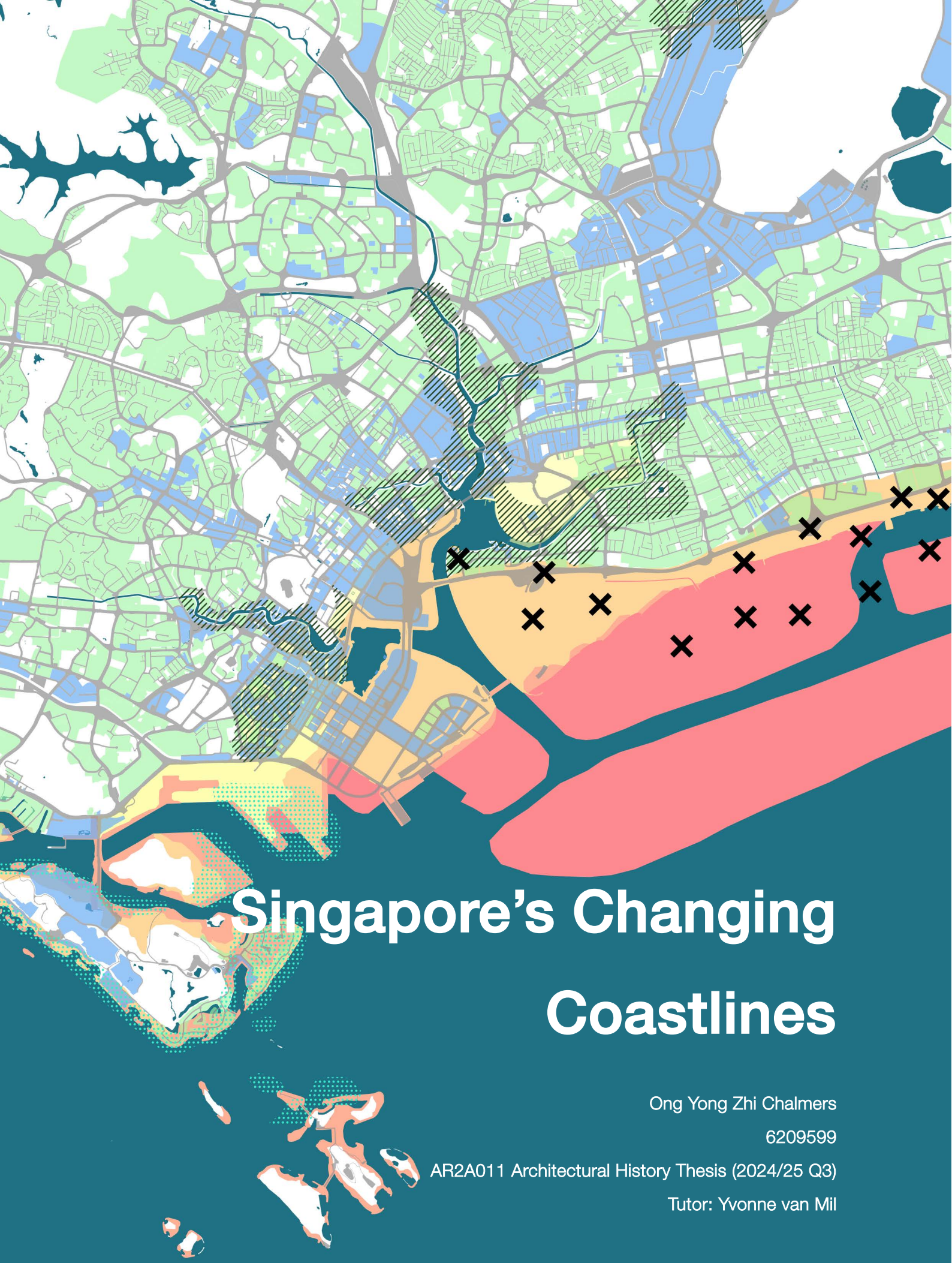

Singapore's Changing Coastlines

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AR2A011 Architectural History Thesis (2024/25 Q3)

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Introduction

Background

Despite being one of the world's smallest countries by land area, Singapore ranks sixth globally in terms of land reclaimed. (Wee, 2017) Increasing from 578 km^2 to 719 km^2 (Fig. 1 and 2) over two centuries (Singapore Land Authority, 2024), most of the land that houses top-performing global industries sits on reclaimed land - land that did not exist when the British first arrived on the island.

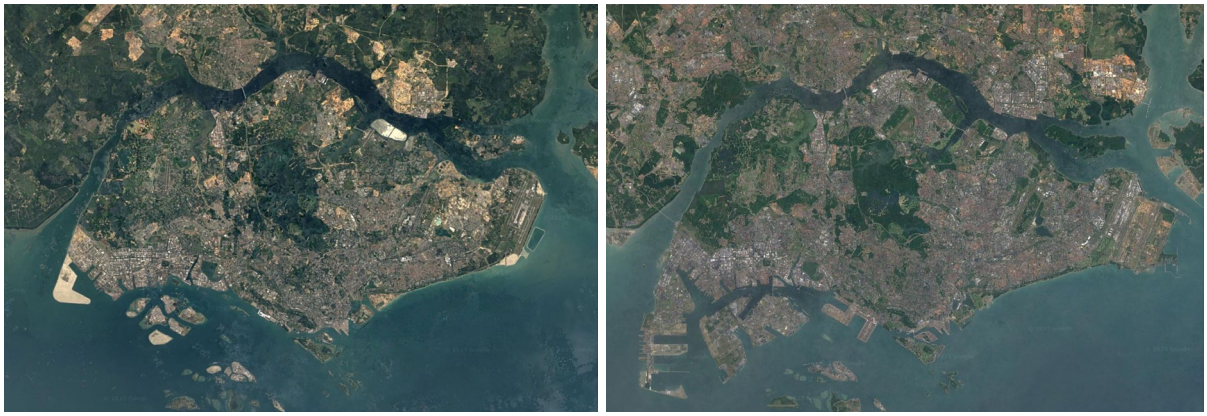

Fig 1: Singapore Land Reclamation, 1984 – 2020 (Google Earth, 1984 & 2020)

Land reclamation has been a key driver of Singapore's economic success from a third-world to a first-world economy, less than a decade after independence in 1965. Existing scholarship focuses on the research of land reclamation through a binary lens: either looking at early Singapore with a focus on colonial-era efforts or contemporary Singapore framed around environmental impact.

"(…before the British arrived) there was no organised human society in Singapore, unless a fishing village can be called a society."

- Lee Kuan Yew, founding Prime Minister of Singapore (Lee, 1969)

This perspective highlights a state-endorsed narrative that suggests an enduring logic of colonial power in postcolonial Singapore's development. While scholars link Singapore's unique postcolonial identity with the act of reclamation, few examine what role this reshaping of coastlines has in Singapore's maturing (or evolving) postcolonial condition.

Thus, this research proposes to bridge this analytical gap by examining Singapore's three distinct eras that form a complex interplay: from Singapore's colonial founding to its early expansion during post-independence, and its contemporary transnational actions regarding sand mining. Each era is examined through the lens of postcolonial theory – tracing material losses and impacts. The coastline becomes a physical and symbolic site of negotiation about authority and postcolonial identity. It prompts the question: **How does Singapore use its changing coastlines to legitimise authority and script its historical and cultural identity?**

Studying the evolution of Singapore's coastlines, we will see how a hybrid landscape shaped by erasure and displacement is beginning to grow. By challenging the binaries of natural vs. constructed and colonised vs postcolonial, a new *freakosystem* - a term informally used by Ponsford (2025) to describe an accidental hybrid environment born of human intervention – emerges from the Singapore landscape.

Methodology

The temporal structure of this essay can be attributed to two main texts: Powell's Singapore's Last Coast (Powell, 2021) on colonial and postcolonial periods and Jamieson's Granular Geographics of Endless Growth (Jamieson, 2022) on contemporary Singapore. Through a hybrid of journalistic and cartographic approaches, it recognises and attempts to reconcile the inherent limitations of relying solely on either mode of inquiry.

