







Pasi Panjang Port, Singapore - Active reclamation site



Pulau Punggol Timor, Singapore - Strategic sand reserve



Batam, Indonesia - Hills cut to use as fill

6897FA  
02-18

Architecture of Territory  
ETH Zurich  
FCL Future Cities Laboratory

Hinterland  
Singapore, Indonesia, Malaysia  
Project 1, part 2

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# CONSTRUCTION OF TERRITORY

Singapore's Expansion  
into the Sea

by  
Lino Moser  
Gabriela Schär



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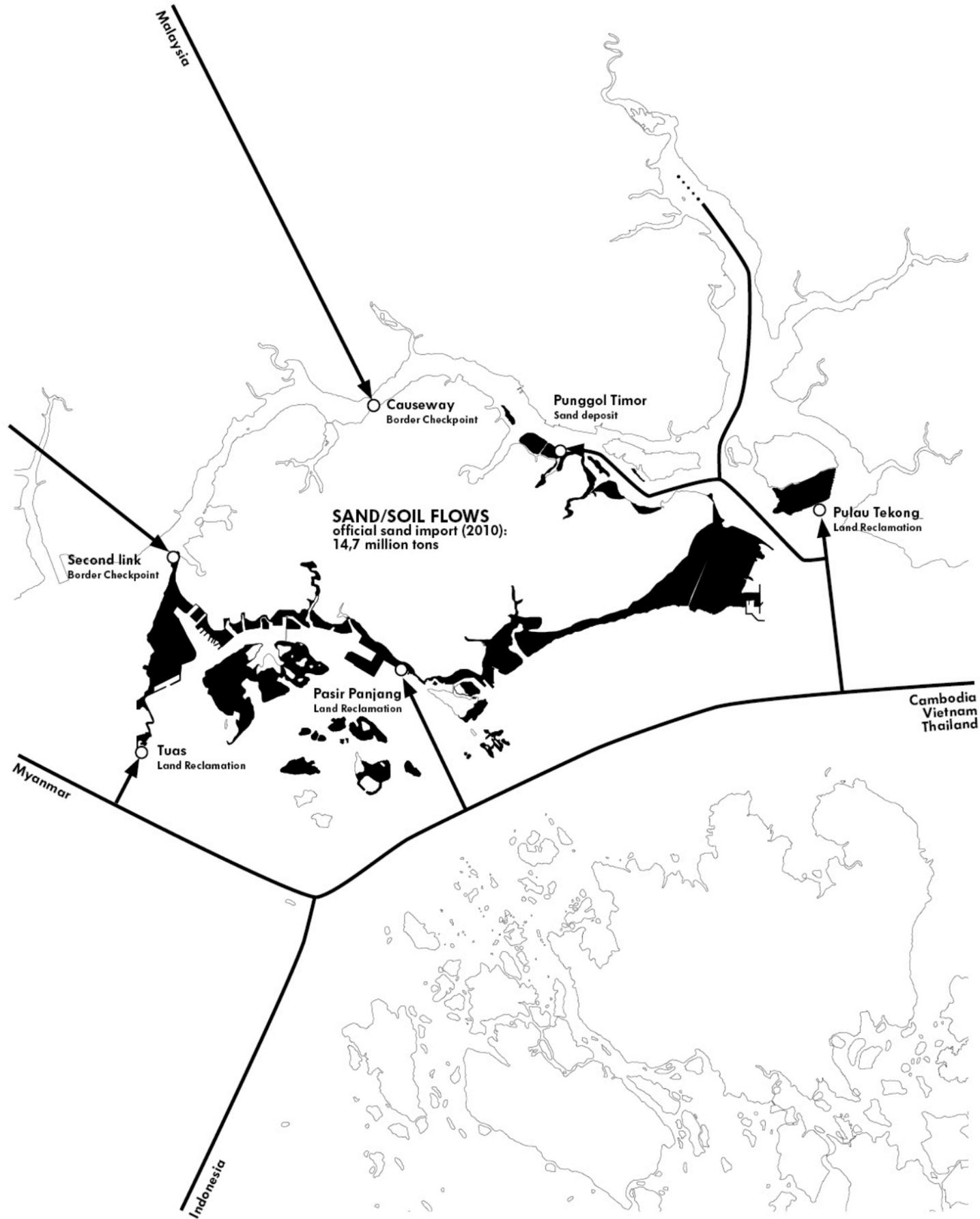
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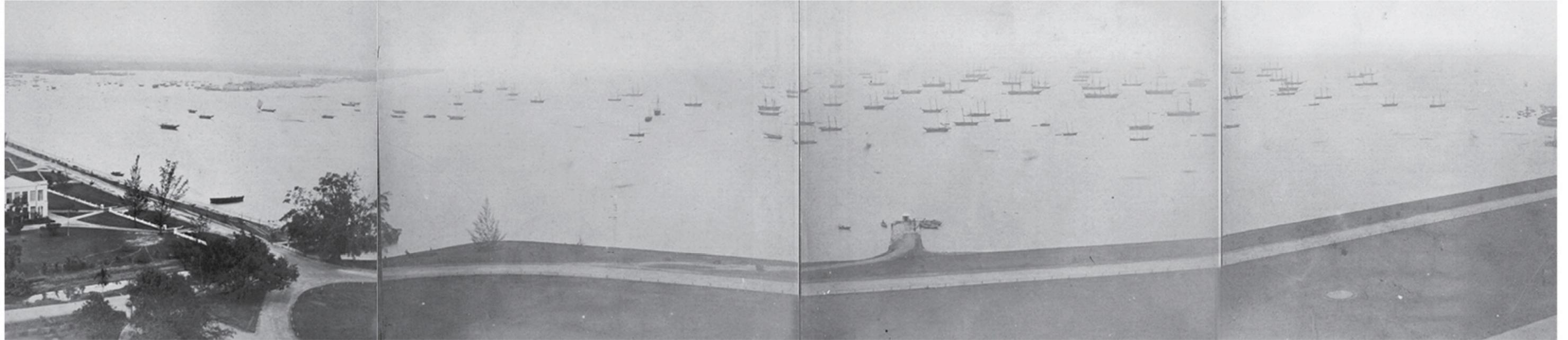
Singapore has expanded its land territory by 25 percent since its founding. Land reclamation took place under British colonial rule and increased exponentially after Singapore became an independent state. Since Singapore has long run out of sand, fill material for land construction has to be imported. The staggering volume of this soil trade has caused environmental, social and political problems. The Singaporean government controls the entire land reclamation process from start to finish. Artificial land in strategic locations is valued very highly by the real estate market, which allows Singapore to make large profits from its constructed territory.

# Claiming Land from the Sea

Singapore's land area has continuously been extended and the successive coastlines form a historical record of this process, similar to the way annual rings document the growth of a tree.

The first land reclamations took place soon after the founding of colonial Singapore in 1819, and by the beginning of the 20th century adding large patches of land to the existing city was commonplace.

Until this day, Singapore has continued to expand into the sea at an unparalleled pace. The government still refers to the process as "land reclamation", although the new land is built where none existed previously.



Top:  
Panorama from St.  
Andrew's cathedral, 1863

Bottom:  
Panorama from Peninsula  
Excelsior Hotel, 2012

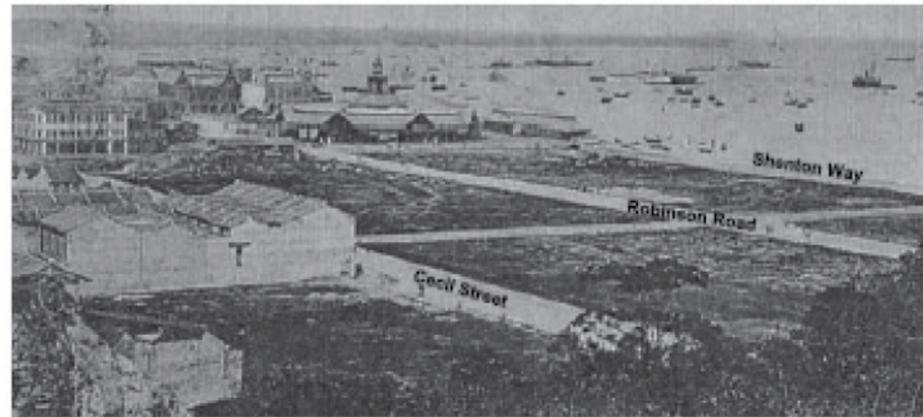
# Shaping Colonial Shores 1820-1958

The first reported land reclamation project was the correction of the Singapore river's shoreline in order to facilitate the landing of trading boats. Optimizing harbor operations remained a major motivating factor for large-scale changes to the waterfront throughout the colonial period.

Starting in 1879, a considerable amount of land was added to the waterfront on both sides of the mouth of the Singapore river. To the south, a deep stretch of land was built into the sea, extending the area of the city designated for the mostly Chinese and Indian immigrant population. A

new harbor basin was also constructed in front of this area. To the north, the new land on the coastal side of Beach Road was used for government institutions, a market, and as recreational and leisure space for the European colonial population centered on that side of the river.

On the eve of World War II, the colonial government carried out the first major land reclamation for infrastructure purposes. Kallang airport was built just north of the city in 1937. This became the model for later expansions by an independent Singapore.



### Telok Ayer Basin

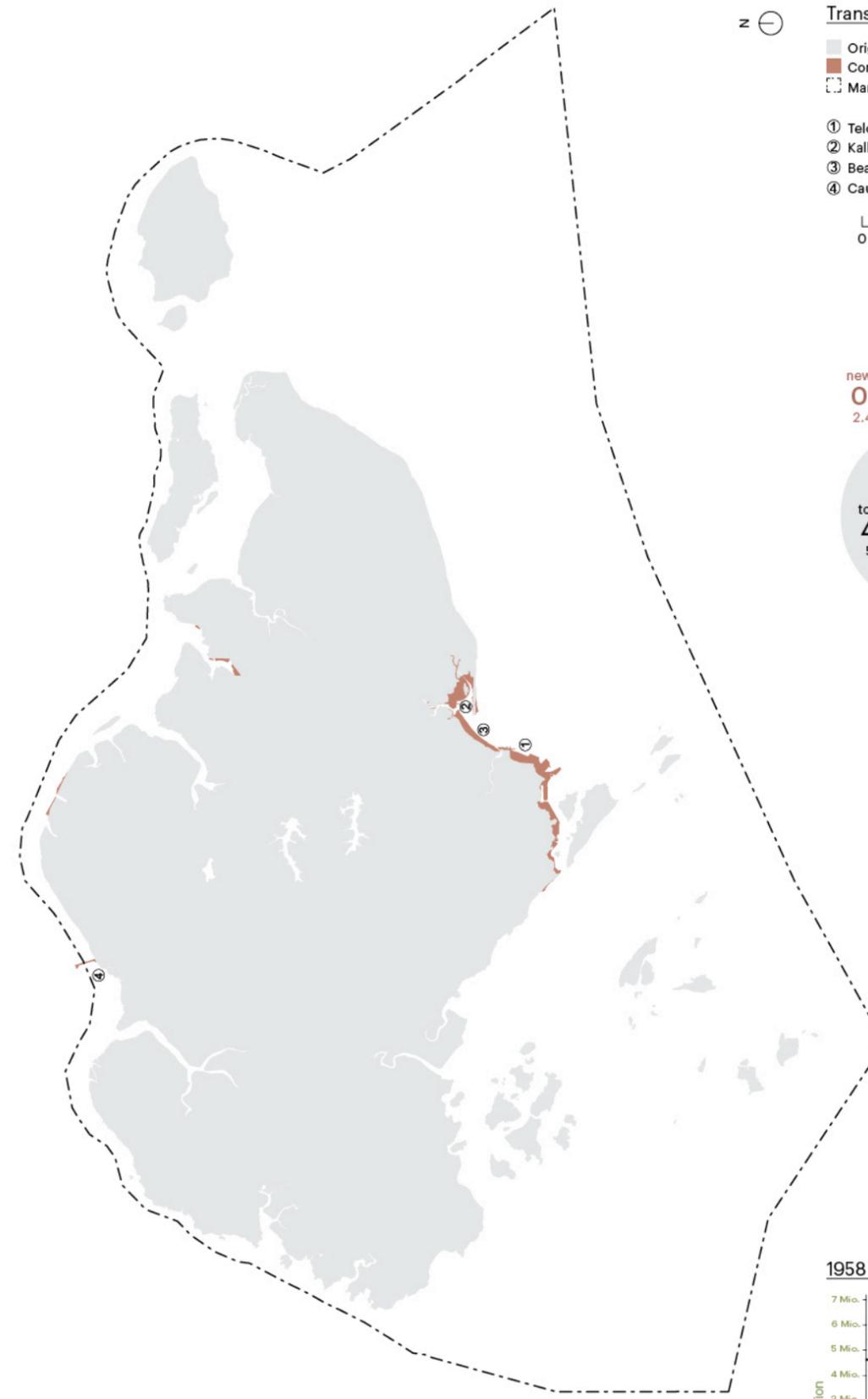
The area east of Telok Ayer street, which follows the original coastline, was built to expand both port and trading operations. The rapidly growing Asian immigrant population was responsible for most of the city's economic activities, and more space for shophouses was desperately needed.

The number of boats calling at the trading post also outgrew the Singapore river. Telok Ayer basin and the adjoining shophouse district were built to relieve these pressures.

### Right: Kallang Airport

With air travel becoming more important, the swampy Kallang Basin northeast of the colonial city was drained in order to build the city's first airport.

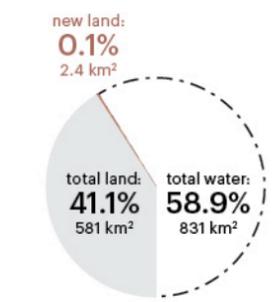
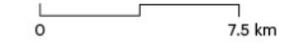
Rapid technological advances meant the runway was soon too short for jet propelled planes, and Kallang Airport ceased operations in 1955.



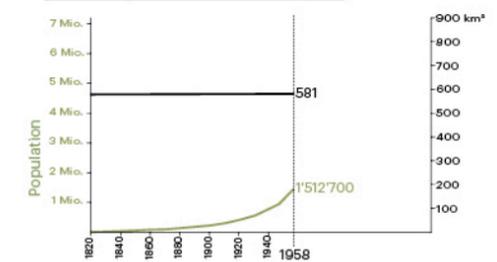
### Transformation of Territory

- Original Land
- Constructed Land 1820-1958
- Maritime Territory

- 1 Telok Ayer Basin & King's Dock
- 2 Kallang Basin
- 3 Beach Road Strip
- 4 Causeway



### 1958 Population vs. Land Area



# Tabula Rasa 1958-1974

After being defeated in Singapore during World War II, British rule in the region was coming to an end. Singapore was granted self-governance in 1958, and eventually became an independent nation in 1965.

The war had left the colonial city unable to handle the rapidly growing population. The new government set out to combat the concerning sanitary and living conditions in the improvised settlements around the formal city, but eventually destroyed the traditional village culture of the

Malay population along with the urban slums.

The Housing Development Board (HDB) was formed in 1960 to initiate and carry out a government housing program. The sheer scale of this operation meant planners had to look to modernist production, assembly and configuration methods. Inland swamps were filled, hills were cut down, and new land was built into the sea to create the flat land on which the new nation was to grow; the ideal tabula rasa of modernist theory.

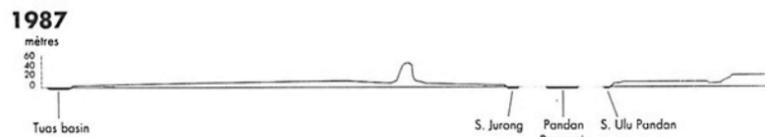


### Marine Parade Housing Estate

The first phase of the East Coast reclamation scheme was built for a large public housing estate, and Marine Parade remains the only HDB housing project on new coastal land. A 12 km stretch of public beach was built along the new coast as well.

