MONSOON ASSEMBLAGES

PALLIKARANAI MARSH, CHENNAI:
ENTANGLED LANDSCAPES AND MONSOONAL ECOLOGIES
Literature Review

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Pallikaranai wetland is a marsh in the city of Chennai. It is situated adjacent to the Bay of Bengal, about 20 kilometres south of the city centre. This review aims to trace the history of the Pallikaranai marsh and its role in the development of Chennai. Historically the marsh has been a minor, even invisible, feature in the landscape of the city; however, it has gained importance in recent years due to severe urban flooding during the monsoon season. Treatment of the marsh in can perhaps be understood as an indicator of human attitudes to the environment and nature. As Giblett (2016: 1) writes "The relationship between cities and wetlands is fraught and they are even inimical to each other". Given the focus of the Monsoon Assemblages project the aim of this paper is to analyse the marsh in relation to the meteorological, socio-cultural as well as urban context. Such an analysis can potentially inform us about the historical development of the city in relation to the wider meteorological and geomorphological landscape, the changing relationship between the monsoon and the city, and the role of more-than-human participants in urbanisation processes. Tracing these developments may enable us to better understand the origins of the city, current and future patterns of urbanisation and their implications.

A range of literature has been reviewed in order to better understand the Pallikaranai marsh area. The review is informed by grey literature, student theses, working papers, technical reports and academic papers from natural and social sciences. The marsh has been well researched: "long term research data on many aspects of the marsh is available; and with further studies this could evolve into one of the most comprehensive bases on natural systems anywhere in the world" (CityConnect & CareEarth, n.d.). However, some of these studies are unpublished and not all are available online. This review would need to be further developed to provide a comprehensive review. Despite the quantity of available literature most information is quite recent in nature and largely revolves around concerns about pollution and ecological decline. There seems to be limited information about the marsh in a historical context, as such this review attempts to view the marsh within a longer time frame and highlight potential areas for future research.

The reasons for focusing on marshes in relation to Chennai may not be readily apparent. Although the city has a large number of waterbodies and is renowned for its human-made reservoirs, it is not traditionally associated with marshlands, unlike other Indian cities such as Kolkata or Bangalore. However, an analysis of the literature indicates that marshlands are potentially more significant than has previously been realised. Chennai, a city that was built on marshy ground in the confluence of two waterways, has been portrayed as "a city that was never meant to be" (Arabindoo, 2011: 383). There are multiple references to marshlands in accounts of the early city. "A low-lying marshy lagoon surrounded the first settlement" (Bradnock, 1984: 38-39). Another description states that "Perambur, Choolai, Purasapakam, Vepery and Basin Bridge… were all low lying swamps… Beyond Mylapore in the south, the ground was swampy and estuarine" (Madras Tercentenery Committee, 1939: 283). Fossilized shell deposits and a layer of "black, stiff buttery" clay underlying the city have been found to indicate the presence of a former lagoon (ibid., 331). Perhaps this should not be surprising considering the city's location. The original site of Chennai is described as a "piece of waste land" lying between the Kuvam and the Egmore rivers, "an islet caught between the waters of two streams and the sea, unfit for any useful purpose" (ibid., 39). Another describes a "desolate sandy strip of land" and a "surf-lashed exposed spit… protected on two sides by river and on the third by the sea" (Muthiah, 2014: 1876).

These marshy origins are no longer evident in areas of the old city, but marshlands remain an obvious feature in the newly developed southern regions where the city is rapidly expanding. Chennai in recent years has been described as a split city with conflicting identities; the more established area of northern Madras representing colonial history and the newly emerging

southern Chennai a globalising, modernising city (Arabindoo, 2011). The city has changed over time from a city of villages which reportedly struggled to shake its small town past, to a global city with ambitions to establish itself on the international stage. These processes of development have influenced patterns of settlement and urbanisation. As the city has developed and boundaries expanded the surrounding areas have transformed from rural hinterlands, to peri-urban areas, to suburbs, eventually coming to form part of the city. However, a polarised geography has emerged between areas that have benefited from neoliberal reforms and those that have been left behind (ibid.).

Pallikaranai marsh, the subject of this review, is located in the southern region of the city. It was formerly part of the Saidapet taluk of Chingleput district and used to fall outside the city boundaries. During the colonial period Chingleput formed part of the agricultural periphery. In the post-Independence period, as the city gradually expanded, the marsh was literally used as a dumpsite for the city, functioning as a convenient place for relocating and absorbing inconvenient elements of urban life. Pallikaranai was incorporated within the Chennai city boundaries in 2011 and as a result the relationship between the city and the marsh began to change. It now represents an area of rapid urban development with a booming real estate market. The expansion of the city over the marsh has highlighted concerns about conservation and the role of nature within the city; flooding, waste and rainwater management; planning, legislation and policy processes and the politics that facilitate urbanisation.

Coastal context

In order to better understand the marsh, it is important to explore how it fits within the broader coastal landscape, and how it might have evolved over time. Chennai is located on the Eastern Coastal Plains of India, a wide stretch of landmass lying between the Eastern Ghats and the Bay of Bengal. The plain stretches from Tamil Nadu in the south to West Bengal in the north. Deltas of many of India's rivers form a major portion of these plains, depositing their sediments into the Bay of Bengal. It is clear that water, in connection with the monsoon climate, has long been an organising element of the landscape. Rivers that run through the coastal plains carry large amounts of sediment that continuously reshape river beds and fill up water bodies, lakes and marshes, and are carried to the coast during monsoon floods. As McCully (2001) has said, "rivers can in effect be considered a body of flowing sediment as much as one of flowing water". Satellite imagery illustrates that these rivers dump sediment from the plains into the sea leading to high concentrations around the river mouths (Ramasamy, 2006: 4402).

The southern part of the coast between the Krishna and Kaveri rivers is known as the Coromandel Coast. This coastal area is classified as an emergent immature coastline and is characterised by the presence of many sand dunes, lagoons, marshlands and salt pans. These coastal landforms are still influenced by tectonic movements, geomorphic processes, delta building activities, sea level changes and the pattern of currents (Ramasamy & Ramesh, 1999). Research indicates that this region, far from being stable, is prone to earth movements affecting both land, water and mudflat distribution along the coast, with dramatic changes observed in topographic and satellite data (K. N. Rao & Sadakata, 1996). Earth movements have also affected the course of rivers, with river migration being observed in the form of a spectacular network of buried palaeo river networks. A large delta area has been identified, and is thought to have been deposited by a mighty river which once drained the region. This is thought to indicate that the Palar river once flowed in a north-easterly direction forming a delta to the north of Chennai where it met the Bay of Bengal at Pulicat Lake (Ramasamy, 2005).

It is likely that this former river greatly influenced the current coastline, and modern day backwater lakes and lagoons could be remnants of the former delta region built by the river in collaboration with monsoonal forces. River-mouth lagoons are known to form where a river interacts with a coastal environment that experiences littoral drift. Coastal lagoons are defined as "a shallow coastal water body separated from the ocean by a barrier, connected at least intermittently to the ocean by one or more restricted inlets, and usually oriented shore-parallel" (Kjerfve, 1994: 3). Sources indicate that ridges running parallel with the Coromandel coast have been formed by littoral currents. These ridges have in turn led to the accumulation of sand dunes. Between the sand dunes and the coast lie lagoons connected to the sea to varying degrees. Their connection with the sea is affected by the formation of sand bars and spits influenced by currents that change with the monsoon, retreating during the northeast monsoon and destroying spits formed during the non-monsoon season (Anuthaman, 2009). An early description of the coast described bars that were formed "by the unceasing action of an exceptionally heavy surf in a shallow sea floor of easily moved materials" (Russell, 1898: 42). These bars resulted in periodic, sometimes annual, closures of all but the largest backwaters which were later forced open to varying degrees with the heavy floods of the north-east monsoon (ibid.).

