were meant to be pivotal in achieving the government's ambition to reclaim 7 million ha for double cultivation. Patronage networks in which village headmen played a crucial role progressively structured themselves, at the expense of smallholders and small-scale capture fishermen. This happened particularly as part of the Lower Burma Land Reclamation Project Phase I and II (Mya Than, 2000), the Tapping the Under-Water Treasures programme that allocated wetlands to agro-business companies with the explicit purpose of converting them into paddy fields (San Thein et al., 2018), and the 'One Hundred Ponds – One Hundred Farms' initiative, which was the first coordinated attempt at promoting aquaculture in the delta.¹³

In parallel to infrastructure development that was under the remit of the Ministry of Agriculture and more specifically the Irrigation Department, the Ministry of Forestry (now the Ministry of Environment, Conservation and Forestry) also played a key role in shaping the landscapes of the lower delta where large patches of reserved (mangrove) forests can be found. Owned by the state, these are under the management of the Forestry Department and have long been exploited to supply wood and charcoal to Yangon (JICA, 2005). Concerns over rapidly decreasing forest cover started to emerge in the mid-1990s, and the government launched mangrove conservation/reforestation projects that were largely aimed at limiting economic use of the mangrove forests by local communities. The 1995 Community Forestry Instructions makes it legal for local communities to engage in forest plantation and conservation activities but is rather restrictive regarding what Community Forestry members can do (ibid). In the late 1990s and early 2000s, however, multiple initiatives linking mangrove restoration and community management were implemented with the support of the UNDP and FAO and later JICA. Between 2002 and 2005, JICA conducted a study and pilot project on "integrated mangrove management through community participation in the Ayeyarwady Delta in the union of Myanmar" (Figure 3). This would lay the groundwork for an eponymous and more ambitious six-year project, initiated in 2006, which was significantly reoriented after Cyclone Nargis when the place given to mangroves for delta management grew in importance (JICA, 2013; see below).

AFTER NARGIS: THE MAKING OF THE AYEYARWADY AS A GLOBAL DELTA

A post-emergency rush: The delta's vulnerability comes to the fore

Myanmar, and more specifically the Ayeyarwady Delta, reappeared on the radar of the international community following Cyclone Nargis, which hit the area in May 2008. Nargis is widely presented as having caused "unprecedented destruction, similar to that experienced by the areas worst affected by the 2004 Indian Ocean Tsunami" (TCG, 2008); it caused an estimated 138,000 deaths, affected 2.4 million people (van Driel and Nauta, 2014), caused flooding and loss of more than 700,000 ha of paddy fields (about 65% of all paddyland in the delta) and the death of more than 120,000 draught animals as well as several hundreds of thousands of other livestock (FAO, 2008).

Discussing the impacts of Cyclone Nargis on the delta and its population is beyond the scope of this paper. What matters to us here is that Nargis inspired a sense of urgency to act as it "tragically (...) demonstrated the vulnerability of the Ayeyarwady Delta" (see IADS, 2018). Our objective here is not to negate the vulnerability of people living in the delta; we merely highlight that discourses and narratives are not neutral, they provide the context that justifies or legitimises future intervention. In this case, the discourse on the vulnerability of the Ayeyarwady Delta and the losses incurred set the stage for two types of strategies and projects, some aiming at disaster risk management and others at enhancing the livelihoods and resilience of the delta population.

¹³ Private companies contributed to the cost of land reclamation in exchange for receiving it in 'concession'. They also benefitted from other advantages such as free provision of public works (by the Agricultural Mechanization Department), land tax exemption, import permits, etc. (Warr, 2000).

In the immediate post-NARGIS context, disaster risk management strategies remained biased towards infrastructure works and the rehabilitation of polders and embankments, notably under a JICA-funded project entitled *The Preservation of Farming Area for Urgent Rehabilitation of Agricultural Production and Rural Life in Areas Affected by Cyclone Nargis in the Union of Myanmar* (JICA, 2011; see Figure 3). Up to 15 polders had been rehabilitated by 2011 though the quality of the work has been debated (JICA, 2012); JICA committed further funds to building the capacity of the Irrigation Department and providing the equipment needed for rehabilitating further infrastructure.

The notion of livelihoods and resilience would, on the other hand, be embodied in the multi-donor Livelihoods and Food Security Fund (LIFT).¹⁴ LIFT was set up in 2009, is managed by the United Nations Office for Project Services (UNOPS), and is almost exclusively implemented through national and international civil society organisations (as were the UN projects implemented during the military regime).¹⁵ LIFT started its operations in the delta in 2010 with a one-year 'livelihood rehabilitation program'; it has been active in the region since then through different programmes called Delta 2 (2011-2014) and Delta 3 (2015-2018). These are aimed at addressing broad agricultural challenges such as low agricultural productivity, the lack of good quality seeds, and the inadequacy of value chains, but also issues of inequality in land access, out-migration, and the low nutritional status of the delta population (LIFT, 2014, 2015). Initiated when the country still faced international sanctions, and though it is recognised at the highest level of policy making, LIFT has until recently had very little contact with line ministries staff or even with the regional government of the Ayeyarwady Region (interview data). Organisations involved in the successive LIFT Delta programmes are little involved in current strategic (delta) planning and water policy reforms, but they are part and parcel of a far-reaching network of actors upon which hinges the establishment of the Ayeyarwady Delta as a global delta (see below).

Losing sight of the delta? Support towards national water policy making

Nargis was not the only striking event that Myanmar witnessed at the turn of the last decade. Following the 2012 by-elections, most countries lifted prevailing sanctions towards Myanmar; this translated into a sudden arrival of bilateral and international donors in all sectors of the economy to support national – not delta-specific – initiatives.

