Singapore’s Resilience Efforts through long term planning

Presenting author: Matthijs Bos, Leading Professional

Haskoning
Enhancing Society Together

The Rising Threat

Rising Seas
According to CCRS, Singapore's mean sea levels could rise by 1.15m by 2100 and 2m by 2150.

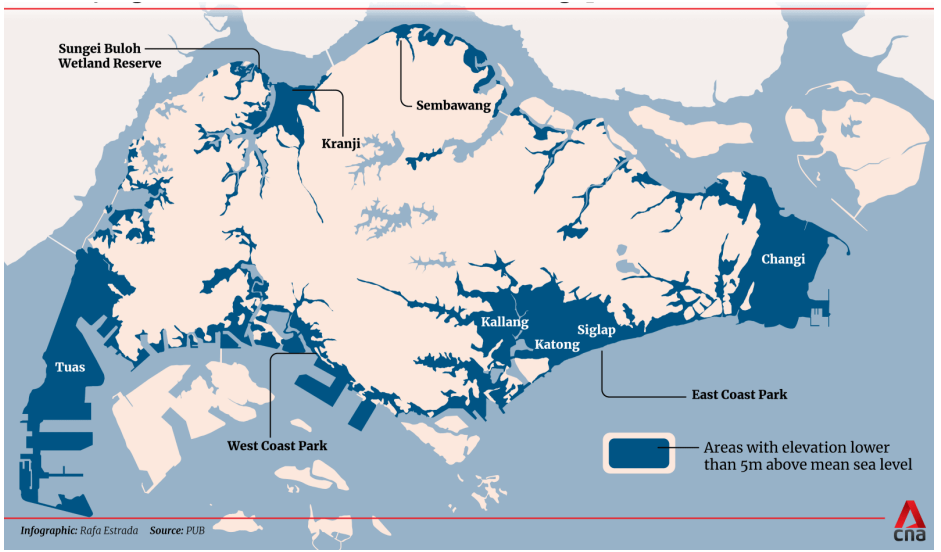
A Reality
This isn't a distant problem; it's a present and future reality. Flood risk management is now a critical component of urban planning

Illustration of sea level rise
Source: PUB

A Nation at a Crossroads

Retreat is not an option
Singapore is a low-lying, densely developed island.

Integration is necessary
Coastal protection measures must be integrated with existing land uses, from ports to parks. This presents a strategic challenge that requires an innovative framework.

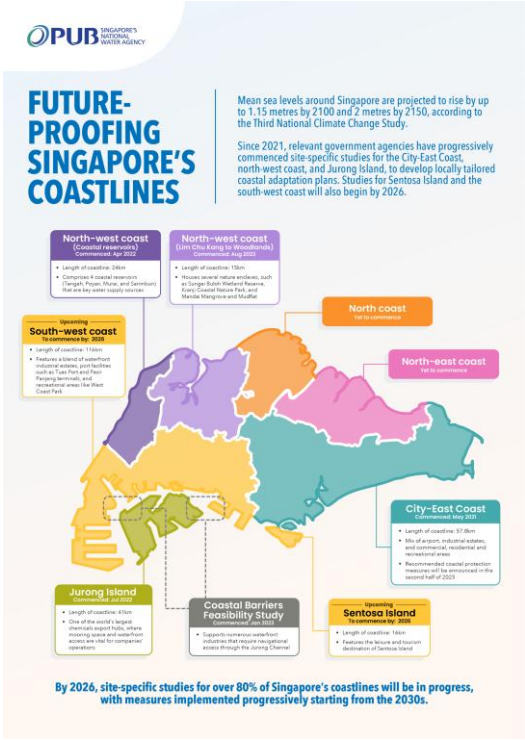


Low lying areas of Singapore
Source: CNA

Our Global Quest

Comprehensive Review
To build a sustainable and adaptive flood management strategy, we sought to understand how other nations determine their flood protection standards.