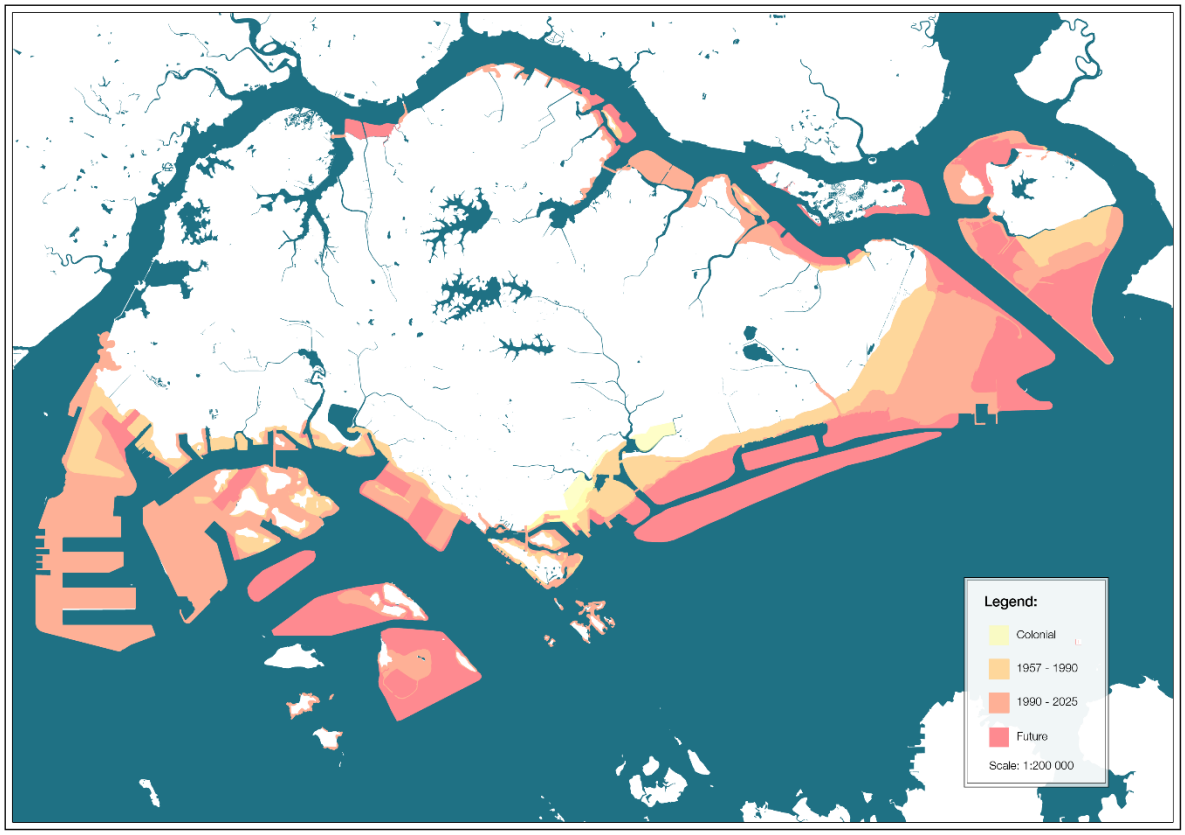

Figure 2: Singapore land reclamation data

Map adapted by the author using data shared by Kontinentalist.

Journalism leads us to qualitative sources such as opinion pieces and archival news reports that surface narratives often omitted from official accounts. The mapping begins with a base map shared by *Kontinentalist* (personal communication, March 2025), who compiled detailed land reclamation boundaries from archival records (Kontinentalist, 2021). This map is further developed to add colonial-era detail (Fig. 2) and compare it with ecological and social data to curate a graphical narrative of cumulative environmental and social impacts.

Secondly, a computational mapping pipeline is proposed as a way forward for future analysis of global sand extraction. It responds to the recurring critique by researchers on the lack of comprehensive datasets on the sand trade for analysis.

Concluding these perspectives through the lens of postcolonial theory will be a framework to decipher how Singapore negotiates with its colonial legacy while finding its place on the global stage, using its coastlines as leverage.

Part 1: Colonial Land Reclamation

When Sir Stamford Raffles first arrived on the shores of Singapore in 1819, the landscape was very different from today's urbanised city-state. Selected for its strategic location as a shipping entrepôt between East and West, it became a trading outpost for the British to rival the Dutch over Southeast Asian trade. While the British acknowledged that Singapore used to be a Fourteenth Century trading port that was attacked by regional invaders, they suggested it fell into decline – this justifying colonial arrival as a civilising mission of economic revitalisation. (Powell, 2021) However, modern historians revealed multiple waves of rebuilding stretching deep into AD 1600, obscuring the simplified colonial historiography. (Miksic, 2017)

While the island had deep-water ports for trade, the mainland was swampy and uneven with hills. These were incompatible with the British vision of a commercial port city (Fig. 3). Strong colonial trading ambitions drove the early colonial reclamation efforts, re-scripting instead of responding to the island site. These projects created a "colonial landscape" that reflected the "power and prestige of the colonialists". (Powell, 2021) Through these projects, we will observe the common theme of reorganising and sanitising space for colonial economy and power.

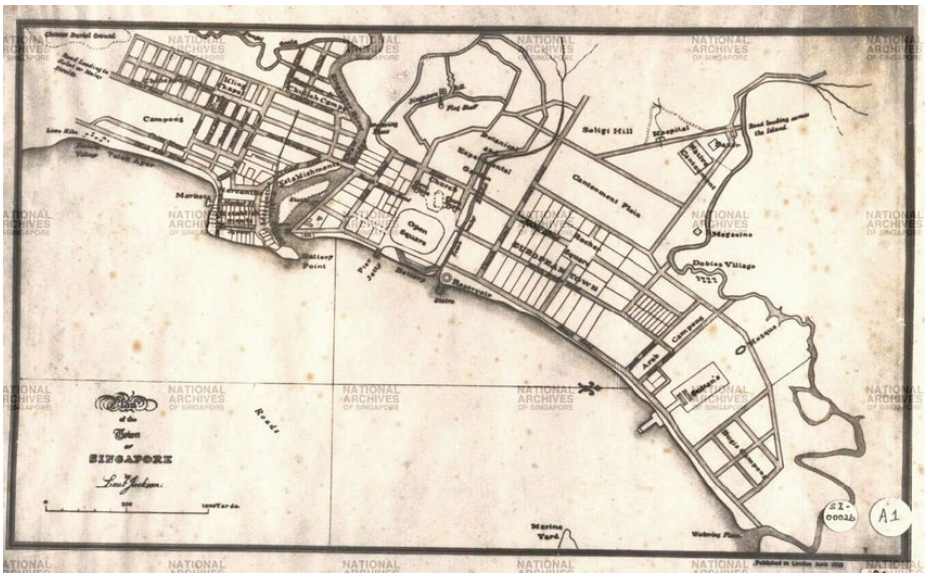

Fig 3: Jackson Plan 1822, colonial Singapore's masterplan.

Reproduced from Dutta Gupta, 2019

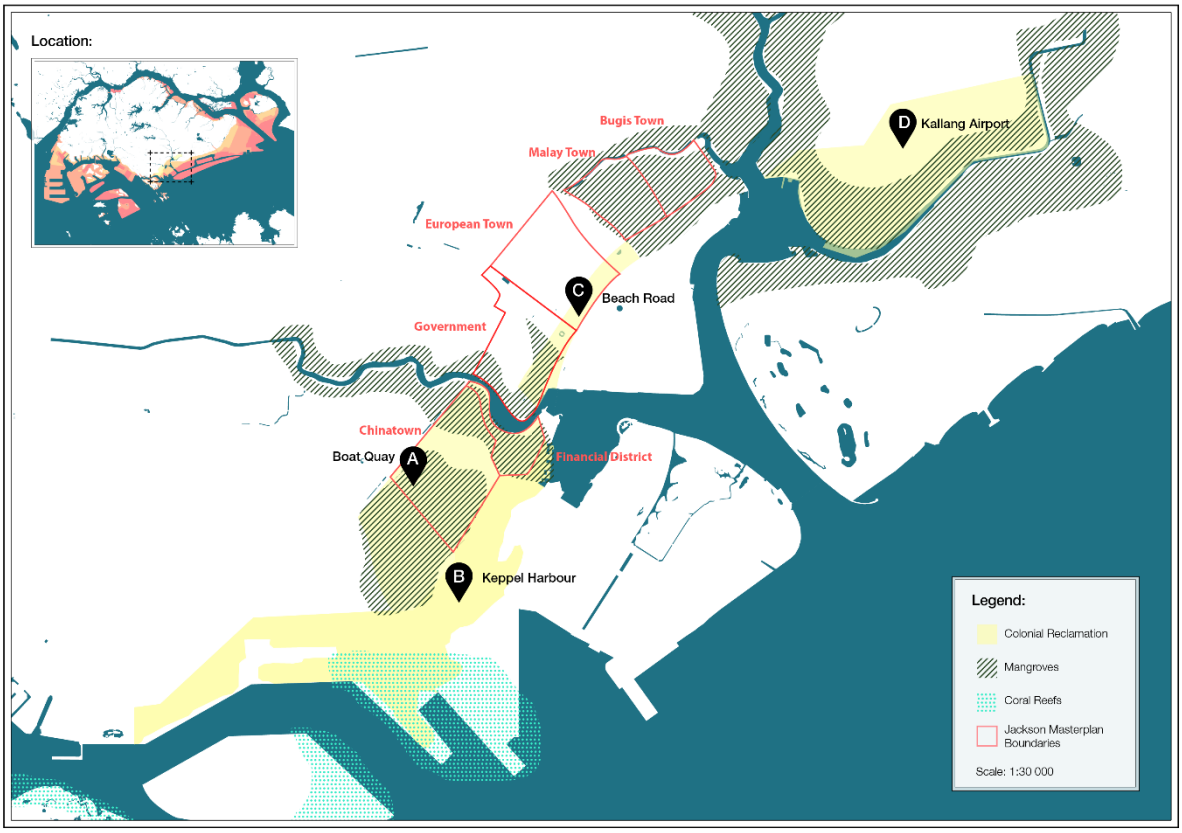

Fig 4: Annotated Colonial Land Reclamation Map

Drawn by author using data from Dutta Gupta (2019) and Ha (2021). The author constructed the layer titled "Colonial Reclamation" using Google Maps referencing and various historical accounts.

A: 1822 Boat Quay

The first reclamation project began in 1822, along the Singapore River. Colonial administration spatially inscribed social order onto the landscape. The drier northern bank with noticeably less swamp (Fig. 4) housed European dwellings and government buildings, while the low-lying flood-prone marsh of the southern bank was left for the South Asian communities. This segregation in the 1822 Jackson Masterplan (red boundaries in Fig 4) reflects the racialised logic to impose an ethnically zoned colonial city. Europeans were literally and symbolically above the rest – echoing the broader colonial desire to order the tropical landscape.

Contrary to Raffles' predictions, the *Kampong Glam* (Malay Town) beachfront was unsuitable for port ships. Instead, traders used the deeper waters of the northern bank. (Buckley, 1902) This miscalculation forced merchants to ironically relocate across the river to the southern bank – later forming the financial district (Fig. 4) – despite its

environmental vulnerabilities. This relocation reveals the rigidity of colonial ideological zoning that ultimately had to bend to the environmental conditions it sought to dominate. Thus, the masterplan was not just urban zoning but an early way of controlling “imperial order-making” – making an exotic environment legible to colonial eyes.