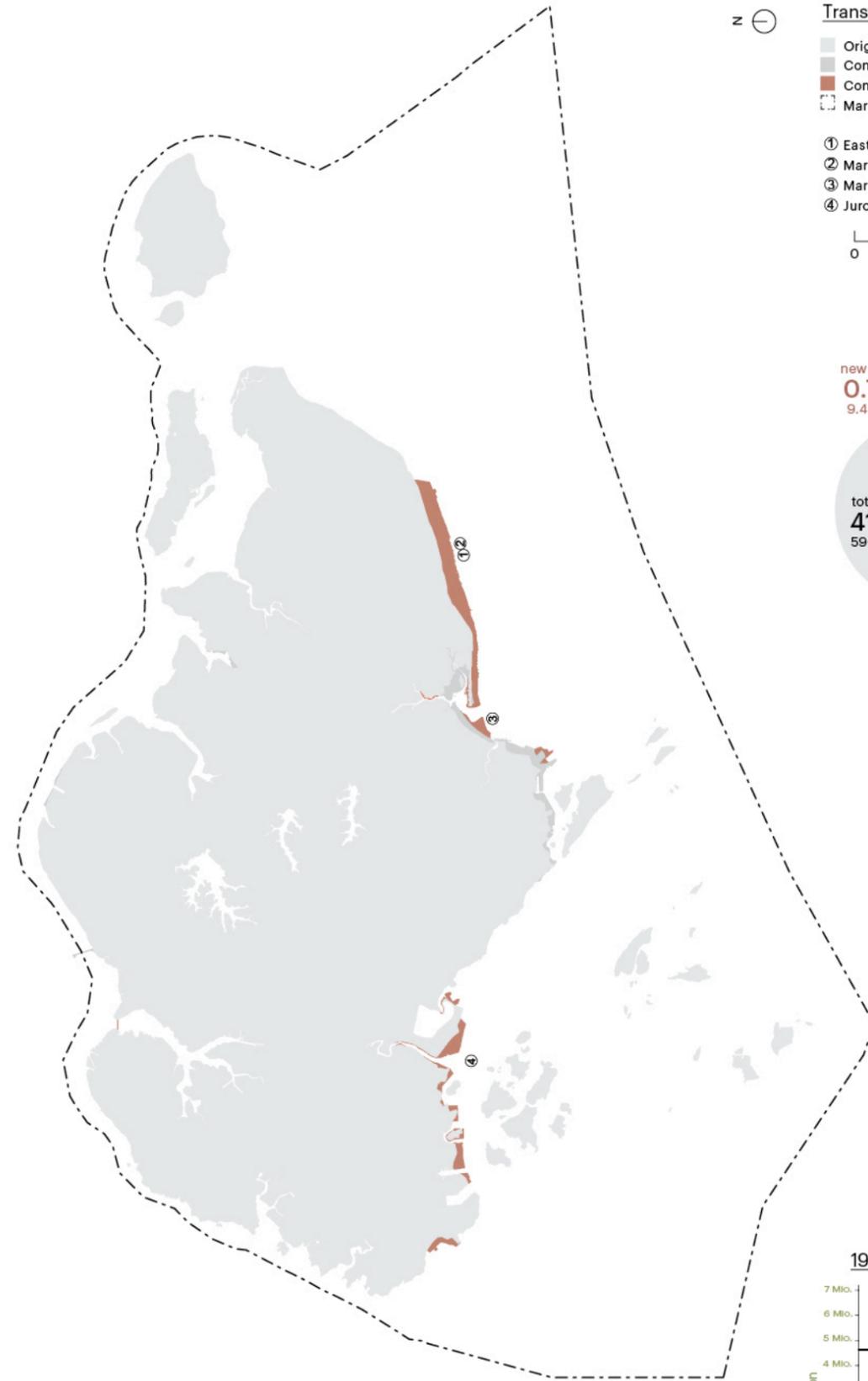
### Infrastructures on the Waterfront

The Nicoll Highway replaced civic and leisure institutions along the shore parallel to Beach Road.



### Tabula Rasa

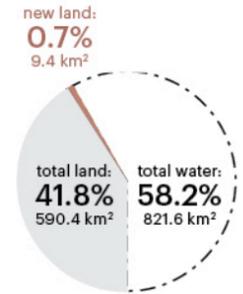
This sketch from Rem Koolhaas's article, "Singapore Songlines", illustrates the all-out transformation of territory during this period.



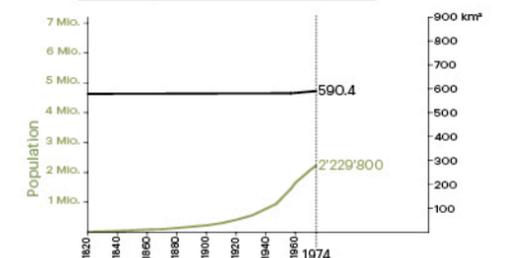
### Transformation of Territory

- Original Land
- Constructed Land 1820-1958
- Constructed Land 1958-1974
- Maritime Territory

- ① East Coast
- ② Marine Parade
- ③ Marina Center
- ④ Jurong Industrial Waterfront



### 1974 Population vs. Land Area



# Sites for the Global City 1974-1987

The rate of new land construction increased rapidly in the late 1970s, along with the size of new projects. The motive was no longer sheer survival, but instead to join the ranks of first-world nations and develop a global city economy.

The first terminal of Changi International Airport was built on new land at the Eastern end of the main island. By the time it became operational in 1981, the new East Coast Parkway (ECP) was already linking the new airport to the city center. This new highway assures a smooth transit to the city, but it separates the dense residential areas of East-



Marina City

The 660 hectares of new land added onto the existing city center were divided between three parcels: Marina South (pictured above), Marina East, and Marina Center, the first of the three projects to be built.

These areas were planned for future extensions of the booming Central Business District (CDB), and eased real estate pressure on the remaining central area neighborhoods. Conservation efforts in the historic shophouse districts of Chinatown, Kampong Glam and Little India were now taken seriously because business demands could be satisfied elsewhere.



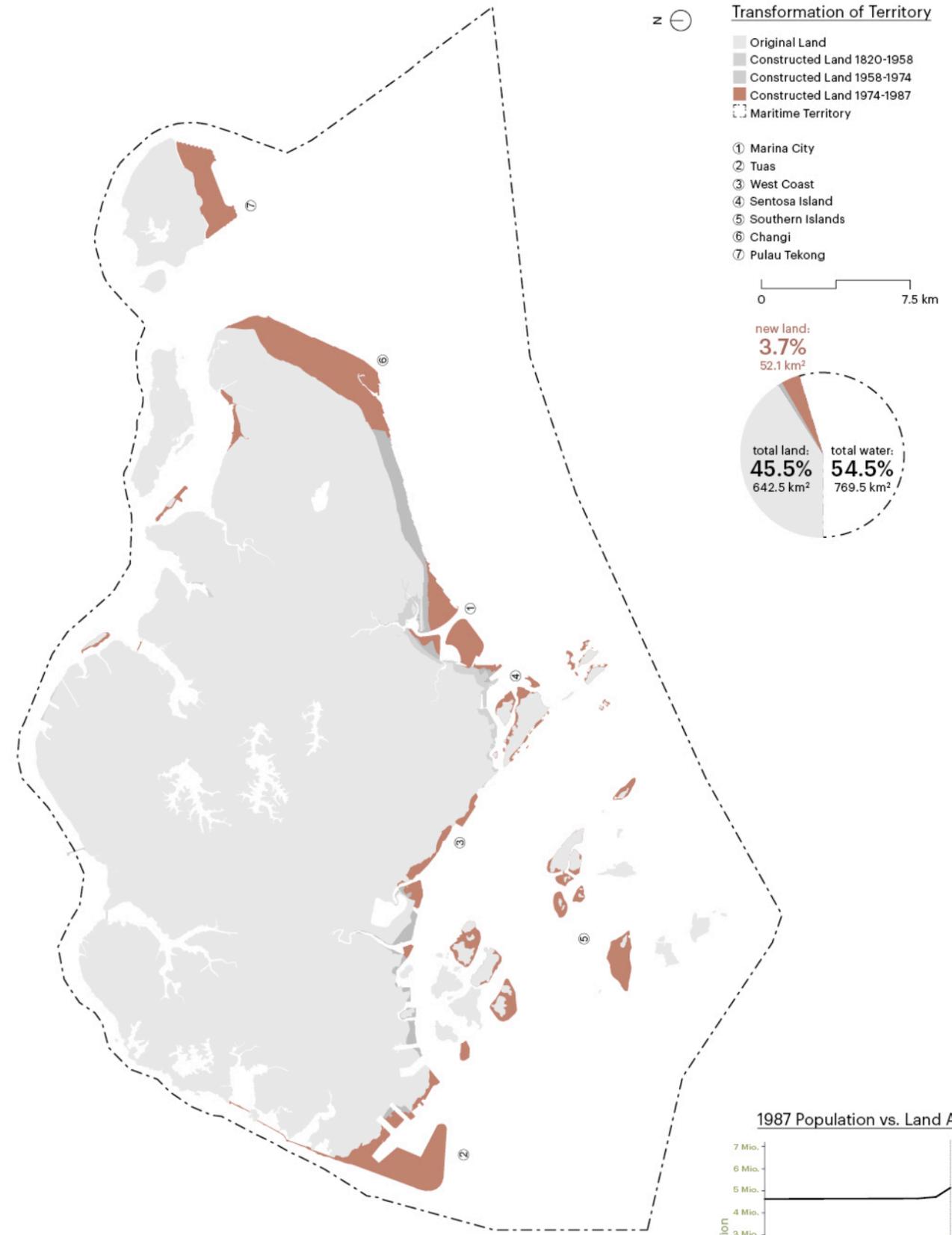
Tuas

This entirely man-made peninsula on Singapore's Western end was built for light industries and manufacturing businesses.

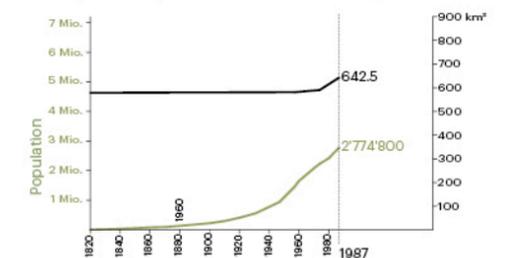
ern Singapore from the island's popular beaches.

With the shipping industry relying on bigger ships, the Telok Ayer Basin became outdated. Large expanses of land were added onto the central area and the economy was transformed into office based activities rather than industrial trades related to the docks of Singapore.

In this period, Pulau Tekong was enlarged exclusively for defense purposes, which freed-up the former military base of Sentosa to be developed into a resort island.



**1987 Population vs. Land Area**



# Updating the Global Hub 1987-2011

The most recent (and still ongoing) phase of land construction in Singapore is concentrated away from the city center, and driven by an intensified and scaled-up version of the global city strategy of the 1980s.

Singapore is building the sites and facilities to become a hub for many of the economic activities it engages in. It is a hub for air travel in the region, a hub for the oil trade and petrochemical industries, and a hub for container shipping. The expanding CBD is an international banking and finance center, and with two integrated casino resorts recently completed (both at least partially on artificial land), Singa-

pore is working to become more of a tourist destination in its own right.

Even the land creation efforts in Northeastern Singapore, which are for housing and military use, play into this 21st century global city strategy. Singapore's defense spending is supposed to guarantee stability in order to attract businesses. In Punggol an existing HDB housing estate is being extended to include a large waterfront housing district, which will be made up mostly of condominiums catering to the upper class of the global city workforce.



**Air Hub: Changi**

Currently operating three terminals, and with an additional 2'000 hectares of land to grown on built during the 1990s, Changi Airport has already outlasted its colonial ancestor at Kallang and looks positioned for intense future growth.

31 years after its opening it is the third busiest airport in South East Asia, just behind Soekarno-Hatta in Jakarta and Suvarnabhumi in Bangkok.



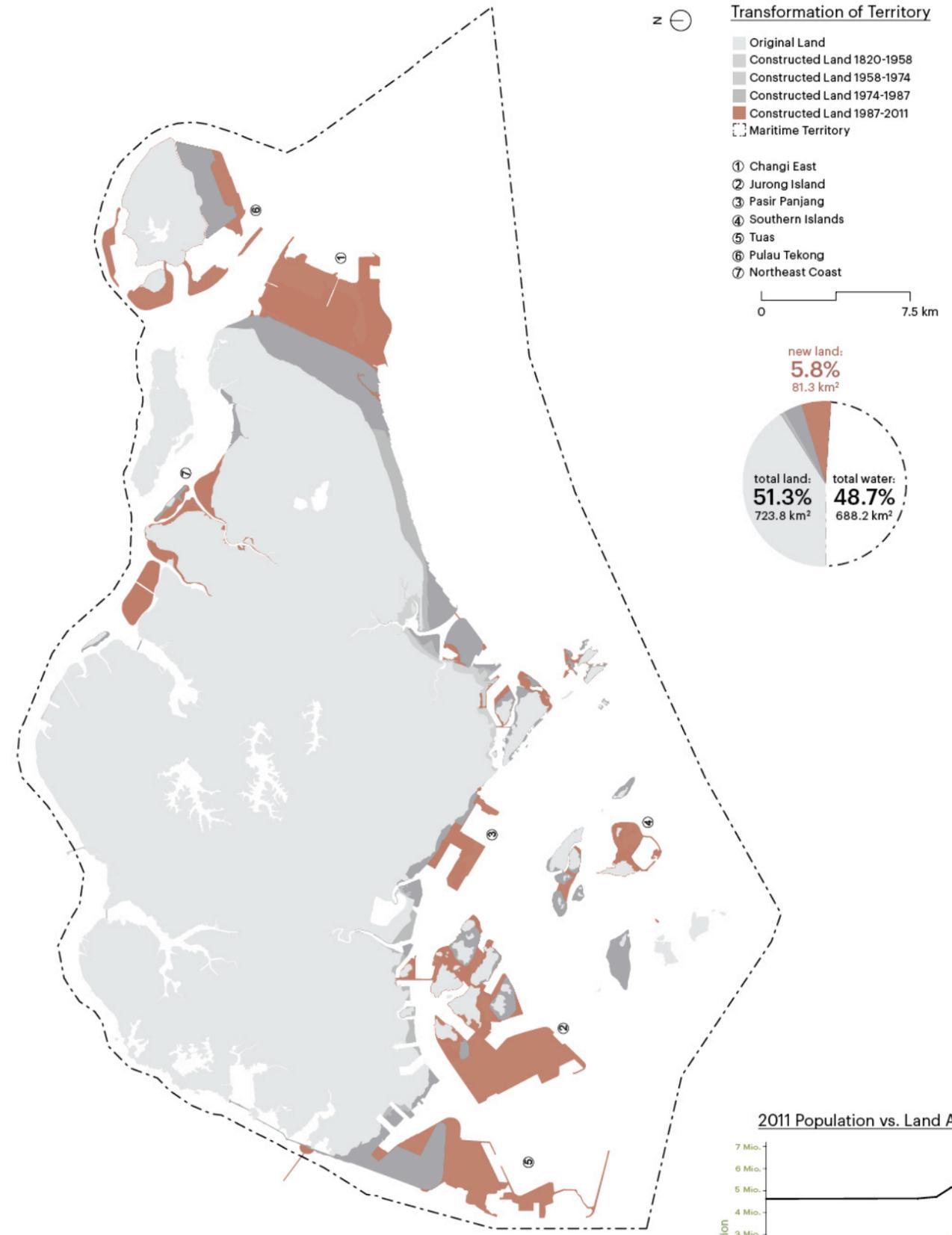
**Petrochemical Hub: Jurong Island**

Some of the islands south of industrial Jurong district have been used by oil companies since the early 1970s. Since 1995 they have all been combined and further enlarged to form the highly secured petrochemical industry site renamed Jurong Island.