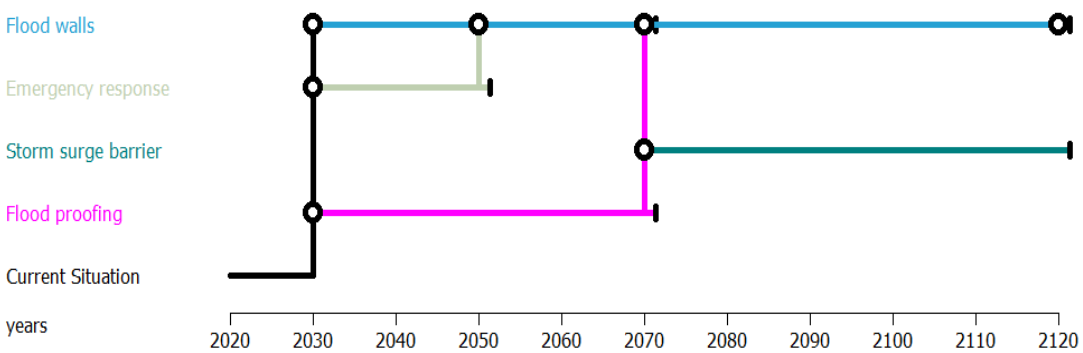
Best Practices
Our focus is to find best practices applicable to Singapore's unique context.



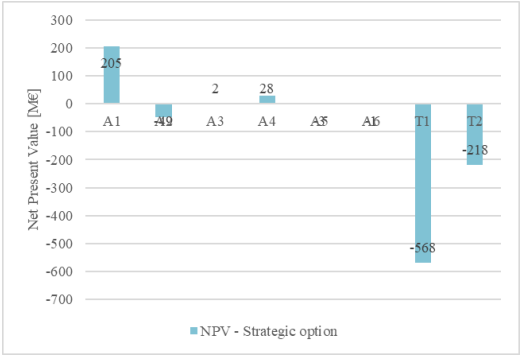
Program of planning project
Source: PUB

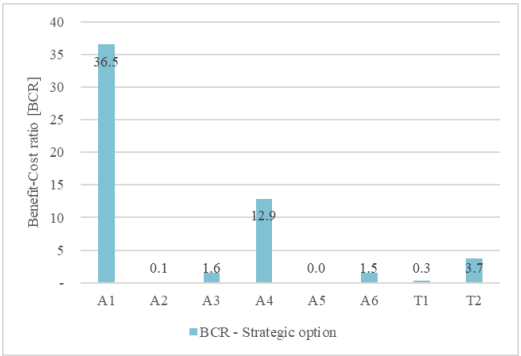
Define Adaptive pathways and test effectiveness