B: 1850s New (Keppel) Harbour & Telok Ayer

In 1852, Keppel Harbour (then known as New Harbour) was established Southwest of the existing port (Fig. 4) to accommodate advancements in oceanic trade – large steamships that required even deeper berths. However, as smaller vessels preferred the sheltered anchorage of old Boat Quay, Singapore embarked on its next land reclamation project to connect the two by circumventing Chinatown along the coast. A network of roads and rails that formed Telok Ayer facilitated the trade by blasting away hills and using the rubble to straighten the shoreline. (“Public Works…”, 1874)

However, the coastal terrain did not yield easily. Hard coral reef (Fig 4) sat on soft mud and sloped bedrock, which caused infill rubble to slide out into deeper waters. Although this problem persisted for years, archival records are vague on how engineers overcame it**.** (Lim, 2017) This archival absence suggests more than a technical gap; it also suggests the engineers’ disinterest in the environment, which was merely another imperial subject to control. What was not recorded might often be what was deemed unimportant. In a sense, the reef becomes a symbol of resistance by the environment to colonial sanitation – a seemingly silent foreshadowing cry by nature for environmental implications to come.

C: 1850s Beach Road

Simultaneously, the colonial authority reclaimed the northeastern part of Singapore (Fig. 4), presently known as Beach Road, to house military facilities and luxury recreation. This prime waterfront land, quite literally created by and for the colonial regime, became a spatial flex of power over the regime's dominance over its subjects and the very terrain itself. (Dorai, 2012)

Today, it remains spatially central to Singapore's urban consciousness. It houses iconic landmarks such as the Raffles Hotel and the *Padang*, which is now pending UNESCO heritage status. (UNESCO, 2022) Despite the deprecation of these colonial-era buildings from their original purposes, their refreshed programmes continually find themselves at the core of postcolonial Singapore's national festivities. For the past two decades, the *Padang* has been used numerous times for national celebrations. The colonial legacy persists, albeit reprogrammed.

D: 1931 Kallang Airport

The final major reclamation project was the infill of the Kallang River Basin to create Kallang Airport in 1931 (Fig. 4). Touted as a milestone of modernity with enhanced air connectivity, the authorities also celebrated yet another rehabilitation of insalubrious, blighted land.

This framing conveniently obscures the true value of the mangrove swamp. It obscured the fact that the swamp was a productive mangrove ecosystem that supported the livelihood of farmers who harvested its blessings in the form of fish and prawns. Instead, official narratives highlighted the health hazards of mosquito-borne diseases in the area and a barrier to urban expansion (Powell, 2021). As the first airport in the world with “quarantine and disinfecting facilities” (Ng, 1961), it achieved a sanitary landscape cleansed of mangrove dirt.

Thus, the area symbolically fell victim to the broader colonial logic of overwriting vernacular complexity with modern narratives of infrastructural development. Rendering local practices invisible, the rhetoric of progress is used to legitimise ecological and societal erasure.

Environmental & Social Loss

Across the four major colonial reclamation projects, a consistent theme emerges: landscape transformation was not just infrastructural but also ideological. Each reclamation project imposed spatial order in different ways: trade, spectacle or hygiene – all while ignoring the ecological and social richness of the overwritten environments. “Unusable” coral reefs and “blighted” swamps were buried under layers of sand and rationalised into imperial activities (Fig. 4). Due to the smaller scale of the colonial projects, environmental losses might not have been as evident as more recent projects and hence less well recorded. However, mangrove swamps and prawn farmers clearly had no place in the imperial colony. They arguably set the precedent for land reclamation as an irreversible overwriting of the landscape.

Although these projects were the beginning of Singapore’s rise as an Asian economic power, it is done at the cost of scripting over its vernacular complexity. Exotic tropical ecologies and social communities were displaced, and land reclamation became a technology of forgetting (Jamieson, 2022) that erased history to create a *tabula rasa* for new order and control. *Singapura* (Singapore’s pre-colonial name), before the arrival of the British, ceased to exist.

Land reclamation would continue in postcolonial Singapore’s early independence – with new narratives and technocratic ambitions. We will explore whether the colonial impulses of re-scripting and sanitation endure and whether the colonial logic of power becomes rearticulated in the postcolonial state.

Part 2: From Colonial Empire to Internal Empire

(Postcolonial Land Reclamation)

Under a refreshed independent government, the radically intensified land reclamation campaign by Singapore's postcolonial authorities made the 300 hectares reclaimed by colonial Singapore pale. Spurred by the post-World War II phenomenon known as the *Great Acceleration* (McNeill & Engelke, 2016), it propelled newly independent ex-colonies to work towards rapid economic modernisation to achieve a standard of living comparable to more developed nations. While the colonial projects focused on organising the island into a sanitary landscape for imperial trade, the government's responsibilities considered social and economic development to survive a post-war era. Thus, land reclamation became a foundation for industrialisation, national building, and its identity in the new world.

Three key government agencies were established to helm this intensive land reclamation era: the Housing Development Board (HDB), Jurong Town Corporation (JTC), and the Port of Singapore Authority (PSA). They were a key component of not just Singapore's success story but also the establishment of the government's authority.

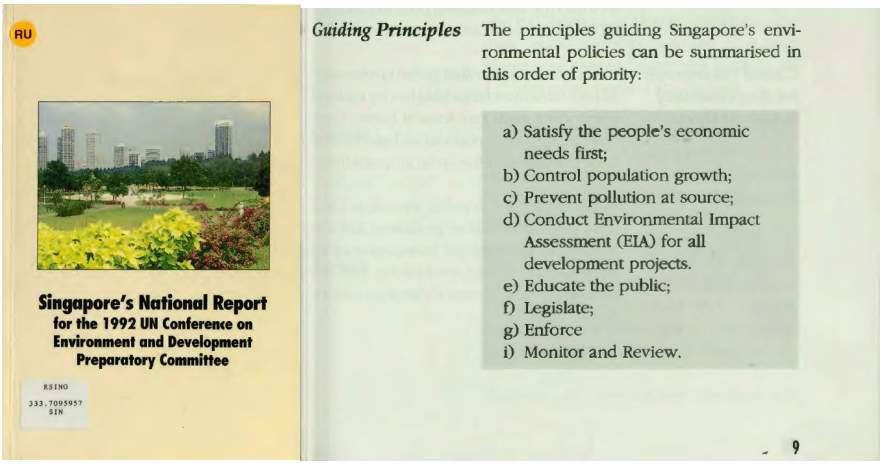

Fig 5: 1992 UN Report on Singapore's Environmental Policies

Reproduced from Ministry of the Environment (1992)

In the 1992 report for the United Nations Conference on Environment and Development (Fig. 5), the government indicated that the guiding principle to its

environmental policies was to “satisfy the people’s economic needs first” (Ministry of the Environment, 1992), neglecting environmental concerns. By pushing the “harsh struggle for survival” agenda, another rhetorical mantle justified heavy-handed schemes to reshape Singapore’s coastline.

Housing Development Board (HDB)

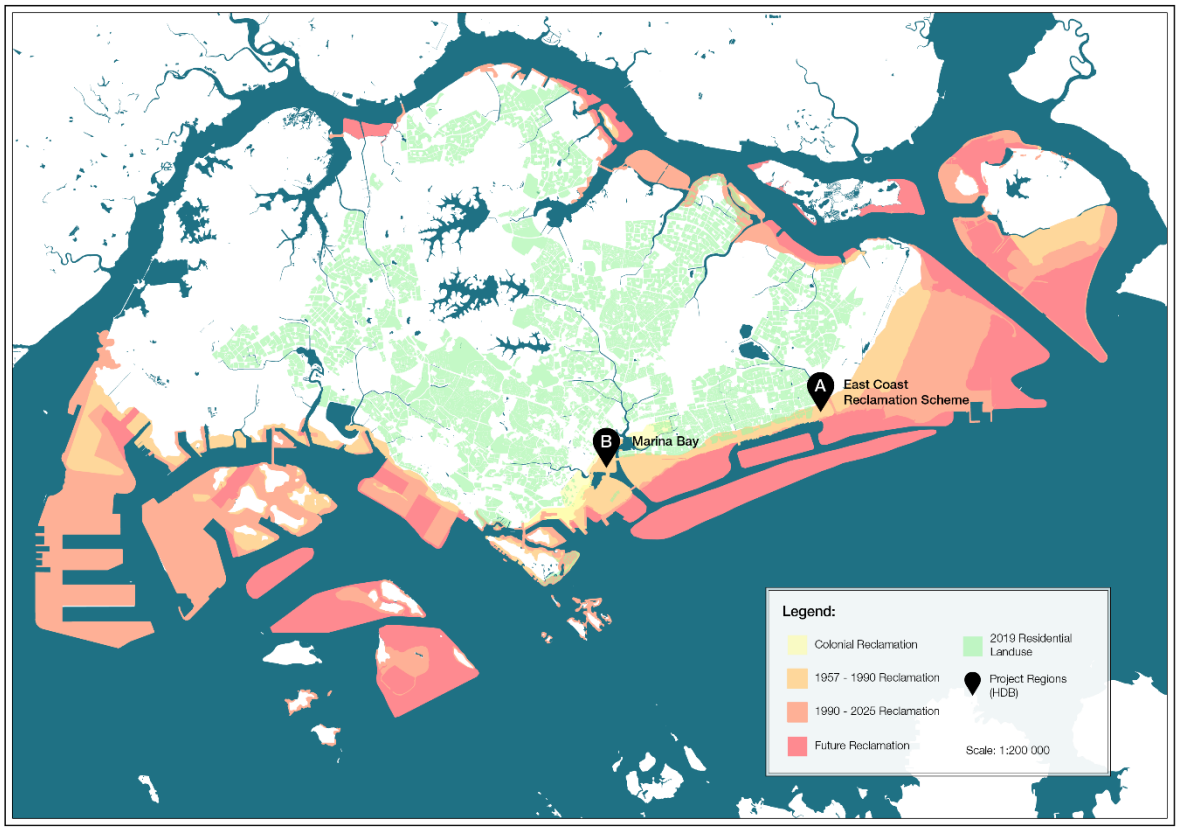

Fig 6: Reclaimed Land (Postcolonial) & Housing

Drawn by the author using data from Kontinentalist (personal communication, March 2025) and the Urban Redevelopment Authority (2019).

