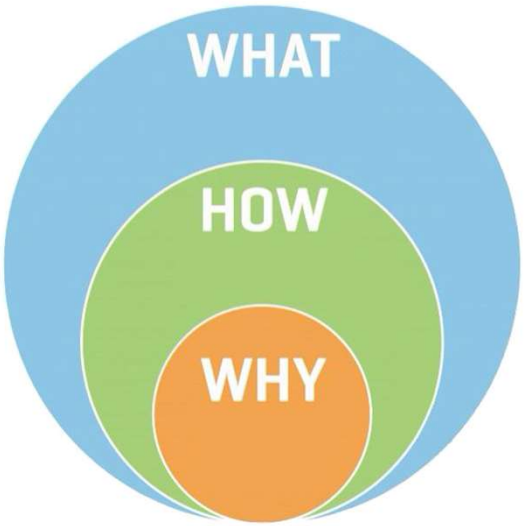
Integration of Terrestrial, Maritime and Cadastral Geospatial Information

Dr Victor Khoo
Singapore Land Authority



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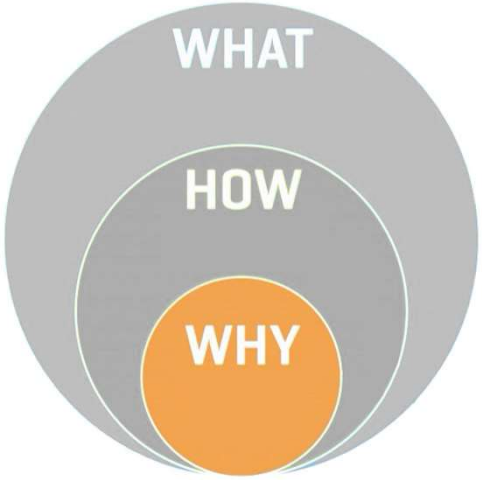
Integrated
Digital Twin



- ☑ Economic
  - ❑ Integrated Spatial Planning
  - ❑ Coastal Economic Activities
- ☑ Social
  - ❑ Food Security
  - ❑ Coastal Recreational Activities
- ☑ Environmental
  - ❑ Protection against Coastal Inundation
  - ❑ Protection of Biodiversity
  - ❑ Transition to Clean Energy Source

Economic

Social

Environmental

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Technologies

Space-based

Aerial systems

Mobile Mapping Systems

Ground based Systems

Hydrography

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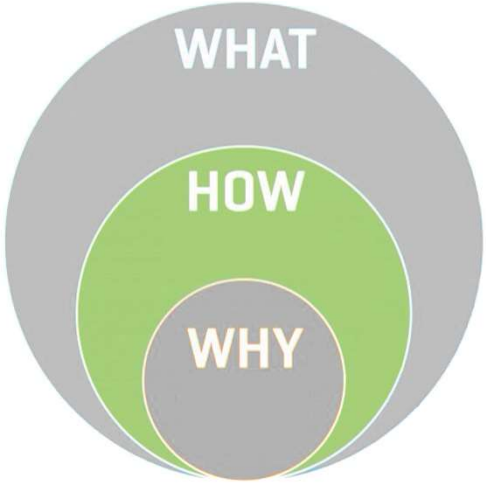
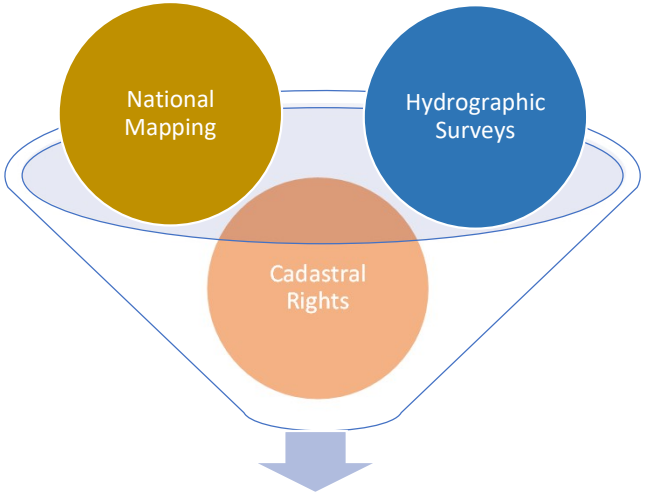
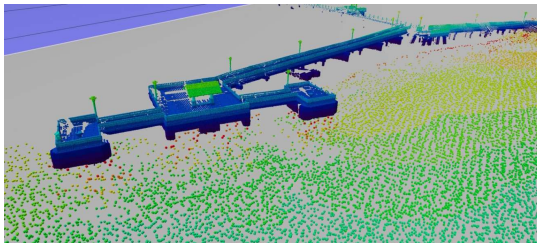
Systems