**Container Hub: Pasir Panjang**

The ongoing expansion of the container terminals at Pasir Panjang will allow Singapore to redevelop the Keppel Harbor site for downtown waterfront condominiums.



# Pushing the Limits 2011-2050

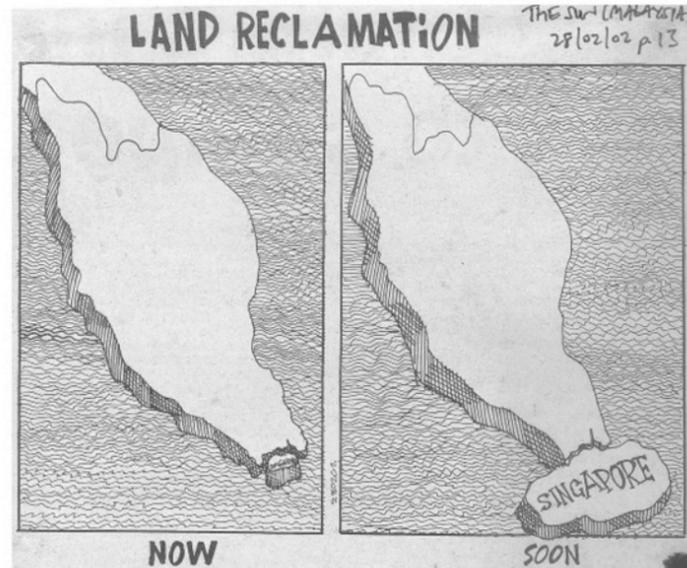
The Urban Redevelopment Authority (URA) Masterplan of 2008 and the 2001 Concept plan show extensive future additions to Singapore's land area.

While some of these projects are already under construction, or are a continuation of trends visible today (such as enlarging and combining industrial offshore islands), the Concept Plan also deals with the projected increase of the population to 6.5 million inhabitants.

In this scenario, new land behind the military installations on Pulau Tekong and Changi airport is planned for housing and industrial purposes. The Northeastern island of

Pulau Ubin is also scheduled for enlargement, for the first time. Today it is preserved as a remnant of a fishing-oriented island culture that has been almost completely wiped out in Singapore, but taking into account future population growth the planning authorities seem willing to sacrifice it.

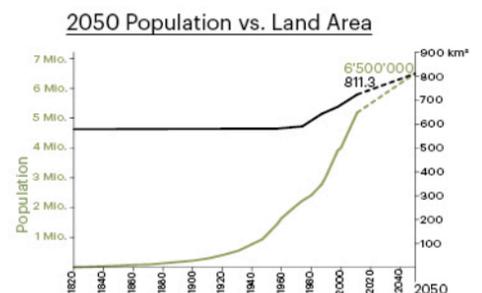
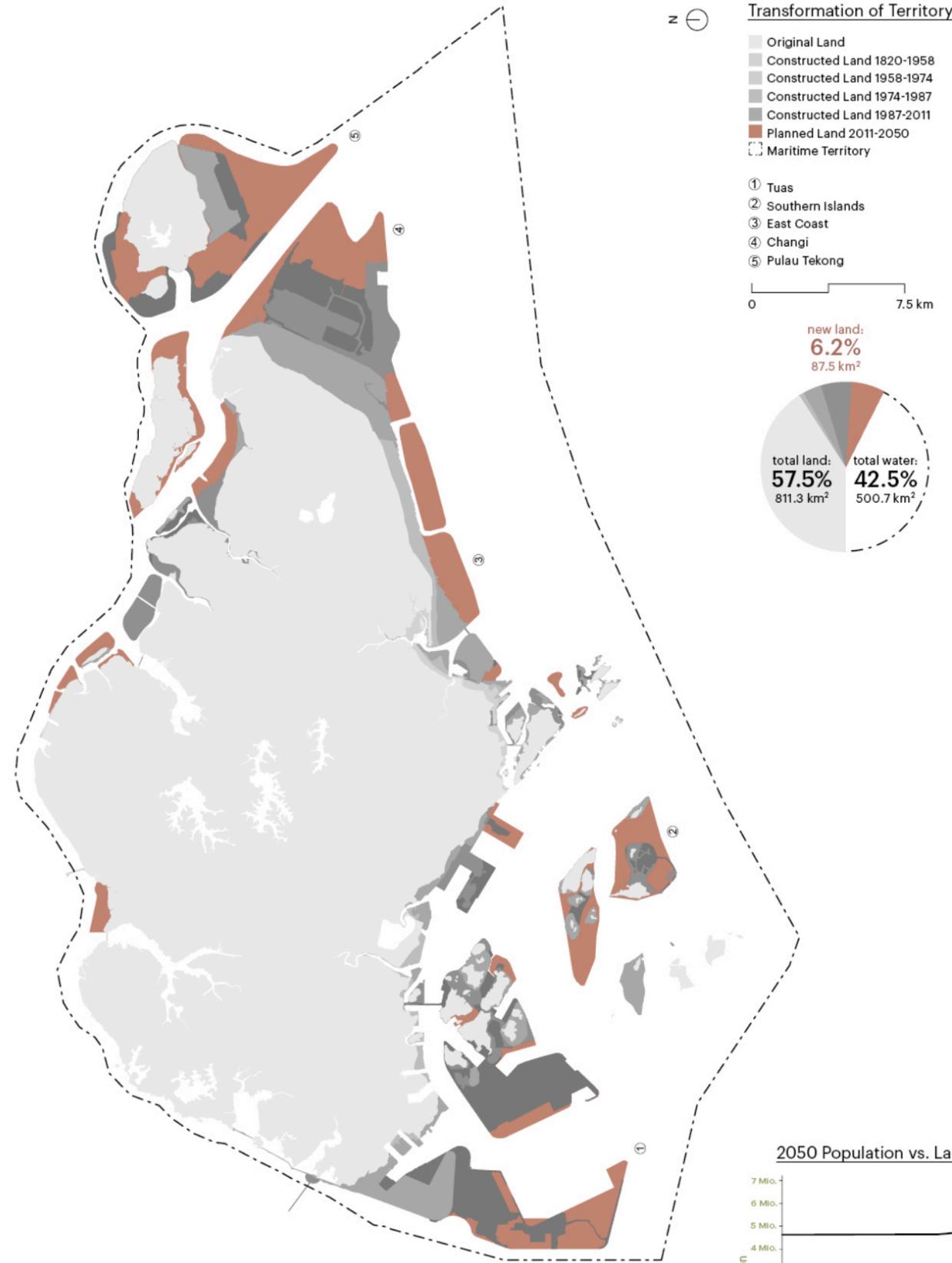
Another addition to the east coast is also planned. A strip of up to 1.5 km wide built in front of the existing beach would produce prime new residential real estate, but a considerable amount of value would also be lost on the current beach-front properties.



### Regional Conflicts

This caricature from a Malaysian newspaper illustrates the concerns Singapore's closest neighbors have about the small island nation expanding its territory.

From the point of view of Malaysia, the physical expansion of Singapore threatens to literally clog up the Strait of Johor, which is crucial to Johor's own port industry.



# Land Construction Techniques

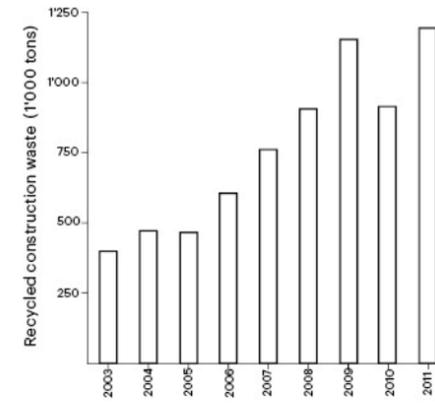
Land construction projects have gotten larger, are carried out in deeper waters, and involve different fill materials depending on their availability. New techniques and technologies are constantly developed to tackle this ever more difficult process.

Initially, land reclamation was done entirely with soil cut from hills and sand dredged from the sea bed. Settling and stability issues were manageable as these materials are firm and porous enough to allow for easy draining.

When these materials were no longer available locally, sand had to be imported and consequently paid for. To

ease the economic impact of intensified land building efforts, testing began on dredged clay mixed in with sand.

As Singapore's hunger for land pushed construction into deeper waters, the demand for sand increased exponentially, driving prices higher. At the same time, expanding port operations and the larger shipping vessels necessitate deeper dredging of the shipping lanes. This process produces large clay lumps of up to 8m<sup>3</sup>, which are now also used.



Large clay lumps are taken from the seabed and dumped into construction sites by bottom opening barges.

### Construction Waste Recycling

As Singapore excavates more underground tunnels for public transport, storage and military purposes, the resulting construction waste is simultaneously too expensive to dump in the offshore landfill and too valuable as a fill material to throw away. Recycling rates have consequently reached 99%.

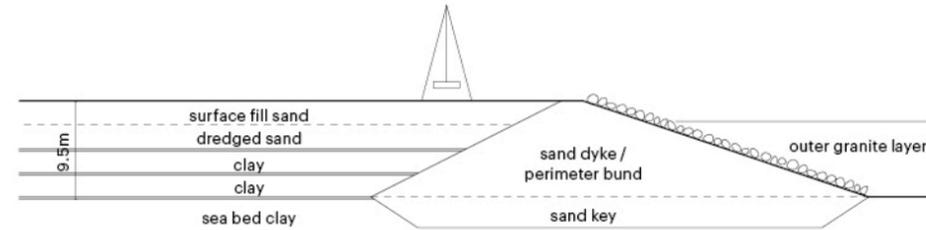
### Layered Clay Scheme

The Changi East project of the early 1990s created 2'000 hectares of land, almost three times that of the earlier phase. The amount of fill material needed, however, increased by a factor of eight.

The use of dredged clay was therefore extensively tested. Since the particles making up clay are smaller than sand, water is

more difficult to remove from the mixture.

The idea of the layered clay scheme is to place 20 cm of sand between the clay layers to help facilitate water run off. The method proved to be too time consuming to apply on a large scale, and Changi East was carried out using sand as the sole fill material.



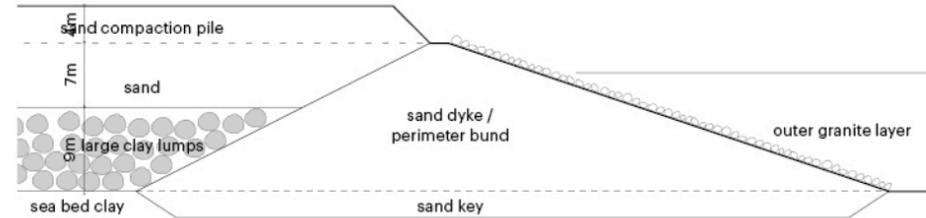
### Large Clay Lumps

The first tests using large clay lumps as fill material started in 2001 at the 2'500 hectare construction site of Pulau Tekong.

Because of the sizeable voids between the large lumps, the upper part of the fill still needs to be made of sand. Additional sand is then piled on top to create enough pressure for the voids to close.

### Cement Mixed Slurry

The most recent methods studied, also at Tekong, involve mixing cement in with dredged slurry, but so far only for the perimeter bund.





1.



2.



3.



4.

1. Dynamic Compaction
2. Installation of prefabricated vertical drains at Changi East
3. Vibro Compaction
4. Vibro replacement columns installed offshore using a gravel jet system

### Land Improvement Technologies

Retroactive and land improvement has become crucial since a rising number of construction projects have chosen the alternatives to sand as a filling material. These are constructed on less suitable seabed or sold and pressed into service before the natural settling process can occur.

The oldest technique is referred to as "dynamic compaction" and involves repeatedly dropping a heavy weight onto the new land from a considerable height. Prefabricated vertical drains have also been used.

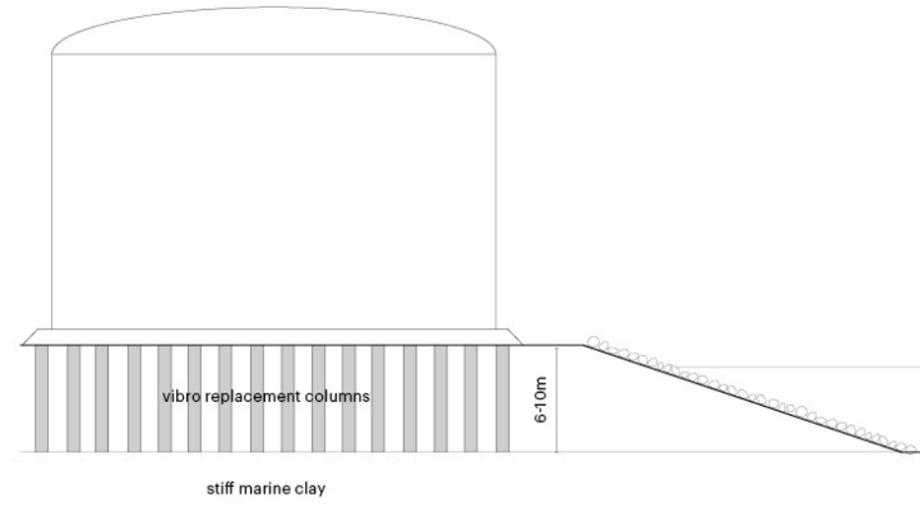
More recently, vibro floatation has become widespread. This technique comprises sticking a vibrating shaft into the land at short intervals to shift the fill material particles into open gaps.

Increased stability can be achieved by installing vibro replacement columns to act as a foundation. VRCs are basically vertical holes all the way to the firm seabed layers, filled with tightly packed gravel.

### Vibro Replacement Columns

Jurong Island, Singapore's artificial petrochemical hub, is booming to the point where sites are sold even before they are built. The expanded island has come to cover some very soft sea bed conditions, where the typical vibro compaction method cannot stabilize the ground enough to support the huge oil storage tanks that are built on it.

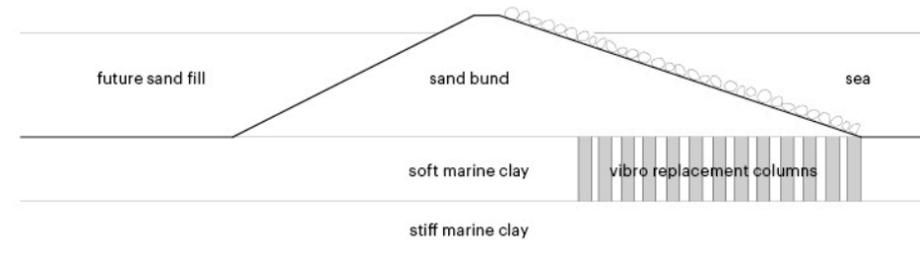
Vibro replacement columns are installed in these cases, because they are much cheaper than conventional concrete support pillars.



### Offshore Vibro Replacement

Traditionally sand keys are dredged from the soft clay seabed to support the perimeter bunds of land construction projects.

At one stretch of the bund at Pulau Tekong the sea bed is unable to support dredging without subsequent loss of stability, so instead offshore vibro replacement columns have been installed by pumping gravel into underwater holes through a long tube.