The Singapore government condensed its agenda into the 'Big Three: Housing, Urbanisation, Reclamation'. (*$276m. Allocated*, 1965) Public housing was key. The Housing Development Board (HDB) was established in 1960 to replace the Singapore Improvement Trust (SIT) due to its failure to solve the housing crisis**.** (Ho, 2016) HDB's successful and affordable public housing strategy has gained a reputation globally, contributing to a national homeownership rate of more than 90%. **(**Majendie, 2020) However, space was required to drive this rapid growth. While often celebrated as a hallmark of postcolonial success, the expansion rested on colonial techniques of spatial conquest like reclamation and relocation. Land reclamation as the solution to horizontal growth created a new kind of empire by technocrats instead of imperial merchants. In total, HDB reclaimed approximately one-third of all new land in Singapore.

Called the “Great Reclamation”, the East Coast Reclamation Scheme (Fig. 6) was the first large-scale reclamation project undertaken by the government post-independence. Adding a 1,525-hectare strip along the southeastern coast, it was carried out in 7 phases from 1966 – 1979 (Lim, 2017), displacing many *kelongs* – a Malay term for offshore fishing communities (Fig. 11).

Starting eastwards from Bedok to Tanjong Rhu (1966 – 1971), it created a 9-km stretch of artificial beach before ending in 1979 with an extended marina centre to form Marina East and Marina South, curving peninsulas to form a freshwater reservoir now known as Marina Bay (Fig. 6). This iconic waterfront serves key tourist and finance industry architecture to support city expansion.

A massive conveyor belt system – claimed to be “so quiet that its operation is hardly audible” by HDB – transported fill material from inland hills to the coast (Powell, 2021). It also aimed to contain dust pollution and avoid road traffic. However, public reception seems to paint a different picture. A recorded oral history by Tan Swee Guan Richard was noted to describe the “dusty” site as a “marshland of sand and dust”, which looked like a desert where “the next thing you know, HDB flats start popping up” (National Archives of Singapore, n.d.-b). He expresses unexpected nostalgia over losing the previous “charming scenery”. However, a HDB employee (National Archives of Singapore, n.d.-a), while admitting the lack of thought over the “ecological side”, echoes the government’s stand that this was of “necessity, not shortsightedness”.

Jurong Town Corporation (JTC)

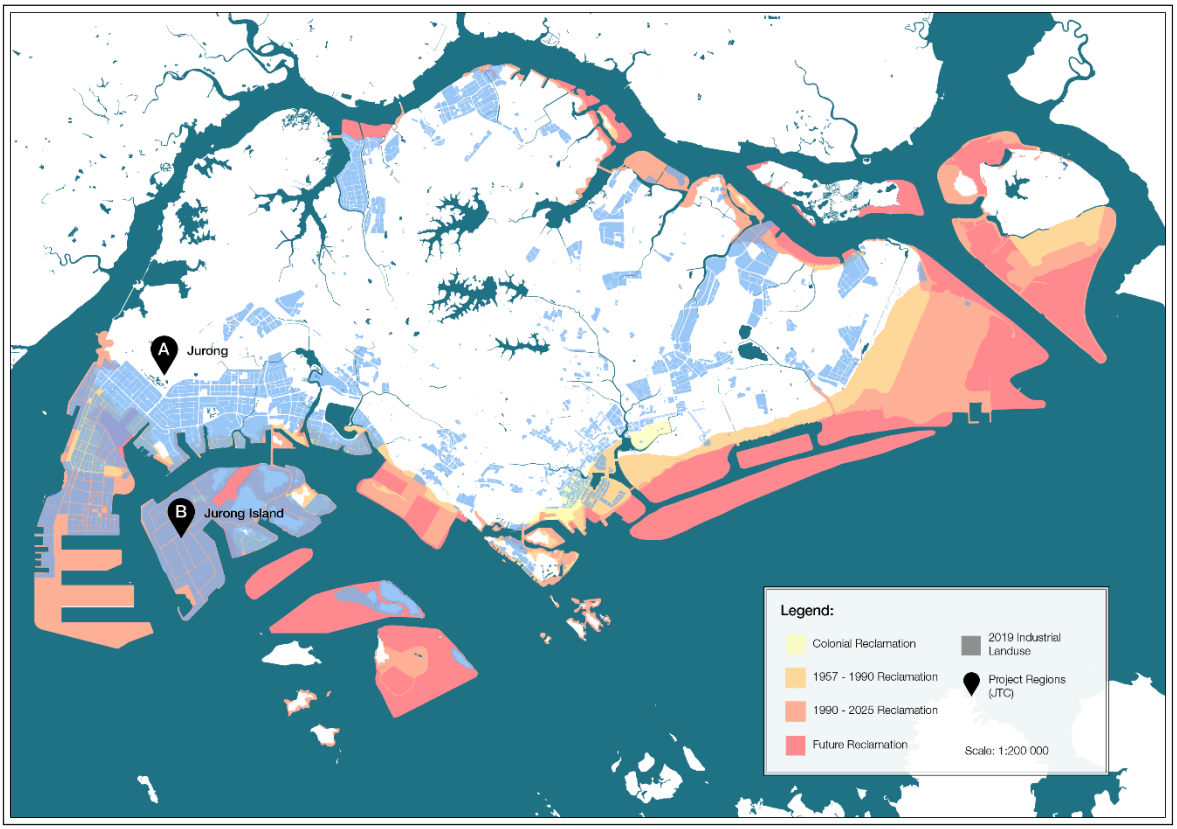

Fig 7: Reclaimed Land (Postcolonial) & Industry

Drawn by the author using data from Kontinentalist (personal communication, March 2025) and the Urban Redevelopment Authority (2019).

While HDB reclaimed the sea to house the nation, the Jurong Town Corporation (JTC) reclaimed to industrialise the nation. Initially avoided by British officials for its troublesome landscape, Jurong (Fig. 7) had three critical assets for industries: deep offshore waters for efficient maritime access, government-owned land with minimal legal resistance, and undulating terrain that could supply fill material for reclamation (Powell, 2019). The flattening of hills is a dual act of landscape re-scripting that mimics colonial resource logics like the Keppel Harbour and Telok Ayer colonial reclamation.

The initial project created the 46-hectare Jurong Industrial Site in 1963. In the 1970s and 1980s, Jurong was merged with Tuas to add almost 3,000 hectares of land for factories, shipyards, and even a golf course to inject recreation into the otherwise utilitarian zone (Lim, 2017).

JTC's most ambitious project was the transformation of the southwestern offshore islands (Fig. 7), merging them to become Jurong Island, a centralised petrochemical hub. JTC described in aestheticised, almost patronising terms that the islands originally housed villagers living a rural "sun-kissed lifestyle like their ancestors" on "palm-fringed islands" (Jurong Town Corporation, 2000) and were relocated to pave the way for Singapore's future as a leading global centre for oil refining. This language suggests that the realities of these islanders, although local Singaporeans, were charming but obsolete – irrelevant remnants of a non-globalized past to be cleared in the name of progress.

This forced relocation, though not precisely recorded in official histories, follows similar power logics of HDB's *kelong* clearances– and even further back, British erasure of the Kallang mangrove swamp community. Spaces that did not fit in the narrative of rational modernity are written over.

Port of Singapore Authority (PSA)

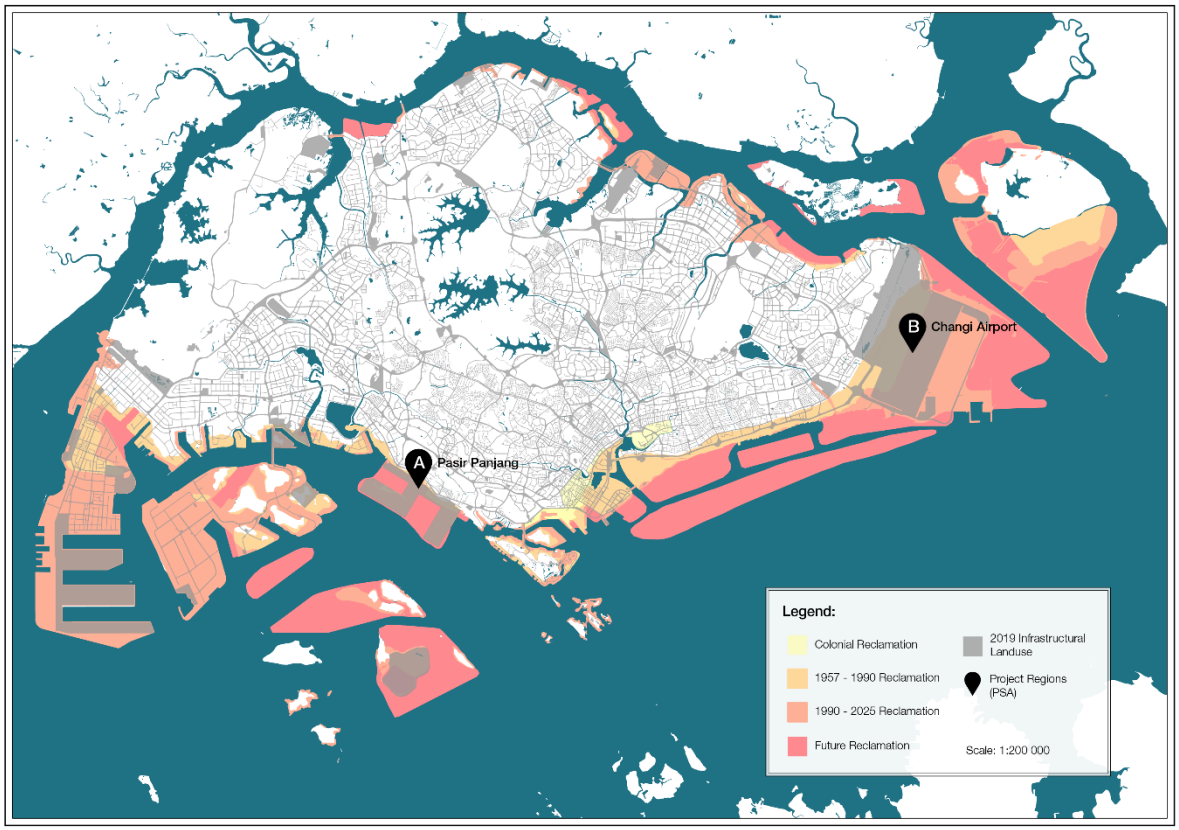

Fig 8: Reclaimed Land (Postcolonial) & Port Infrastructure

Drawn by the author using data from Kontinentalist (personal communication, March 2025) and the Urban Redevelopment Authority (2019).