In the water sector, this translated into renewed efforts towards the elaboration of a water policy framework inspired by the notion of Integrated Water Resources Management (IWRM). The concept of IWRM had first been introduced in the 2003 Myanmar 'Water Vision' whose development was piloted by the Ministry of Agriculture and Irrigation, supported by UNESCAP and FAO (Ti and Facon, 2004). After almost a decade, during which little happened, efforts towards the elaboration of a water policy were reignited in 2013, this time steered by the Directorate of Water Resources and Improvement of River Systems (DWIR) under the Ministry of Transport (MOT). Given the importance of water in their respective foreign policies, the Dutch and Australian governments supported this policy process, resuming a long history of collaboration.¹⁶

In May 2013, and following a year of intense discussions, a Memorandum of Understanding (MoU) with a specific focus on IWRM was signed between the Minister of Infrastructure and the Environment of the Netherlands and her counterpart, the Minister of Transport of the Myanmar government (the MoU was extended in January 2016; see Netherlands Water Partnership and the Netherlands Embassy in Yangon, 2017). The MoU laid the groundwork for Royal Haskoning DHV, a Dutch private company, to

¹⁴ Livelihoods and Food Security Fund, www.lift-fund.org.

¹⁵ LIFT receives funding from the European Union, UK-AID, Australian Aid, the Swiss Agency for Development and Cooperation (SDC), USAID, the Government of Canada and Irish Aid.

¹⁶ The Swedish and Norwegian governments are also currently funding IWRM-inspired projects.

coordinate a strategic study on Integrated Water Resources Management (GoM and GoNL, 2014).¹⁷ The study involved several Dutch organisations that would later play a key role in subsequent delta initiatives (see below) and informed the concomitant work of the National Water Resources Committee (NWRC).¹⁸ The NWRC, set up in July 2013, indeed approved the Myanmar national water policy in March 2014 (GoM, 2014). The policy was prepared by a so-called 'expert group' made up partly of retired civil servants, some of which have ties to international organisations and networks such as the United Nations, the World Bank or the Global Water Partnership.

In 2015, the Australian government, which had supported research and capacity-building initiatives in the Myanmar water sector for several years through its Greater Mekong Water Resources Program, also signed an MoU on IWRM with NWRC (the MoU was further extended in December 2018). The MoU governs activities that are implemented in the framework of the Australian Water Partnership (AWP). The AWP is an international cooperation initiative of the Department of Foreign Affairs and Trade (DFAT),¹⁹ and brings together more than 150 Australian organisations involved in the water sector (universities, civil society organisations, private companies and state agencies). It is described as following a 'demand-led model' and as being an "effective mechanism to connect requests for assistance from governments internationally through the Department of Foreign Affairs and Trade to Australian water sector expertise" (<https://waterpartnership.org.au>). In Myanmar, AWP funded more than 20 organisations, some of which supported the implementation of the World Bank – funded Ayeyarwady Integrated River Basin Management (AIRBM) project implemented under the auspices of NWRC. Australian organisations for instance contributed to two basin-wide studies under the AIRBM project: the Ayeyarwady State of the Basin Assessment (SOBA) (HIC, 2017) and the Ayeyarwady Basin Exploratory Scoping Study (BESS) (Foran et al., 2019).

Recentring on the Delta: A Dutch story?

As ever more actors started to be involved in the Myanmar water sector, and as the World Bank took centre stage through the AIRBM project,²⁰ the Dutch government, cognisant of its limited financial means,²¹ refocused its activities in the delta to be in line with its International Water Ambition (see above), and aimed at building strategic alliances with other actors. Their primary interest in the delta was already evident in the 2014 IWRM Strategic Study, whereby the second sentence reads as follows: "[T]he fullest possible use has been made of insights into *delta* management, IWRM and adaptive water management as developed in the Dutch *delta* programme and elsewhere in the world" (GoM and GoNL, 2014: 10). (emphasis added)

The recentring of the bilateral cooperation on the Ayeyarwady Delta was enacted in early 2016 when the MoU between the transport ministries of both countries was extended for another three years (Netherlands Water Partnership and the Netherlands Embassy in Yangon, 2017). As part of this MoU, and positioning itself as a knowledge partner (in contrast to development partners who are financing

¹⁷ Royal Haskoning DHV has long been involved in Myanmar. In the late 1980s, it conducted the World Bank feasibility study for the improvement of navigation on the Irrawaddy and Lower Chindwin Rivers (Royal Haskoning DHV, 1988). Having stopped its operation during the military regime, it re-entered Myanmar in 2012 and opened an office in Yangon in 2013.

¹⁸ The NWRC is chaired by the vice president of Myanmar; the Minister of Transport is the vice-chair and the DWIR assumes the secretariat of the NWRC.

¹⁹ The Australian Water Partnership was established in 2015 by DFAT with a total budget allocation of about US\$30 million in two successive four-year grants (2014-2018 and 2019-2023). See The Australian Water Partnership (<https://waterpartnership.org.au>).

²⁰ The AIRBM is a US\$100 million project taking place over five years. It is the first large-scale project the World Bank has undertaken since it stopped operating in Myanmar in the late 1980s (the concept note of the project was published in April 2014). The project offers opportunities of contracts for a wide range of organisations (research institutes, universities, consulting and engineer firms, etc.). In the SOBA study alone, 25 organisations and more than 100 people were involved (HIC, 2017).

²¹ The 2013 MoU earmarked a budget of about €3 million over three years (interview data).

infrastructure development), the Dutch government continues to invest in several capacity-building programmes alongside and in collaboration with the Australian government. The 'Young Water Professionals' initiative, for instance, provides the opportunity for young engineering graduates or government staff (particularly from the Irrigation Department and the DWIR) to be trained abroad for a year and then further mentored when they come back to Myanmar and contribute to water-related projects such as the AIRBM.