Datasets

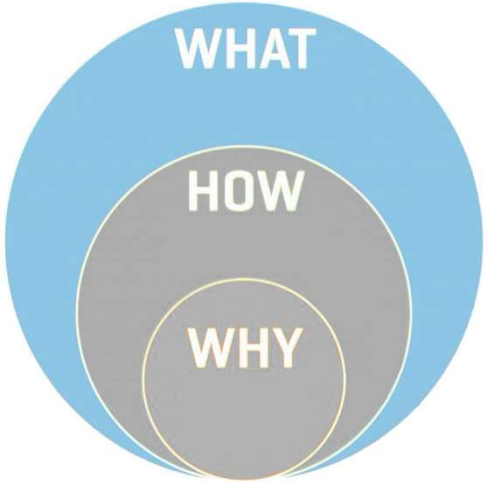




TopyBathy Model

What we do to overcome the Challenges

- Current Challenges
  - Data Acquisition near coastline
  - Harmonisation of Singapore Height Datum and Chart Datum
  - Data Sharing at GeoSpace-Sea
- Future Challenges
  - Vertical Land Motion Monitoring for Coastal Adaptation Study



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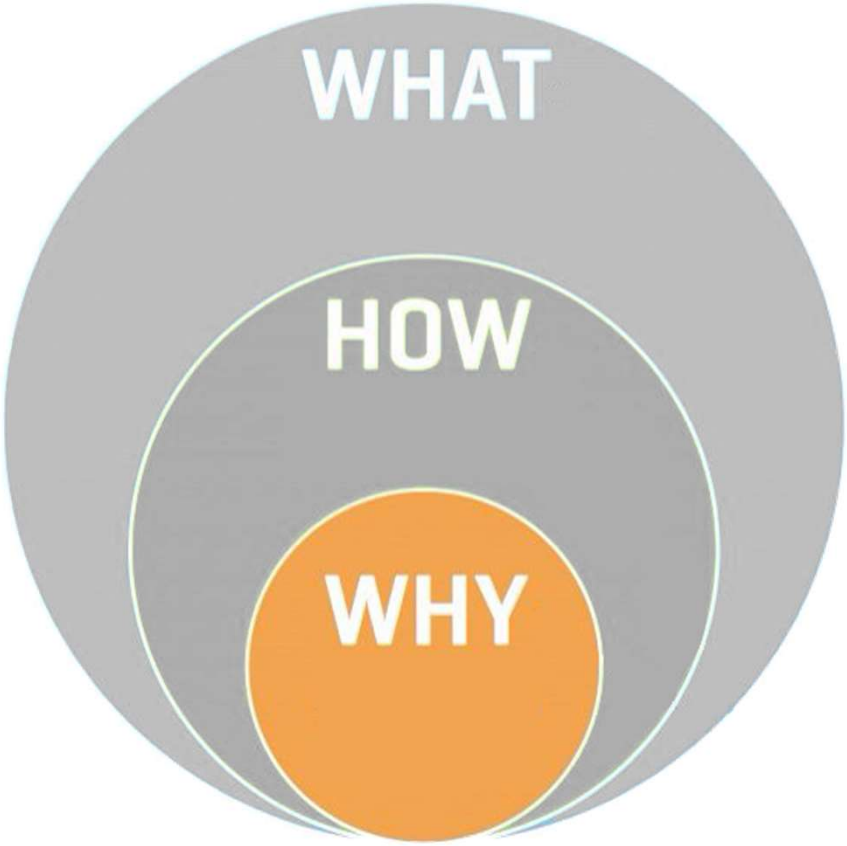
Why we need to Integrate