Alongside HDB and JTC, the Port of Singapore Authority's (PSA) efforts were focused on maritime and air transportation infrastructure. Established in 1964 to replace the colonial-era Singapore Harbour Board, it was tasked with upgrading port facilities to serve the growing global economy. The first project in 1967 expanded Keppel Harbour to build the nation's first container terminal, then Pasir Panjang terminal (Fig. 8) in the 1970s to support lighter cargo operations, with expansions leading up to 2017. They were also involved in the reclamation of Changi Airport, which sits mostly on reclaimed land. These developments helped Singapore surpass Rotterdam to become the world's busiest port (United Press International, 1985) – a title it held until overtaken by Shanghai in 2013.

Like their colonial predecessors, PSA planners extensively re-engineered Singapore's southern coast to support maritime trade operations. Expanding trade capacity allowed Singapore to spatially relocate port functions away from the city centre – creating space to reprogram city centre activities. This mirrors early British strategies of space organisation built on *tabula rasa* land creation to serve extraction, but now for the postcolonial economy. Explicit mention of environmental or social considerations during this development period was not often found with the abovementioned projects.

As we can see, the three agencies leveraged land reclamation advantageously to support Singapore's astronomic growth in the postcolonial era. Through the powerful narrative of economic development for the citizens and survival in a volatile post-war period, the government was given legitimacy to conduct large-scale reclamation projects, often without reflecting on their costs.

Environmental & Social Loss

Singapore's postcolonial land reclamation created housing, industry, and ports – but submerged marine ecologies and local cultures in the process.

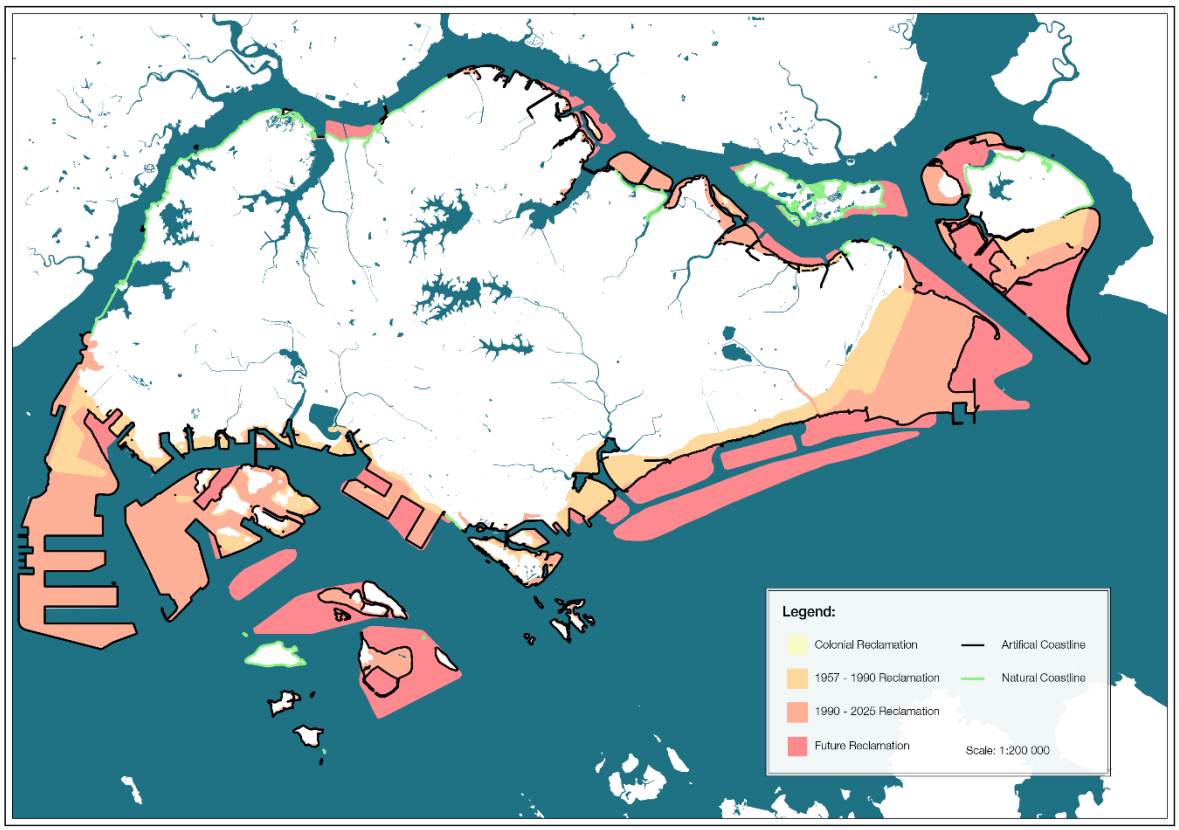

Fig 9: Singapore's artificial coastline

Drawn by author based on independent calculations, using raw data shared by Kontinentalist (personal communication, March 2025).

Only small parts of Singapore's natural coastlines remain after two centuries of land reclamation. A mere 1km stretch of Labrador Park remains the final remnant of Singapore's natural coastline and mangrove habitat along the southern coast. (Fig. 9) Historically, Singapore's coastline mainly comprises three main habitats: Mangrove forests, Sandy Beaches and Coral Reefs.

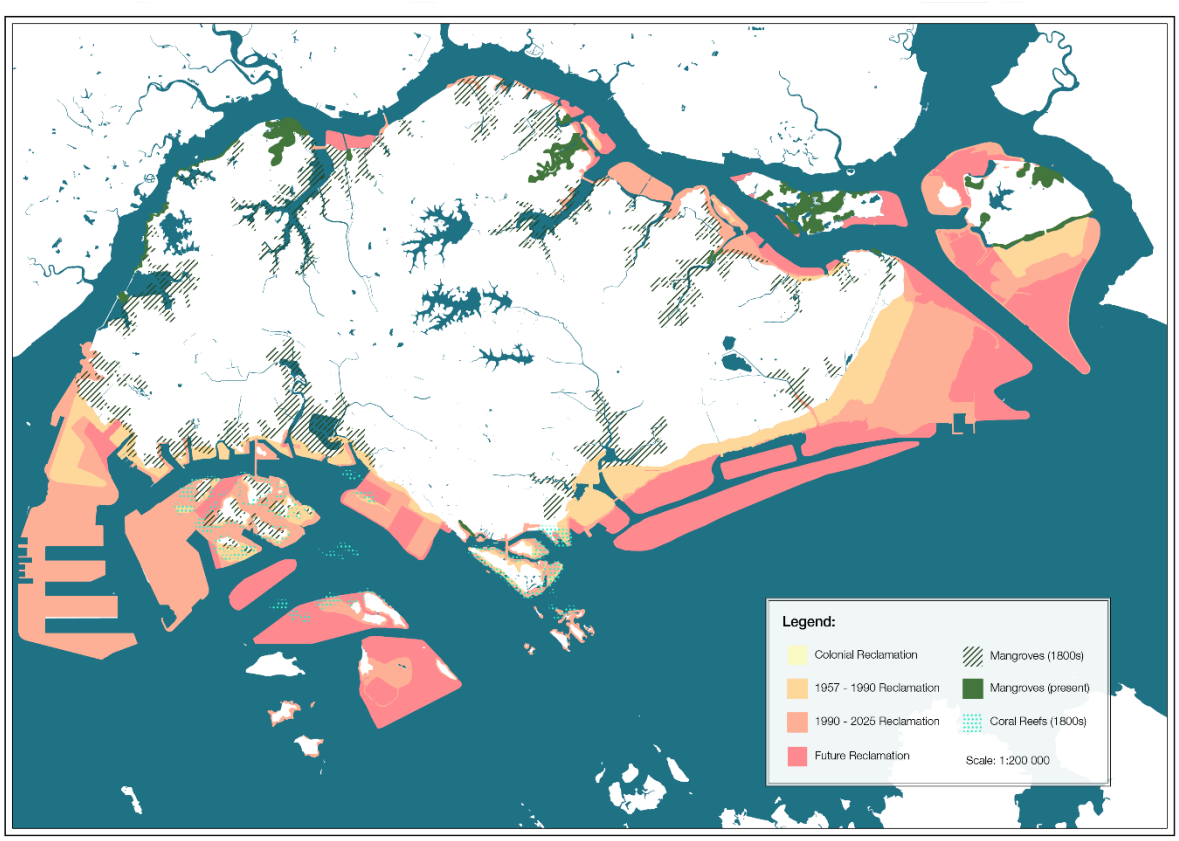

Fig 10: Loss of Singapore's Coastal Habitats

Adapted from visualisations by Ha (2021) and Singapore Institute of Biology (2018).