The flagship initiative under the 2016 MoU would be a project for the development of an Integrated Ayeyarwady Delta Strategy (IADS), justified on the grounds that:

Tragically, it [Nargis] demonstrated the vulnerability of the Ayeyarwady Delta to extreme weather conditions which are generally expected to occur more frequently in the future due to climate change (...) At the same time, socio-economic development in the Ayeyarwady Delta is increasing the pressure on the Delta's land and water resources (...) [S]trategic choices will increasingly have to be made (IADS, 2018: iii).

The IADS was implemented by a consortium of Dutch consulting companies and research organisations (led by Arcadis NV) together with experts from the National Engineering and Planning Services (NEPS), a Myanmar company set up in 1998 by former civil servants who are also current members of the Expert Group of the NWRC, and IUCN-Myanmar. It was presented as "an important new step in the cooperation between Myanmar and the Netherlands, in particular because of the extreme importance and vulnerability of the Ayeyarwady Delta and the national and international experience of the Dutch experts in Adaptive Delta Management" (Arcadis, 2016b).

The IADS puts forth its connection to the Dutch Delta Approach and is presented as drawing on the lessons learned during the elaboration of the Mekong and Bangladesh Delta Plans, to which some of the members of the IADS team contributed (Netherlands Water Partnership and the Netherlands Embassy in Yangon, 2017; IADS, 2018). If the IADS claims such a connection it also distances itself from these past exercises, confirming the analysis of Zegwaard et al. (2019) that the Dutch Delta Approach is less generic than presented in official brochures, and should be seen as continuously evolving when confronted to different deltas and the actors involved in shaping them.

Central to highlighting the specificity of the IADS were repeated statements of team members who stressed the limited time (a one-year project), small budget (€0.5 million), and lack of data when compared to the Mekong and Bangladesh Delta Plans.²² These statements served to justify the claim that the IADS "does not provide a list of specific investment opportunities (...) The development of a detailed delta plan requires more data, dialogue, and time" (IADS, 2018: iii), but that it remains focused on formulating a "vision (...) for a safe, prosperous and sustainable delta with a vibrant diversified economy and ecology that are resilient to salinization, floods and water shortage" (IADS, 2018: iv). Still, concerns about action and its evaluation were not totally brushed aside. On the contrary, they underpinned the translation of this vision into a set of five generic objectives upon which the realisation of the vision hinges: 1) ensure safety from floods, 2) develop climate-smart agriculture, 3) improve water and sanitation, 4) conserve and restore ecosystems and promote their sustainable use, and 5) develop effective institutions and equitable governance for delta management and planning. These objectives further provided a framework according to which 90 measures have been assessed and qualitatively evaluated. The most promising measures – keeping in mind overall consistency and coherence – have then been grouped thematically according to five strategic development directions; together they constitute what is described as a "most promising strategy" for achieving the delta vision (IADS, 2018). The final stylised representation of this 'promising' strategy shows 19 measures/ideas pooled in 4 categories (IADS, 2018: 56).

²² The IADS consortium has also elaborated a 'Delta Atlas', the most comprehensive attempt at collecting delta-related data in a single repository since the studies conducted in the early 1980s.

Many of these 19 measures/ideas are in fact phrased differently from any of the measures identified in the 90-strong exhaustive list initially drawn up by the IADS team. Though they largely overlap in terms of content, they are noticeably broader in scope. This is not only a question of formulation; we argue that it also illustrates the interpretative flexibility that is inherent to strategic exercises such as the IADS. The generic nature of the recommendations and measures identified by the IADS final document could be seen as the result of the limited timeframe and funding devoted to the project, a consideration that our interviewees repeatedly highlighted.²³ Without denying that this has played a role, we argue that there is more to it. Through such genericity – and echoing a study a few years earlier on the vulnerability and resilience of the Ayeyarwady Delta that was conducted by two Dutch research organisations under the auspices of the Delta Alliance (van Driel and Nauta, 2014) – the IADS actually shapes the Ayeyarwady Delta as a global delta. In doing so, the IADS offers a platform for multiple actors to engage with/in the delta and becomes, in turn, itself, a boundary object in its own right. While this process of enacting a global delta was largely steered by the Dutch IADS team, this could not have happened without relays in Myanmar and without selected individuals who played an active role in establishing the delta's place on the political agenda. In the rapidly evolving (political) landscape of Myanmar this can change rapidly, as stressed by one of our interviewees who, when talking about some of his counterparts, stated:

They are survivors. They are not believers. They get involved because they have an agenda (...) The question is whose agenda [our work] fits? The VP for instance, if he endorses it, it is because he sees it as beneficial [for himself, politically] (...) (interview data).

That the IADS also served as a way to create a coalition of actors that would support future interventions in the delta is maybe best exemplified by the attempts at linking the IADS with the larger AIRBM project; these attempts cannot be understood without looking towards Vietnam and the statements of high-ranking Dutch officials that the Mekong Delta Plan allowed the leveraging of World Bank support towards practical projects grounded in an integrated approach (to delta management) (Netherlands Water Partnership and the Netherlands Embassy in Yangon, 2017: 13).²⁴ The opportunities for collaboration between the World Bank and the Government of the Netherlands are clearly highlighted in the AIRBM project appraisal document (World Bank, 2014), while the idea of signing an MoU between the Government of Myanmar, the World Bank, and the Government of the Netherlands "for cooperation in the development and implementation of the Integrated Ayeyarwady Delta Strategy" was flagged when the IADS was launched (Arcadis, 2016a). To increase the chances of future linkages, the IADS team noted clearly that their approach was informed by guidelines that had been developed as part of an IWRM planning guidelines study funded by the World Bank in the Philippines (IADS, 2018; World Bank, 2016). They also made sure that individuals involved in managing the AIRBM project participated in their own consultation. The final visualisation of the IADS's most promising strategy also highlights the importance of understanding the delta in the broader context of the Ayeyarwady basin. In a way that was similar to what was at play in Vietnam at the same time, the idea was that (some of) the 'quick win/no regret' measures identified by the IADS could be selected as activities for priority investments under the AIRBM project. In addition, the work conducted and the knowledge acquired as part of the IADS could feed in to the SOBA study. Several of our key informants, however, mentioned that differences in timeline, the methodologies adopted and the implementation challenges faced by both projects made it impossible for some of the quick win/no regret measures identified by the IADS to be funded under the World Bank