The coastal lagoons that form as a result of these processes trap sediment and organic matter that are flushed from the land during monsoon rains thus serving as sinks or filters. As such, on a geologic time scale, they are usually short-lived features. Literature indicates that the lagoon that once existed between the Cooum and the Adyar gradually filled in over time by "sand blown in from the shore by the wind during the dry season, and the clay being brought down during the rainy season by streams", leading to the establishment of the alluvial and sand deposits upon which the city was founded (Madras Tercentenery Committee, 1939: 331). Considering this evidence, in addition to the shape and behaviour of Pallikaranai, it is possible that the marsh is a remnant of a much larger lagoonal system that existed in previous times. The literature about Pallikaranai certainly indicates that the marsh was created by the backwaters of the Bay of Bengal. The marsh formed when seawater water was trapped behind the sand ridges that run parallel to the coast. The construction of the saltwater Buckingham canal in 1876, which runs along the length of the coast, virtually stopped the inflow of seawater (Surya, 2016). Thereafter rain water turned the marsh into a freshwater body, fundamentally altering its properties and connection with the coast. By turning our attention to the marsh's place within the coastal context, the relationship between the marsh, the surrounding landscapes and waterscapes and the monsoon becomes apparent.

Marsh as an ecological system

Certain elements of the Pallikaranai marsh, in its current state, are well described. The low lying coastal plain of which it is part, has an average altitude of five metres above mean sea level (Azeez et al., 2007). According to Parameswari (2012) the elevation is six metres on the eastern side, reducing to sea level at Pallikaranai marsh and rising to 12 metres on the western side, indicating an underlying depression with a sloping gradient towards the east and south east. The undulating topography that characterises the southern area of Chennai is related to the presence of charnockite, a crystalline granite-like rock found beneath the marsh region, erupting at Guindy and St Thomas Mount to the north of the marsh. In a description of the Madras Presidency, Thurston, (1913: 59) wrote, "the characteristic feature of these masses of charnockite is the formation of large plateau-like masses with undulating surfaces of a kind which permits, with slight artificial help, the formation of lakes". The presence of charnockite is corroborated by more recent studies of the marsh which state that "the substrate in the entire region is made up of

weathered charnockite rock bed" (Lavanya, 2014). The rock is reportedly found at around 11-45m below ground level (Surya 2016: 1823).

The soil types correspond with the underlying geology, both of which influence the hydrological functioning of the marsh. The dominant soil type in the marsh area is vertisol, which consists of expanding clay minerals, transmits water slowly and is high in natural fertility (Parameswari, 2012). The presence of clay soils as well as hard and impervious rock with low porosity means that rainwater is likely to percolate slowly and be held by the soil for a longer time explaining the presence of surface water. However, there is some variability with the eastern part of the marsh closest to the coast consisting of a narrow belt of sand and clay layers and alluvial entisols with a higher porosity (Lavanya, 2014; Shanmugam & Ambujam, 2012). According to Surya (2016) "the low lying swamp land consists of black and shallow water mud in which many aquatic plants grow. The topography of the swamp is such that is always retains some storage, thus forming an aquatic ecosystem". Radio carbon dated soil sediments collected from the marsh show that the marsh has a long history and was flourishing with living organisms dating back to 2,700 years ago (Krishnan, 2014).

Today the flow of water to the marsh is largely provided by monsoon rains and as such it can be understood as a monsoonal ecological system. In this area of the Tamil Nadu coast, the majority of the rain falls during the north east monsoon in the months of October, November and December due to depressions forming in the Bay of Bengal. In contrast to the north east monsoon, the southwest monsoon rainfall is highly erratic. Analysis of rainfall patterns indicates a wide variation within short distances across the city and also from year to year with incidents of mild drought. Severe drought is rarer, but the city has a history of droughts and associated water shortages. As the monsoon rains are variable the amount of water contained by the marsh can change from year to year, and from season to season. Accordingly, parts of the marsh are permanently wet whereas others are only seasonally inundated (Parameswari, 2012).

In addition to water received from direct rainfall, Pallikaranai is also fed by runoff from a range of other connected rain-fed water bodies including Velacheri Lake, Keelkattalai Lake, Perungudi Lake, and numerous associated tanks and wells. According to Surya (2016: 1822) "there are 31 tanks located at the West, South and Northern catchment area of the swamp which release the surplus water during rainy seasons to the swamp. The sustainability of this marshland is linked with the vitality and sustenance of these tanks… and vice versa because they belong to a single system of water bodies". Groundwater quality studies indicate that the quality of water in the marsh, and nearby wells, changes in relation to the monsoon indicating its connection with this meteorological system that dominates life in the Tamil Nadu region.

The marshland retains a link to the Bay of Bengal through the Okkium Maduvu channel via the Buckingham Canal with outflows to the sea at the Kovalam estuary to the south. Reflecting these rain-fed and coastal connections the marsh is freshwater in the north and brackish to the south (Joshi & Kale, 2013). The connection to the sea is an important feature. "The ecology of Pallikaranai Marsh is sustained by the seasonal hydrology in general and the mixing of sea and freshwater in particular … freshwater wetlands that are in the stage of marshes are unstable as they eventually transform to grasslands and then to scrub and forests due to the semi-aquatic and terrestrial plants that over-run the habitat. It is only the mixing of seawater that sustains marshes as very few plants are adapted to living in saltwater systems" (CityConnect & CareEarth, n.d.-a). The Okkium Maduvu channel that facilitates the interchange of fresh and salt water is therefore crucial to the existence of the marsh. According to Azeez et al. (2007) Pallikaranai wetland has a

catchment area of 235 km^2 and is estimated to hold five million cubic metres of water at any given time. It also serves to charge the aquifers of the region (Surya 2016).

The marsh is described by various sources as a “mosaic”, “composite” landscape, “a wetland of diverse character” (Azeez et al., 2007; CityConnect & CareEarth, n.d.-b; Patnaik & Srihari, 2004). In addition to the areas that are permanently inundated with water the wetland is also composed of smaller satellite wetlands, large tracts of grassland or pasture and patches of dry forest or scrubland, which also act as water catchment and storage areas. Different habitat types within the marsh include fresh and saline water bodies, reed beds, mud flats and floating vegetation. The plant diversity of the marsh is enriched by the presence of at least two species of grasses that are endemic to Peninsular India (Vencatesan, 2007). As a result of this hydrological and ecological diversity, the marsh supports a variety of species and is an important area of biodiversity within the city, the region and even the country. According to ecological surveys, the marshland is home for 61 species of naturally occurring plants, 46 species of fish, 112 bird species, 7 species of butterfly, 9 species of amphibians, 9 species of molluscs, 5 species of crustaceans, 10 species of mammal and 21 reptile species (Azeez et al., 2007: 10). Pallikaranai is particularly renowned for its bird life, including resident and migratory, rare and endangered species. Waders and migratory birds are found in the marsh, particularly during the monsoon season when the marsh is flooded (Jose et al., 2016).

It is clear from the research conducted to date, that the extent of the marsh has changed dramatically over time. The original expanse of Pallikaranai was about 5,500 hectares which has currently reduced to about 600 hectares, based on Survey of India toposheets and aerial photographs (CityConnect & CareEarth, n.d.-a). In the literature, the shrinkage of the marsh is largely linked to anthropogenic activities including encroachments in the form of a dumpsite, construction of residential and commercial buildings, development of transportation infrastructure (rail and road), and pollution from the dumping of both solid waste and sewage. These encroachments have led to the fragmentation of the marsh which has in turn affected its ecology.