Once covering 75 square kilometres of the island in the 1800s, more than 95% of Singapore's original mangrove forests have been destroyed. (Fig. 10) Much of it is due to reclamation projects that did not integrate ecological restoration. Though biologically rich and essential to shoreline stabilisation, past authorities dismissed them as unattractive and irrelevant.

Sandy beaches, common in the southeast and southwest, have also been buried by HDB's East Coast Reclamation and PSA projects. Coral reefs have declined by nearly 60% in coverage as they are buried by land reclamation infill and dredging. Despite early conservation efforts by the Nature Society in the 1990s, the low survival rates of 10% show difficulties in damage mitigation hindered by limited state support and continued urbanisation (The Straits Times, 1992).

There might, however, be a glimmer of hope. A surprising range of marine life has been recorded to still inhabit older artificial beaches. The new artificial habitats – such as reclaimed seawalls and man-made beaches – act as secondary biodiversity sinks that, while less structurally complex with reduced ecological functions, retain the potential to develop into richer ecologies. While they do not provide full ecological equivalence, they suggest opportunities for habitat recovery – leveraging on biodiversity persistence for conservation that works with, rather than against, altered landscapes (Tan, Acerbi, & Lauro, 2016). Native species adapting to artificial substrates reflect an unexpected resilience, suggesting that not all is lost and that there may be opportunities to reimagine hybrid environments within the parameters of an engineered coast.

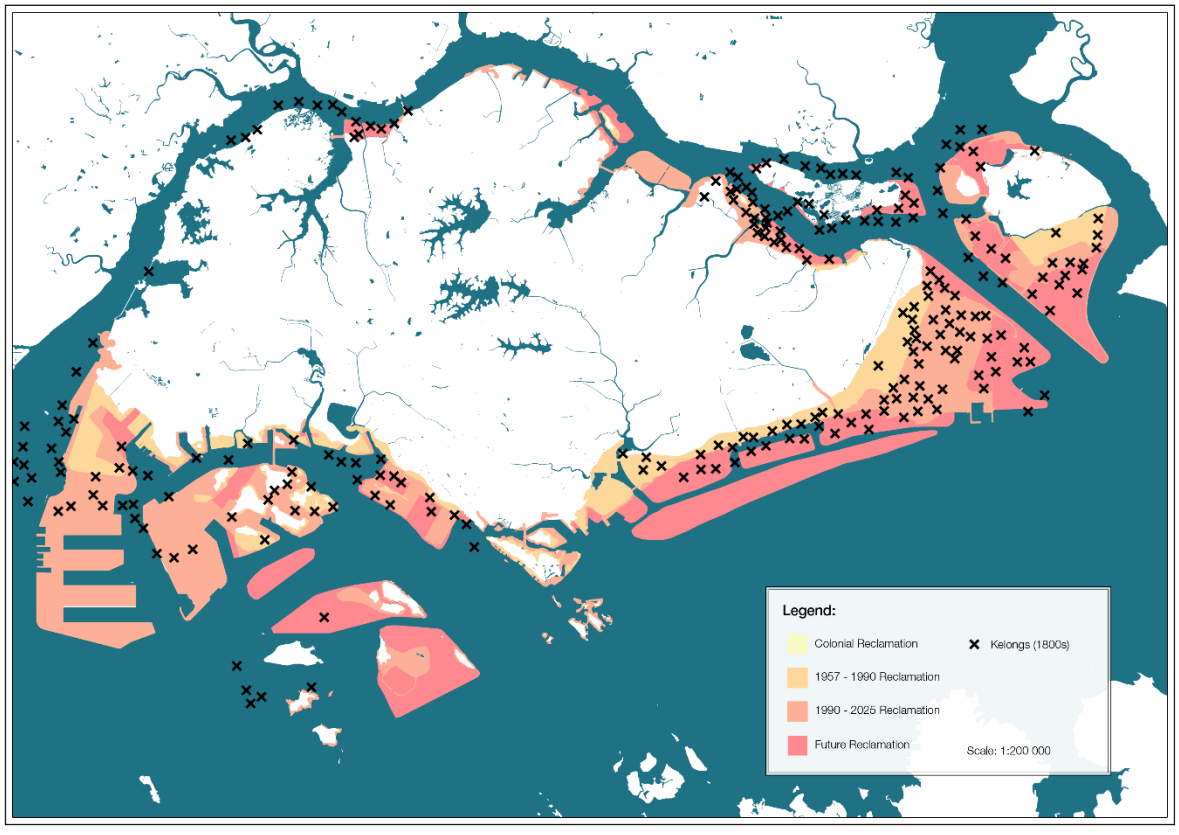

Fig 11: Loss of Singapore's fishing communities - kelongs

Drawn by author, adapted from Chua, Low and Gouw-Iwata (2003), and Kontinentalist

The impact of Singapore's coastal transformation was not limited to erased ecologies and included uprooted communities that shared a physical connection with the sea. In the 1950s, approximately 300 *kelongs* were recorded along the coast (Fig.

11). These people relied on the specific coastal geographics of Singapore's coast as a source of livelihood and culture. Fishing was an everyday livelihood up till the mid-20th century. Dotting the entire coast, they were not merely economic structures, but social landscapes shaped by cultural practices and place-based knowledge.

While multiple factors, like access to education and other economic opportunities, contributed to their decline, land reclamation played a key role. By the 1980s, only a few (unspecified) of the *kelongs* remain. Land reclamation completely changed the coastal landscape by converting water to land, forcing the *kelongs* out of the way. While the state acknowledged the disruption, they also clearly stated their priorities: in the words of the former Minister of National Development official James Cher, the ministry did not see a future where Singaporeans earned a living by fishing (New Nation, 1972). The government might have arranged for transitional housing for these communities, but they were only interested in the citizens living within their vision of a postcolonial Singapore. Higher-value industries like trade, finance, and tourism were prioritised, for which present-day Singapore is ranked highly globally.

A similar fate occurred to traditional aquaculture, which flourished in the swampy mangrove forests. This aquaculture leveraged resource extraction in tune with the rhythm of tidal cycles and mangrove barriers to harvest shrimp. However, as mangrove swamps were cleared out, this practice too faded along with it. Knowledge rooted in labour and place was lost – and with it, the cultural link between Singaporeans and the sea (Chua, Low, & Gouw-Iwata, 2003).

As *kelongs* and aquaculture farms were replaced by financial districts and high-density housing, Singapore's connection to the coast was reduced from livelihoods to a mere spectacle – from lived space to engineered view. The narrative of the then-ruling authority might have shifted from imperial trade to the necessity of economic development. However, the underlying logic resonates with the past: waters and coastlines conquered, lives displaced. Land reclamation serves as a tool for making and unmaking – making new ground by unmaking memory, ecology, and cultures.

Part 3: Neo-colonisation

(Contemporary Land Reclamation)

By the 1980s, Singapore had run out of locally sourced sand, primarily comprised of excavated hills and dredged seabed and began importing sand from its neighbours (Jamieson, 2021). It is thus relevant to discuss the actions of contemporary Singapore on both a local and international scale.

Upcoming Reclamation Projects

Fig 12: Long Island Development Overview

Reproduced from Urban Redevelopment Authority (n.d.)

Recent projects illustrate that the Singapore government is increasingly open to environmental and social concerns. Its latest long-term reclamation project, Long Island (Fig. 12), proposes another 800 hectares of reclamation off the eastern coast.

Environmental Impact Assessments (EIA) guide this new project, where no reclamation work will be conducted until environmental studies, including surrounding intertidal flats and coral reefs, are completed (Ministry of National Development, 2024). A

5-year long technical study is dedicated to this along – a process that was notably excluded in early Singapore's rapid reclamation projects, underscoring a new design paradigm.

Fig 13: Proposed Long Island Design that preserves original coastline into a reservoir

Reproduced from Urban Redevelopment Authority (n.d.)

The design incorporates lagoon-like zones (Fig. 13) to accommodate recreation and restored ecosystems like mangroves and marine habitats. Importantly, it also integrates existing waterfront parks (Ministry of National Development, 2023), treating them not as tabula rasa but as hybrid environments—shaped by decades of everyday use and ecological succession.

Moreover, the project is guided by extensive public consultation. Engagement began in 2023, and the reclamation concept has been shaped in meaningful ways socially. Though most effective and cheapest, earlier concepts of a massive seawall were mooted (Ministry of National Development, 2023) as this would demolish East Coast Park. This familiar hybrid environment public space resulted from HDB's early reclamation. The unique chain of islands design helps keep existing coastlines open and familiar, creating an enclosed waterbody that supports the existing water sports community and beach recreation (Urban Redevelopment Authority, n.d.-b).

Thus, we see an evolving narrative from the colonial logic of rescripting landscapes into one that responds to existing landscapes – recognising ecological (EIAs) and social (public engagement) layers as conditions to be respected and preserved. Development and urgency are still core to the approach and less about sacrifice on this domestic front. However, at the regional scale, a new problem arises.

Regional Sand Trade

In his 2019 National Day Rally speech, Prime Minister Lee Hsien Loong pledged SGD 1 billion per year for land reclamation till 2100 (Prime Minister's Office Singapore, 2019) but failed to mention where this sand would come from. After Malaysia banned sand exports to Singapore in 1997, Indonesia picked up the slack till 2007, when environmental degradation, including the submergence of Pulau Nipah (an island), forced its hand. Since then, the supply chain has jumped around Southeast Asia, reaching Cambodia (which has imposed multiple bans), Vietnam, and China (Jamieson, 2021). This choppy sand supply chain signifies deeper problems that can only be discovered at source.