²³ We thank one of the reviewers for also bringing this to our attention.

²⁴ The current 'Mekong Delta Integrated Climate Resilience and Sustainable Livelihoods Project', launched in 2016 by the World Bank, is indeed said to be partly inspired by some of the results and recommendations of the Mekong Delta Plan (interview data).

project (interview data).²⁵ Some of these are now being funded directly by the Dutch government while an IADS – Phase B is currently being implemented by a subset of organisations that were involved in the IADS – Phase 1. This Phase B is focused on (modelling) capacity building and the development of a numerical simulation model for the hydro-morphological system of the delta.

The establishment of a coalition that would support the integrated development of the Ayeyarwady Delta is hence still in the making, but in Myanmar development does not wait... Many projects are currently underway in the delta. The Korean Development Aid Agency (KOICA) has initiated a project for a *Comprehensive Agriculture and Irrigation Development Master Plan in the Ayeyarwady Delta Region, Myanmar* (Mohinga, 2017); JICA and the Norwegian government are supporting community-based mangrove rehabilitation projects; and the Government of Myanmar is currently negotiating with China to initiate projects to raise the height of embankments in the upper delta (interview data). These projects take place against the background of far-reaching land reforms triggered by the enactment, in 2012, of the Farmland Law and the subsequent Vacant, Fallow and Virgin Lands Management Law. These laws are indeed bringing about significant changes, given the past history of land reclamation and allocation in the delta. Aiming at formalising land use rights, these laws have notably opened windows of opportunity for political actions and grassroots movements that question former land confiscation and lobby so that the new laws will not only benefit wealthier individuals (see, for instance, Boutry et al., 2017 for a detailed study of the limits and opportunities of recent land reforms).²⁶

CONCLUSION

The analytical objective of this paper was to highlight, and reflect on, the emergence of what we called a 'global delta'; an entity that would be of worldwide relevance, and which would lend itself – and even require – generic research and governance approaches and their critique. We argue that what is at play is not only discursive framing of delta dynamics; by using the concept of 'boundary object' (Star and Griesemer, 1989), and through a case study of water infrastructure and policymaking in the Ayeyarwady Delta, we show how the 'global' and the 'grounded' are constitutive of each other. While the concept of the global delta strongly shapes current understandings of the Ayeyarwady Delta, the specific development interventions and knowledge generation dynamics that the delta has witnessed over time, in turn, 'give body' to this global delta. In other words, the Ayeyarwady Delta 'becomes' the global delta and vice versa.

Our 150-year historical analysis of water infrastructure development and policymaking provides insights on how this happens. Notably, it shows 1) that infrastructure development in the Ayeyarwady Delta shares many similarities to that of other deltas of Southeast Asia, and 2) that the delta has always been enmeshed in global networks and, as such, has been partly shaped by outside events and foreign actors despite the political turmoil the country went through. Indeed, large-scale water infrastructure development dates back to the mid-19th century and has been driven by two key concepts, that of 'flood protection' and 'land reclamation'; these proved to be also pivotal in shaping the landscapes of other deltas in Southeast Asia (Biggs, 2010; Molle and Tuân, 2006). First focused on flood protection, infrastructure development consisted of the construction of embankments in the upper delta during the

²⁵ The discussion on linking the IADS and the SOBA exercise partly revolved around the need for ensuring that modelling tools and results obtained as part of the IADS and AIRBM projects would be consistent with each other. As no modelling activities were conducted as part of the IADS, the discussion stopped. Arcadis, however, piloted one of the sub-components of the SOBA – the organisation of multilevel stakeholder consultations. Such stakeholder consultations served to extend the knowledge base Arcadis had acquired on the delta through the few workshops they had organised with government officials as part of the IADS project (interview data with IADS staff).

²⁶ In the delta, significant land reallocation is taking place. Areas where land use rights remain actively contested include wetlands that were reclaimed in the 1990s/2000s but which have not been, or have only partly been, converted into farmland or aquaculture ponds (see Box 2), and polders where land allocation was carried out in haste and without transparency following the 1988 military coup.

British period. The two decades after World War II saw little investment, after which infrastructure then 'moved south' towards the middle and lower delta, where polders were built in the 1970s and 1980s primarily with the support of the World Bank. The focus on land reclamation was further stressed in the 1990s and early 2000s when the Government of Myanmar exerted its power through, among other actions, increasing control over the agricultural sector and land allocation processes for the benefit of private companies and individuals with links to the military regime, and at the expense of smallholders and the capture fishery sector. Flood control (in the context of disaster risk management) then came back on the agenda following Cyclone Nargis in 2008; today, the delta tends to be seen through broader discussions that relate to the foreseen development of the Ayeyarwady basin as a whole and climate change trends that serve to highlight its vulnerability (Table 1). This infrastructure development pathway did not take place in isolation and can be related to far-reaching knowledge and development networks.