A link road in the middle of the marsh has led to a reduction in water and nutrient flows, the settling of sediment in the northern section of the marsh, colonisation by rooted and weedy species of plants and reduced migration of wildlife between the two sections (Azeez et al., 2007: 18). Land cover change and the removal of vegetation caused by construction activities has led to widespread soil erosion. “Rapid urbanisation involves land clearing, levelling and construction activities in the catchment. Disturbed and loosened surface soil is easily washed away in runoff. Soil and sediments reach the wetland reducing the depth and extent of the marsh” (ibid: 17). In addition to processes of fragmentation and sedimentation, there are reports that the marsh is gradually drying up due to the cutting off of connections with other crucial water bodies on which it depends, including the former agricultural and pasture lands which served as catchment areas. The satellite wetlands, vital water sources for the marsh, are also gradually disappearing as they are filled in by encroachments, waste and vegetation. In addition to this the Okkium Maduvu, the only remaining connection between the marsh and the sea, has been substantially reduced in size leading to less saltwater exchange (Coelho & Raman, 2013).

Although there is no doubt about the severe impact that these encroachments have had on the functioning of the marsh, the focus on anthropogenic activity perhaps means that ecological processes functioning on a longer timescale are largely ignored. The limited historical analysis and

the proliferation of micro-scale work on isolated features may result in a tendency to portray the marsh as a static entity, indicating the importance of a holistic and temporal perspective.

Knowledge of the marsh in a historical context

In order to understand how the marsh has been understood and engaged with, this section attempts to outline evolving forms of knowledge about the landscape and environment of the region over time. Information has been divided into the pre-colonial, colonial and post-colonial periods, although it should be acknowledged that distinctions are not rigid. Relevant knowledge systems from each period are outlined using a broad brush approach. Information pertinent to the marsh is scarce for some periods leading to a very partial and fragmentary perspective. Specific references to Pallikaranai marsh are largely invisible in pre-colonial and colonial sources, possibly because it fell outside the city boundaries or because the marsh did not exist in its current state. General references to marshlands and wetlands within the wider agricultural and social landscape are referred to for insights. Attitudes towards and interactions with nature have implications for the management of resources, as well as livelihoods and settlement patterns. Associated knowledges also have legacies which extend over time periods, albeit in modified forms.

Precolonial period

Tamil Nadu has a long history of habitation with evidence of human settlement from the Stone Age onwards. According to archaeological and historical findings, Tamil Nadu was ruled by the Chera, Chola and Pandya dynasties from 300 BC to 200 AD; a period also known as the Sangam Age. Research about Pallikaranai marshland indicates that historic systems of land classification have significantly influenced how the marsh has been managed from ancient times to the present day. The concept of land classification is traceable from the Sangam age. A cursory analysis of the pre-colonial landscape can perhaps reveal information about the role of wetlands within prior socio-ecological systems. Given the dynamic nature of the landscape and coastal area we cannot assume that the Pallikaranai marsh was in existence at this point in time so this section should be taken as an attempt to understand the role of marshlands more generally.

Descriptions of early Tamil society indicate spatially defined livelihoods based on different environmental zones. These eco-zones, known as *tinai*, were a poetic convention utilised in early Sangam literature. *Tinai* consists of multiple elements including: primary aspects (*mutal*), the terrain and time; organic aspects (*Karu*), food, flora and fauna, human activities and water sources; and behavioural patterns (*Uri),* referring namely to behaviour considered to be characteristic of each region including human emotions (Sivathamby, 1974). “Early Tamil cosmology correlates specific landscapes with aspects of culture: human beings, their feelings and actions and their artefacts” (Selby & Viswanathan, 2009). There is debate as to whether these categories were simply literary devices or operational concepts. Nonetheless, they provide a useful insight into early Tamil cosmology and associated knowledge systems.

The earliest reference to *tinais* is found in the ancient Tamil text *tolkaappiyam*. “The regions of *kurinji* (forested hills), *mullai* (pastoral tracts), *marutam* (wetlands or marshes) and *neytal* (littoral), are each identified by the name of a typical botanical specimen endemic to that ecological niche” (Haricharan & Keerthi, 2014: 642). The fifth *tinai*, *pallai* (dryland/scrub) is understood to have been a temporary arid physiography that may appear in any region where water is scarce (ibid.). These five landscapes are thought to have been linked to specific livelihood practices that were governed by people’s access to resources. These include hunting and gathering in forest areas, cattle raiding in desert lands, shifting agriculture and animal husbandry in pastoral areas, plough cultivation in fertile wetlands and fishing and salt extraction in coastal tracts. It is understood that

these geographical zones and associated livelihoods influenced the formation of tribes and the subsequent emergence of political organisation in the region. *Tinai* is described as the basis of a social order which preceded the caste order, but later became caste groups. In support of this argument some have referred to the fact that the major caste groups in Tamil Nadu are vocational groups: "the *Vellalar* (the farmers), the *Karaiyar* (those of the coast – fishermen), *Pallar* (those of the low-lying area – agricultural serfs)" (Sivathamby, 1974: 30).

According to Srivastava (2008) the concept of individual land ownership was absent in the Sangam age, land was considered the property of kings. There are also indications that concepts of land value may have been very different during this period. Indeed, Vencatesan (2006: 1455) makes the point that while early categorization systems outlined in Sangam literature recognise degradation and desertification, they do not attribute any non-use value to any natural resource. This possibly suggests a more nuanced understanding of the values of each landscape type and associated resources, in contrast with classification systems that developed during subsequent periods.

The early historic period was a time of remarkable change in peninsula India with the development of regional polities and formalized relations of social inequality (Morrison, 2015). As a result of these processes of formalisation, over time land became subject to finer-grained forms of classification and categorisation. In the succeeding middle period, land typologies were based on parameters such as soil quality, fertility and local climatic conditions, knowledge of which was largely based on agricultural practice. This period also saw the beginnings of revenue systems with cultivable land being subject to higher taxes. During the Vijayangara Empire (AD 1330 to 1650), agriculture was divided into three types based on water requirements, types of crops grown and their productivity: wet cultivation, dry cultivation and wet-cum-dry cultivation. These classifications were adopted in a modified form by colonial authorities who used the classifications of wet, dry or garden land for revenue purposes (Morrison, 1995).

Due to the climate of the region, complex agriculture was only possible through the construction of irrigation works. This is evidenced by the fact that the geography of Tamil Nadu is characterised by a large number of reservoirs, known as *erys*. These structures can be seen as physical representations of a knowledge system that developed in response to the monsoon. The tank and reservoir system engineered the landscape to harvest monsoon rainwaters for crop production. The earthen embankments of the *erys*, often formed around natural depressions, helped to control potentially dangerous floods as well as erosion resulting from intense downpours. Landlords who inhabited this region during the Chola period were referred to as Vellalar or "rulers of the flood" and Karalar or "lords of the cloud" in recognition of their expertise (Choudhary, 2009: 144). These irrigation works saw the introduction and expansion of wet rice or paddy agriculture, which resulted in the emergence of complex agricultural regimes.

Described as "interactive webs of land, water and vegetation", the *erys* uses extended far beyond the capture and storage of water (Pandey, 2000: 2). According to Ariza et al. (2007) the *erys* comprised the physical area occupied by the tank, the surrounding spaces, resources associated with the tank, populations living in the area, and connected water bodies. As with the Pallikaranai marsh, areas occupied by the *erys* changed during the rainy and dry seasons depending on the extent of water. As such *erys* can perhaps offer insight into the role of natural wetlands. During the dry season, when the *ery* is at its lowest, the bed became open common land (*porambok*e) and was utilised for its natural resources (ibid.). Catchment areas of *erys* contained grazing pastures and the water body sustained plants and fish. The *erys* also captured sediment which was removed through desilting and used to fertilise surrounding fields, the clay deposits were also

used for pottery and construction (Mukundan, 2005). Their use and maintenance required an understanding of the connections between monsoon rains, sediment flows and the topography of the land, knowledge which presumably would have been extended to the management of natural wetlands. It is likely that wetlands were used as fisheries and a source of aquatic resources during flooded periods, with grazing and agriculture becoming predominant in drier periods. Their capacity to absorb water meant that could have been used for residual moisture cropping, acted as a buffer in times of drought and scarcity. The occurrence of an endemic endangered salt tolerant variety of paddy rice *Oryza rufipogon,* also known as brownbeard rice, wild rice or red rice*,* in the Palllinkaranai marsh supports this (CityConnect & CareEarth, n.d.-a).

