

The Proposed Cross Island Line in Singapore: Nature or Development?

Introduction

23 June 2013, Singapore. The air was dense with the recurrent trans-boundary haze arising from land and forest fires. The National Environmental Agency advisory for the day urged citizens to minimise prolonged outdoor activity.¹ Braving the health hazard, a small group of Singaporeans assembled at the Hong Lim Park to participate in a peaceful protest called “Chained to the Roots”. In a dramatic act, the lead artist tied herself to a tree and vowed to stay put for an entire day. The protest was intended to draw attention towards the potential environmental damages from the newly proposed Cross Island Line (CIL). A section of CIL, an initiative to improve public transport in Singapore, would run through the largest nature reserve in Singapore. The protestors wanted the line to be realigned such that it would skirt the nature reserve.²

Encouraging Public Transport Ridership

On 1 January 2008, Prime Minister Lee Hsien Loong of Singapore delivered the customary New Year message on the back of an impressive 2007. Singapore was still attracting significant foreign investment, jobs were being created and unemployment was at a decadal low. High inflation seemed the only sore point in an otherwise good macroeconomic report card. Singapore flyer, the country’s answer to London eye, was to be operational in a few months. The inaugural Singapore Grand Prix was to be the first ever night race in the history of formula one. Still, the Prime Minister called for cautious optimism in the outlook for the

¹ [http://app2.nea.gov.sg/corporate-functions/newsroom/advisories/haze-update-from-nea-\(12pm-on-23-june-2013\)](http://app2.nea.gov.sg/corporate-functions/newsroom/advisories/haze-update-from-nea-(12pm-on-23-june-2013))

² <http://sg.news.yahoo.com/singaporean-eco-artist-calls-on-lta-to-reroute-cross-island-line-062932507.html>

This case was written by Krishnan Chandramohan under the guidance of Jesuthason Thampapillai, Visiting Professor, Lee Kuan Yew School of Public Policy (LKY School), National University of Singapore and has been funded by the LKY School. The case does not reflect the views of the sponsoring organisation nor is it intended to suggest correct or incorrect handling of the situation depicted. The case is not intended to serve as a primary source of data and is meant solely for class discussion. This case is based largely on publicly available sources and actual events, but some characters and events have been altered for the purposes of this case study. This case won Honourable Mention in the LKY School Case Writing Competition 2013.

year ahead as the earliest impacts of the financial crisis were reaching the shores of the nation. Among the several issues he assured to address were the problems of inadequate public transportation and inflation. Stressing on the importance of public transport, the Prime Minister assured to make it “the choice model of transport”. Emphasising Singapore’s vulnerability to rising energy prices, the Prime Minister further highlighted the need for a convenient public transport network.³

The responsibility of addressing Singapore’s transport needs is assigned to the Land Transport Authority (LTA). Set up in 1995 under the supervision of the Ministry of Transport, LTA has overseen the improvement in Singapore’s rail and road networks. The Land Transport Master Plan 2008 chalked out the policy responses to the problem of public transport outlined by the Prime Minister. Apart from making public transport the choice mode of commute, the plan aimed at managing road transport while meeting the diverse needs of the population.⁴ Among other things, this also meant constant attention towards making the public transport in Singapore more environmentally friendly.

In the master plan, new Mass Rapid Transport lines were conceived with an aim to double the rail network from 138km to 280km by 2020. By 2013, the rail network was extended by 40km to 178km. This included opening a new route as well as extending an existing route. New trains were added to the existing routes to reduce congestion and waiting time. Although the overall occupancy rate of the rail network was a comfortable 70% in 2008, the trains were getting overcrowded during peak hours. LTA along with the service providers introduced free rides and discounted fares to spread travel demand outside the peak hours.