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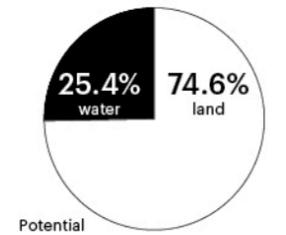
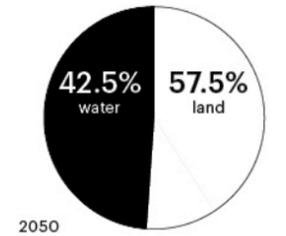
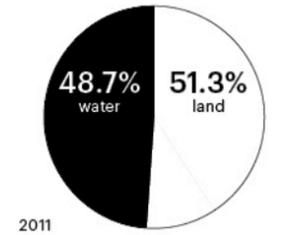
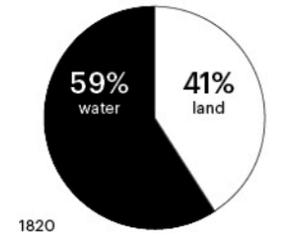
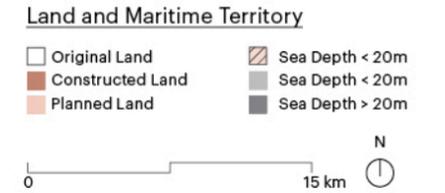
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Pasir Panjang Land Construction  
 Work on container terminals 3 & 4 at Pasir Panjang port was well under way at the time of writing. The photo series covers a period of about two months.





### Maximizing Territory

While Singapore has never ceased to extend its territorial area, this practice will eventually reach its limits. Even such a rich and technologically advanced nation cannot overcome all the challenges presented by the deeper waters and the scarcity of fill materials. Theoretically, the national borders and the 20 meter seabed contour define the limits of Singapore's potential expansion.

### Depth of the Straits

According to the Singaporean Urban Redevelopment Authority (URA), constructing land in waters more than 20m deep is financially unfeasible. This still leaves Singapore sizeable potential territory beyond the already planned projects, but most of these areas are crucial to port operations as they are currently organized.

### Political Relations with the Neighbors

Another limiting factor is the close proximity of the maritime borders with Malaysia and Indonesia. Singapore has already transformed its territory to the point where it is only 48.7% maritime, down from 59% before reclamation works began. Quite literally, Singapore is inching closer and closer to its neighbors.

### Scarcity of Fill Materials

The most immediate concern for Singapore's land expansion is the scarcity of fill materials. Even with the most advanced reclamation schemes currently being tested, the amount of soil needed to fill the deeper sea bed is staggering and securing supply is becoming more and more difficult.

# Soil Extraction & Trade

Singaporean demand for soil is at an all time high. Land reclamation projects are being carried out in deeper waters which requires increasing quantities of fill material, and high quality local sources have long been depleted. Singapore's strong economic growth has gone hand in hand with rapid development. Sand is imported for building construction as well as for land reclamation purposes, and this high demand coupled with a lack of local supply

has raised prices. This growing disparity between the value of sand in Singapore and its cost in the region has made the soil trade a very lucrative business. Profits are high and restrictions are poorly enforced, so environmental concerns have mostly been ignored.



Imported sand arriving at the Pulau Punggol Timor sand depot by barge

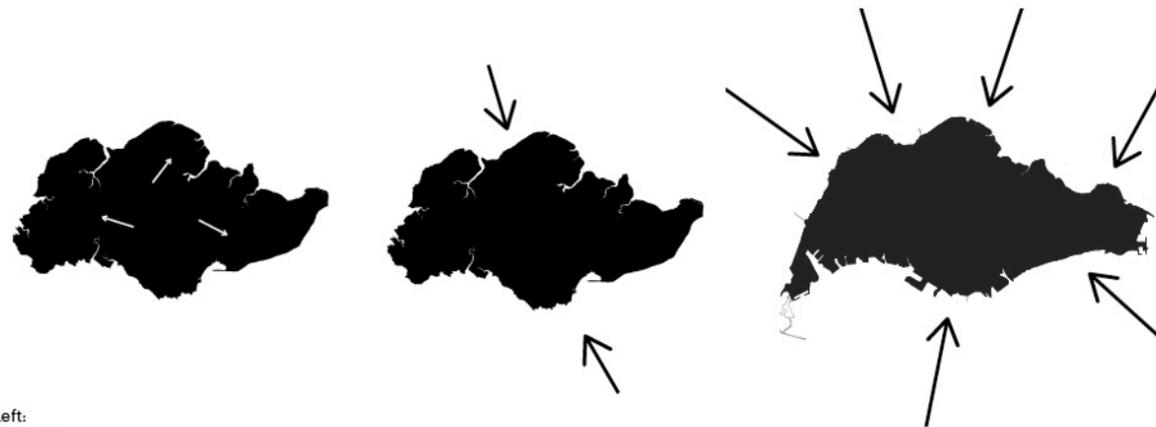
# The Expanding Radius of Sand Sourcing

Since the pace of building new land sped up dramatically after the mid-1970s, the issue of sand exploitation has gone from a very local to a regional scale, and now concerns all of Southeast Asia.

Early land reclamations in Singapore were carried out in shallow foreshore and swampy inland areas close to the hills that were cut down to provide the fill material. As a result, new flat land was created both where a hill was leveled and at the site where the soil was dumped into the water. Dredging sand from foreshore areas had a very similar, if inverse, effect.

As local sources were depleted, dredging operations expanded into the Straits around Singapore. This informal trade with neighboring Indonesia and Malaysia reached such a magnitude that entire islands began to disappear due to massive erosion. Both countries have banned the export of natural sands to Singapore, with mixed results.

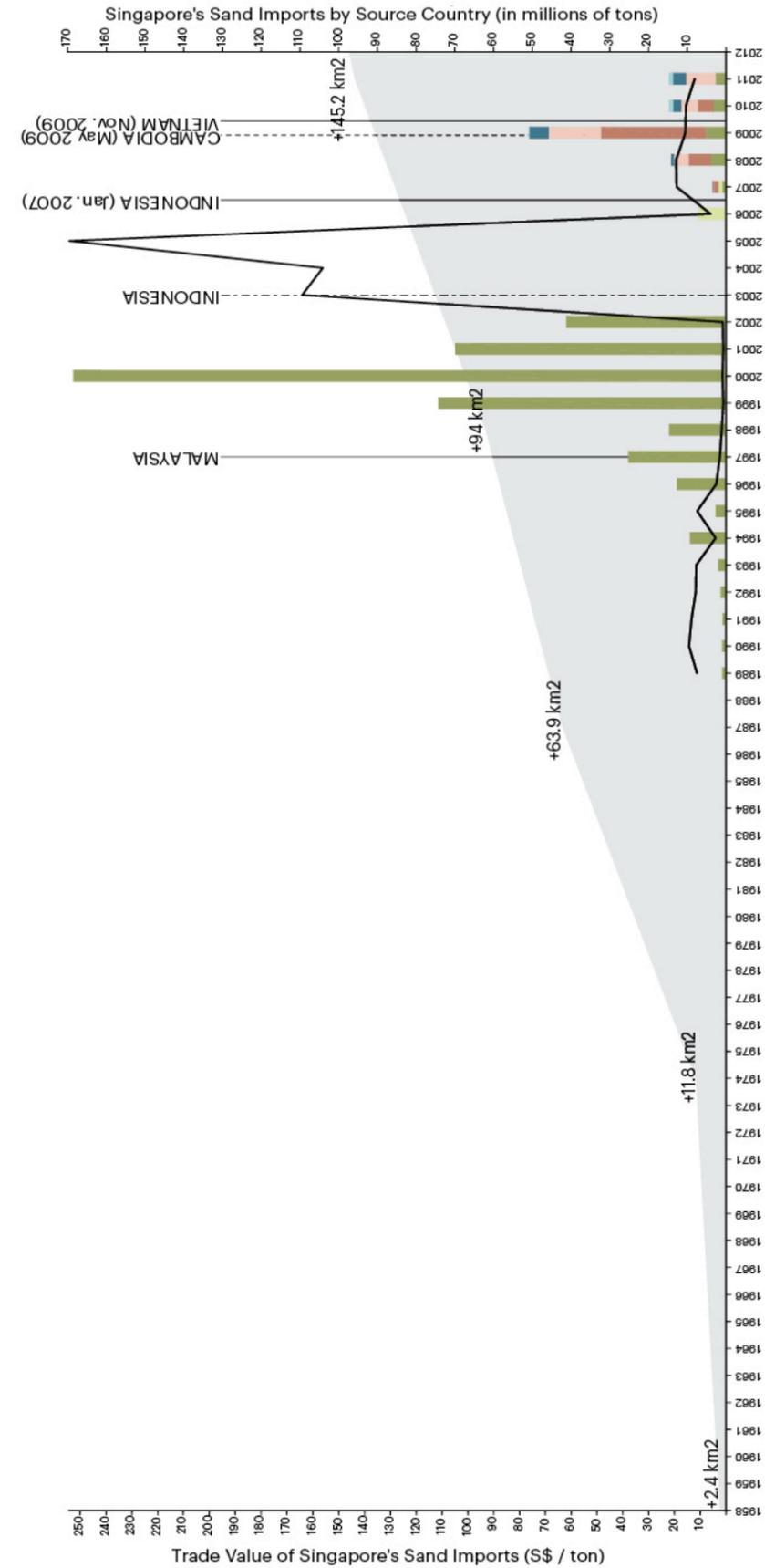
In order to replace these regional suppliers, Singapore has had to look to the wider region for willing trading partners, some of which have in turn banned sand exports after a few years of rampant exploitation.



Left: Local sourcing - cut and fill

Middle: Regional scale - depleting the Straits

Right: Southeast Asian trade - diversified & distant sourcing



## Soil Trade Statistics

Imports and exports of natural sands in the region have been reported to the United Nations global trade statistics division (UN COMTRADE) starting in 1989.

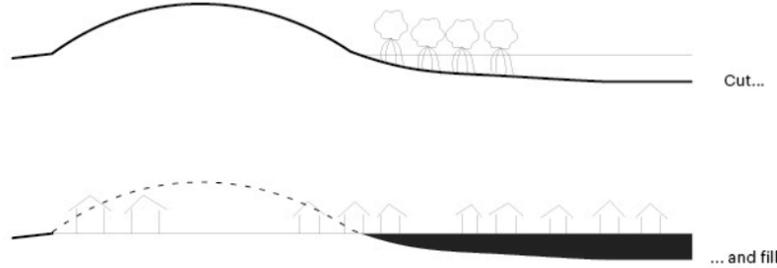
The import figures reported by Singapore do not cover the informal trade, but they do give a sense of the scale of these operations. Graphing the imports against the export bans and the reported yearly value of the trade reveals which bans have been effective, and how the trade has shifted to partners farther away.

- Added Land Area
  - Total of added Land Area
- Source Countries
  - Malaysia
  - Indonesia
  - Vietnam
  - Cambodia
  - Myanmar
  - Philippines
- Export Bans
  - All natural sand
  - Sea sand
  - River sand
- Trade value / ton



Left:  
Housing land (foreground) was created by partially filling a mangrove swamp (middle left) with material cut from a nearby hill (background left)

Right:  
Google satellite image of Batam, showing the scale of territorial transformation



**Cut and Fill:  
Batam Time Capsule**

A 45-minute ferry ride from Singapore, the Indonesian island of Batam allows a glimpse into Singapore's past.

Being one of Singapore's industrial hinterland, Batam has experienced rapid development and large-scale transformations of its territory. Much like in Singapore after independence, sites for development are created by cutting hills and using the soil to fill up mangrove swamps inside the island.

More recently, new land has also been built onto the sea, and it will be interesting to see how Batam deals with sourcing fill materials when it has flattened its hills and mountains.



Left:  
Pulau Nipah in July 2003  
Google Earth

Right:  
Pulau Nipah in May 2008  
Google Earth



Dredging the sea bed

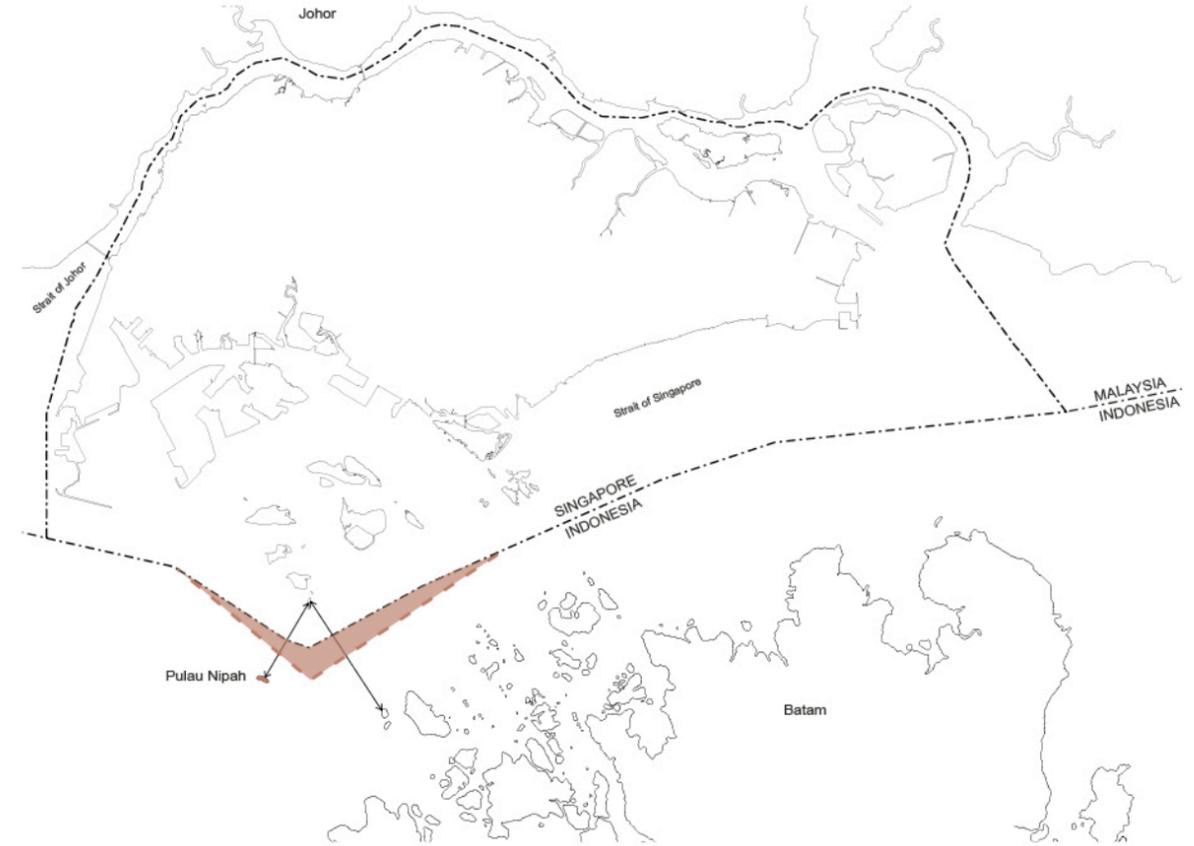


Erosion, destruction of mangroves, corals and fish spawning grounds

### Nipah Case: Shifting the Border

Massive dredging in the straits around the Indonesian Riau Archipelago has seriously diminished sea bed stability and caused some smaller islands to crumble into the sea.