Coastal Economic Activities

Economic

Port of Singapore
(Source: maritimegateway.com)

New floating fish farm off Changi aims to produce more seafood than traditional coastal farms

Integrated Spatial Planning

Economic

Social

Environmental

Social

Integrated Spatial Planning

Environmental

Youth Kayaking beside Sports Hub.
(Source: Today Online)

Singapore now home to one of the world's largest floating solar farms.
(Source: Straits Times)
Photo: Sunseap

Protection against Coastal Inundation

Environmental

High tide at East Coast Park Area B on 4 Feb,2016
(Source: Straits Times)

Submerged boardwalk at Sungei Buloh Nature Reserve during a spring tide in January 2015 (Source: Straits Times)

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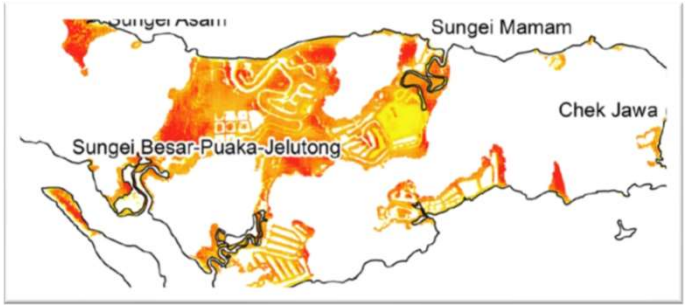
Protection of Biodiversity

Environmental

The Coastal Protection and Restoration of Mangrove Biodiversity at Pulau Tekong conducted by NParks and HDB

Elevation mapping was conducted as part of the mangrove restoration program in Pulau Ubin



Mapping the mangrove sites to quantify the blue carbon stocks (Source: Mangrove Lab, NUS)