The introduction of rice, made possible by the *ery* system, led to a decisive shift in settlement patterns with a movement to the plains in order to farm the seasonally inundated and silt rich plains of the coastal delta. Despite the flood risks, people inhabited these plains due to their ability to provide fertile crops, namely paddy rice. The introduction of rice effectively "transformed landscapes and waterscapes and underwrote the existence of cities, towns and temples" (Morrison, 2015). Along the Coromandel coast a network of towns, villages and temples emerged linked by some of the earliest roads in the region. Settlements, temples and associated infrastructure were located according to the topography of the landscape. Sources indicate that during the development of early Chennai roads, settlements and temples were located on sand-hills whereas cultivation took place in marshy depressions that were liable to flood during the rainy season. "The swampy conditions seem to have persisted long enough to restrict all early human settlements to the relatively higher sites provided by the sand hills. All the old and important temples have been built on them; and since temples are generally placed in conspicuous or focal positions in relation to the neighbouring human habitations, the early settlements must have also been on these sandy ridges. This is further borne out by the close network of narrow streets in these higher areas" (Madras Tercentenery Committee, 1939: 333). It is thought that in the early days, farmers were likely to have been a minority; obliged to get consent for construction works from fisher folk who were not only older inhabitants but also a majority. As the wetland areas dried up, farmers grew in number and influence. Until European occupation brought trade and industry, the site of Madras remained in the occupation of small, more or less separate communities of farmers and fisher folk (ibid., 334).

Colonial period

Modern Chennai began as a colonial city and its initial growth was closely tied to its importance as a port and trading centre. The Madras region was settled by Europeans starting with the Portuguese who arrived in the 16th century establishing the port of Sao Tome, the Dutch who settled to the north of the city near Pulicat Lake in the early 17th century, followed by the British East India Company. In the 18th century the British came to dominate India's southern region establishing the Madras Presidency, of which Madras was the capital. This section will focus primarily on the period from the East India Company through to the British Raj.

Due to its coastal location Chennai has always had to deal with flooding and cyclones associated with the monsoon. "Be it the Ghats or the plains; the cyclones or the winter monsoons – these features were responsible for shaping the 'world' on the Coromandel' (Nawani, 2007). In colonial sources the coast is described as dangerous with no natural harbour, boats wanting to get to shore had to negotiate an "ever violent and swelling sea" (ibid.). Accounts from the period indicate that new arrivals were often underwhelmed by what they found upon landing. "The stranger who lands in the port of Madras is often disappointed by the vegetation. In and about the town he sees, it is true, many forms of more or less tropical vegetation… but the country around seems to be a

somewhat uninteresting stretch of wet rice land with occasional rocky hills emerging from here and there, and clothed with a shrubby and mostly thorny vegetation" (Thurston, 1913: 104). Despite such accounts, people were attracted to the region due to its cotton, dyes, spices and salt, which were important commodities and facilitated international trade. Europeans battled the elements to secure these resources, eventually creating an artificial harbour in Madras to ensure safe passage. It seems Europeans were also attracted to the pleasant ambience of the area created by "an adjoining chain of hills which intercepted the hot land wind, although the region was infested with mosquitoes" (Nawani, 2007: 22).

Research on colonial experiences in West Bengal, a similarly monsoonal landscape, reveals that climatic and ecological conditions were perceived as obstacles to the establishment of colonial rule. Cederlöf (2014: 29) writes, "the British struggled endlessly with mastering the riverine systems, quagmires and seasonal lakes that changed with every monsoon". In an effort to gain control of a region and a climate of which they had limited understanding, the British embarked on extensive documentation of the region. This included anthropological analysis of the people, documentation of flora and fauna, traveller and missionary accounts, and elaborate mapping and surveying exercises for administrative, military and planning purposes. Marshes and wetlands are mentioned in accounts of these survey expeditions as making travel "tedious" (ibid.).

Although no specific references to the marsh have been found, it is likely that Pallikaranai was still a predominantly agricultural area during colonial times. This period saw changes to the pre-colonial land classification and revenue system, which in turn influenced agricultural production patterns. The *ryotwari* land tenure system was introduced purportedly in an attempt to establish a fairer system with peasants being recognised as owners of the land, whilst also attempting to increase the efficiency of revenue collection. Land categorization was an attempt to exercise control over both the population and natural resources and minimize "grey areas" (Vencatesan, 2006: 1454). Mapping served the purpose of getting the local revenue structure in order, and was a statement of political intent (Neild, 1979). Lands were surveyed and classified as cultivated, fallow or waste, an amended version of the pre-colonial classification system. Cultivated land was the only land regarded as productive by colonial officials so only land recorded under this class was included in the revenue system. "Assessed dry and wet wastelands were lands that were kept uncultivated until an official allotment was made by the Revenue Department. This category of land included a range of habitats such as marshes, seasonal wetlands, steep and rocky slopes, abandoned pasture lands, and lands under shifting cultivation" (Vencatesan, 2006: 1455).

The categorisation of wetlands as 'wastelands' during this period, with associated ideas about low productivity, represents a fundamental misunderstanding of the landscape and its related resources and livelihoods. "Water logging of the south Chennai Floodplain was of local relevance, historically. The seasonal flushing and retention of water enabled three primary livelihoods in the landscape, the cultivation of paddy and green leafy vegetables, the production of fodder for livestock, and fishing" (CityConnect & CareEarth, n.d.-a:). Throughout the Empire the value of wetlands for the provision of reeds and fodder were not recognised by the revenue system. As a result these essential resources are often invisible in early revenue files (Pournelle, 2003). Such examples reveal different perceptions of value from 'above' and 'below'. The conceptualization of wetlands as wasteland by those in power led to their devaluation in official terms, with long-lasting consequences for their management and perceived usefulness. However, the monsoonal landscape with its annually flooding rivers, seasonal lakes, patterns of erosion and sedimentation and changing river courses refused to conform to categorization. "Lands classified as cultivated could turn into lakes, fallows be broken up and cultivated and river flood plains cropped or swept

away during the rains" (Cederlöf, 2013: 21). Throughout British rule there was a constant reinterpretation of the 'actual' meaning of the different revenue classes to make revenue administration adjust to the natural conditions (Cederlöf, 2014: 34).

Continued engineering of the landscape was undertaken by the British through large-scale infrastructure works, these hydraulic interventions have been referred to as "colonial hydrology" by D'Souza (2006). The Buckingham canal was the first known manipulation of the Pallikaranai marshland area. The primary purpose of the canal was transportation. Road and rail infrastructure were limited in the early days of the Presidency and the dangers of the coast meant there was a need for safer means of transporting goods by boat. The canal involved engineering on an immense scale, in its entirety the canal extends for a total length of 796km. The project was conceived in 1800. Construction on the northern and southern sections of the canal took place in stages from the early 1800s until 1900 (Rao, 2015). Certain sections were developed in the 1870s as part of famine relief works following the Great Famine of 1876-78, caused partly by failure of the monsoon rains but exacerbated by imperial policies such as the *ryotwari* system (Davis, 2002).

The canal was built by connecting the lagoons and backwaters that ran parallel to the coast. Descriptions of the process provides valuable information about the Coromandel coastline and surrounding areas. The canal was described as passing through "a dreary waste of sand, but much of this barren and arid country has been greatly developed and improved owing to the remarkably cheap means of communication afforded by the canal" (Russell, 1898). The physical construction of the canal, and its later operation, resulted in a high level of awareness of the surrounding delta system and weather patterns, although it is likely that such knowledge was unevenly distributed. Russell's history of the canal includes detailed descriptions of the sand bars that formed at outlets from the canal, backwaters and rivers along the coast which required manual cutting in some years to prevent the canal from flooding, and cyclones constantly threatened the canals operation (ibid.). It is clear from then that the canal required constant management to keep it functional.