Singapore placed its faith on a multi-model transport system to address the public transport problem. This necessitated an improved bus service to compliment the enhanced rail network. The master plan intended to increase the bus fleet, improve the connectivity of the network and augment the frequency of services. In order to improve bus connectivity, bus network planning was centralised and LTA undertook the responsibility of planning. Working along with public transport operators, the governments aims to increase the bus fleet by 20% or 800

³http://www.mfa.gov.sg/content/mfa/overseasmission/washington/newsroom/press_statements/2008/200801/press_200801_01.html

⁴<http://www.lta.gov.sg/content/dam/ltaweb/corp/PublicationsResearch/files/ReportNewsletter/LTMP-Report.pdf>

buses.⁵ Quarterly data on capacity utilisation and frequency of service was used to better allocate the bus fleet. By 2013, 80% of the bus routes had services at least every 10 minutes.⁶

Apart from increasing the attractiveness of public transport, the government concurrently reduced the supply of private transport. The government steadily reduced the number of new vehicles allowed on road by issuing fewer certificates of entitlement (COE)—a government issued license mandatory for owning a vehicle in Singapore. Since COEs are auctioned every month, the reduction in supply was immediately met with an increase in COE prices. This further widened the gap between the costs of riding private transport and availing public transport. However, the parking fee in Singapore is still low and flexibility in pricing of parking is a policy the government could implement to encourage people to take buses and trains.

The shift towards public transport was also intended to nudge the country to a more environmentally friendly path. While Singapore accounts for a mere 0.2% of global emissions, in 2010 it had the largest per capita carbon footprint in Asia Pacific.⁷ Being a small coastal country, Singapore is not insulated to the perceived problems of climate change. A significant amount of the territory is less than 15m above sea level. More ominously, 30% of the land area is less than 5m above the mean sea level⁸ making large swathes of Singapore vulnerable to potential rises in sea level. Periods of drought or sustained rain could negatively impact the country.

In 2005, 19% of carbon emissions were associated with the transport sector.⁹ Private cars and taxis together accounted more than half of these emissions. On the other hand, buses and trains together contributed less than one fifth of the emissions from transport sector. Encouraging public transport ridership was important for reducing greenhouse gas emission. The increase in the coverage and frequency of the public transport network ensures substantial environmental benefits through reduced fuel consumption and consequent greenhouse gas emissions.¹⁰ LTA also strived for furthering these gains by improving the

⁵ <http://app.nccs.gov.sg/nccs-2012/docs/NCCS-2012-Publication.pdf?AspxAutoDetectCookieSupport=1> pp32

⁶ <http://www.lta.gov.sg/content/dam/ltaweb/corp/PublicationsResearch/files/ReportNewsletter/LTMP2013Report.pdf>

⁷ <http://travel.cnn.com/singapore/life/singapores-dirty-honor-asia-pacifics-biggest-carbon-footprint-876659>

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⁹ http://app.mewr.gov.sg/data/ImgUpd/NCCS_Chapter_3_-_Mitigation.pdf

¹⁰ http://www.apta.com/gap/policyresearch/Documents/facts_environment_09.pdf

energy efficiency of the service. Through design and material modification, the weight of the train cars was reduced to improve fuel efficiency. Introduction of train coasting and changes to rail alignment were other steps taken to reduce energy consumption. This reduction was complemented with energy regeneration from braking to further enhance efficiency.¹¹

The Bane of Success: Pressure on the Public Transport System

Over the years, the population of Singapore has steadily increased. In 2008, when the public transport was given the thrust, Singapore had a population of 4.59 million. The low fertility rate along with an ageing population has necessitated a calibrated approach towards immigrant workers and naturalisation of foreigners. By 2013 the population was 5.31 million with the combined citizen and permanent resident count at 3.82 million. More often than not, infrastructure development has kept abreast with the closely managed population growth. But by 2013, the public transport capacity seemed insufficient to meet the increased demand. Transport data revealed by SMRT and SBS – the two mass transport providers – highlighted the increase in ridership. While part of the growth in ridership could be associated with the introduction of the new line, the increase in population is also an important factor.