Table 1. At the interface: influencing, framing and building infrastructure in the Ayeyarwady Delta

Period	Issues to be addressed (vision of the Delta)	Major actors	Potential influences and reference points	Types of actions
British Empire	Flood protection; rainy season rice cultivation	Public Works Department; district officers	Mississippi floods	Construction of embankments (roads and dikes)
1950s 1960s	Flood protection	Government of Burma		Limited rehabilitation of existing embankments; low-lift pumping schemes
1970s 1980s	Land reclamation; flood protection	World Bank; JICA	UN (ECAFE; UNESCO)	Polders
1990s to mid-2000s	Land reclamation for dry season irrigation	Military government of Myanmar	Engineering and hydrology studies of the earlier decades	Tidal irrigation projects and sluice gates; pumping schemes
2008-2012	Disaster risk reduction	Government of Myanmar; UN system; NGOs	Cyclone Nargis	Housing and shelter construction; mangrove plantation; reconstruction of damaged infrastructures
From 2012 onwards	Integrated and adaptive management; capacity building	Dutch cooperation; World Bank; JICA; KOICA; Chinese Aid	Delta 'plans' and 'strategies'; IWRM	Elaboration of policy documents; polder rehabilitation; mangrove plantation

The debates around the Mississippi floods in the 1920s, for instance, partly influenced the construction of embankments in the upper Ayeyarwady Delta at the time; the scientific discussions over the management of deltaic areas conducted under the auspices of ECAFE and UNESCO in the 1960s inspired the construction of polders in the 1970s and 1980s, even though they took place at a time when Myanmar was relatively isolated; projects implemented during the 1990s found their roots in studies that had been conducted by international consultants as early as the 1950s, and these projects have often consisted in extending/upgrading existing infrastructure, illustrating the 'infrastructural lock-in' identified by Wesselink et al. (2015); and, finally, the recent Integrated Ayeyarwady Development Strategy supported by the Government of the Netherlands is a recent and striking illustration of the fact that the Ayeyarwady Delta is embedded in far-reaching knowledge and development networks.

We analysed the IADS in relation to recent efforts to export the Dutch Delta Approach (NWP, 2014; Ministry of Infrastructure and the Environment of the Netherlands, 2016) with the concept of the global delta in mind. We see the IADS not only as contributing to, but also aiming at, shaping the global delta as a boundary object. The elaboration of a 'delta vision', and the identification of a series of measures to support it, are among the many outcomes and objectives of exercises such as the IADS. Perhaps more significant is the setting up of a supportive coalition of actors (including Dutch companies) who can finance and implement some of these measures. As stressed by Hasan et al. (2019) in their analysis of the making of the Mekong Delta Plan, it is about creating *interessement*.

So what if, after all, this is what it takes to build a sustainable (delta) future? A first point of tension relates to the fact that what 'makes' a sustainable delta future differs from one stakeholder to another; despite claims of far-reaching consultation, many strategic delta exercises developed to date have actually been drawn up by experts and decision makers with limited inputs from people actually living in these deltas. Given timeline and budget, it would have been unreasonable to expect the IADS team to develop a participatory approach that could have accounted for the viewpoints of millions of people; yet such lack of direct involvement should not be brushed aside. A second, and perhaps more fundamental, point of tension is that the making of a boundary object comes hand-in-hand with depoliticising development, so that the supportive coalition of the boundary object can be as broad as possible. That the Dutch Delta Approach and its iterations abroad hinged on depoliticisation is made clear when Zegwaard et al. (2019: 241) recall the head of the Second Delta Committee of the Netherlands – who was also involved in the formulation of the IADS project – telling him that "the art is, like we did in the Netherlands, to create a structure, to de-politicize the problem". This is something we find to be problematic. Let us take an example for the sake of illustration. Our historical analysis clearly shows that the politics of land allocation has played a major role in shaping the Ayeyarwady Delta – with a significant impact on smallholders and capture fishermen – and that it will continue to do so given the far-reaching land reforms currently at play in the country. The politicised nature of land allocation and its impact on the delta, however, are minimally alluded to in the IADS 163-page report. How then can it be addressed if it is not even acknowledged?

The point here is not to throw the baby out with the bathwater, but instead to highlight the different implications of the emergence of the global delta. On the one hand, it allows for a diversity of actors to potentially engage with, and in, the Ayeyarwady Delta on their own terms. A broad coalition is of crucial importance in ensuring that the delta remains a policy object as the number of development organisations operating in Myanmar increases. Yet, it must do so in a depoliticised way, leaving room for the expression of multiple interests and their tangible consequences (be it the construction of dikes, the dredging of river channels, the rehabilitation of mangroves, the development of a knowledge base and ever more complex models, or the strengthening of communities' capacities). The global delta only sets the scene; as has been the case over the last 150 years, the future of the delta will not be shaped by the IADS but by the inner workings of the coalition and by which actors have the legitimacy and power to push their agendas through.

ACKNOWLEDGEMENTS

We thank Casper Bruun Jensen, Sanjiv da Silva, Matthew McCartney and Nicolas Faysse for their constructive comments on an earlier draft of this paper. Our thanks also to the three anonymous reviewers who helped us sharpen our argument. Research conducted for this paper was funded by the French National Research Agency (ANR) under the DOUBT project (<http://delta.hus.osaka-u.ac.jp/>).