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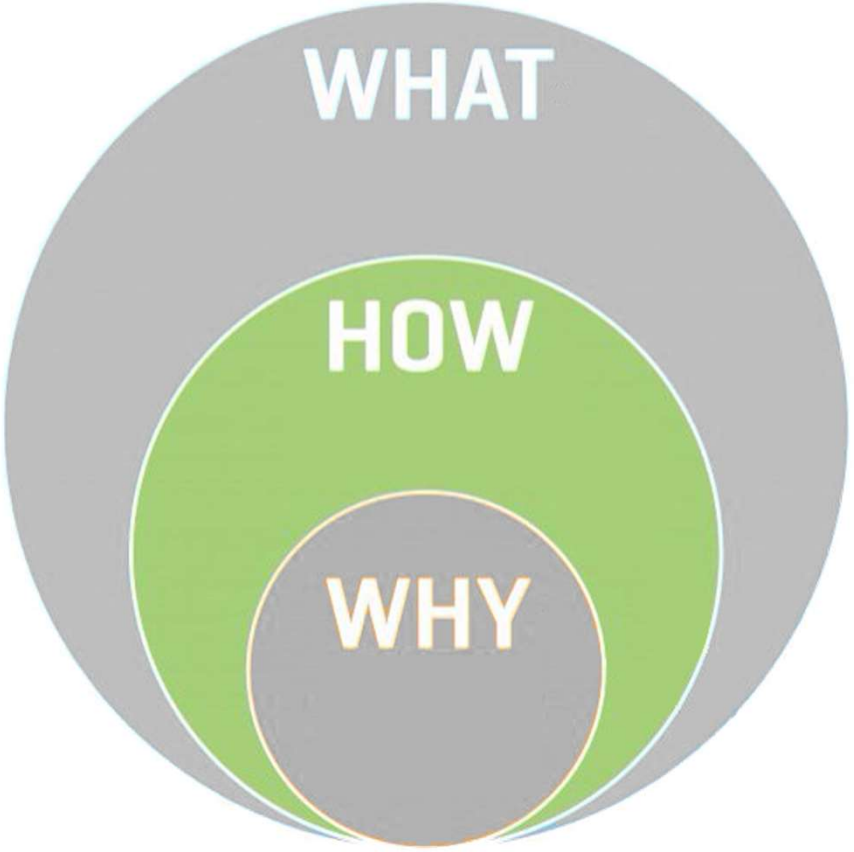
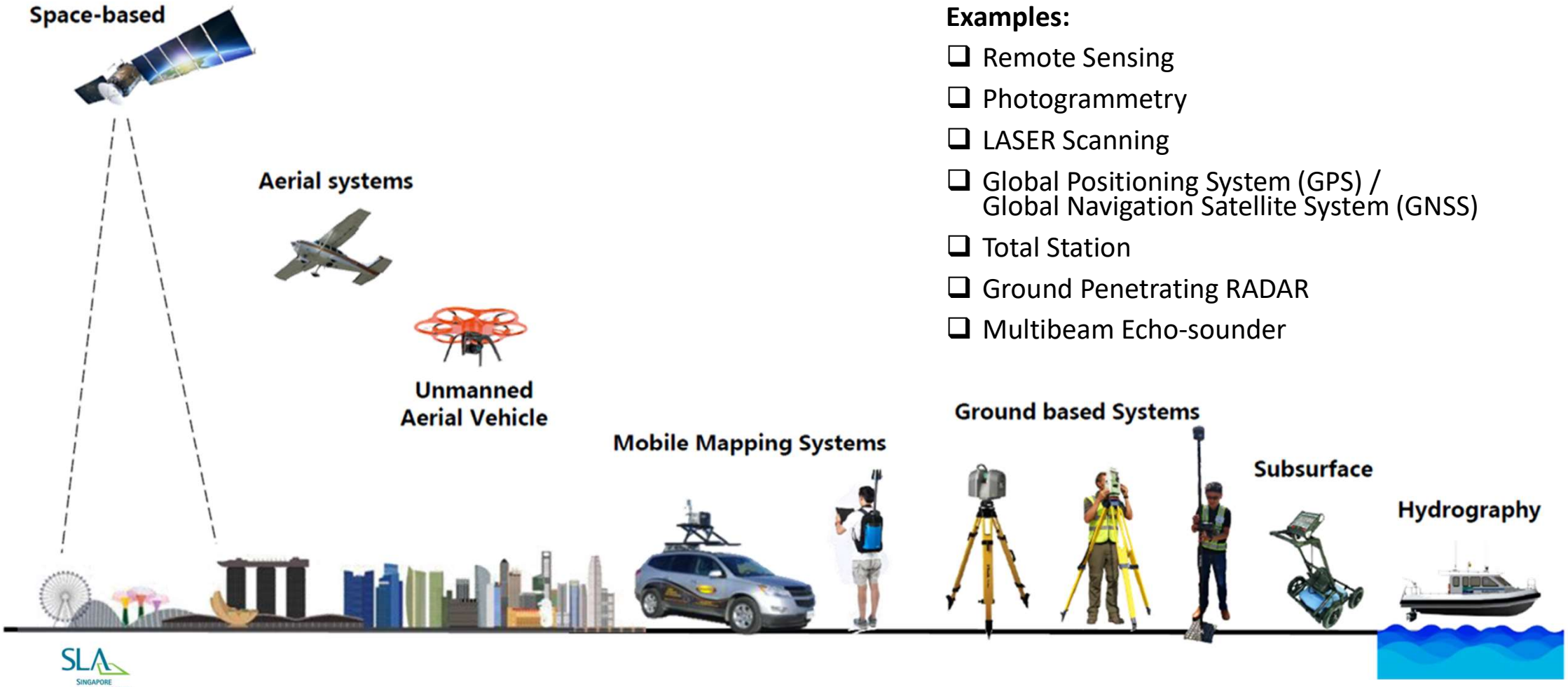
How we Integrate