Table.1 Land Transport Fact Sheet

	2007	2008	2009	2010	2011	2012
Population	4,588,600	4,839,400	4,987,600	5,076,700	5,183,700	5,312,400

Private Car Fleet Size	451,745	476,634	497,116	511,125	520,614	535,233
Private Cars per 1000 Population	98	98	100	101	100	101
Average Annual Private Car Mileage	20,800	19,700	19,600	19,100	19,000	18,200

¹¹ http://ltaacademy.gov.sg/doc/J12%20May-p38Melvyn%20THONG_Energy%20Efficiency%20in%20Singapore%20Rapid.pdf

Average Daily Ridership						
MRT	1,527,000	1,698,000	1,782,000	2,069,000	2,295,000	2,525,000
Public Bus	2,932,000	3,087,000	3,047,000	3,199,000	3,385,000	3,481,000
Total Public Transport	4,459,000	4,785,000	4,829,000	5,268,000	5,680,000	6,006,000

Average Ridership / Population						
MRT	33%	35%	36%	41%	44%	48%
Bus	64%	64%	61%	63%	65%	66%
Total Public Transport	97%	99%	97%	104%	110%	113%

Growth Rates						
Private Car Growth Rate	7.07%	5.51%	4.30%	2.82%	1.86%	2.81%
Population Growth Rate	4.25%	5.47%	3.06%	1.79%	2.11%	2.48%
Public Commute Growth Rate	5.14%	7.31%	0.92%	9.09%	7.82%	5.74%

Source: Collated from annual factsheets by the Land Transport Authority of Singapore

The increase in population was coupled with an increase in the average daily commuters using public transport. The concurrent reduction in the average mileage of private transport suggests that public transport was increasingly being substituted for private transport. This is reflected in the fact that the growth in public transport has outstripped the growth in population. Table 1 provides quick statistics on private and public transport ridership in the city state.

The concern over congestion was further accentuated by policies suggested by The National Population and Talent Division (NPTD) and LTA. The population white paper, drafted by the NPTD highlighted the need for a growing population to support the economic growth of the country. The population, as per the white paper, is estimated to breach 6.5 million by 2030.¹² The LTA on the other hand is moderating vehicle growth to tackle congestion on Singaporean roads. The increase in COEs issued is to fall to 0.5% starting February 2013. Increase in population with reduced vehicular growth will accentuate the demand for public transport.

Mitigating Congestion

Five years after the initial land transport review was announced, Mr. Lui Tuck Yew, the Minister for Transport, announced further measures to tackle the problem including more bus services, increased rail connectivity, cycling lanes and rapid transport system link. Significant among the steps announced was the decision to construct the Cross Island Line. The proposed line was 50km long and stretched across the country. It would connect Changi in East to Jurong Industrial estate in the West of the island nation. The current commute on public transport between the two locations takes close to two hours at peak time. Once operational, the line was expected to drastically reduce the travel time from the east to west and concurrently ease the pressure on rest of the public transport network.¹³

An important concern regarding the proposed Cross Island Line (CIL) was that one section of it passes through Central Catchment Nature Reserve (CCNR) which encompasses a significant portion of Singapore's remaining primary forest coverage. Central Catchment Nature Reserve is one among the four gazetted nature reserves in Singapore. It is thus protected under the Parks and Trees Act of 2005. Nature enthusiasts and the Nature Society raised concerns regarding the impact of the new rail line on the country's natural endowment.¹⁴

¹² http://www.nptd.gov.sg/content/NPTD/news/_jcr_content/par_content/download_98/file.res/population-white-paper.pdf

¹³ http://www.news.gov.sg/public/sgpc/en/media_releases/agencies/mot/speech/S-20130117-1.html?AuthKey=6f13c409-6695-f04f-8fad-9059894df821

¹⁴ <http://www.pub.gov.sg/mpublications/Documents/Factsheet%20on%20ABC%20Waters%20at%20MacRitchie%20Reservoir.pdf>