Adaptation pathway map

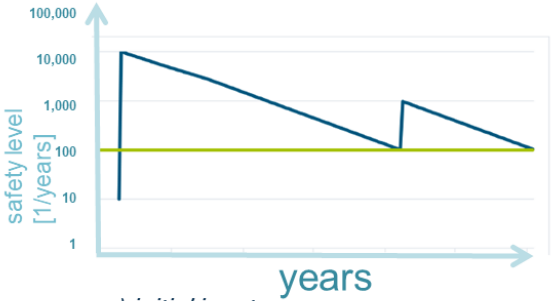


Map generated with Pathways Generator, ©2015, Deltares, Carthago Consultancy

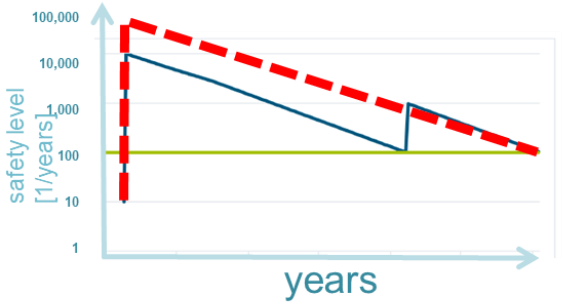




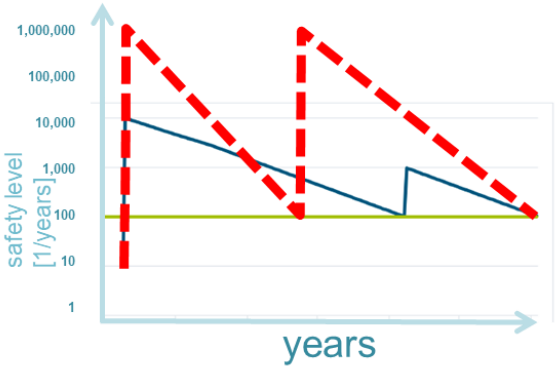
Economic evaluation: Scenario testing



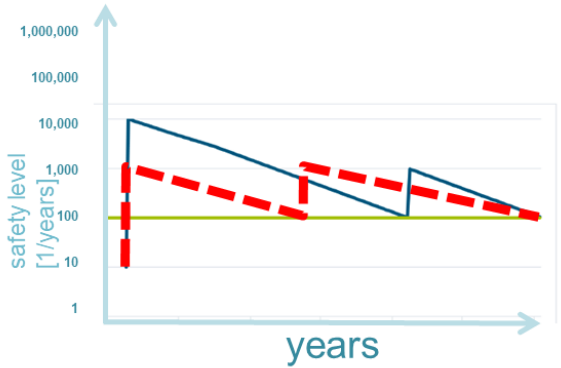
a) initial inputs



c) lower net discount rate



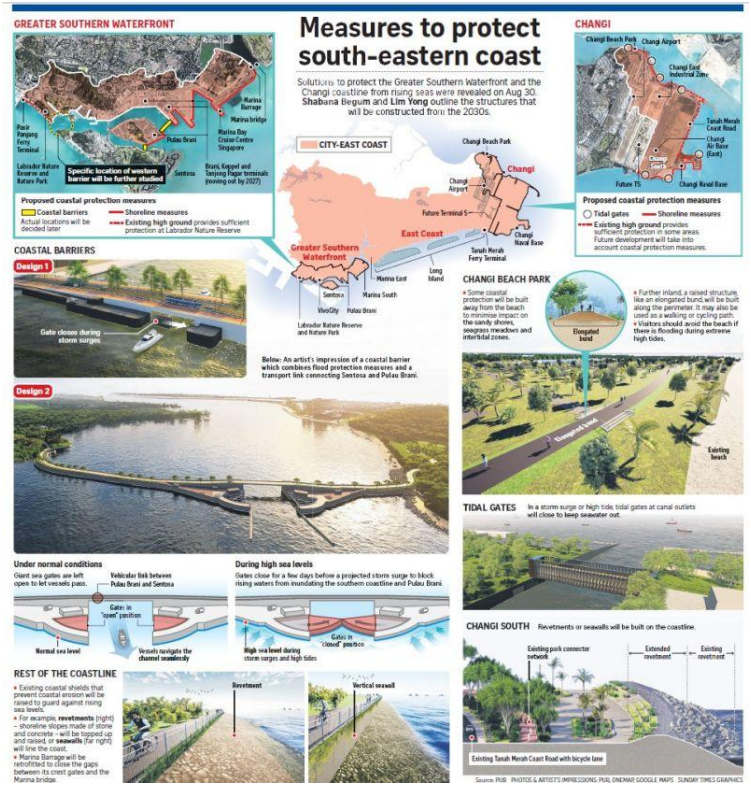
b) increased sea level rise



d) higher inflation rate

Ongoing project developments

- **Greater Southern Waterfront:**
  - Keep area accessible from the sea and main saline water environment for ecology, while shortening coastline in time of storm surge by closing of barrier
- **Long Island:**
  - 800ha Reclaimed land to create freshwater reservoir and create land to support growth of Singapore
- **Southwest coast: Tuas and Jurong Port area**
  - Feasibility study of coastal barriers



Source: Straits Times

Greater Southern Waterfront

Key Contributions

Lead Design & Technical Advisory

- Haskoning (with CPG) led the design phase for the Keppel Harbour–Sentosa Island storm surge barrier, commissioned by PUB, Singapore's National Water Agency.