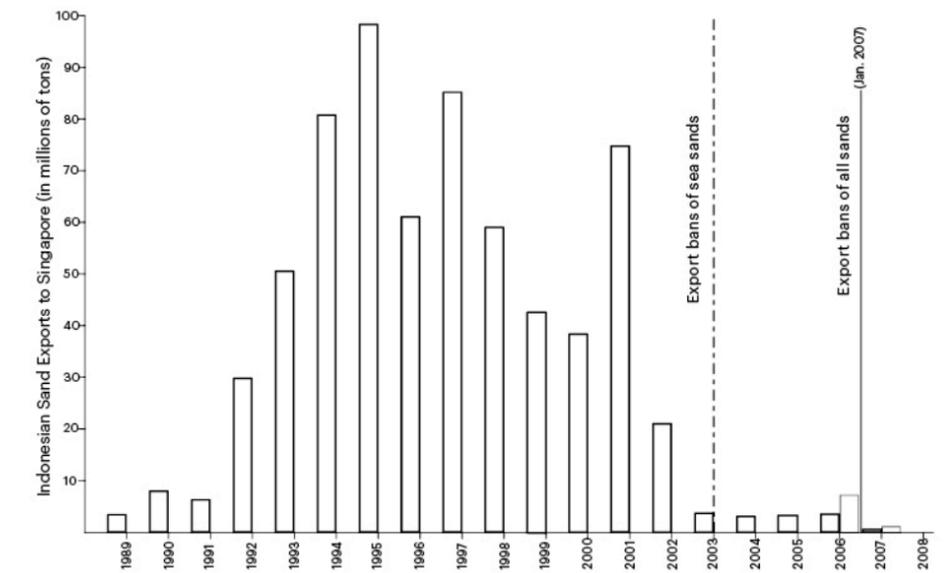
The most famous of these is Pulau Nipah, one of the Indonesian islands used to calculate the international border with Singapore. By 2003 it was so depleted that it barely broke the water surface at high tide. Indonesia, fearing that the border could be recalibrated to Singapore's advantage rebuilt the island over the next years.



**Indonesia's Contribution to Singapore**  
 The UN COMTRADE database shows that Indonesia reported considerable exports of natural sand to Singapore starting in 1989. The export peaked at almost 100 million tons in 1996. Singapore only started reporting sand imports from Indonesia in 2006, just before Indonesia banned all export of natural sands to Singapore.

Since Singapore reported imports of a comparably large scale from Malaysia during the same period, it seems that Singapore does not consider the Straits in and around the Riau Archipelago as sovereign Indonesian territory.

### Bans of Sand Exports to Singapore



# Trade Bans & Territory

Singapore's construction of territory has an impact on a subcontinental scale. Sand sourcing reaches more than 2'000 km across Southeast Asia and every large coastal country in the region besides Thailand has contributed to Singapore's expanded land mass.

As each source runs out or is cut off, Singaporean importers look for a new, unspoiled sources one step further out. After a few years of rampant exploitation, these new source countries become aware of the negative impacts large scale sand extraction has on their coastal and river-based ecosystems and societies. Exports to Singapore be-

came banned, and the whole process starts over again.

Export bans are passed for different reasons, as each nation has a different relationship to Singapore and specific internal dynamics. The early Malaysian and Indonesian bans were largely expressions of political disputes, while the recent ban in Cambodia is a result of public pressure over environmental concerns.



### A Global City Built on Foreign Soil

For all of its defensive nationalist rhetoric about being a small, surrounded island, the story of its land construction shows a very clear regional hierarchy of economic power.

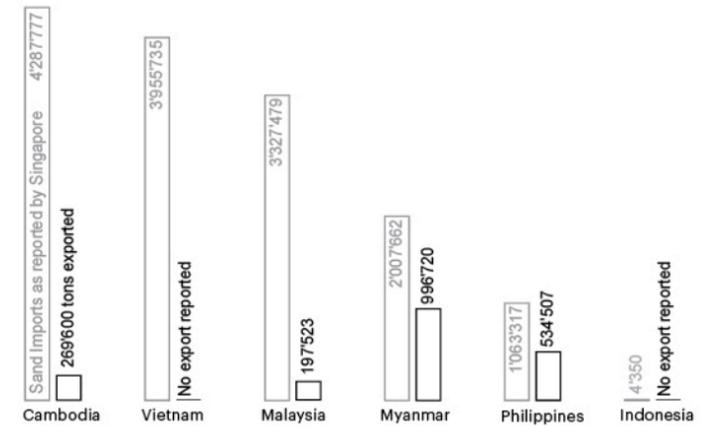
Although individual contributions are difficult to quantify, about three quarters of Singapore's constructed land area is built from foreign sand (Lee et al).



### Trade Bans in Effect (2010)

The three largest sources of natural sand Singapore reported to UN COMTRADE for 2010 had at least partial bans in effect.

Existing contracts are usually allowed to be concluded past a ban taking effect, but the discrepancy between Singapore's reported imports and the source countries' reported exports is striking.





A sand barge in the strait of Johor, on its way to the Punggol Timor sand depot



Dredging the river bed

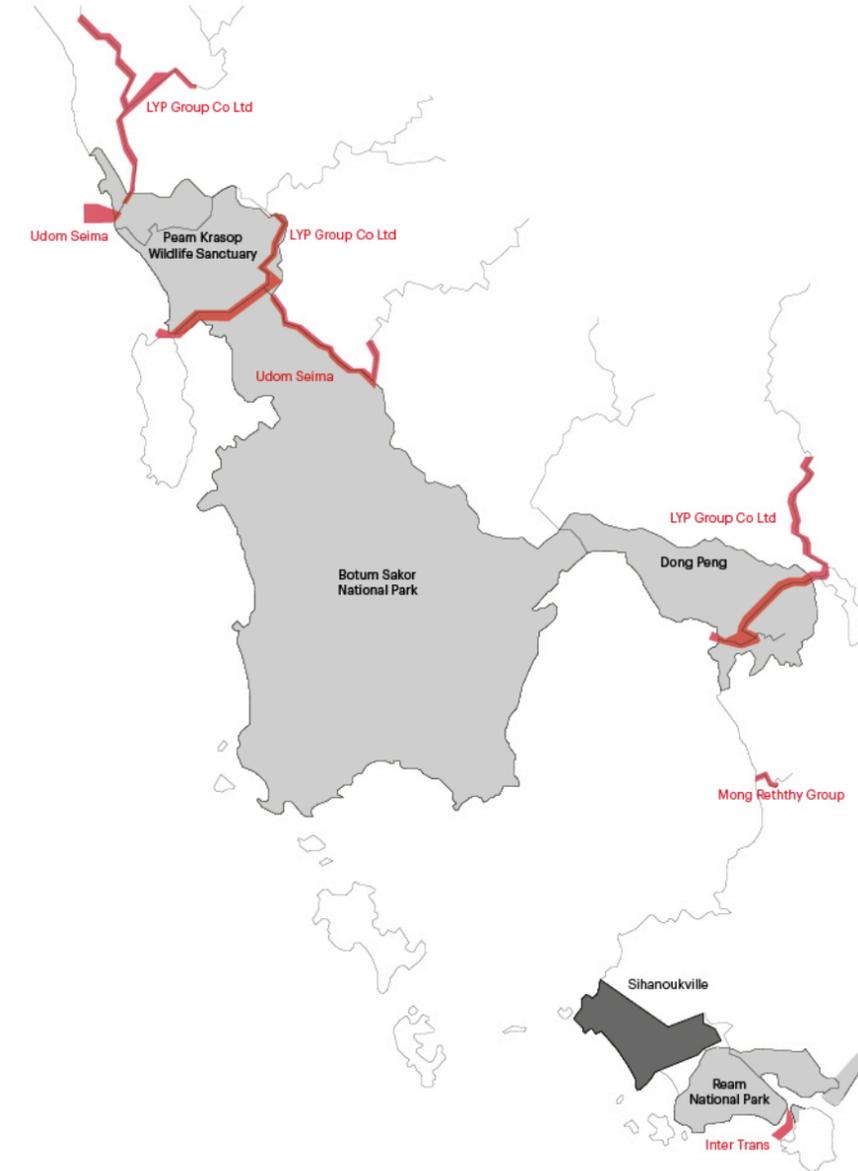


Erosion, destruction of mangroves and fish populations

### Cambodian Case: Circumventing the Ban

Despite a May 2009 ban on the export of river sand, the Cambodian government issues concessions for the dredging of both sea and river beds.

Two of the three major sand mining corporations are run by sitting Cambodian senators, Ly Yong Phat and Mong Reththy. The NGO Global Witness estimates that LYG Group Co Ltd and Mong Reththy Group together export 8.1 million tons of sand to Singapore per year. In 2009, the year the Global Witness report was written, Cambodia reported less than 1 million tons of natural sand exported to Singapore.



### River Dredging Concessions

- Dredging Concessions
- Regional Center
- Nature Preserves

0 10 20 km



Koh Kong Province in Cambodia

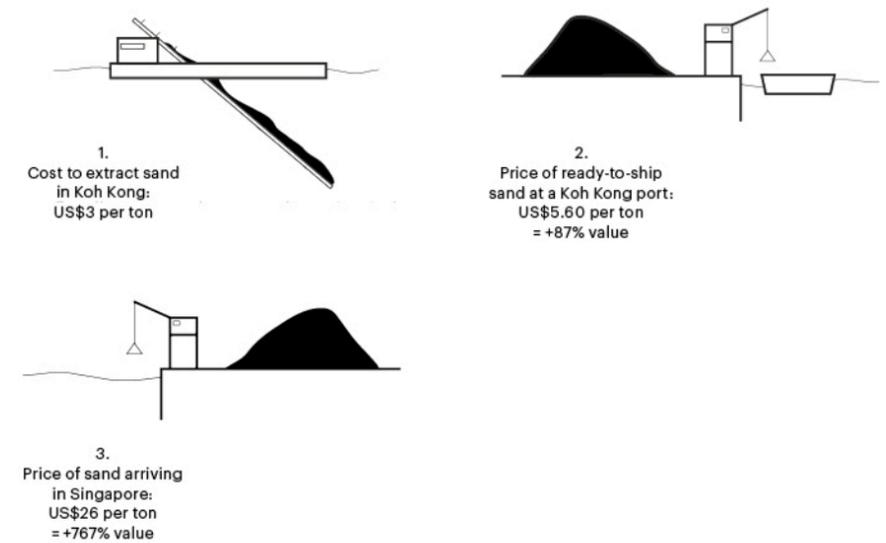
### Environmental Preservation vs Profit

Sand mining operations are concentrated in Koh Kong province, home to large rivers and the majority of the country's coastline.

The concessions for river dredging are in or upriver of national parks and wildlife sanctuaries. Smaller companies are subcontracted by the concession holders to do the actual dredging.

Sea bed sand is the primary fill material used for land reclamation, while the construction industry needs finer river sand mainly for mixing concrete. The cost to extract a ton of sand in Koh Kong province is less than 12% of what that same ton of sand is worth in Singapore. The profits being made in this business are so high that those involved in it are not very concerned about environmental preservation efforts and agreements.

(Global Witness, "Shifting Sands")



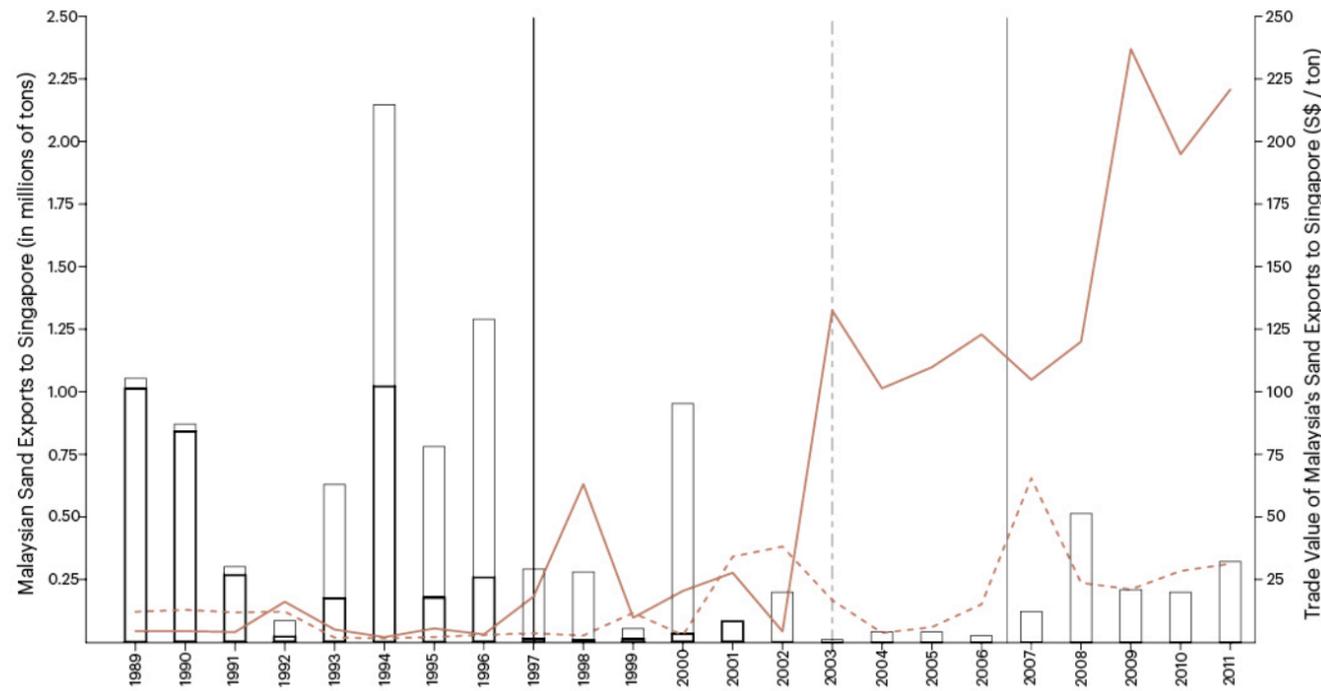
# Sand Gates & Strategic Reserves

Sand is brought to Singapore by land and by sea. Malaysian trucks full of sand cross the Causeway and the Second Link at Tuas. Barges carrying sand arrive at Pulau Pungool Timor.

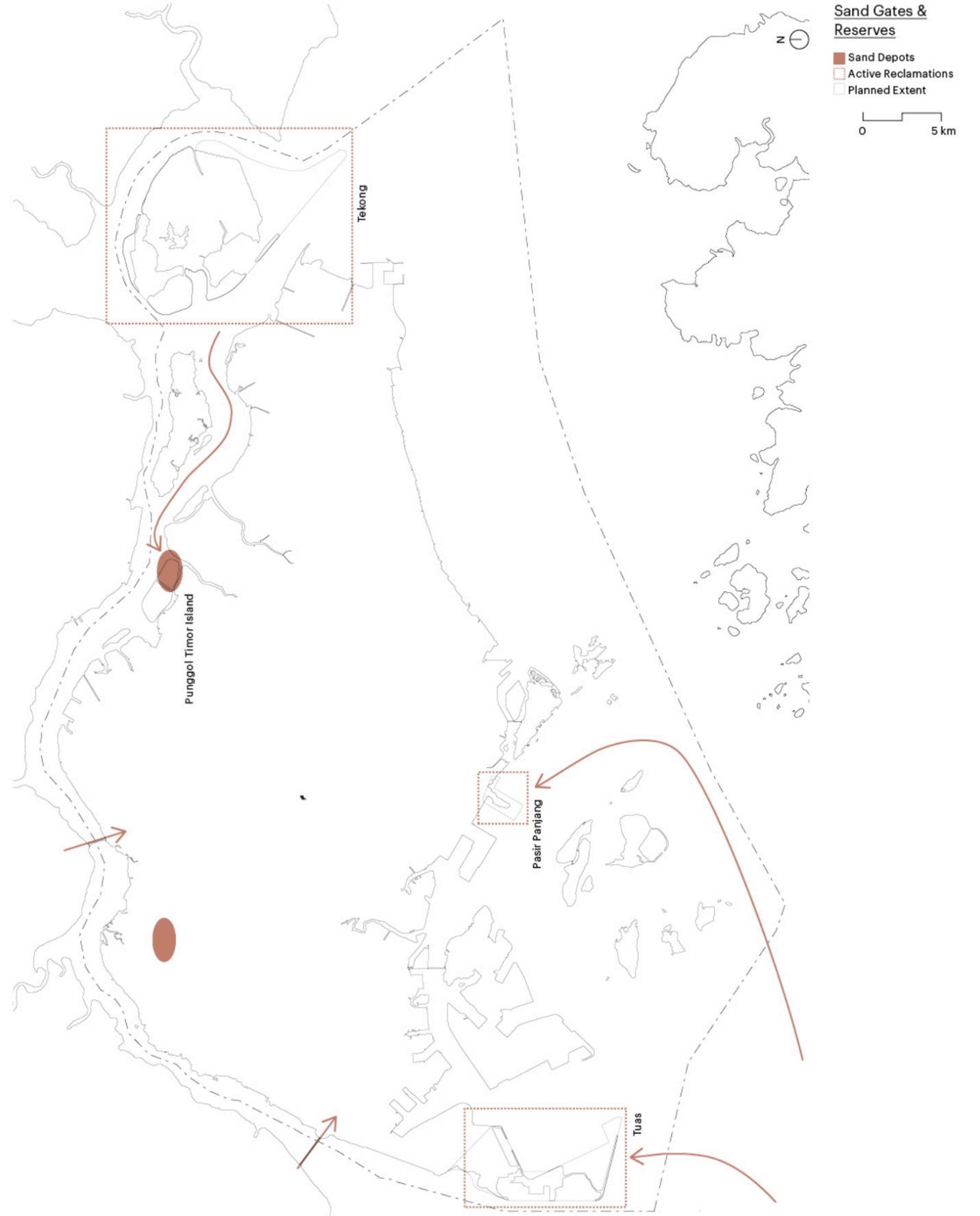
At these sand gates, the loads are transferred to trucks that deliver them either to a sand depot or directly to a construction or reclamation site.