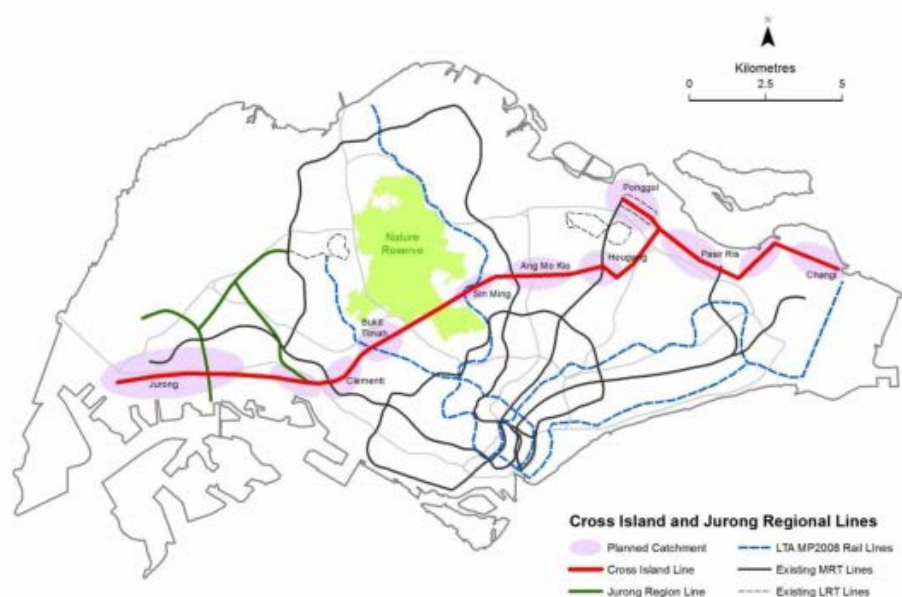


Fig. 1. The proposed Cross Island Line

Source: [http://www.nss.org.sg/documents/\(NSS\)%20CrossIsland%20Line%20Position%20Pa%20per.pdf](http://www.nss.org.sg/documents/(NSS)%20CrossIsland%20Line%20Position%20Pa%20per.pdf) page 4

The Reserve at the Heart of the City

Hearteningly, for a small land scarce country, the green cover in Singapore has increased from 35.7% in 1986 to 46.5% in 2007 largely aided by urban planting.¹⁵ However, gazetted nature reserves at 3318 hectares¹⁶ cover less than 5% of the area of Singapore. Spread over 2800 hectares, the CCNR is the largest among the four gazetted nature reserves. Until the beginning of the 19th century, most of Singapore was covered with primary forest. The sudden increase in agriculture, especially plantations, led to large scale deforestation. In less than hundred years, primary forest cover declined to a mere 5% of the land area. Today only a few fragmented patches of primary forest remain and all lie within CCNR. Fortunately, the early impetus given to agriculture tapered and large tracts of land used for cultivation were abandoned.

Secondary forests have grown in some of these erstwhile pepper and gambier plantations. These secondary forests, most of it a century old, account for most of the vegetation covering

¹⁵ <http://www.bgci.org/resources/article/0585/>

¹⁶ <http://www.mnd.gov.sg/MNDAPPIimages/About%20Us/From%20Garden%20City%20to%20City%20in%20a%20Garden.pdf>

CCNR. It also provides buffer to primary forest cover protecting the latter from invasive species. With time, these disturbed forests could attain the features of primary forest.¹⁷ Abutting the secondary forest is Nee Soon Swamp Forest, a fresh water swamp. Fresh water swamps are created by the flooding of low lying forest areas creating an ecosystem conducive for supporting rich biodiversity. The copious amount of annual rainfall coupled with low altitude make Singapore an ideal location for fresh water swamps. Yet, Nee Soon is the only fresh water swamp in the entire country.¹⁸ This variety of ecosystems - ranging from primary forests to regrowth forests and to fresh water swamp- within the nature reserve has ensured rich biodiversity among fauna and flora including endemic and locally threatened species.