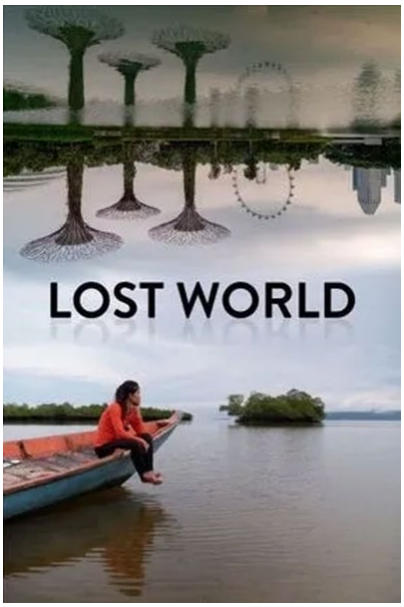

Fig 14: Promotional poster of Lost World

The poster juxtaposes Cambodia's excavated landscapes with Singapore's built environment. Reproduced from the University of Michigan (2021).

Kalyanee Mam's documentary *Lost World* (Fig. 14) reflects on the mass movement of her homeland to Singapore through excavated Cambodian sand, which devastated mangroves and homes in the process. Juxtaposing the "crime scene" of a sand mining site near a village in Koh Kong with the luxury of Singapore's Gardens by the Bay which was built on reclaimed land, it claims Singapore has imported almost S$1 billion worth of sand at the cost of Koh Kong's environment and villages (Mam, 2018).In

parliamentary responses to sand imports, the government deflected responsibility by stating that it “does not condone illegal trade” and expects the sourcing to comply with “regulations of the source countries”, notably not declaring its own standards (Low, 2019; Ministry of National Development, 2021) .

This passive stance effectively externalises the consequences of land reclamation, pushing the responsibility of environmental and social burdens to the source countries. Ironically, these are problems that Singapore once faced during its early reclamation projects. Conveniently, the sand market of its Southeast Asian neighbours has often been mixed with national-level corruption of briberies and favours to circumvent bans.

Thus, while Singapore’s contemporary coastlines are now shaped through a logic of hybrid response rather than erasure, the shift is made possible by exporting this erasure. The colonial logic of erasure has not disappeared – but rather relocated from Singapore’s shores to its neighbours. This is a strategy a country with one of the highest Gross Domestic Products per capita globally (World Bank, n.d.) can afford. In this light, today’s economic power functions as a continuation of yesterday’s imperial power. Although not reducible to economic privilege alone, it reflects a situation where a once-colonized state enacts its own forms of dominance using the logic of extraction and erasure that it inherited – no longer just locally but also regionally.

Temporal Data Mapping

During research on unregulated sand trade in the Southeast Asia region mentioned in the previous section, Koh Kong was an area of focus (Fig. 15) to attempt to visualise the records of sand mining shown in the area. Limited and inconsistent data, fuelled by a black market, made mapping extraction and trade flows unproductive. While scholars call for more credible datasets (Yuen, Das, Tran, & Park, 2024) for analysis, I turned to Dietmar Offenhuber's concept of autographic design (Offenhuber, 2023). This framework proposes reading material traces (instead of official data) as evidence and is used to help bridge this gap in sand accounting through creative mapping.

This computational mapping uses satellite data to produce "autographic" mappings on hydrological disruptions by sand mining instead of using trade volume. Using the JRC Global Surface Water Monthly History dataset (1990–2020; Pekel et al., 2016), accessed via Google Earth Engine, a pre/post-mean comparison technique is used to temporally localise sand mining sites, differentiating them from natural erosion, which occurs slower. This method detects rapid, permanent water gain as a proxy for excavation.

For each year Y, we compute per pixel:

$$\Delta Y = \text{Pre-Mean}_{1990\text{-}Y-1} - \text{Post-Mean}_{Y\text{-}2020}$$

The resultant image reveals per-pixel ΔY increases in water presence after year Y. The constant historical bound and calculated mean keep the baseline constant and avoid shifting temporal references or fluctuating water levels. Gradual and natural erosion of shorelines will also have lower ΔY values, making it possible to distinguish from sudden anthropogenic changes like sand excavation. Visualised using a Viridis colour scale, dark blue regions indicate regions of abrupt and permanent changes.

Fig 15: Location of Koh Kong, Cambodia and Singapore (OpenStreetMap contributors, n.d.)

In Koh Kong (Fig 16):

- 2011 shows faint blue deltas that suggest relative coastal stability.
- 2012 – 2014 shows darkening blue deltas, reflecting abrupt permanent changes from land to water. The intensification in 2013 suggests the height of sand mining activity around this period.
- From 2015 onwards, the blue deltas lighten as the modified coastal typology becomes a new normal in pre- and post-means.
- Having pinpointed the disturbance temporally, we can geographically verify the regions on Google Earth (Fig. 17).

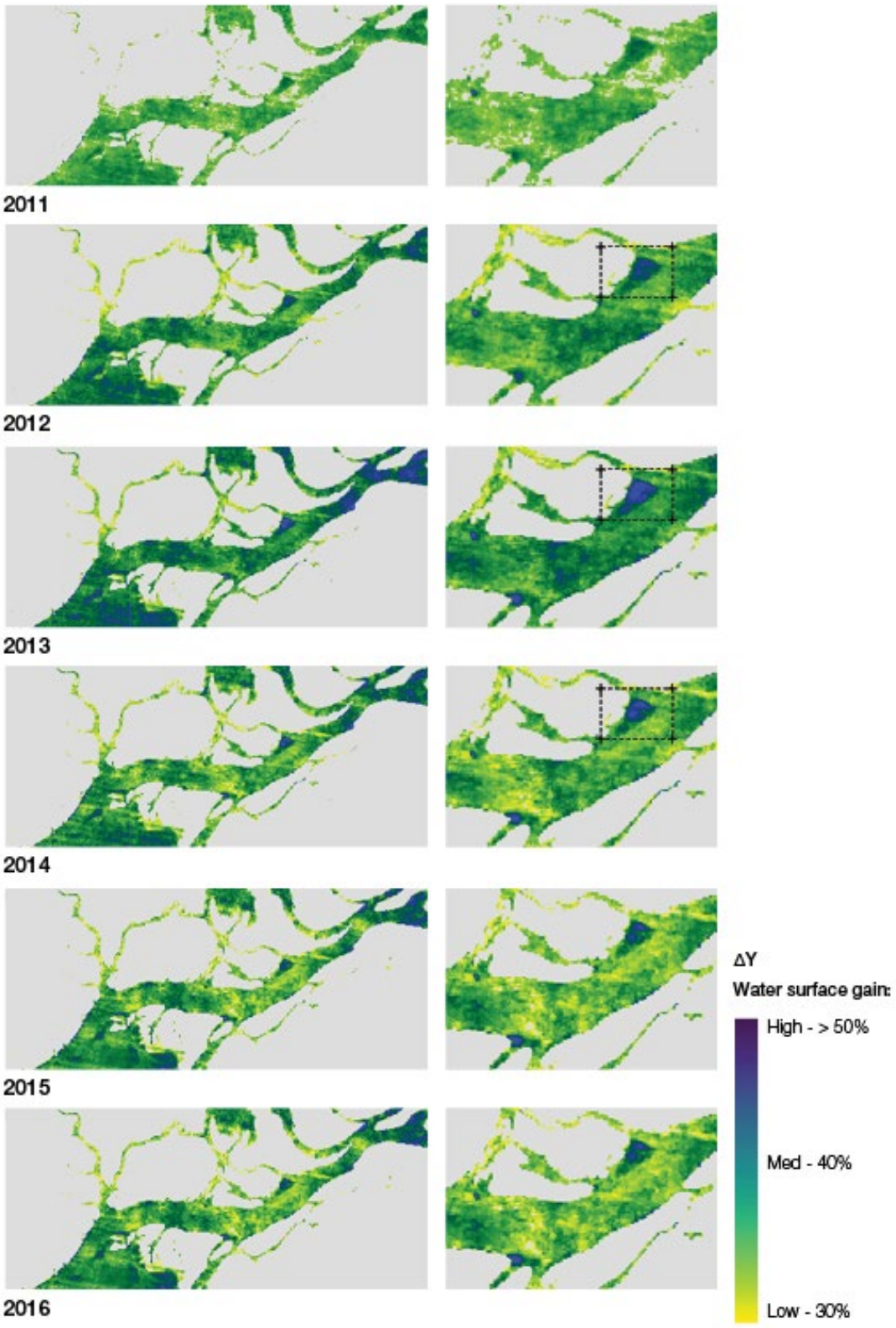

Fig 16: Temporal Data Mapping of Koh Kong. Darkening blue regions suggest sand mining activity.

Fig 17: Identified Sand Mining Sites Verified

Ships visible excavating in 2014. Imagery from Google Earth (2012, 2014 & 2016).

Thus, raw planetary-scale data becomes material witness to environmental devastation – autographic traces of sand mining otherwise hidden by geopolitical complexity.

This approach builds on the central postcolonial claim of this thesis, suggesting how postcolonial states can replicate colonial logics of erasure with new infrastructures of invisibility. The mapping begins to challenge the idea that environmental and economic progress within Singapore's borders is unrelated to the regional sacrifice by bringing these landscapes to light. Exemplifying how spatial displacement and data opacity in postcolonial modernity can mask extractive brutality, this pipeline suggests how we might begin to counteract this with technology.

Conclusion

This thesis follows three historical phases of coastal transformation in Singapore. Each phase has reshaped Singapore's coastline in varying narratives of progress while leaving behind layered hybrid geographies. Singapore's land reclamation history reveals shifting, yet hauntingly continuous control dynamics across the periods. Once a colonial power tool, land reclamation was reanimated by independent Singapore for survival. Today, its reach extends across Southeast Asia in a novel form of economic colonisation. Singapore, though postcolonial, enacts colonial logic.