The Singaporean government keeps strategic sand reserves, in order to react to extreme fluctuations in the price and availability of such a crucial, locally not available resource.

For example, if a major supply country institutes an export ban and sand prices skyrocket until new sources can be tapped, the government can release a certain amount of sand at a fixed price. This allows the government to practically guarantee that land and building construction projects can continue on schedule without major delays or cost overruns.



**False Declaration**  
Malaysia still exports natural sand to Singapore on a yearly basis, even though it passed a ban on doing just that in 1997. Since the early 1990s, more than half of the exports reported have been quartz and silica sands. Former Malaysian MP Mahathir Mohamad famously stated that these exports are surely falsely declared.





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**Pulau Punggol Timor Sand Depot**  
 The gate for barges bringing sand into Singapore by sea occupies an artificial island in Northeastern Singapore. Sand is stored on two separate plots, one of which has a high daily turnover while the other appears to be a strategic sand reserve where multicolored mountains of sand lie for long periods of time.  
 The site also has an industrial area where several concrete premixing companies are located, as well as one concrete precasting operation that produces the elements for HDB construction.



- 1. Strategic sand reserve - the sand piles are fitted with drainage elements, which adds to the militarized aesthetic of the site
- 2. Strategic sand reserve - unpopulated but equipped with basic infrastructure
- 3. Strategic sand reserve - closely guarded and devoid of life
- 4. The high-turnover part of the site is full of machines ready to transfer sand
- 5. SinMix - one of the concrete mixing plants on the site
- 6. G & W Precast Pte Ltd - the biggest and newest of the company's three plants in Singapore. 90% of production is for HDB construction projects

# Decoding the Constructed Territory

The construction of territory in Singapore is an extremely controlled, entirely top down process. It involves the highest levels of government, and depends on precise execution from the initial planning phase until the new land is developed and integrated into the city. Projecting developments decades in advance requires not only careful planning, but also a high level of control over the population and economic strategy.

Looking at the entirety of Singapore's constructed territory instead of concentrating on the individual phases reveals a complex system of networks and dependencies.



## Actors, Processes & Profits

The hierarchical structure of colonial society was replaced with a paternalistic one party system whose success is based on getting results. Priorities have changed over time but the success of the government in achieving its planning goals has been constant.

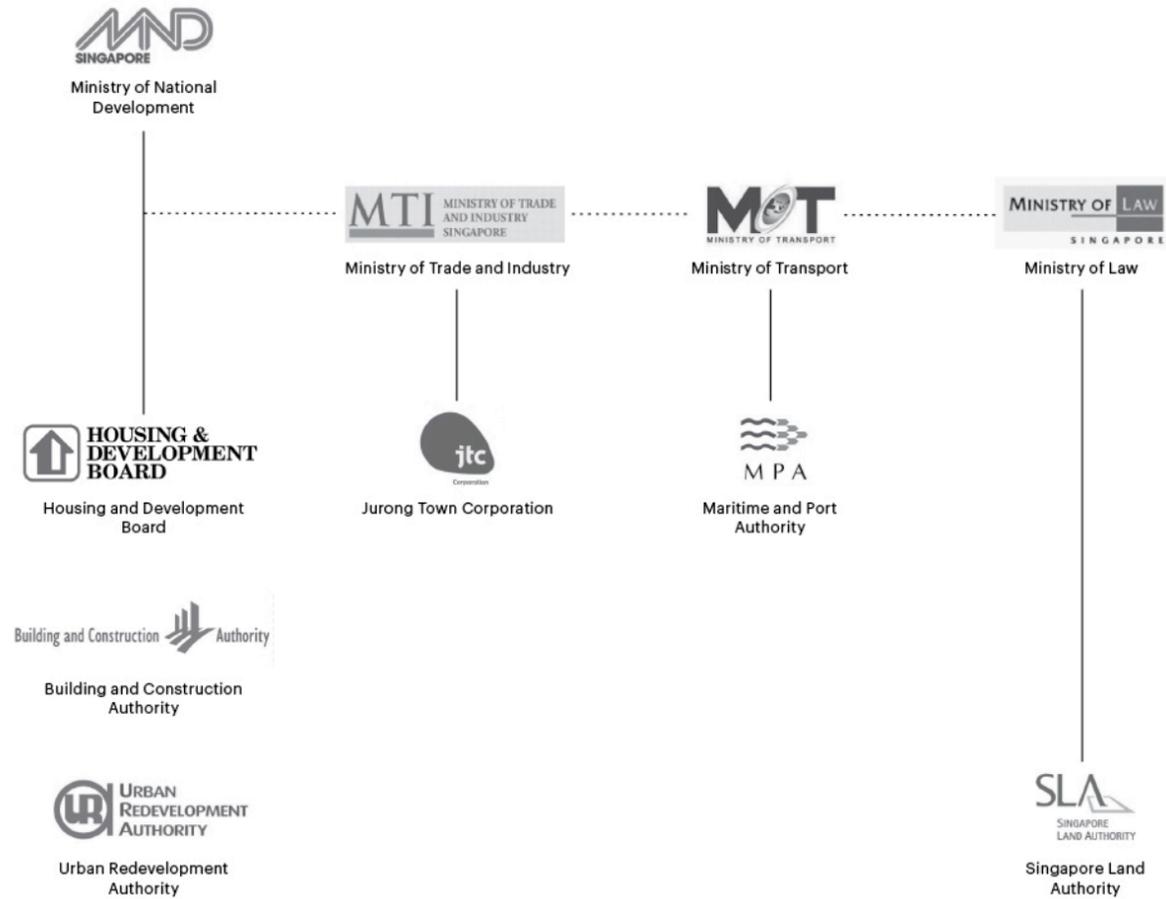
Creating and distributing new land is the most effective way the government can steer Singapore's evolution and therefore it never relinquishes control over the process. At every step a government agency is directly or indirectly involved, and if something is not to their liking the



Singapore's defining first prime minister, Lee Kuan Yew, going over plans for the original east coast reclamation scheme.

Land Aquisition Act of 1967 allows them to take over private property and decide on the appropriate compensation.

In the early days of independent Singapore, the goal was to create land for economic development and to build housing for the population. In more recent years, the process has become a money making operation in itself. Where the government used to have to build the pieces of their planned city themselves, they now make large profits letting private developers do it for them.



### Obscure Hierarchy

The web of government agencies, subsidiary boards and ministries involved in land reclamation is difficult to untangle, but in the end the Ministry of National Development seems to be pulling all the strings.

**Land Reclamation Process:**

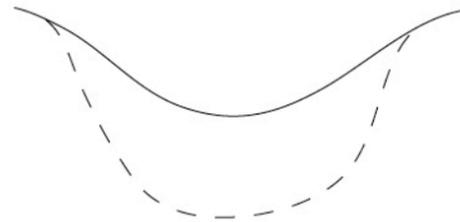
**1. Planning Phase**

The general development strategy for Singapore comes from the Ministry of National Development (MND). The semi-autonomous HDB then takes care of the specific site planning while the JTC and the MPA plan for their respective purposes.



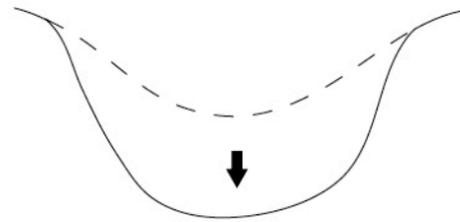
**2. Implementation**

The actual building of new land is done by private contractors chosen by the respective subsidiary boards through an open tender process. Smaller subcontractors are brought in for specific phases of the reclamation works.



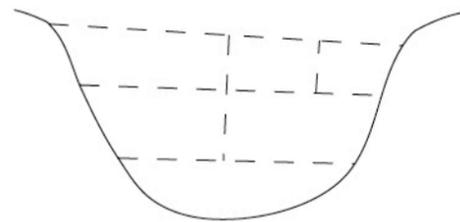
**3. Settling**

While the new land settles, it is officially handed over to the contracting government agency and ownership is transferred to the government. The SLA and the URA are in charge of planning for the sites' development.



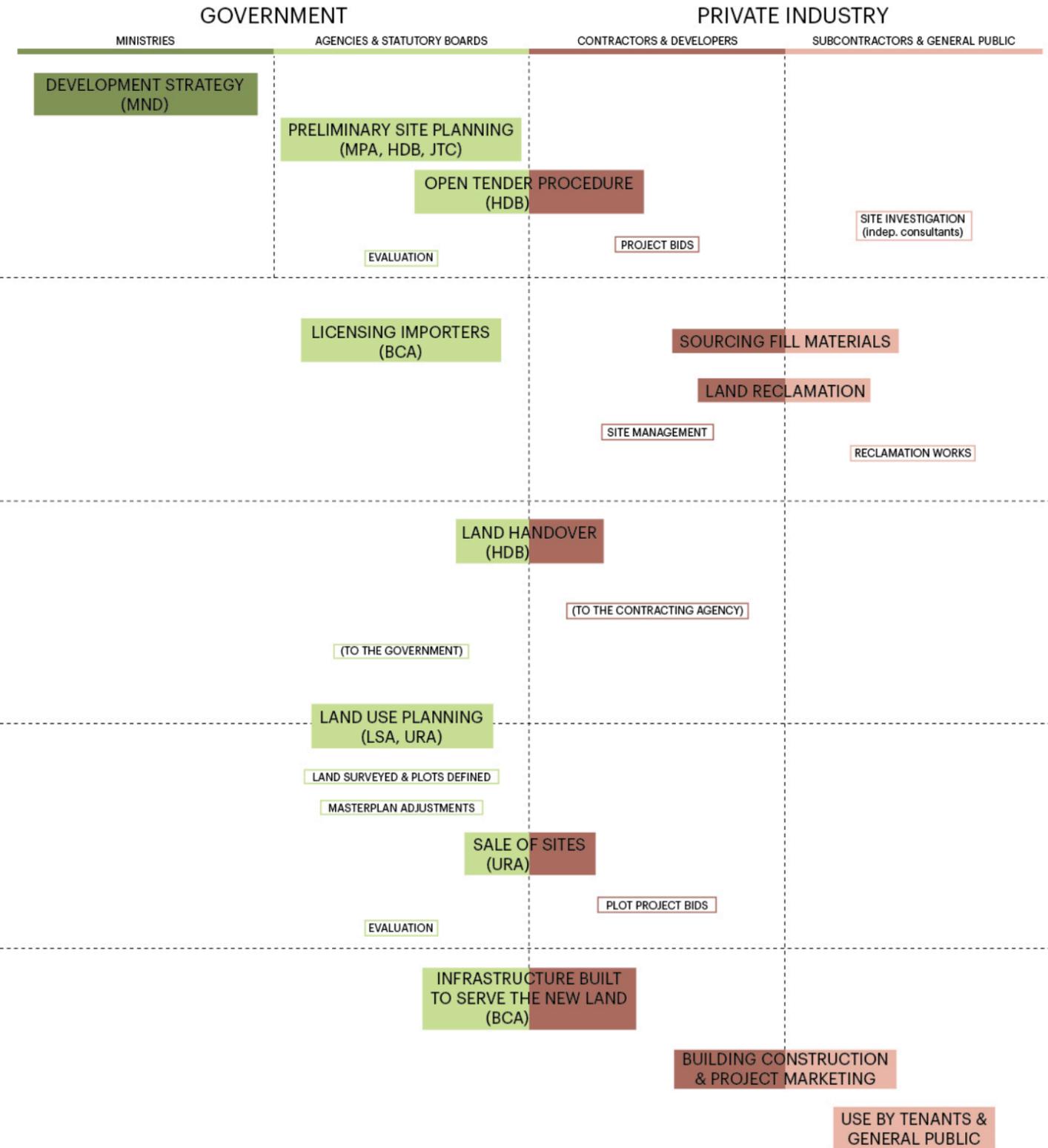
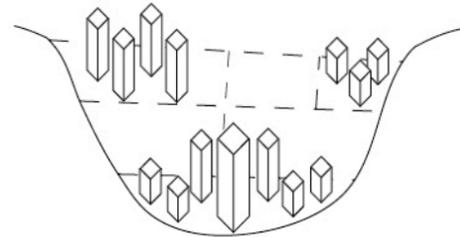
**4. Parcellation**

Plots are defined in adjustments to the URA Masterplan, and most of the land leasing is also done through the URA Sale of Sites program.



**5. Exploitation**

Private developers, having paid a premium price for a finite lease on the land, still have to follow strict guidelines for the development of the sites. However, the JTC, MPA and often also the HDB end up developing the land for their purposes.



# The Extra 25 Percent

The 145.2 km<sup>2</sup> that have been added onto Singapore's islands since 1820 represent a 25% increase in the total land area. Having analyzed the successive phases of this growth, it makes sense to also look at the entire constructed territory as a whole.

The different hubs of the Singaporean global city economy are all located on artificial land, as are some of the infrastructures linking them. The reclaimed land seems to form a sort of linear city, but it is in not self sufficient by any

means. In fact, it relies heavily on the original island to house and serve the population and to supply the workforce.

In many ways, the original island at the center of Singapore serves as the hinterland for the economic engines of the constructed territory. The workforce being channeled in from the dormitory suburb that is the middle 75% of Singapore is like an intravenous fluid for the coastal city wrapped around it.



Left:  
Singapore in 1820

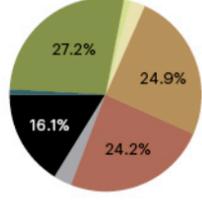
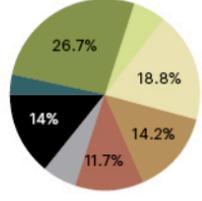
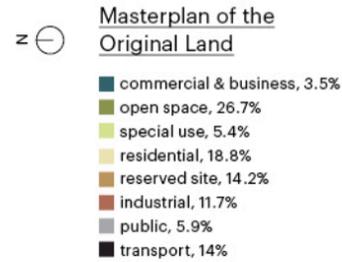
Right:  
Singapore in 2011



Raffles Quay in 1890, after the Telok Ayer reclamation



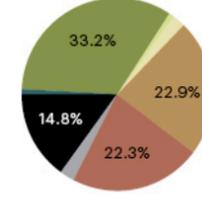
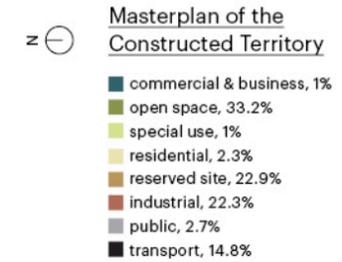
Raffles Quay in 2012



URA Masterplan 2008 (eight categories)



**Space for the Global City Economy**  
 The transition from a quai- and dock- to an office economy has profoundly transformed the territory of Singapore, but interestingly enough the same location is still absolutely central.