As early as 1849, Sir Stamford Raffles mooted the idea of biodiversity research in Singapore.¹⁹ Since then, the Raffles Museum of Biodiversity Research has extensively documented flora and fauna in South East Asia and particularly in Singapore. The rich biodiversity along with ease of access has made it ideal for biodiversity research. The twin features were also ideal for conducting studies requiring frequent monitoring or delicate equipment.²⁰ Its accessibility also enhanced its value as an outdoor educational site for schools. However the fragility of biodiversity had been a recurring issue in the short history of Singapore.

The substantial loss from the early anthropogenic activity highlighted the fragility of biodiversity unambiguously. Deforestation in Singapore—first for plantation agriculture and later for urban development—razed 95% of the primary forests. This led to substantial local extinction of flora and fauna with as little as 27% of the original species extant locally. Even among the surviving species, more than two thirds were threatened locally.²¹ For instance, among the fully grown century old trees of the reserve reside the last tribe of Banded Leaf monkeys in the country. Their long term survival seem unlikely.²² The forest reserves, while restricted to a small portion of the land area, now possess over half of the residual biodiversity. Similarly, the Nee Soon freshwater swamp—spread over just five square kilometres—harbours half of the fresh water fish and almost two thirds of the amphibians

¹⁷ <http://www.cbd.int/doc/world/sg/sg-nr-04-en.pdf>

¹⁸ <http://rmbn.nus.edu.sg/dna/places/details/35>

¹⁹ <http://rmbn.nus.edu.sg/dna/places/details/64>

²⁰ <http://rmbn.nus.edu.sg/dna/docs/fb6050e4ee025362a43a216afd6af802.pdf>

²¹ <http://www.ncbi.nlm.nih.gov/pubmed/12879068>

²² <http://www.nparks.gov.sg/cms/docs/redbook/presbytis-femoralis.pdf>

found in Singapore.²³ This includes most of the native and threatened species such as the Swamp Forest Crab, a species endemic to this fresh water swamp.²⁴ The destruction of original vegetation cover also led to the disappearance of many forest dependent bird species.²⁵ Compared to mainland forests in peninsular Malaysia, the forest reserves of Singapore have fewer wild bird species. Even among the existing species, close to 20 of these species were restricted to patches of secondary forest.²⁶

More recently, the construction of the six-lane Bukit Timah Expressway separated the Bukit Timah Nature Reserve from the Central Catchment Nature Reserve. In species rich forests, fragmentation could lead to reduction in species population and species isolation. The genetic impact increases the mortality of plants and could even lead to extinction.²⁷ Concerned by the adverse impact of fragmentation, the National Parks board and LTA have joined hands to construct an eco-link bridge to connect the two aforementioned fragments. The bridge, to be constructed over the expressway, would enable free movement of animals between the two nature reserves. This movement of animals will also facilitate cross pollination across the two fragments reducing genetic vulnerability.²⁸

The amenities provided by CCNR play an integral part in the day to day life of Singaporeans. Primary forest and fully grown secondary forest in CCNR sequester carbon thus acting as the lung of the city state. The forests in CCNR are characterised by fully grown woody trees. On average, the trunk and branches of a tree together account for 83% of the biomass and thus the carbon sequestered. As a result, over 95% of the carbon sequestered is held by fully grown large trees although they represent only 36.8% of all the trees in Singapore.²⁹ The good quality of air in Singapore in spite of its large carbon footprint is partly due to these reserves. Moreover, even a small destruction to fully grown trees could have a disproportionately large impact on the carbon capture potential of the green cover.

Although Singapore has limited ground water resources like aquifers, it receives copious amounts of rainfall annually. To harvest the plentiful rainwater seventeen reservoirs of

²³ <http://www.cbd.int/doc/world/sg/sg-nr-04-en.pdf>

²⁴ <http://rmbn.nus.edu.sg/dna/places/details/13>

²⁵ <http://link.springer.com/article/10.1023/A:1015869106512>

²⁶ <http://www.sciencedirect.com/science/article/pii/S0006320704001740>

²⁷ http://link.springer.com/chapter/10.1007/978-3-540-37398-8_9

²⁸ http://www.nparks.gov.sg/cms/index.php?option=com_news&task=view&id=264&Itemid=50