Adaptive & Future-Proof Solutions

- Developed adaptive design strategies to address deep uncertainties in sea-level rise, climate change, and long-term operational scenarios.
- Applied scenario planning to ensure barrier performance remains robust for decades.

Balancing Complex Requirements

- Harmonized flood protection, environmental impact, water quality, and multi-functional use of the water body.
- Integrated considerations for shipping, flow velocities, and ecological effects.

Innovative Gate Selection

- Shortlisted high-reliability gate types (vertical, horizontal sector, horizontal rolling) based on technical, operational, and environmental criteria.

Sustainable, Resilient Infrastructure

- Emphasized long-term planning, risk management, and stakeholder engagement to deliver a resilient solution for Singapore's coastline.

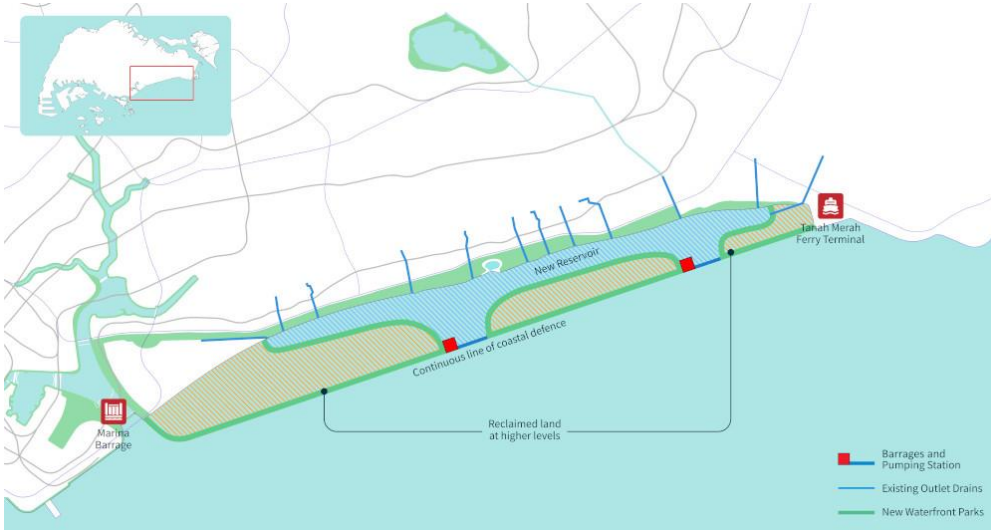
Photo: PUB

Long Island

Key contributions:

Haskoning (with CPG) led the design phase for Long Island reclamation, commissioned by PUB, Singapore's National Water Agency.

- Reclamation (fill, ground improvements)
- Coastal sea defense (armour)
- Barriers (tidal gates)
- Pumping station