**Built up Area on the Original Land**

- Building footprint
- Land area

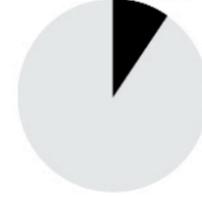
**22.8%**  
built up  
area



**Built up Area on the Constructed Land**

- Building footprint
- Land area

**9.5%**  
built up  
area

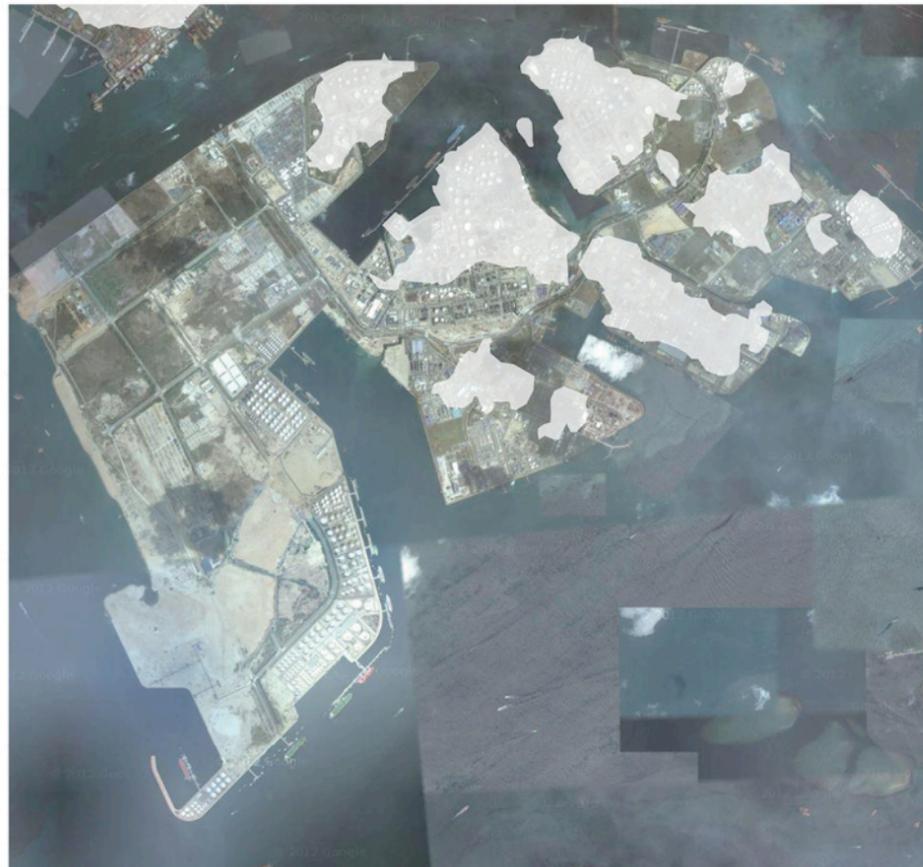




Ingredients of a Global City

There are two basic types of sites to zoom on: the purpose-built ones with a specialized use, and the mixed use areas.

There is a clear difference in scale between the two. Special use sites are generally created so as to provide maximum land area, while mixed use sites tend to focus on generating more waterfront spaces.



1. Jurong Island is visibly in a state of transition. The booming petrochemical industry is buying land before it is even built.



2. Changi illustrates the long term planning when creating land for strategic industries. Most of the site is unused, awaiting future airport growth.



3. Pulau Tekong is undeveloped because it is used exclusively for military training.



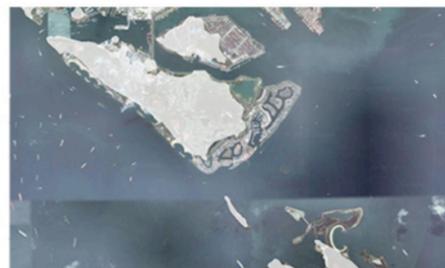
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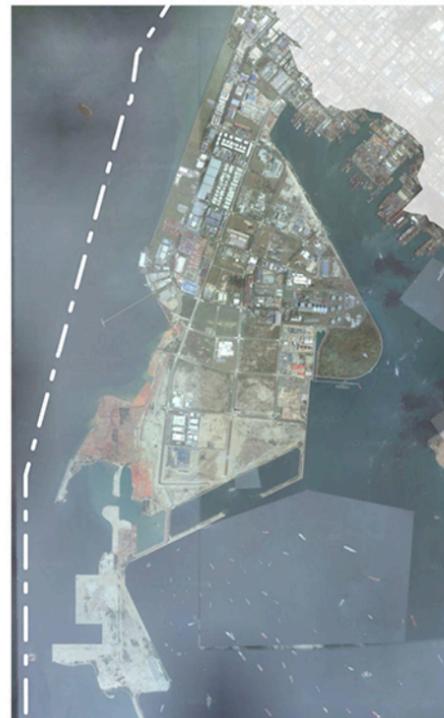
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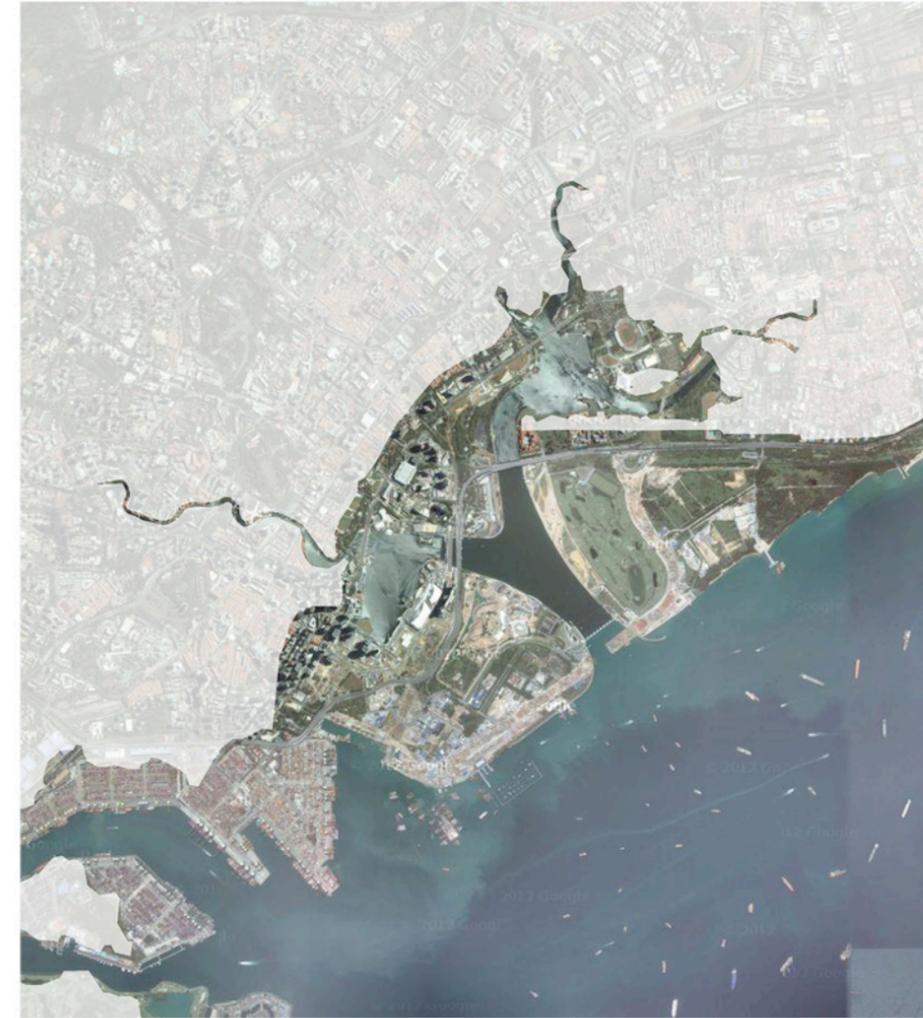
4.  
Punggol shows the redesigning of the shore to create reservoirs and waterfront areas.

5.  
The East Coast is a linear arrangement of large scale projects parallel to the older city.

6.  
Pasir Panjang is shaped only to efficiently process shipping containers.

7.  
Sentosa Island wants to maximize waterfront properties like Dubai.

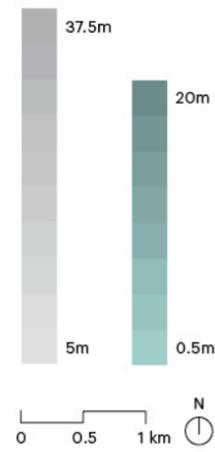
8.  
Tuas is organized on a grid but has to allow ship access to industrial Jurong.



9. **The Mixed Use Central Area**  
All the various strategies come together here. The constructed land is shaped to expand the shoreline and create a reservoir. Like Tuas, it is adjacent to an existing economically productive area that wants to expand. Port facilities are present, as is the large golf club, which temporarily uses the new land.

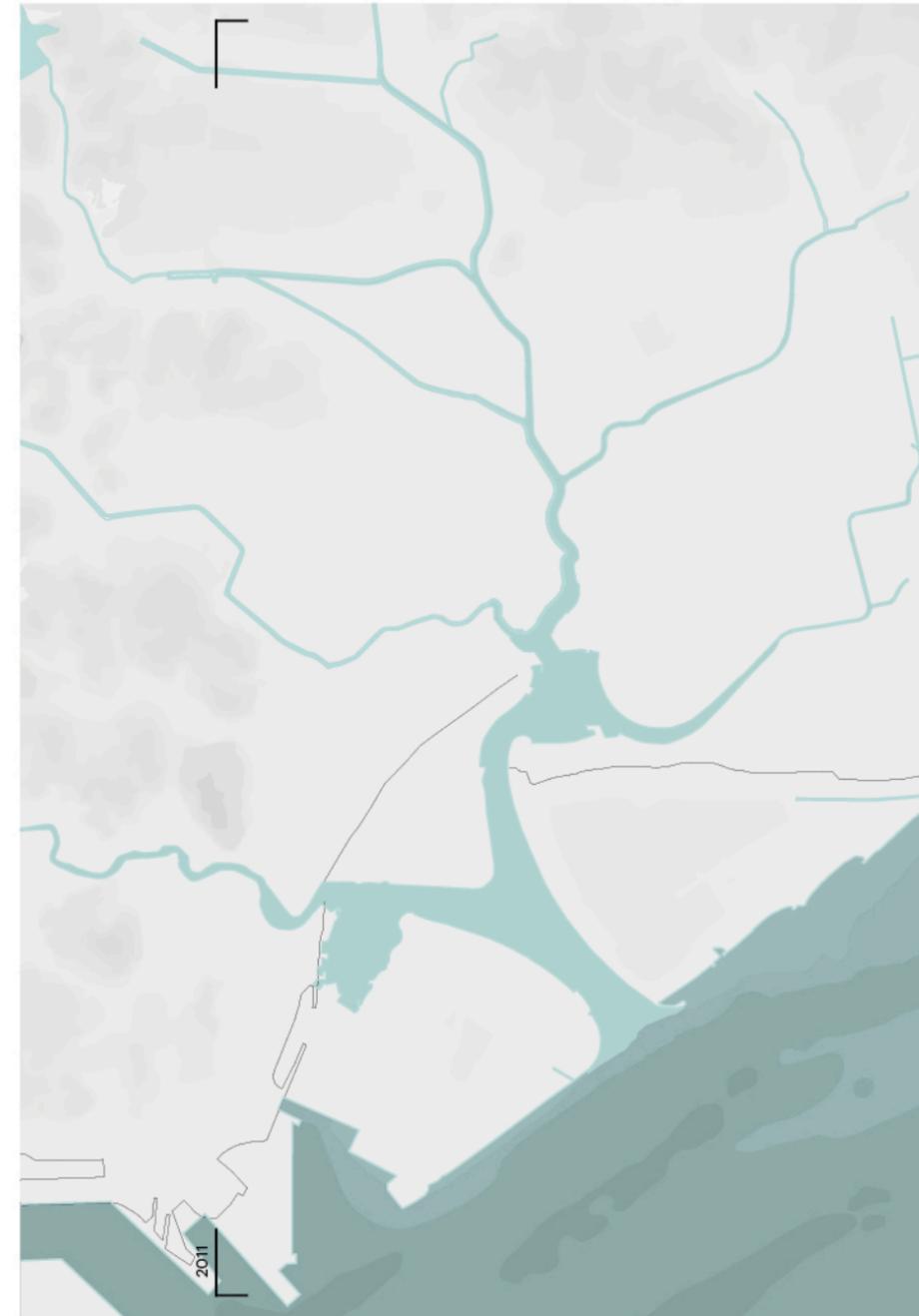


Land and Water Topography

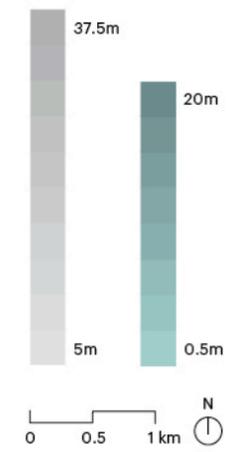


1937: Natural Topography

The central area was still defined by hills and an extensive canal system as well as by the waterfront. The underwater topography was shallow and quite complex at this time.



Land and Water Topography



2011: Transformation to meet Expenses

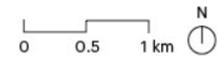
By 2011, the hills have been flattened considerably, the canals to the east filled, and the rivers have been straightened.

Large land areas have also been built out into the sea, which is much deeper than it used to be.



#### Road Network 1937

- Original land
- Reclaimed land 1820-1937
- Main roads
- Secondary roads



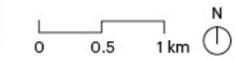
**Centrality of the Historical Structure**  
The road network in 1937 was a grid along which the colonial city was organized, with country roads connecting the rural back-country with the city.



#### Road network 2011

- Expressways
- Underground
- Main roads
- Secondary roads
- New Expressway
- Underground

- Original land
- Reclaimed 1820-1937
- Reclaimed 1937-1958
- Reclaimed 1958-1974
- Reclaimed 1974-1987
- Reclaimed 1987-1998
- Reclaimed 1998-2011



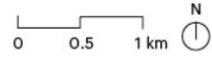
**Multi-Centered-City**  
The road network in 2011 is much more complex, with an expressway system overlapping the main and secondary roads. These expressways actually circumvent the inner-city as they link the entire island around the central area.



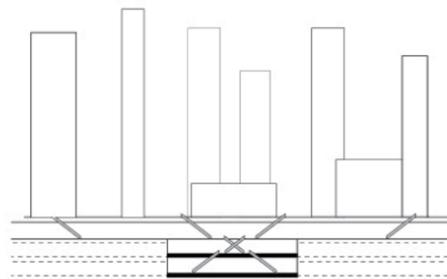
MRT Network 1990

- North South Line, 1988
- Underground
- East West Line, 1990
- Underground

- Original land
- Reclaimed 1820-1937
- Reclaimed 1937-1958
- Reclaimed 1958-1974
- Reclaimed 1974-1987



**Connection to Suburbs**  
 The original two lines of the MRT system built at the end of the 1980s connect the main axes of the island with the central area. Stations were built near central nodes, retrofitting the existing city.