²⁹ <http://www.atmos-chem-phys.net/13/10185/2013/acp-13-10185-2013.pdf>

various sizes have been built around the country.³⁰ Four of these reservoirs namely, MacRitchie Reservoir, Upper Seletar Reservoir, Lower Peirce Reservoir and Upper Peirce Reservoir lie within the CCNR. Apart from aiding in water self-sufficiency, the reservoirs help in flood mitigation and urban storm water management. The nature reserve plays a crucial but often neglected role in microclimate management. When vegetation is replaced with high mass structures like concrete buildings, a larger amount of solar radiation is absorbed resulting in higher ambient temperature known as urban heat island. Evaporation from the reservoirs and transpiration from vegetation in CCNR absorb heat, thus reducing the ambient temperature.

The forest area and reservoirs within the nature reserve also play host to a variety of recreational activities. A large number of trails in the reserve are frequented for jogging and strolling. The treetop walk and Jelutong tower, which give a bird's eye view of the forest, are other sought after features of the reserve. Even the existing diversity among avian population attracts a number of dedicated bird watchers. Finally, the reservoir also doubles as a popular venue for water activities with facilities for kayaking and fishing.

Impact on CCNR: Legitimate Concerns or Extreme Paranoia

A small segment of the proposed CIL cuts through the Central Catchment Nature reserve. This gave rise to concerns regarding the impact on the nature reserve in specific and the country in general. The existing underground MRT network, especially the newly constructed Circle Line in Singapore, could provide valuable pointers on the risks associated with the proposed line. The differences in the projects could also be instrumental in identifying the point of departure from past experience. This could help differentiate between legitimate concerns and mindless paranoia.

This would be the second time in recent history that CCNR would be fragmented. The earlier occasion was the construction of Bukit Timah Expressway (BKE) more than two decades ago. Unlike the BKE which runs on surface, the proposed line runs underground suggesting that the flora and fauna on the ground could possibly be saved. The Botanic Garden station, a functioning underground MRT station, was constructed within the Singapore botanic garden.

³⁰ <http://www.pub.gov.sg/water/Pages/LocalCatchment.aspx>

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The station lies at the fringe of the garden where the tree density was low and access to the site of construction was available. Comparing pictures taken before the construction with ones taken after the construction of the station reveal the loss of vegetation. CIL cuts across the nature reserve and passes through dense vegetation with minimal access roads.