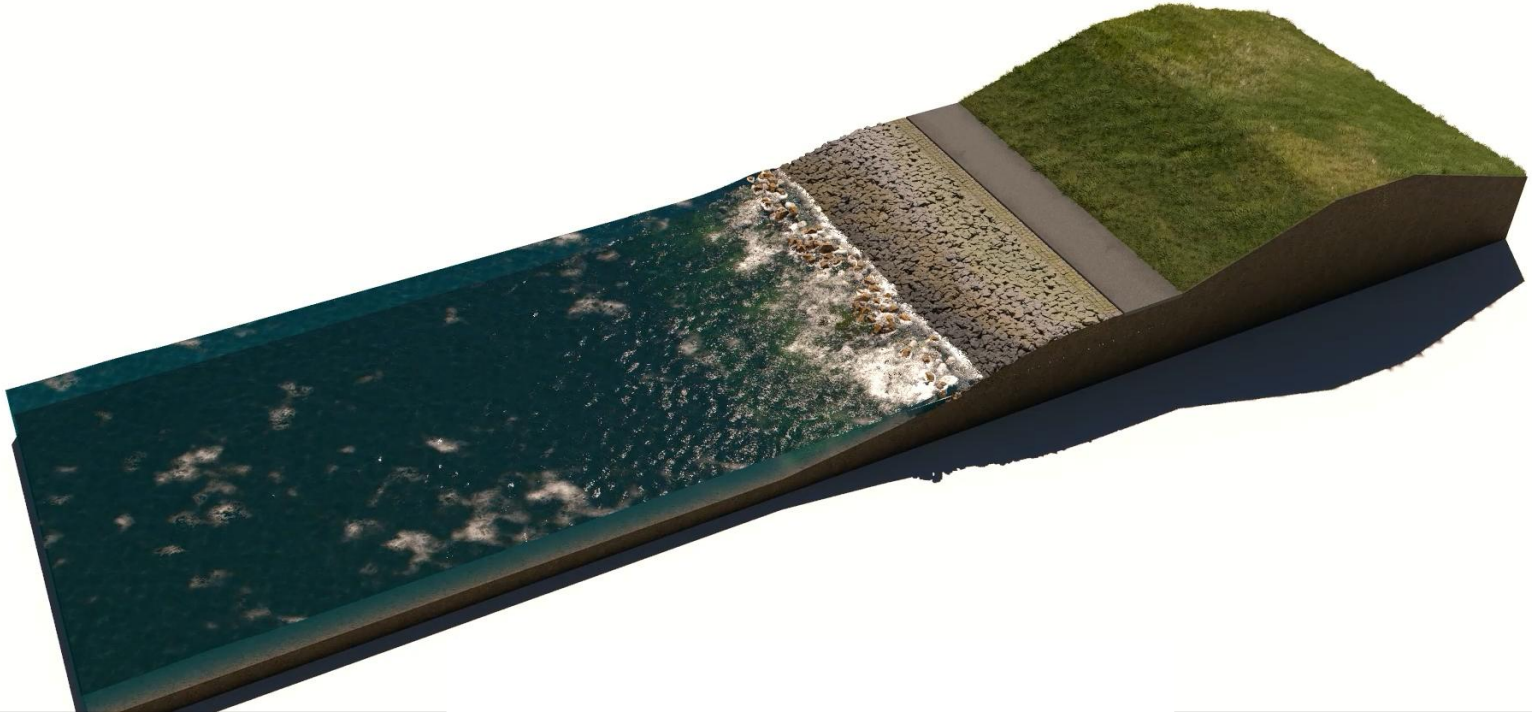
Source: URA

Long Island Artist impressions

Source: URA

Reference design – Lake Ijsselmeerdike NL

- Existing situation



Reference design – Lake Ijsselmeerdike NL

- Nature-based solution: foreshore protection with perched beach, creating new habitats

Reference design – Afsluitdijk NL

- Capacity: 300m^3/s (>10k ft^3/s) pumps and 4000m^3/s (>140k ft^3/s) tidal gates