REFERENCES

- Adas, M. 2011. *The Burma Delta: Economic development and social change on an Asian rice frontier, 1852-1941*. New Perspectives in Southeast Asian Studies Series. Madison, USA: University of Wisconsin Press.
- Agricultural Corporation. 1983. Special Whole Township Crop production development programme in Burma. Yangon, Myanmar: Extension Division, Ministry of Agriculture and Forest (MAF) (In Burmese).
- Arcadis. 2016a. An approach towards an integrated Ayeyarwady Delta strategy. www.bit.ly/2m7IDSB (accessed 31 August 2019)
- Arcadis. 2016b. Summary-Proposal Integrated Ayeyarwady Delta Strategy (20 November 2016). Yangon, Myanmar: Arcadis. www.iadsmyanmar.com/downloads/factsheet-1.pdf (accessed 31 August 2019)
- Aye Myint. 2012. Rice bowl of Myanmar: The Ayeyarwady delta and its water management developments through the ages of paddy production. Presentation at the Stockholm World Water Week, August 26-31, 2012.
- Aye Myint. n.d. Tidal gravity fresh water supply for Integrated Water Resources Management in Nyaungdone Island for food security of Yangon City urban population: A case study. Unpublished manuscript.
- Barnett, C.G. 1913. Note on protective embankment in the Delta 1862-1912. Rangoon, Burma: Office of the superintendent, Government printing.
- Biggs, D. 2010. *Quagmire: Nation-building and nature in the Mekong Delta*. Seattle: University of Washington Press.
- Boutry, M.; Allaverdian, C.; Mellac, M.; Huard, S.; San Thein; Tin Myo Win and Khin Pyae Sone. 2017. Land tenure in rural lowland Myanmar: From historical perspectives to contemporary realities in the dry zone and the Delta. Of lives and Land Myanmar research series. Yangon, Myanmar: GRET.
- Candy, J.P. 1931. Unauthorised embankments on the east bank of the Irrawaddy river in the upper delta. Rangoon, Burma: Public Works Department, Government of Burma.
- CUR (Center for Civil Engineering Research and Codes). 1993. Hydrology and water management of deltaic areas (No. 93-5). Gouda, The Netherlands: CUR, Ministry of Transport, Public Works and Water Management of the Netherlands. [In the text refer to CUR (1993)]
- Cheng, Siok-Hwa. 1968. *The rice industry of Burma, 1852-1940*. Kuala Lumpur, Malaysia: University of Malaya Press.
- Delta Programme Commissioner. n.d. What is the Delta programme? www.english.deltacommissaris.nl/delta-programme/what-is-the-delta-programme (accessed 31 August 2019).
- ECAFE (Economic Commission for Asia and the Far East). 1950. *Flood damage and flood control activities in Asia and the Far East*. Flood control series No. 1. Bangkok, Thailand: Bureau of Flood Control, ECAFE, United Nations. [In the text refer to ECAFE (1950)]
- ECAFE (Economic Commission for Asia and the Far East). 1969. *Proceedings of the second symposium on the development of deltaic areas*. Water resources series No. 39. Tokyo, Japan, 4-13 November 1969: New York, United Nations, ECAFE. [In the text refer to ECAFE (1969)]
- FAO (Food and Agriculture Organization). 2008. Needs assessment for the cyclone Nargis affected areas. Rome, Italy: Myanmar Emergency and rehabilitation program, FAO. [In the text refer to FAO (2008)]
- Foran, T.; Grigg, N.; Barbour, E.; Wahid, S.M.; Gamboa Rocha, A.; Hunter, R.; Sawdon, J.; Moolman, J.; Adams, G.; Rahman, J.; Lebel, L. and Wallbrink, P. 2019. At the heart of Myanmar: Exploring futures of the Ayeyarwady river system. Ayeyarwady Basin Exploratory Scoping Study (BESS). Final Report. Australia: CSIRO.
- Foufoula-Georgiou, E. 2014. DELTAS: Catalyzing a towards sustainability of deltaic systems. www.research.umn.edu/inquiry/post/deltas-catalyzing-action-towards-sustainability-deltaic-systems (accessed 28 May 2019).