In terms of settlement patterns the bulk of the land on the outskirts of the city was still described as paddy fields irrigated by tanks. According to colonial accounts, the tanks were recognizable by "their stagnant pools in monsoon time menacing the public health" (Madras Tercentenery Committee, 1939: 283). However, this period sees the beginnings of urban expansion, with the development of colonial garden suburbs in the southern outskirts (Gajendran, 2016). This was partly promoted by a desire to escape the cramped conditions in the European quarters, and partly to ensure that the lives of the Europeans and the lives of Indians were as segregated as possible. "For this reason they built lavish homes in unoccupied areas … (i.e. on uncultivated land), even building roads that deliberately avoided Indian villages… family life was protected from the surrounding environment – partly by using fences and trees to ensure privacy and partly by simulating English conditions within the house's grounds" (Pile, 1999: 29). As the city expanded these became suburban compounds.

Post-colonial

After Indian independence in 1947, the city became the administrative and legislative capital of Madras State which was renamed Tamil Nadu in 1968. The city was renamed Chennai in 1996. This period saw city makers striving to transform Chennai into a metropolitan city on both a national and international stage. The post-Independence period witnessed the emergence of a new system of politics. The Dravidian movement began as the 'Self-Respect' movement in 1925 under the Madras Presidency. Dravidian populist politics aimed to emulate Enlightenment "rationalism", and attacked Sanskritic superstition, Brahman clericalism, and the exploitative, hierarchical caste order

(Rudolph, 1961: 285). According to Arabindoo, despite a strong inclination to reject a city that was a product of British colonialism, Madras was chosen as a political headquarters due to it being a "convenient administrative centre, with a well-developed infrastructure system not available in other Tamil cities" (Arabindoo, 2008:138).

Despite the removal of colonial legacies from the city, for example the renaming of buildings and roads, there was a continuation of the colonial land classification and associated revenue system. A portion of the marsh has been classified as wasteland since 1970 (Joshi & Kale, 2013: 333). The continuation of this classification system had major implications for the status of Pallikaranai and is cited as one of the main causes for the multiple encroachments into the marsh during this period. Wetlands such as the marsh "are considered almost synonymous with wastelands, to be filled up, occupied and diverted for various human needs, disregarding the ecological services these ecosystems offer" (Azeez et al., 2007: 1).

It has been observed that as part of neoliberal attempts to develop the city during this period, urban water bodies were prime targets, seen as sites for "land in the making" (Coelho & Raman, 2013). The Ramscar Convention for the protection of wetlands was signed in 1971, but despite this the 1980s onwards saw the rapid disappearance of wetlands within Chennai. Increasing urbanisation led to changes in the patterns of social life. Over time the *erys*, tanks and the canal fell into disuse and were gradually filled with sediment and waste. According to a report by IIT Madras, Chennai used to have about 650 small and big water bodies in and around the city, but this number has been reduced to less than 30 (Lavanya 2012: 5). Some of the hydrological structures that had been developed over the last three thousand years remained, continuing to play an important but largely unrecognised role in the management of the hydrological landscape. The Buckingham Canal which no longer functioned as a transportation system fell into disrepair, but it still served to protect the city from seawater intrusion and acted as a buffer for cyclones, perhaps creating a false illusion of stability (Srivathsan & Lakshmi, 2011). It seems that this period saw a loss of knowledge about the important role that water bodies played in the regional landscape, a process that began under colonial rule. Their value only becoming apparent through their loss, or when they ceased to function as they should.

Later, the influence of globalization and ideas of progress and improvement led to urban water bodies being seen as sites for improvement, development and profit. "In Chennai… water bodies and waterways are now, above all, emblems of the cities aspiration to world-class status. Waterfront development, beautification, and eco-restoration, along with high-end infrastructure, are both direct strategies for real estate accumulation" (Coelho & Raman, 2013). However, it seems that only selected water bodies were designated for 'improvement'; there is still evidence of the filling in of 'low value' water bodies which indicates limited concern for wetlands and the dominance of socio-political agendas. The 1990s onwards saw the gradual encroachment of the Pallikaranai marshlands, as well as coastal areas which had previously been considered too precarious for residential purposes.

Urban relations with the monsoon are ambiguous in literature on the modern city. It is possible that urbanisation, and the development of lifestyles that are less dependent on the vagaries of the weather and seasonal cycles, saw a distancing between city dwellers and the monsoon. However, it is claimed that the annual wait for the monsoon continues to span the urban-rural and rich-poor divide in India. "The farmers wait desperately because they need the rain at the right time to sow their crops. The city managers wait because by the beginning of each monsoon period, the reservoirs that supply water to cities are precariously low. All of us wait, in spite of our air-

conditioned living, for the relief rain brings to the scorching heat and dust" (Narain et al., 2016: 4). Many of the references to the monsoon in recent literature relate to flooding and extreme weather events. Both the tsunami in 2004 and extreme flood events in 2015 reminded Chennai residents of their proximity to the coast and the dangers brought by unregulated monsoon rains. These threats to the city led to a re-evaluation of the urban landscape with a recognition of the role that water bodies play in flood management and groundwater replenishment, resulting in renewed recognition of the marsh.

During this period Pallikaranai suddenly becomes visible in the literature. The proliferation of studies on the marsh utilise a range of methods. Satellite imagery and aerial photography giving a 'birds eye view' of the landscape has helped people to understand the changes in size and impact of the encroachments. Hydrological modelling has enabled the mapping of groundwater flows, inflows and outflows and the movement of sediment and pollution. Sampling of soil and hydrological modelling have made links between marsh and monsoon explicit. Questionnaires have been undertaken to assess resident perceptions of the marsh in relation to ecosystem services. Ecological surveys have produced detailed descriptions of the habitat types and lists of the species they support. Environmental impact assessments have been carried out, mainly for construction purposes. Much of this research has been aided and encouraged by environmentalists and civil society activists concerned about the place of the marsh in the city. As well as leading to the expansion of new knowledge, the marsh and other water bodies also prompted renewed interest in traditional knowledge with the *ery* system and the *tinai* concept being revisited for insights into ecologically sensitive approaches to water and land management (Ganesan, 2008; Vencatesan & Daniels, 2016).

Marsh as urban production system

The marsh has only been incorporated into urban Chennai in the last thirty years or so. Processes of incorporation through the expansion of city boundaries has been influenced by a confluence of human and more-than-human forces. During this time a proliferation of urban systems have emerged and organised around the marsh, many of them a result of historical and global patterns of influence. These systems, the publics they gather and the controversies they provoke will be described in this section in order to outline the entangled landscape of the present day marsh and its current status within the city.

Urban systems

Since the 1990s the area around Pallikarani marsh has been undergoing a conversion from peri-urban to urban. In a study conducted in 2002-2005 (DUSD, n.d.), the land surrounding Pallikaranai village is described as being good agricultural land occupied mainly by scheduled castes with paddy being cultivated two times a year. However, the sale of agricultural land for residential purposes led to a reduction in the area under cultivation. Landowners in the area converted their livelihoods to non-agricultural activities, many starting small businesses following sale of their land. It seems the margins of the marsh were initial targets for development, followed by landfilling to reclaim areas of the marsh for construction. As a result, the population of Pallikaranai increased markedly from 7,822 in 1991 to 22,503 in 2001, a three-fold increase in size (ibid., 40).