Source: Van Oord

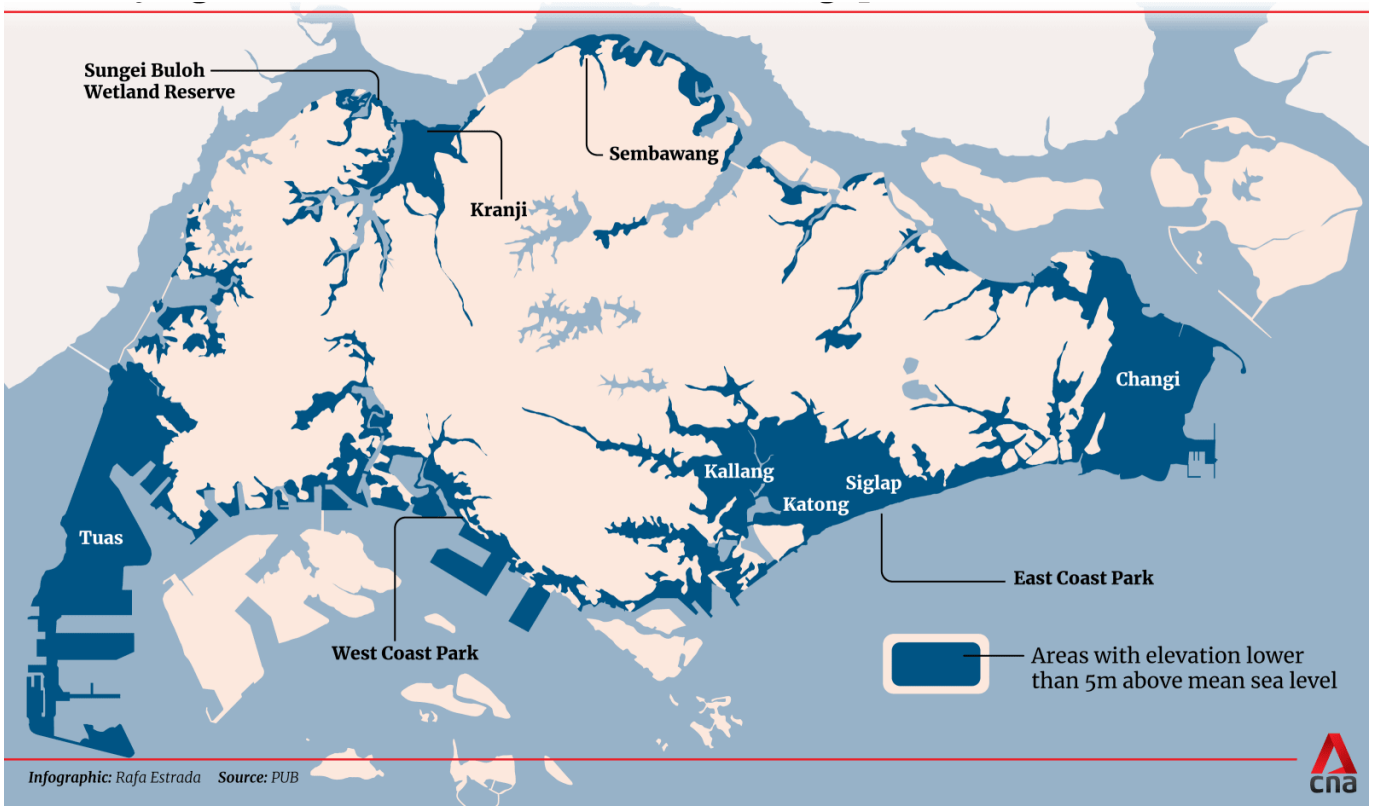
Afsluitdijk: cross-section

- Pumping station → 50m^3/s (>1700 ft^3/s) capacity single pump

Source: Van Oord

For reliability, series of 3x gates to comply with 1/10,000 per year safety standard/ stand of protection