- Foufoula-Georgiou, E.; Syvitski, J.; Paola, C.; Hoanh, C.T.; Tuong, P.; Vörösmarty, C.; Kremer, H.; Brondizio, E.; Saito, Y. and Twilley, R. 2011. International Year of Deltas 2013: A proposal. *Eos, Transactions, American Geophysical Union* 92(40): 340.
- Furuichi, T.; Win, Z. and Wasson, R.J. 2009. Discharge and suspended sediment transport in the Ayeyarwady River, Myanmar: Centennial and decadal changes. *Hydrological Processes* 23(11): 1631-1641
- Giosan, L.; Syvitski, J.; Constantinescu, S. and Day, J. 2014. Protect the world's deltas. *Nature* 516: 31-33.
- GoM (Government of Myanmar). 2014. Myanmar National Water Policy. National Water Resources Committee: Yangon, Myanmar. [In the text refer to GoM (2014)]
- GoM and GoNL (Government of the Netherlands). 2014. Myanmar Integrated Water Resources Management strategic study. Yangon, Myanmar: GoM and The Hague, The Netherlands: GoNL. [In the text refer to GoM and GoNL (2014)]
- Gordon, R. 1893. Hydraulic work in the Irrawadi delta. *Minutes of the Proceedings of the Institution of Civil Engineers* 113(2678): 276-313.
- Hasan, S.; Evers, J.; Zegwaard, A. and Zwarteveen, M. 2019. Making waves in the Mekong delta: The work behind the transfer of Dutch delta planning expertise. *Journal of Environmental Planning and Management* 62(9): 1583-1602.
- Hedley, P.J.; Bird, M.I. and Robinson R.A.J. 2010. Evolution of the Ayeyarwady Delta region since 1850. *The Geographical Journal* 176(2): 138-149.
- HIC (Hydro-Informatics Center). 2017. Ayeyarwady State of the Basin Assessment (SOBA) 2017: Synthesis Report, Volume 1. Yangon, Myanmar: HIC.
- IADS (Integrated Ayeyarwady Delta Strategy). 2018. Integrated Ayeyarwady Delta Strategy-Delta report. Zwolle, The Netherlands: Arcadis.
- ICSU (International Council for Science). 2014. <https://council.science/current/news/icsu-endorsed-initiative-sustainable-deltas-2015-launches-in-rotterdam> (accessed 17 September 2019).
- Information Department. 1962. The Burmese way to socialism (No. 48), Towards socialism in our Burmese way. Ministry of Information: Yangon, Myanmar.
- Jensen, C.B. and Morita A. 2015. Infrastructures as ontological experiments. *Engaging Science, Technology, and Society* 1: 81-87.
- JICA (Japan International Cooperation Agency). 1980. The master plan survey report on the Irrawaddy Basin Agricultural Integrated Development Project (IBAIDP). Tokyo, Japan: JICA.
- JICA (Japan International Cooperation Agency). 2005. The study on integrated mangrove management through community participation in the Ayeyarwady delta in the union of Myanmar. Tokyo, Japan: Japan International Cooperation Agency.
- JICA (Japan International Cooperation Agency). 2011. Final report for the project for preservation of farming area for urgent rehabilitation of agricultural production and rural life in areas affected by Cyclone Nargis in the Republic of the Union of Myanmar. Tokyo, Japan: Japan International Cooperation Agency (JICA) – Sanyu Consultants Inc. Nippon Koei Co.; Ltd.
- JICA (Japan International Cooperation Agency). 2012. Preparatory survey report on the project for improvement of machinery for rehabilitation of polder embankment in Ayeyarwady Delta in the Republic of the Union of Myanmar. Tokyo, Japan: Japan International Cooperation Agency (JICA) – Sanyu Consultants Inc. Nippon Koei Co.; Ltd.
- JICA (Japan International Cooperation Agency). 2013. Completion report for the project for integrated mangrove rehabilitation and management project through community participation in the Ayeyarwady Delta in Myanmar. Tokyo, Japan: Japan International Cooperation Agency (JICA) – Mangrove Community Forestry Task Force. Forest Department. Nippon Koei Co.; Ltd.
- KTA (Knappen-Tippetts-Abbett). 1953. Economic and engineering development of Burma (Comprehensive report). Yangon, Myanmar: Knappen-Tippetts-Abbett-McCarthy Engineers in Association with Pierce Management, Inc. and Robert R. Nathan Associates, Inc.
- Krause, F. 2017. Towards an amphibious anthropology of delta life. *Human Ecology* 45(3): 403-408.

- Lahiri-Dutt, K. 2014. Beyond the water-land binary in geography: Water/lands of Bengal re-visioning hybridity. *ACME: An International E-Journal for Critical Geographies* 13(3): 505-529. www.acme-journal.org/index.php/acme/article/view/1025/879
- LIFT (Livelihoods and Food Security Trust Fund). 2014. Livelihoods and food security trust fund strategy (2014-2018). Yangon, Myanmar: LIFT.
- LIFT. 2015. Delta 3 Programme framework. Yangon, Myanmar: LIFT.
- Maung Aung Myoe. 1999. The counterinsurgency in Myanmar: The government's response to the Burma communist party. PhD Dissertation. Australian National University, Canberra, Australia.
- MoAI (Ministry of Agriculture and Irrigation). 2002. Nyaungdone Island land reclamation project Ayeyarwady Division. Naypyidaw, Myanmar: Irrigation Department, MoAI.
- MoALI (Ministry of Agriculture, Livestock and Irrigation). 2015. Myanmar rice sector development strategies. Naypyidaw, Myanmar: MoALI.
- Ministry of Infrastructure and the Environment of the Netherlands. 2016. International water ambition. The Hague, The Netherlands: Ministry of Infrastructure and the Environment of the Netherlands. www.waterinternationaal.nl/files/documents/iwabrochure_internationaal.pdf (accessed 1 August 2018)
- Minkman, E. and van Buuren, A. 2019. Branding in policy translation: How the Dutch Delta Approach became an international brand. *Environmental Science and Policy* 96: 114-122.
- Mohinga. 2017. The project for Establishment of Integrated Agriculture and Irrigation Development Master Plan (EIAIDMP) in the Ayeyarwady Delta Region, Myanmar. www.mohinga.info/en/profiles/activity/MM-FERD-6057/ (accessed 25 June 2017)
- Molle, F. and Tuân, D. 2006. Water control and agricultural development: Crafting deltaic environments in South-East Asia. In Tvedt, T. and Jakobsson, E. (Eds), *A history of water Volume 1: Water control and river biographies*, pp. 144-171. New York: IB Tauris.
- Morita, A. and Jensen, C.B. 2017. Delta ontologies: Infrastructural transformations in Southeast Asia. *Social Analysis* 61(2): 118-133
- Mya Than. 2000. Changing faces of the Ayeyarwady (Irrawaddy) Delta (1850-2000). In Proceedings of the conference Chao Phraya Delta: Historical development, dynamics and challenges of Thailand's rice bowl, Kasetsart University, Bangkok, Thailand, 12-14 December 2000.
- NWP (Netherlands Water Partnership). 2014. The Delta Approach. The Hague, The Netherlands: NWP. www.dutchwatersector.com/uploads/2014/11/140209-01-delta-approach-a4-web-07.pdf (accessed 1 August 2018)
- NWP (Netherlands Water Partnership). 2019. NIWA – Sequel Dutch Water Ambition policy published. Netherlands Water Partnership. www.netherlandswaterpartnership.com/news/niwa-sequel-dutch-water-ambition-policy-published (accessed 31 August 2019)
- NWP and the Netherlands Embassy in Yangon. 2017. Myanmar-The Netherlands; Partnership for water Challenges. The Hague, The Netherlands: NWP.
- Renaud, F.G.; Szabo, S. and Matthews, Z. 2016 Sustainable deltas: Livelihoods, ecosystem services, and policy implications. *Sustainability Science* 11: 519-523.
- Rodolfo, K.S. 1975. The Irrawaddy Delta: Tertiary setting and modern offshore sedimentation. In Broussard, M.L. (Ed), *Deltas: Models for explorations*, pp. 339-356. Houston Geological Society.
- Royal Haskoning DHV. 1988. Feasibility study for the improvement of navigation on the Irrawaddy and Lower Chindwin rivers. The Netherlands: Royal Haskoning DHV.
- Samuelson, B.M. 1917. The effect of flood embankments on the river-levels in the Irrawaddy Delta. *Minutes of the Proceedings of the Institution of Civil Engineers* 203(4171): 362-370.
- San Thein, Diepart J.C.; Hlwan Moe and Allaverdian, C. 2018. Large-scale land acquisitions for agricultural development in Myanmar: A review of past and current processes. MRLG Thematic Study Series #9. Vientiane, Laos: MRLG.
- Sir William Halcrow & Partners. 1982. Irrawaddy Delta hydrological investigations and delta survey. 5 volumes. Washington, DC: World Bank.