During this time the space provided by the marsh was in demand for various purposes leading to multiple forms of encroachment. Perhaps the most prominent of these, visible even in satellite imagery, is the Perungudi dumpsite. Established in 1987, when Pallikaranai was outside of the city boundaries, the dump has come to dominate the landscape. The site has rapidly increased in size, doubling in area from 1995 to 2002 (Parameswari, 2012: 31). Research conducted in 2013

estimated the amount of waste received by the site to be 2,450 tons per day (Roumeau, Seifelislam, Jameson, & Kennedy, 2015). Burning and burying are main methods of 'disposal'. Burning is used by waste pickers, who derive their livelihoods from the dump, as a means to retrieve metals and non-combustible materials. In addition to the dumpsite, the Perungudi sewage works, managed by Chennai MetroWater, has also been located in the marsh area. The plant was originally built in the city outskirts in order not to affect residents, but houses were later built around it. The works were expanded some years ago to serve the IT corridor. The additional facilities were located in Perungudi because of the construction activity in the south of the city, treated sewage water being used for construction.

Low land values, partly due to the marsh's wasteland status and partly due to the presence of the dumpsite and sewage works, led to the establishment of public and government sector buildings. These include the National Institute of Ocean Technology and the Centre for Wind Energy and Technology. "The marsh and its surrounding areas faced a barrage of municipal infrastructure constructions from the early 1970s as the Municipal Corporation of Chennai capitalised on the vast expanse of 'wasteland' on the city's peripheries" (Coelho & Raman, 2013: 152). These developments were facilitated by the ability of politicians to utilise government or *poramboke* land, and manipulate regulations in order to enable construction works to take place. "Every plot of land in Chennai has been classified according to its use. These classifications were originally marked out over 200 years ago by the colonial government for revenue generation. The ELCOT plot area was designated as a wasteland. These lands can be put to alternative uses only after they are reclassified, which is a nine-fold process. But in the case of ELCOT, reclassification was directly dealt with by a Special Committee and then sent to the Government for approval" (Govindarajan, 2016). Another factor cited for the cities expansion to the south was the freshwater resources. As a water scarce city, the presence of the freshwater aquifer running parallel to the coast has contributed rather significantly to the expansion of Chennai's boundaries to the south (CityConnect & CareEarth, n.d.-a).

The 1990s saw the establishment of slum resettlement colonies in the marsh area. Maylai Balaji Nagar, located to the north west of the marsh, was built to rehouse families living alongside the Buckingham Canal in order to make way for the new Mass Rapid Transit System (MRT). The land on which the settlement is built was also reclaimed from the marsh. According to newspaper reports the community face severe drainage problems particularly during monsoon season with references to stagnant pools of water which form around the settlement and serve as breeding grounds for mosquitoes. There are issues with access to sanitation services and the maintenance of access roads and concerns about groundwater quality due to its proximity to the dumpsite (Manikandan, 2013). Another resettlement colony called Kannagi Nagar was constructed over the Okkium Maduvu to the south of the marsh, the channel that connects the marsh to the sea. Construction began in 1989 and by the end of 2009 the settlement comprised 15,000 apartments. "The scale and pace of the change that this colony wrought on the local area in terms of population alone was enormous" (Coelho & Raman, 2013: 153). Engineering interventions were required to make the marshy land suitable for construction "The low-lying area has required filling to an average depth of 2.5 metres to bring it up to the level of the surrounding development and to avoid inundation during the monsoon" (ibid., 154).

The Pallavaram Thoraipakkam Radial Road, also known as the 200 Feet Road, was constructed across the middle of the marsh in 2000 by the State Highways Department. The road connects the Grand Southern Trunk Road with the Rajiv Gandhi Expressway (OMR). This road is cited as one of the first major manipulations of the marsh following the Buckingham Canal, contributing

significantly to fragmentation. “The marsh is divided into two distinct portions by the KT link road… The road practically cuts off the continuity of the wetland system” (Azeez et al., 2007: 18). The presence of the road has encouraged the development of residential areas. “This part of the city considered by public as backward and not favoured few years back, has changed rapidly after the construction of the KT Link Road and opening of a string of stylish residential projects” (ibid.). In addition to the road, a sprawling station for the Mass Rapid Transport System (MRTS) was built on the northern side of the marsh taking up yet more land (Coelho & Raman, 2013). The development of transport infrastructure has facilitated access to the rest of the city, as well as the world with better transport links to the airport. Again, it seems the marsh’s *poramboke* status has facilitated these expansions. A feasibility report conducted prior to the road construction referred to the commons as *poramboke* lands that were empty and unused. ”By constructing the expressway over them, the government would be mobilising ‘worthless’ lands to create worth, while relieving congestion in the hinterland” (Kumar et al., 2014: 48).

Developing alongside the marsh is the IT Corridor project, an initiative of the Tamil Nadu Government to promote Chennai as an IT friendly global city. Export oriented IT and IT enabled services are a key part of Chennai’s international growth strategy. The corridor consists of some 15 million square feet of commercial space (Coelho & Raman, 2013). It is home to a number of major companies as well as prominent government institutes and technical educational centres. The corridor stretches roughly 20 km from Tidel Park to SIPCOT IT Park along the newly widened Old Mahabalipuram Road, now known as the Rajiv Ghandi Salai Expressway. In order to attract global and domestic investments, preferential policies have been put in place and regulations relaxed. The road is now dominated by high-rise, high-end developments, the presence of high-rise buildings made possible by the charnockite rock underlying the marshland (Surya, 2016). Due to the employment opportunities created by the private and public sectors operating in the area there is high demand for housing for employees. “As more and more information technology parks emerge along the old Mahabalipuram road, large workforce requires accommodation and other basic amenities” (Azeez et al., 2007: 7). This has led to further changes in the landscape and economy.

Urban publics

These rapid developments have had widespread consequences which have mobilized, and impacted on, urban publics. Traditional users of the marsh have been gradually pushed out, although apparently the marsh is still a source of livelihood for some communities. “Inhabitants of seven villages, namely Pallikaranai, Taramani, Velachery, Perungudi, Perumbakkam Thorapakkam and Sholingannalur, are partially depend on the wetland for subsistence. Of these some ethnic groups are highly reliant on the wetland” (CityConnect & CareEarth, n.d.-a). However, these livelihoods have diminished both due to changes to the marsh ecosystem and the urbanisation of the area. Along with their alienation traditional forms of resource use and knowledge about the marsh are likely to disappear with negative consequences for the marsh. “Erosion of the commons quickly follows the erosion of community institutions. After all, commons need communities to retain their identity and integrity. Where the community has receded, the government and private sector step in, and the commons have either shrunk or been lost to notions of worth dictated by capital and the markets” (Kumar et al., 2014: 48).

The influx of middle-class and wealthy urbanites has contributed to growing social inequity in the residential areas surrounding the marsh. Most of the long term settlers, living in ancestral properties, are either high school dropouts, uneducated or are involved in their own business activities. Recent settlers in contrast belong to a higher economic status and tend to have tertiary

level education (Parameswari, 2012; Venkatachalam & Jayanthi, 2016). The influx of the wealthy may lead to the displacement of the poor in the longer term, particularly if land values continue to rise. However, in the present it is argued that employment opportunities offered by the IT corridor have led to greater livelihood opportunities for the poor (Kennedy et al., 2014; Next City, 2013). There is little information in the literature about people's day-to-day interactions with the marsh. It is likely that differences in the length of settlement in the area will influence people's relationships with the marsh, with more recent settlers lacking knowledge of the history and role of marsh in the landscape. It is reported in newspaper articles that new settlers are often unaware that they are purchasing property in a former marshland area, despite indications of the presence of water contained in local street names (Nirmal, 2015).

Rapid changes in the condition of the marsh have mobilized conservationists and researchers to raise awareness of the consequences of urbanisation for the marsh and the species that inhabit it, as well as for the city at large. As a result of its enhanced profile the marsh has attracted much research interest and has been the object of study for students, academics and international research projects. Apparently there are 40-45 studies on various aspects of the marsh by national and international institutions (CityConnect & CareEarth, n.d.-a). Many of these studies have played a valuable role in advancing knowledge about the marsh. Possibly as a result of these activities, a series of actions have been taken by city and state officials to help conserve the area. In 2003, 548 hectares of the marsh were classified as protected land. Following this, 317 hectares were declared reserve forest and brought under the jurisdiction of the Forest Department (Wikipedia, n.d.).