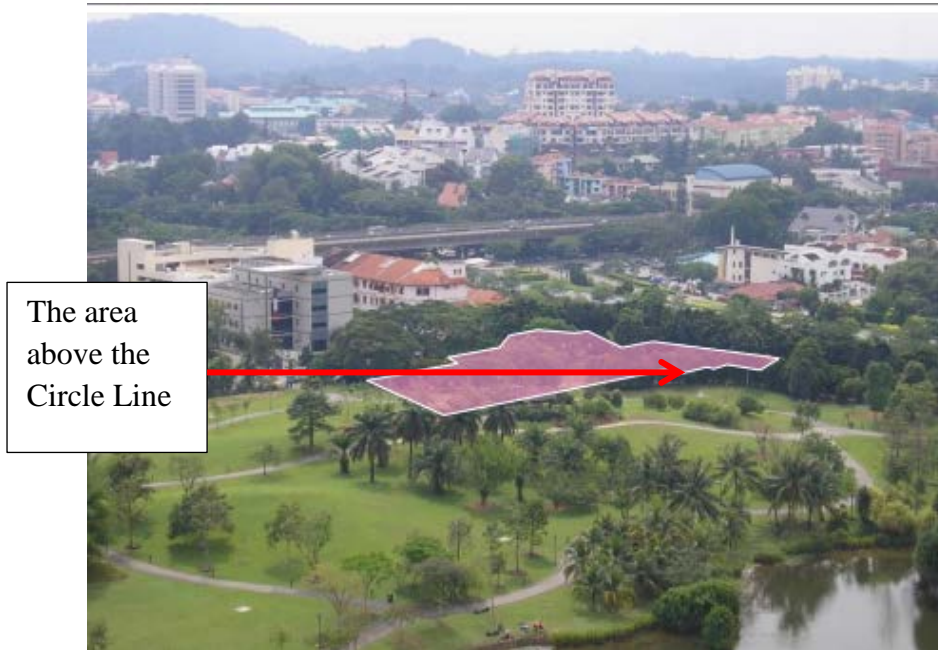


Fig 2. The area above Botanic Garden MRT Station before construction
Source: http://www.taisei.co.jp/english/business/sub_inter24.pdf page 4

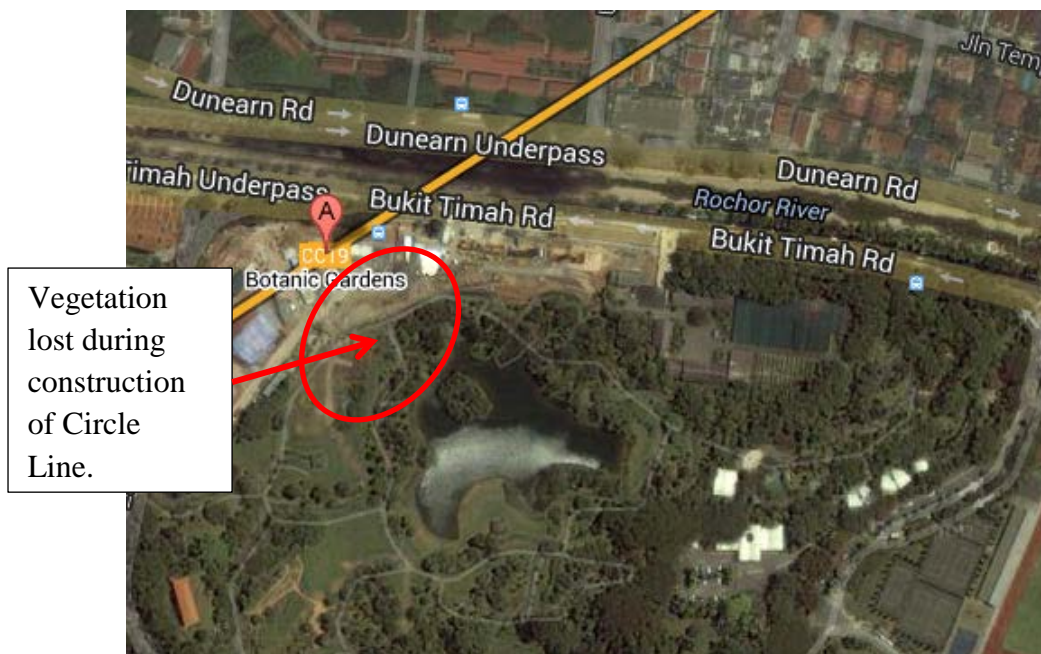


Fig 3. The area above Botanic Garden MRT Station during construction
Source: Google Maps

The tunnels for the proposed Cross Island Line are expected to be built deeper into the ground than the existing lines. The deeper excavation is more time consuming and the new line is expected to be functional only by 2030. Tunnel construction as such is fraught with risk as revealed by the unfortunate events during the construction of the Circle Line. On 20 April 2004, a section of the tunnel collapsed killing four people. The highway above the tunnel caved in obstructing traffic. The magnitude of the damage brought to a grinding halt tunneling at twenty other sites.³¹ Deeper tunnels also increase the risks and the engineering techniques are being fine-tuned to mitigate this risk.