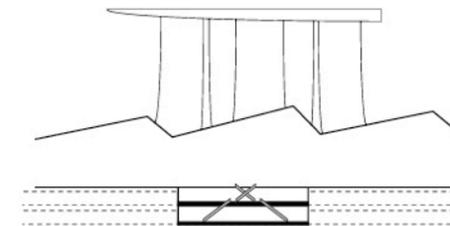
MRT Network 2013

- North South Line, 1988
- East West Line, 1990
- Underground
- North East Line, 2003
- Circle Line, 2009
- NS Line Extension, 2014
- Downtown Line, 2013-17

- Original land
- Reclaimed 1820-1937
- Reclaimed 1937-1958
- Reclaimed 1958-1974
- Reclaimed 1974-1987
- Reclaimed 1987-1998
- Reclaimed 1998-2011



**Interconnection as Upgrade**  
 More recent MRT construction has focused on interconnecting the existing structure, as well as driving new development by making specific sites on the constructed territory more attractive.





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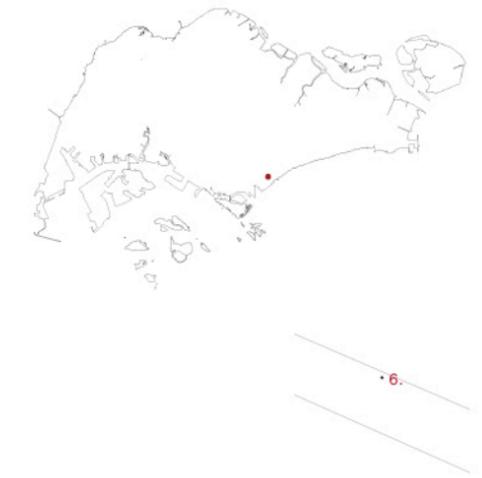


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6.

Cross Section of the City's Layers  
 Stills from the video short, "Coral City", shot along Boon Tat street as it crosses the successive historic coastlines in the city center.



# Coral City Case Study

Singapore's growth can be compared to that of corals. From a solid base it grew outward continuously, and upward as well. Studying this process in the Telok Ayer / CBD part of the city is especially rewarding since this is a site on which land and buildings have been rebuilt multiple times.

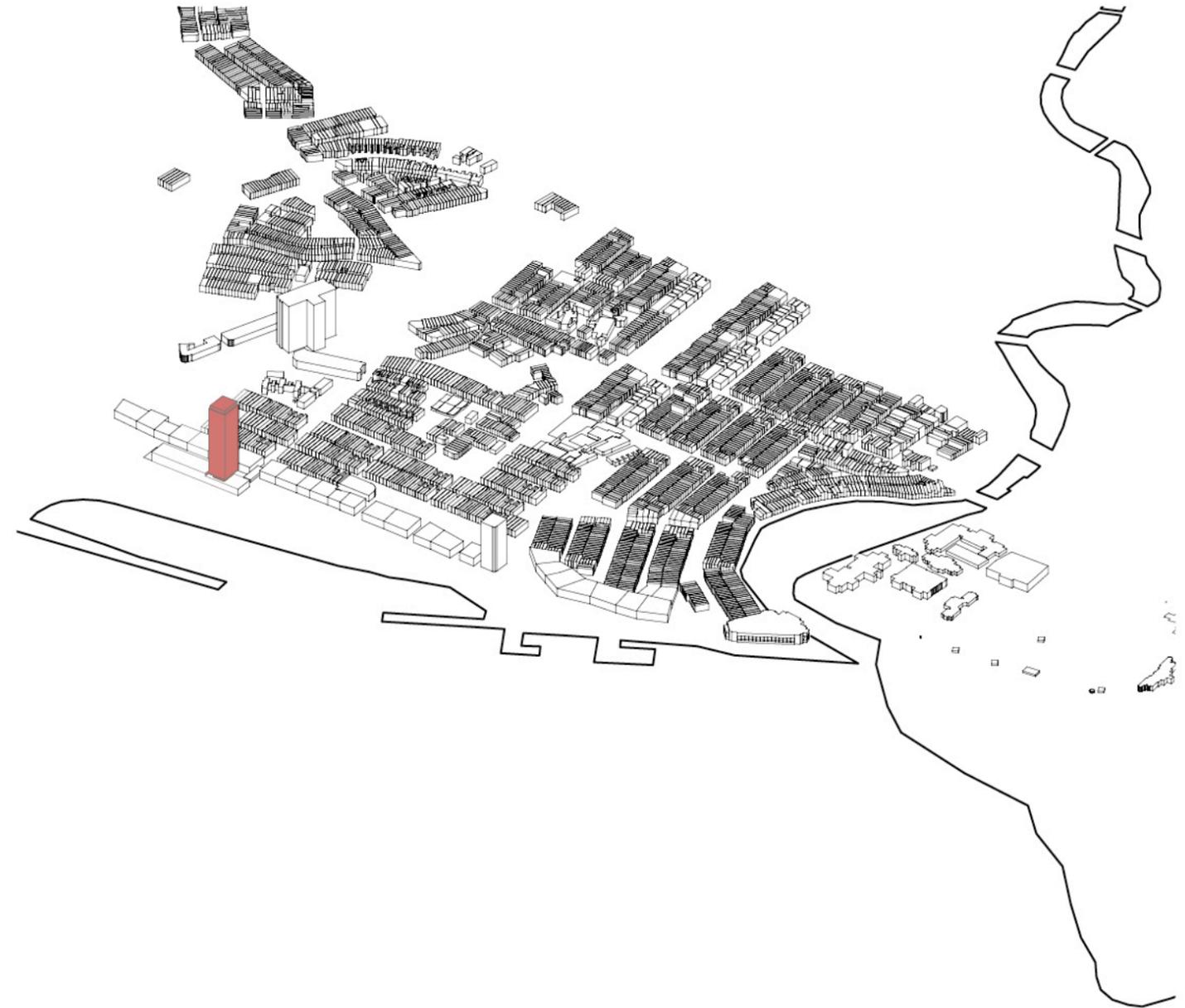
The Singaporean government has steered this process starting with the development of the Golden Shoe at the end of the 1960s. Through the URA's Sale of Sites program, the government has control over what gets built where,

and which program mix is achieved in a certain neighborhood. The Golden Shoe, adjacent to the Telok Ayer Basin in the economic heart of the city, was planned as the Central Business District from the beginning.

What is interesting is that although the nature of the economy has changed completely, and the territory has been totally transformed, this part of the city has retained its economic centrality.

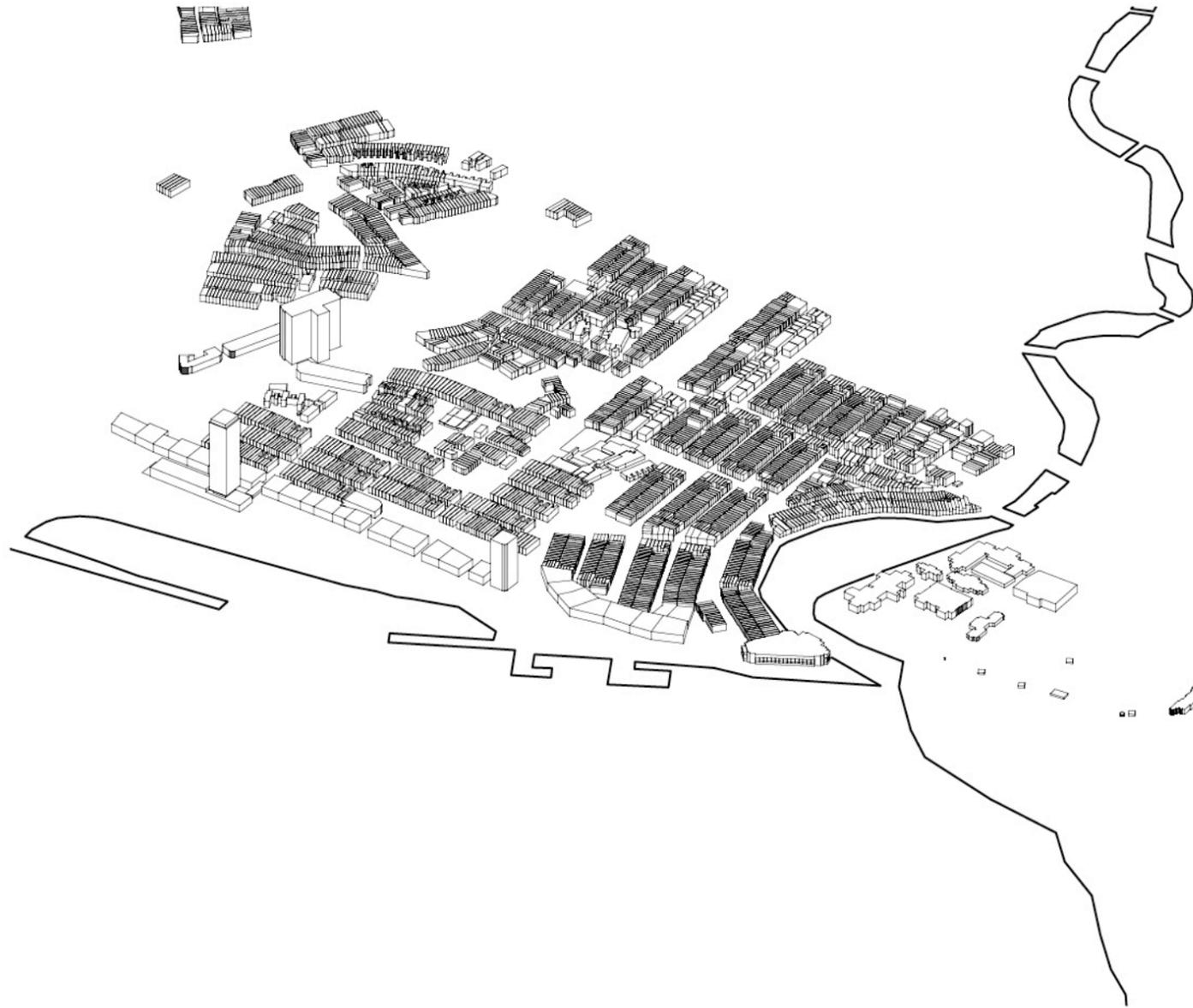


The dock-based and the office economy in the area around the CBD



Transaction Price ca. 1958  
Shenton House:  
S\$ 624/m<sup>2</sup>

**1958: The Post-War Harborfront**  
On the eve of self-governance the area between the Singapore river and Telok Ayer basin was still a major trading and business center. Shophouses dominated the district, with larger representative buildings lining Raffles Quay. The first modern tower had already been built in the area; a sign of things to come.



**1974: Starting the Golden Shoe**  
 By the mid-1970s the first signs of increased investment in the city center are visible. A couple more towers have been built, the Marina Center reclamation scheme is under way, and many sites in the Golden Shoe area around Robinson Road and Shenton Way had been sold.



Transaction Price ca. 1990  
 UOB Centre:  
 S\$ 22'217/m<sup>2</sup>

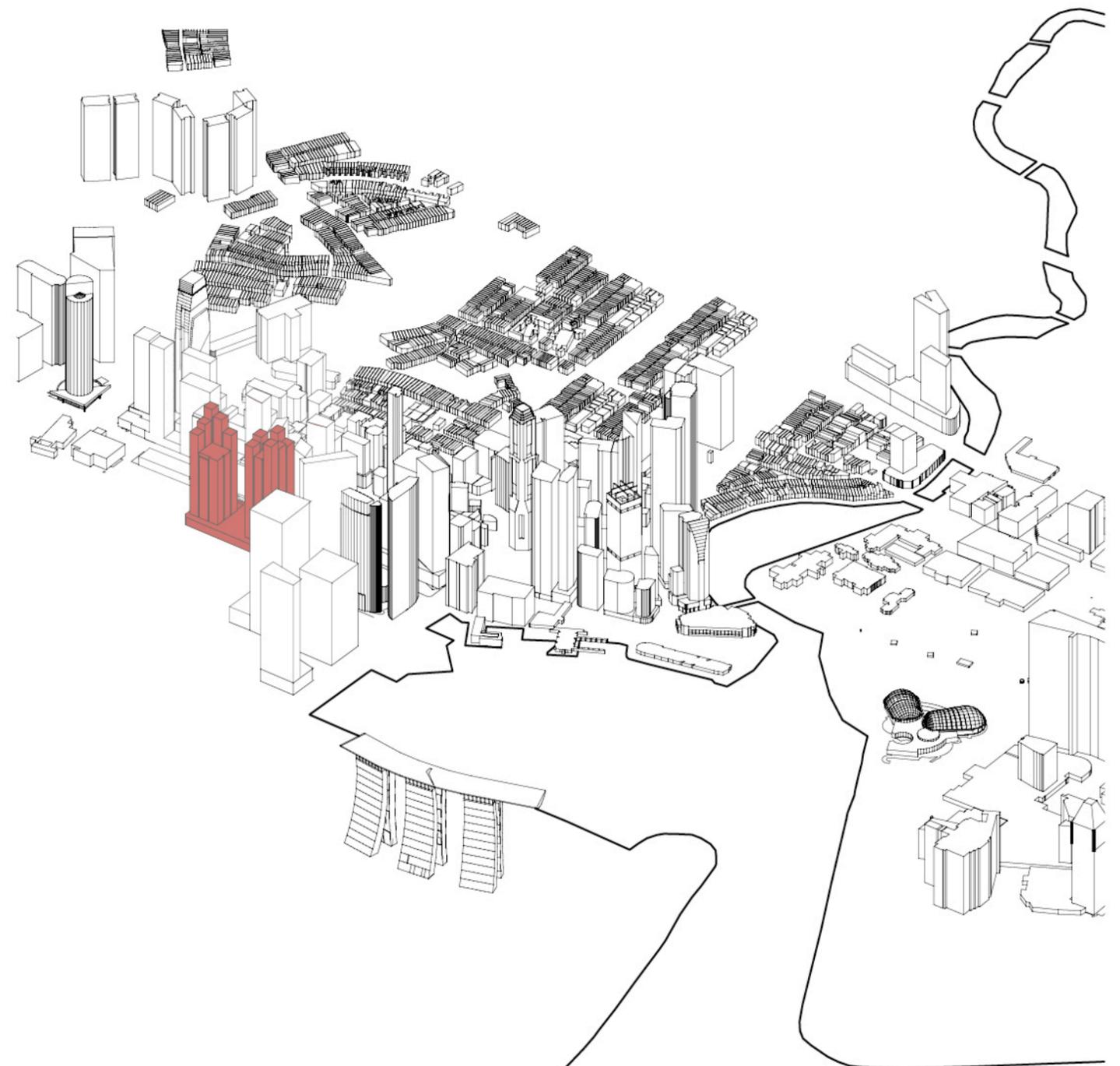
**1990: Rediscovering the River**  
 The Central Business District really got going in the late 1970s. A large number of office towers were built behind Telok Ayer Basin and the area around Raffles Place was redeveloped as well. At the same time, with the construction of Marina South and Center, a huge amount of land was added to the area.



Transaction Price ca. 2000  
One Raffles Quay:  
S\$ 108'721/m<sup>2</sup>

**2000: Filling in the Gaps**

The 1990s saw significant densification of the area around Shenton Way and Robinson Road. The city center was obviously an attractive location, but development stopped short of the adjacent Marina South. The last part of Telok Ayer Basin was filled up to better connect the existing CBD and the new land targeted for development.



Transaction Price ca. 2012  
Asia Square:  
1. S\$ 197'188/m<sup>2</sup>  
2. S\$ 109'080/m<sup>2</sup>

**2012: The Run on Marina Bay**

As the first new towers started to break the plane of the older waterfront to venture out onto Marina South, the government cleverly situated the Marina Bay Sands project. By placing the new integrated resort and MRT station at the edge of the reclaimed land, the URA sent a signal that the entire area up to there would be integrated into the city.

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