The city was seriously affected by floods in 1996, 1998, 2005 and 2010 (Gupta & Nair, 2011: 1641) and areas surrounding the marsh were some of the worst hit in the 2015 floods. In response, there has been a surge of resident groups and multi-stakeholder platforms advocating on behalf of the marsh. "After severe floods affected residential areas along the marsh in 2002, a widespread citizen movement began actively pressing for better floodplain management through restoration and conservation of the marsh" (Coelho & Raman, 2013: 152-3). The 2007 Management Plan also reports a widespread interest in the marsh on behalf of the general Chennai populace. "Several individuals have undertaken studies of the marsh on their own concern and involved in studies and awareness campaigns" (Azeez et al., 2007: 23). The floods and the plight of the marsh have been a source of inspiration, journalists have written a vast number of newspaper articles, there are amateur films and music videos about the marsh as well as numerous blog entries and social media groups.

Urban controversies

Flooding has served to generate and highlight a number of controversies in relation to the marsh. Waste has been identified as a major contributor to the floods, both in terms of the dumpsite's effect on the marsh and the fact that unregulated garbage disposal has restricted the storage of water by many of the city's water bodies. Plastics and other forms of waste have also blocked the storm water infrastructure exacerbating the flooding. There seems to be a clear connection between waterbodies and waste, not just in Chennai but in other Indian cities too. In the context of Chennai, it is argued that the categorization of areas like the marsh as 'wasteland' leads to them being used as areas for waste disposal. "Ignorant about the ecological values…it is easy for public to consider them as wasteland and use for easy garbage dump and sewage release. This practice serves two purposes in the public eye; filling up a seemingly useless low lying area and saving expenditure on solid waste management" (Azeez et al., 2007: 15)

Although a seemingly simple solution, there have been growing concerns about the effects of the resulting pollution on the health of urban residents. There is no bottom liner for the dump and no leachate collection or treatment systems, resulting in the seepage of pollutants into the marsh. “Dark pool of foul smelling streams are common in the area around the garbage dump in many parts of wetland in Pallikaranai. Mass kills of frogs, fish and sometimes water birds have also been reported” (Priya, 2014: 108). Although the marsh itself acts as a carbon sink, the dump is thought to contribute to greenhouse gas emissions (Jha et al., 2008). Concerns about the effects of pollutants on the ground water table are evidenced by the number of studies that have been carried out (Aravindkumar et al., 2014; Jayaprakash et al., 2010; Karpagavalli et al., 2012; Parameswari & Mudgal, 2015; Parameswari et al., 2012). Studies undertaken in residential areas skirting the marsh reveal that water at all depths is unfit for drinking, with water in and around the garbage dump containing low levels of heavy metals (Azeez et al., 2007). Burning of garbage means that the air as far as 1,000 miles from the dump yard are impacted by chemical particulates including carcinogens (ibid.). The effects of groundwater contamination and environmental pollution have found to be uneven in terms of who they impact. Women and children who live around the marsh are more susceptible to health problems, children because they are more vulnerable and women who stay at home because they are exposed to contamination for longer periods of time (Parameswari et al., 2012).

These issues, particularly the pollution of groundwater and its implications for the aquifers in the region, have forced city officials to address how Chennai deals with its waste. Projects such as Exnora have been established to encourage citizens to take responsibility, as a result of the Corporations inability to manage waste effectively (Mahajan, 2016). Apparently Pallikaranai panchayat was among the first local body to experiment with source segregation, delivering training to women self-help groups on composting kitchen waste (Manikandan, 2008). However, resident attitudes to waste are only part of the problem. There is also evidence of illegal dumping of solid waste and sewage, even by companies associated with the Corporation of Chennai (Coelho & Raman, 2013). There have been some attempts to regulate this through court action, but with little avail.

The marsh falls under the jurisdiction of multiple agencies. This has shed light on the lack of coordination between departments and poor urban planning processes. As a result of the administrative fragmentation of the marsh area into multiple local government bodies “the city failed to recognise the extent of the marsh the unity among its various segments, and the interconnections between the marsh, the larger floodplain, and the drainage channels to the sea” (Coelho & Raman, 2013: 152). They go on to say that “The manifest damage to the southern aquifer since the 1990s, and the sudden and significant increase in flooding problems in neighbouring parts of the city since the early 2000s speak of the incoherence of the ‘environmental planning and management’ (EPM) frameworks that has been deployed by Chennai’s urban planning establishment since the early 1990s” (ibid., 153). Despite the creation of the ‘Protection of Tanks and Eviction of Encroachment Act’ in 2007 and multiple court cases, there has been little implementation of this law to protect Chennai’s wetlands and water bodies (Gupta & Nair, 2010; Seenivasan, 2016).

Drescher et al., (2007: 3) write that the Chennai planning authorities are “paralysed by different interests, corruption and economy driven decisions and also by a discord in the roles and responsibilities of different agencies” with devastating consequences. “Canals are dysfunctional; storm water drainages are not cleaned regularly; water bodies are not maintained. Residential areas as well as encroachments mushroom fast. Already now, the Northern side of the marsh is

completely encroached. Uncontrolled construction of IT-companies and private citizens, both legal as well as illegal, are in complete ignorance and violation of the norms and rules of the government. The combination of these factors results in a collapse of natural drainage systems" (ibid.). Some go further, suggesting the state has actively colluded with developers and encouraged encroachment of the marshland. "Rather than check such takeover of government and common lands, the Corporation of Chennai and local bodies have actively colluded with private developers by providing such illegal developments with 'world-class' roads, electricity, sewage, and water connections. A 2011 directive to the CMDA and Corporation of Chennai to identify all violations of the CRZ remains on paper with no action taken till date" (Kumar et al., 2014: 49). Others have gone as far as alluding to the possibility of "guarded schemes" that proactively encourage the filling in of the marsh with waste in order to facilitate construction works, the refilled land being acquired for real estate development (Azeez et al., 2007).

Despite the obvious impact of anthropogenic activities on the marsh, there have been public debates about whether the causes of past floods were 'natural' or manmade. Leaders of the Tamil Nadu government were criticised for blaming the 2015 floods on "unprecedented rains" resulting in "inevitable damages", thereby evading anthropogenic factors such as poor urban planning and the lack of adequate contingency plans (NDTV, 2015). The severity of the recent floods also led to speculation about the links between flooding and climate change with changes in monsoon rainfall being attributed to shifting El Nino patterns (Rajgopal, 2015). Analysis of the meteorological data seem to suggest that while rainfall quantities may not have increased, rainfall patterns may be subject to changes. Gupta & Nair (2010: 368-9) state that 'meteorologically, there is no major upward or downward trend of rainfall during the last 200 years'. Drescher et al., (2007) have found that the last 20 years have been characterised by a decrease of annual precipitation, although the number of floods is increasing. They, along with many others, argue that man-made changes in the area of the marsh are aggravating the frequency and intensity of floods.

It is now widely recognized that the rapid urbanisation that occurred from 1995-2007 led to drastic changes in urban land cover. Most of the green cover in the city was reduced to non-vegetative or concrete space leading to high surface runoff and a reduction in infiltration capacity (Lavanya 2012). Lost vegetation, included sacred groves, had previously helped to maintain ground water levels as well as serving as repositories for floral and faunal biodiversity (Janardhanan, 2011). Loss of trees changed the micro-climate of the city and contributed to a reduction in the absorptive capabilities of urban spaces. The connections between water bodies and their role in flood mitigation is also recognised. "Buffer areas of a lake are the first causes of rapid urbanisation. Known as *odai porambokku* and *yeri porambokku* in Tamil – meaning rivulet across a wasteland and lake on a wasteland respectively – these buffer areas connected lakes and drained excess water from one water body into another. These channels formed an integral part of a natural flood mitigating system… Also, pastoral land adjoining the lakes acted as floodplains during monsoon. With the channels and farmlands gone, flooding was imminent" (Oppilil, 2016). In addition, groundwater extraction leading to subsidence makes the city even more vulnerable to flooding, as well as rising sea levels, dangers that delta cities worldwide are facing (Tessler, 2015). Knowledge has also emerged about the possible effects of heat islands as a result of urban land cover change on rainfall patterns (Mitra, Shepherd, & Jordan, 2012). Such advances have led to increasing awareness of the need to coordinate urban planning with the hydrological cycle.