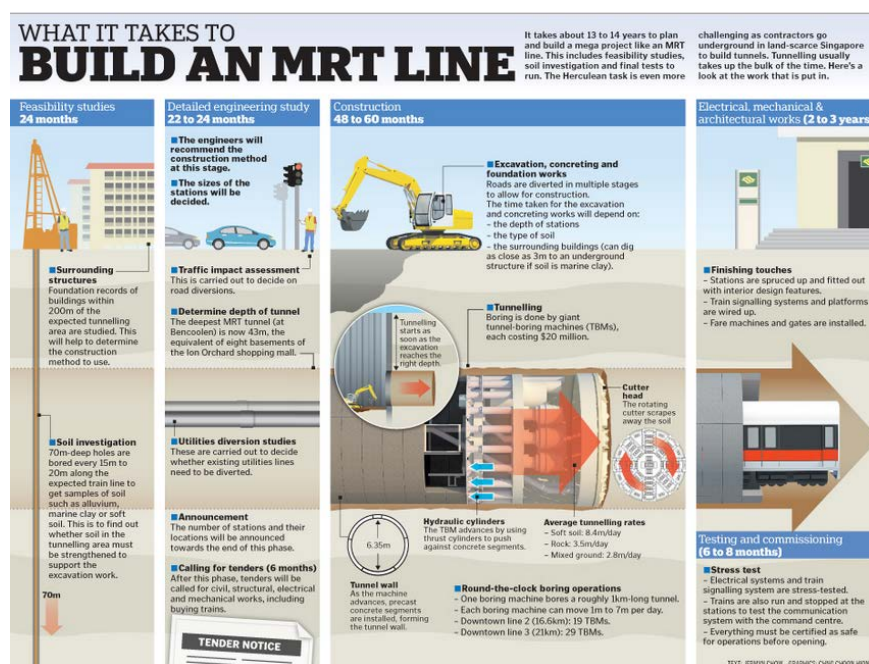


Fig. 4. MRT construction explained

Source: <http://www.straitstimes.com/sites/straitstimes.com/files/mrtline06.jpg>

The proposed project, due to the depth and terrain of excavation, needs extensive soil sampling. Current estimates suggest that soil sample needs to be collected every 15-20 metres by drilling 70 meter bores. Experts believe that the soil profile might change every 2 to 3 metres further complicating the process. As the sampling needs to be executed across the proposed line, even the stretch inside the nature reserve will not be spared. The tunnel boring machine requires close to 20 square metres for area for functioning. Further, diesel and slurry leakages are a possibility.³² The proposed line runs through patches of primary and mature regrowth forest. It also cuts across couple of natural streams that drain into MacRitchie

³¹ <http://web.mit.edu/newsoffice/2008/collapse-highway-0201.html>

³² [http://www.nss.org.sg/documents/\(NSS\)%20Cross-Island%20Line%20Position%20Paper.pdf](http://www.nss.org.sg/documents/(NSS)%20Cross-Island%20Line%20Position%20Paper.pdf)

reservoir. Drilling and associated deforestation along with copious amount of rain received by Singapore will make the top soil susceptible to erosion. If the eroded soil settles in the reservoir, the catchment capacity of the water body will reduce. Further, there is enough evidence to suggest that erosion in upper catchments lead to damage in downstream system.³³



Fig. 5. Surface activity at a drilling site

Source: http://www.taisei.co.jp/english/business/sub_inter24.pdf

Environmental Impact Assessment

Given the concerns, the Government of Singapore has ordered for an Environmental Impact Assessment to be conducted by a third party consultant. Valuing a complex environmental asset like CCNR is challenging. Equally so is the myriad impacts of anthropogenic activity on the amenities flowing from the natural endowment. While the government's decision will be guided by findings including transport connectivity, land use compatibility and environmental impact,³⁴ it is understood that environment is the primary criteria.

³³ http://wwf.panda.org/what_we_do/where_we_work/borneo_forests/borneo_deforestation/

³⁴ <http://app.lta.gov.sg/apps/news/page.aspx?c=2&id=d4160c85-6165-4049-b6d2-a6a28cb25de7>

Questions

- 1) Determine a method/ combination of methods that could be used to estimate the economic value of the Central Catchment Nature Reserve?
- 2) Given the nature of the environmental asset, suggest valuation techniques that are not applicable in this case?
- 3) In the above case, how could the twin issues of effective public transport and environmental protection be balanced?