- Star, S. L. and Griesemer, J.R. 1989. Institutional ecology. "Translations" and boundary objects: Amateurs and professionals in Berkeley's museum of vertebrate zoology. *Social Studies of Sciences* 19(3): 387-420.
- Syvitski, J.P.M.; Kettner, A.J.; Overeem, I.; Hutton, E.W.H.; Hannon, M.T.; Brakenridge, G.R.; Day, J. et al., 2009. Sinking deltas due to human activities. *Nature Geoscience* 2(10): 681-686.
- Thawngmung, A. M. 2004. *Behind the teak curtain: Authoritarianism, agricultural policies, and political legitimacy in rural Burma*. New York: Columbia University Press.
- TCG (Tri partite Core Group). 2008. Post-Nargis Recovery and Preparedness Plan. Yangon, Myanmar: TCG.
- Ti, L.H. and Facon, T. 2004. From vision to action- A synthesis of experiences in least developed countries in Southeast Asia. RAP publications 2004/32. Bangkok, Thailand: UNESCAP and FAO.
- UNESCO (United Nations Educational, Scientific and Cultural Organization). 1966. Scientific problems of the humid tropical zone deltas and their implications: Proceedings of the Dacca Symposium. Humid Tropics Research Program, UNESCO. Paris, France, 24 February- 2 March 1964.
- van Driel, W.F. and Nauta, T.A. 2014. Vulnerability and resilience assessment of the Ayeyarwady Delta in Myanmar. Full assessment report. Delta Alliance report no. 10. Delft-Wageningen, The Netherlands: Bay of Bengal Large Marine Ecosystem (BOBLME) Project, Global Water Partnership (GWP) and Delta Alliance.
- van Schendel, W. 1991. *Three deltas: Accumulation and poverty in rural Burma, Bengal and South India*. Indo-Dutch Studies on Development Alternatives No. 8. New Delhi, India: SAGE.
- Volker, A. 1964. Surface hydrology of deltaic areas. In Proceedings of the Dacca Symposium on scientific problems of the humid tropical zone deltas and their implications. UNESCO Publications Center. University of Dacca, Bangladesh, 24 February – 2 March 1964.
- Volker, A. 1983. Rivers of southeast Asia: Their regime, utilization and regulation. Hydrology of humid tropical regions with particular reference to the hydrological effects of agriculture and forestry practice. In Proceedings of the Hamburg Symposium, IAHS Publ. No. 140, pp. 127-138. Hamburg, Germany, August 1983.
- Warr, P.G. 2000. The failure of Myanmar's agricultural policies. *Southeast Asian Affairs*, 219-238.
- Wesselink, A. 2007. Flood safety in the Netherlands: The Dutch political response to hurricane Katrina. *Technology in Society* 29(2): 239-247.
- Wesselink, A.; Warner, J.; Md Abu Syed; Chan, F.; Dung Duc Tran; Huthoff, F.; Ngan Le Thuy et al., 2015. Trends in flood risk management in deltas around the world: Are we going 'soft'? *International Journal of Water Governance* 3(4): 25-46.
- World Bank. 1974. Irrigation Project. Appraisal Report. Washington, DC: World Bank.
- World Bank. 1976. Lower Burma Paddyland Development Project. Appraisal Report. Washington, DC: World Bank.
- World Bank. 1978. Paddyland Development II Project. Staff Appraisal Report. Washington, DC: World Bank.
- World Bank. 1983. Burma Irrigation Sector Review. Washington, DC: World Bank.
- World Bank. 1986. Lower Burma Paddyland Development Project. Project Completion Report. Washington, DC: World Bank.
- World Bank. 1991. Paddyland Development II Project. Project Completion Report. Washington, DC: World Bank.
- World Bank. 1999. Myanmar: An Economic and Social Assessment. Washington, DC: World Bank.
- World Bank. 2014. Ayeyarwady Integrated River Basin Management Project – Project Appraisal Document. Washington, DC: World Bank.
- World Bank. 2016. Philippines: Integrated Water Resources Management Planning Guidelines. Washington, DC: World Bank.
- Zegwaard, A. 2016. MUD: Deltas dealing with uncertainty. PhD thesis. University of Amsterdam, Amsterdam, The Netherlands.
- Zegwaard, A.; Zwarteveen, M.; van Halsema, G. and Petersen A. 2019. Sameness and difference in delta planning. *Environmental Science and Policy* 94: 237-244.