The reclaimed land becomes a materialisation of erased histories from local mangroves and communities to foreign sandbanks. If being postcolonial meant dismantling the power epistemologies of the past empire (Jamieson, 2021), it must also question what it means to inherit these landscapes built on erasure.

Nature offers a clue. Contemporary Singapore now sits on inherently impure geography – constructed coastlines of foreign soil. Any concept of cultural or ecological purity can no longer be valid, and Singapore must embrace this just like how it embraces its diverse immigrant origins as a "cultural melting pot", even if it means accepting the past mistakes of colonial power. The idea of a *freakosystem* (Ponsford 2025) offers a perspective. Describing novel ecologies that emerge in the aftermath of anthropogenic influence, it captures Singapore's coastlines as not just artificial but transformed environments shaped by erasure. Like Hawaii's hybrid wilderness due to American intervention (Ponsford, 2025) and matsutake forests that emerge from the ruins of American industrial deforestation (Tsing, 2015), Singapore's coastlines are not natural but have become lived realities that demand new forms of recognition.

Freakosystems are a form of critical realism that accepts there is no going back. The challenge is not to restore a mythical original state, but to cultivate new stories and meaning in the altered landscapes with responsibility.

Singapore's sand story is thus not a binary of progress or loss. It is a palimpsest that questions what it means to design this colonial-postcolonial-neocolonial *freakosystem* that does not overwrite the past but acknowledges and builds on it. In a truly postcolonial future, we stop asking whether our landscapes are pure but start asking how we might inhabit them more ethically and authentically.

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Appendix A

Google Colab Python Notebook: Temporal Data Mapping

This appendix includes the code used to conduct temporal data mapping using the JRC Global Surface Water Monthly History dataset (1990–2020), accessed through Google Earth Engine. The final version of the notebook is accessible at the link below:

https://colab.research.google.com/drive/18Bm0wgyh_GzJGx2DECP_nWz9dciARGp1#scrollTo=IcCbVL7nObLS

```
# Load image collection
monthly = ee.ImageCollection("JRC/GSW1_4/MonthlyHistory")

# Create two periods
pre = monthly.filterDate('1990-01-01', '2015-12-31').map(lambda img: img.select('water').eq(2))
post = monthly.filterDate('2017-01-01', '2019-12-31').map(lambda img: img.select('water').eq(2))

# Mean water presence for each period
mean_pre = pre.mean()
mean_post = post.mean()

# Water gain: where water increased
gain = mean_post.subtract(mean_pre)

# Optional: mask out low-change/noise
gain = gain.updateMask(gain.gt(0.3))  # Change >10%

# Inspect min/max gain values (slow for large regions)
stats = gain.reduceRegion(
    reducer=ee.Reducer.minMax(),
    geometry=gain.geometry(),
    scale=30,
    maxPixels=1e9
)

# Visualization
Map.addLayer(gain, {'min': 0.3, 'max': 0.5, 'palette': ['yellow', 'green', 'blue']}, "Water Gain After Mining")
Map
```

Figure A1: Screenshot of Colab code block

Appendix B

Dataset: Singapore's Masterplan 2019 usage

Singapore's Masterplan 2019 contains 33 land use types. For simplification for graphical narrative purposes, they have been re-mapped into 5 general groups to match the 3 agencies – HDB (Residential), JTC (Industrial), and PSA (Infrastructure).

```
lu_groups = {
    # 1. Residential & Mixed-Use
    'RESIDENTIAL': 'Residential & Mixed-Use',
    'RESIDENTIAL WITH COMMERCIAL AT 1ST STOREY': 'Residential & Mixed-Use',
    'COMMERCIAL & RESIDENTIAL': 'Residential & Mixed-Use',
    'RESIDENTIAL / INSTITUTION': 'Residential & Mixed-Use',

    # 2. Retail & Service Commercial
    'COMMERCIAL': 'Retail & Service Commercial',
    'COMMERCIAL / INSTITUTION': 'Retail & Service Commercial',
    'WHITE': 'Retail & Service Commercial',
    'HOTEL': 'Retail & Service Commercial',

    # 3. Industrial & Business Use
    'BUSINESS 1': 'Industrial & Business Use',
    'BUSINESS 2': 'Industrial & Business Use',
    'BUSINESS PARK': 'Industrial & Business Use',
    'BUSINESS 1 - WHITE': 'Industrial & Business Use',
    'BUSINESS 2 - WHITE': 'Industrial & Business Use',
    'BUSINESS PARK - WHITE': 'Industrial & Business Use',
    'UTILITY': 'Industrial & Business Use',

    # 4. Civic, Institutional & Health
    'CIVIC & COMMUNITY INSTITUTION': 'Civic, Institutional & Health',
    'PLACE OF WORSHIP': 'Civic, Institutional & Health',
    'EDUCATIONAL INSTITUTION': 'Civic, Institutional & Health',
    'HEALTH & MEDICAL CARE': 'Civic, Institutional & Health',
    'SPECIAL USE': 'Civic, Institutional & Health',

    # 5. Open & Green Space / Infrastructure
    'OPEN SPACE': 'Open & Green Space / Infrastructure',
    'PARK': 'Open & Green Space / Infrastructure',
    'SPORTS & RECREATION': 'Open & Green Space / Infrastructure',
    'WATERBODY': 'Open & Green Space / Infrastructure',
    'BEACH AREA': 'Open & Green Space / Infrastructure',
    'AGRICULTURE': 'Open & Green Space / Infrastructure',
    'CEMETERY': 'Open & Green Space / Infrastructure',
    'RESERVE SITE': 'Open & Green Space / Infrastructure',
    'ROAD': 'Open & Green Space / Infrastructure',
    'MASS RAPID TRANSIT': 'Open & Green Space / Infrastructure',
    'LIGHT RAPID TRANSIT': 'Open & Green Space / Infrastructure',
    'TRANSPORT FACILITIES': 'Open & Green Space / Infrastructure',
    'PORT / AIRPORT': 'Open & Green Space / Infrastructure'
}
```

Figure B1: Screenshot of python mapping for Masterplan landuse

Appendix C

Composite Map of All Data Layers

This map consolidates all spatial datasets used for this study. While individual maps in the report isolate specific datasets for focused analysis, this composite visualisation provides a holistic overview of the entire data landscape and context.

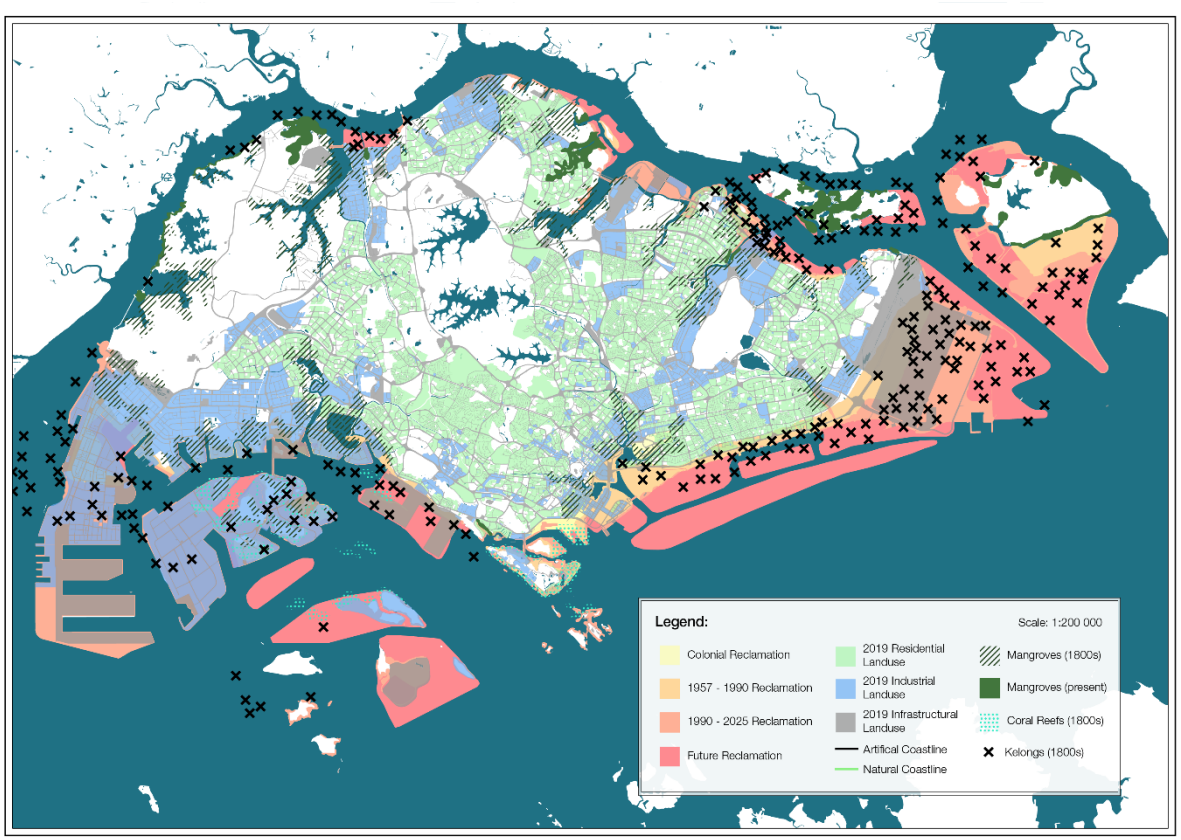

Figure C1: Composite Visualization of All Mapped Layers

Author-generated map combining multiple spatial datasets used across the report for contextual reference: Kontinentalist (personal communication, 2025), Urban Redevelopment Authority (2019), OpenStreetMap (n.d.), Chua et al. (2003), Singapore Institute of Biology (2018), and Google Earth (2012 & 2014).