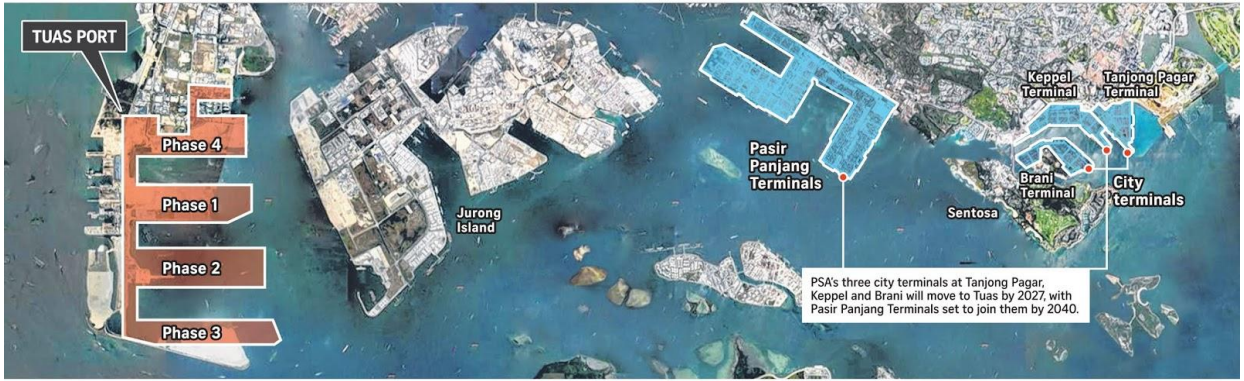
Southwest Coast: Tuas and Jurong port



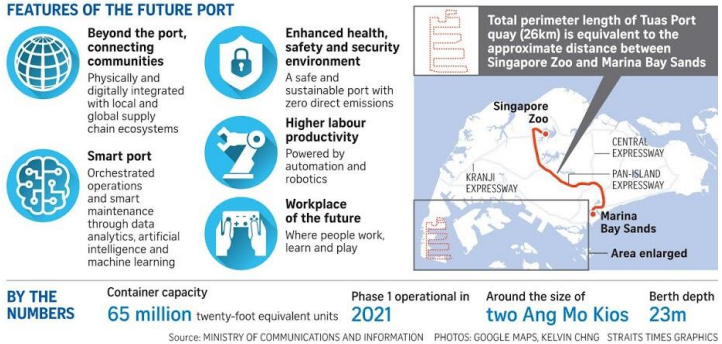
Source: CNA

Singapore port development – long term plan

World's largest automated terminal




A crane carrying out development work at the future Tuas Port.



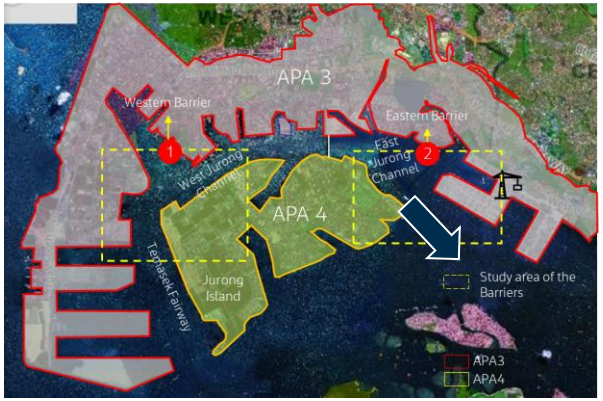
Source: Straits Times

Coastal Barrier Feasibility Study (CBFS)

Key contributions:

Haskoning (with Jacobs) conducted the Coastal Barrier feasibility study, commissioned by PUB, Singapore's National Water Agency.

- Hydraulic analysis of effectiveness of barriers or barrages (warning time, operational time, operating levels in basin, characteristics of surge events)
- Feasibility design of barrier and barrages
- Sizing of locks, gates and pumps



- 5-days surge events, and nearest ESL is already higher than the inland drainage requirements
- Long closed position, can disrupt the industry and terminal activities.

Storm surge barrier

Tidal barrage + locks

Tuas Mega Port Capacity – Singapore

Current Capacity (2025)

- 11 operational berths
- Over 10 million TEUs handled since opening (Sep 2022)
- Phase 1 (by 2027): 21 berths, **20 million TEUs/year**

Future Capacity (2040s)

- 66 berths, 26 km quay length
- Planned annual capacity: **65 million TEUs**
- Will be the world's largest fully automated container port

Key Features

- Full automation (electric vehicles, smart yard systems)
- Net-zero emissions target by 2050
- Consolidation of all container operations from older terminals


Photo: Ministry of Transport, Singapore


Photo: MPA

Public Engagement - Rising the Tides

Public Engagement - Rising the Tides

Photo: PUB

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We're happy to have Deputy Prime Minister and Minister for Trade and Industry Mr Gan Kim Yong and Minister for Sustainability and the Environment Ms Grace Fu at Singapore's first coastal protection exhibition 'Riding the Tides' yesterday!

In his remarks, DPM Gan underscored the importance of early planning to protect Singapore against sea level rise. He also shared the recommended measures for Greater Southern Waterfront and Changi.

Through interactive panels and hands-on activities, visitors gained a deeper understanding of Singapore's coastal protection approach, the range of solutions available, and how the recommended r ...more

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Contact us

Matthijs Bos
Leading Professional Flood Risk International

E: matthijs.bos@haskoning.com
M: +31 883 489 438

Haskoning Singapore PTE. LTD., part of Haskoning
1 Harbourfront Avenue
Level 13 Keppel Bay Tower
Singapore 098632

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