Marsh as knowledge production system

A review of the literature illustrates a shift in the way the marsh is represented over time, different representations reflect changes in people's interactions with and understanding of the

marsh. Various terminology has been used to describe the marsh over the years including: *kaiveli* (drain), *poramboke* (wasteland), *Kazhiveli* (generic names for marsh and swamp). The continued significance of the *poramboke* term can be seen in the fact that recent conservation efforts have actively sought to reclaim the term and reinstate the value of areas designated as wasteland (Poorvaja, 2016). More recently there has been more positive recognition of the marsh with it being cited as "one of the last remaining natural wetlands of South India" (Drescher et al., 2007) and as such is of "international significance" due to its biodiversity (Venkatachalam & Jayanthi, 2016: 7), and is widely recognized as habitat for "several rare or endangered and threatened species" (Rajarajeswari et. al., 2015: 1310). As a result of perceived threats to this now valuable ecosystem, the marsh is described variously as: under threat, in need of saving, a dying wetland, as delicate or fragile and at risk of disappearing, in danger of ecological flip, requiring restoration and protection from further disturbance. As a result, the marsh has come to be a symbol of environmental degradation and an example of the worsts of capitalist development. Emotive language is frequently used, in both newspaper coverage and academic papers, as an appeal to action (Madhav & Victor, 2010). This includes the use of bodily metaphors, the Okkium Maduvu channel being referred to as "the aorta" or "pulmonary vein" of the marsh (Coelho & Raman, 2013: 154) and Pallikaranai as the "lung and kidney of the city" (Azeez PA et al., 2007: 7).

Various solutions have been proposed to save the marsh, each with slightly different framings and rationales. One management plan proposes to build a boundary wall with watchtowers to protect the marsh from encroachers, it describes the need to take urgent action on a "war footing" (Azeez et al., 2007: 25). However, it is not clear who the encroachers are that they seek to prevent. In contrast, the later management plan written by Care Earth and CityConnect (n.d.), advocates a "flexible, inclusive and knowledge based approach". This plan proposes the establishment of one governing body for the marsh, requiring expert ecological knowledge. This highlights the possible political and territorial agendas at play in the formulation of such plans. Research has been undertaken on eco-restoration through the planting of species to ensure biodiversity (Rajarajeswari et al. , 2015). Presumably these species need to be carefully selected, the invasive plant and fish species already present in the marsh are possibly remnants from previous attempts at 'improvement'. Various proposals have been made to de-silt, dredge and re-channel areas of the marsh and connected water bodies. Such actions are controversial because they alter the hydrological functioning of the marsh with potential unforeseen consequences. There are also plans to map and re-establishing connectivity between different water bodies. This requires an understanding of the complex hydrogeology required to establish subsurface connectivity; delays in implementation indicate a potential lack of knowledge by planners.

"Design with nature" proposals have been developed that aim not to subjugate nature including a proposal for eco-mimicry taking inspiration from mangroves (Surya, 2016). However, the fact that the marsh is not a mangrove ecosystem raises the question of whether such interventions are appropriate. One scientific study has explored whether a bacterial culture found in the landfill area could be utilized to break down low grade polythene, something known as "biodegradation" (Karim et al., 2015). Another describes a bacteria-driven electrochemical device capable of cleaning up waste water containing organic matter. Apparently the devices are available at a pilot level but are not yet commercially available (Sreema et al., 2013) indicating potential cost issues. There have been proposals and initiatives to re-landscape and improve the greenery around the dump (Lopez, 2014). Such 'greening' may just be a short-term solution that masks rather than deals with the waste disposal issues. The Forest Department have taken steps to facilitate birdwatching areas and educational centres have been proposed to encourage public interaction and raise awareness.

A number of these proposals raise questions about whose needs are being met by such solutions; what are the politics of the distribution and management of these solutions? Who and what is marginalised in the course of the subsequent 'improvements'? When considering preservation efforts, it is important to ask what is being preserved, how and by whom. Should conservation efforts be based on the status of the marsh at a particular point in time? Do these efforts contradict with an ecology that is dynamic, liminal and fluid by nature? What consequences will restoration processes have on the species that interact with and inhabit the marsh? Who has the right to represent the marsh and who should be involved in the decision making processes that take place on its behalf? There are already a number of advocates for the marsh who are considering some of these questions.

It is also clear that depictions of the marsh as fragile and vulnerable contradict somewhat with its undeniable presence in southern areas of the city, its uncontrollable eruption during periods of flooding and its emergence in inconvenient places such as residential areas, slum resettlement complexes and the IT corridor. Through its unpredictability the marsh helps to highlight that "agentive force belongs not only to humans, but also to water, plants, animals, and to the geosphere" (Morrison, 2015: 6). Without undermining the urgent claims of those wishing to conserve it as an ecological site of importance, the marsh perhaps serves to remind us that "instability, rhythmical movement and dramatic changes of state are ordinary aspects of the earth's own history" (Clark, 2011: xii). It also demonstrates that "'nature' will not submit to total control, arrangements of such complexity are incapable of having an order or logic imposed upon them" (ibid., 10). With this in mind the marsh, as a monsoonal ecology, can perhaps help to foreground 'nature' and ecology, including the meteorological, in the urban and political imaginary, facilitating the production of new knowledge and responses.

Conclusion

This review has attempted to historicise and acknowledge the array of processes that converge and influence the making of a place. It has attempted to frame the marsh, and therefore the city, within a timescale that stretches beyond current activities in order to encompasses earthly and human processes which may otherwise escape us. The various representations of the marsh that have emerged and the associated knowledges, solutions and actions are revealing. They enable us to map the effects of shifting patterns of power in global and local governance systems past and present, including processes of colonisation. They highlight patterns of citizen alienation and participation in political and planning processes. We can trace changing attitudes towards nature and the environment and the ongoing need for humans to exploit and protect, preserve and improve. Different relationships to the land and resources result in different ways of capitalising on and monetising so-called ecosystem services. Confluences of meteorological, earthly and social forces demonstrate the importance of moving beyond the human. Processes of forgetting and remembering indicate that knowledge systems can persist and influence over time, as well as become lost or marginalised. It is hoped that this review helps to highlight gaps and areas for further exploration and research in the context of the Monsoon Assemblages project. Potential questions moving forward include:

- How can we better understand the marsh as an 'entangled landscape': a place where human activities, animals, plants and material objects are intertwined? What is the role of people in this context and how do we move beyond the human?
- How do people experience/interact with the marsh on a daily basis? What does the marsh mean to different groups? How is it known? How do these understandings intersect/complement/contradict?

- Can we as western researchers act as mediators/translators/brokers? What is our claim to authenticity, or right to speak on behalf of the marsh? How can we give the marsh voice, to whom and why? What research methods can we use?
- What are the implications of our research findings for design interventions that take the marsh seriously as a more-than-human entity that can be co-designed with?
- How can we better understand the marsh as monsoonal ecosystem? How does a monsoonal focus frame the marsh differently? Is it ever referred to in this way?
- How does the marsh feature in the monsoonal ecology of the city/monsoonal imaginary of the city? Does the marsh and its predicaments have the potential to foreground the monsoon in the urban and political imaginary? If so, how?
- Can the marsh's vital significance in Chennai's monsoonal ecology be conveyed to relevant stakeholders (e.g. city planners, real estate developers)?

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