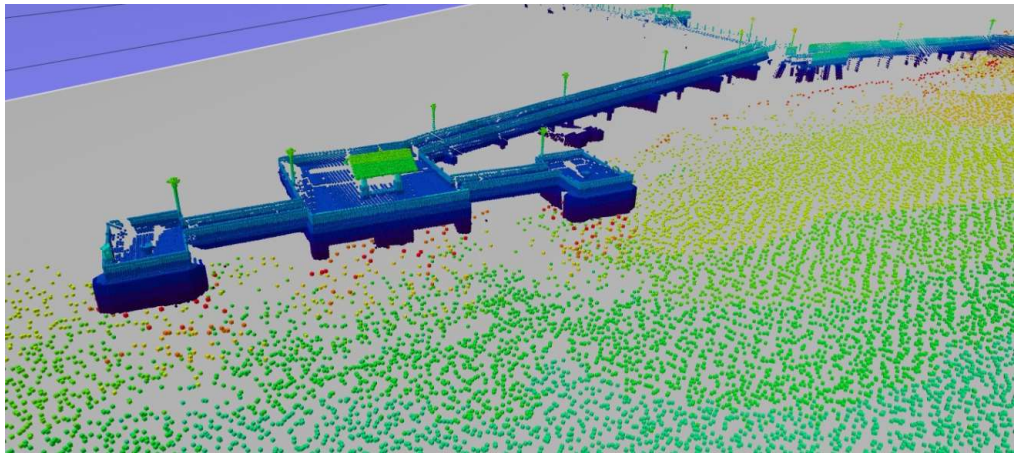
Adoption of Multi-Sensors and Technologies

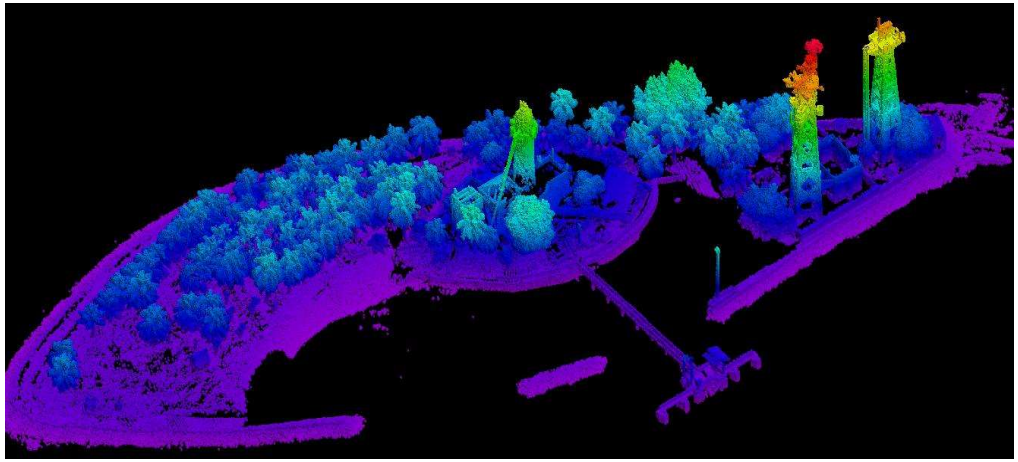


Examples:

- ❑ Remote Sensing
- ❑ Photogrammetry
- ❑ LASER Scanning
- ❑ Global Positioning System (GPS) / Global Navigation Satellite System (GNSS)
- ❑ Total Station
- ❑ Ground Penetrating RADAR
- ❑ Multibeam Echo-sounder

Simultaneous Survey with Multibeam Echo Sounder and Laser Scanner

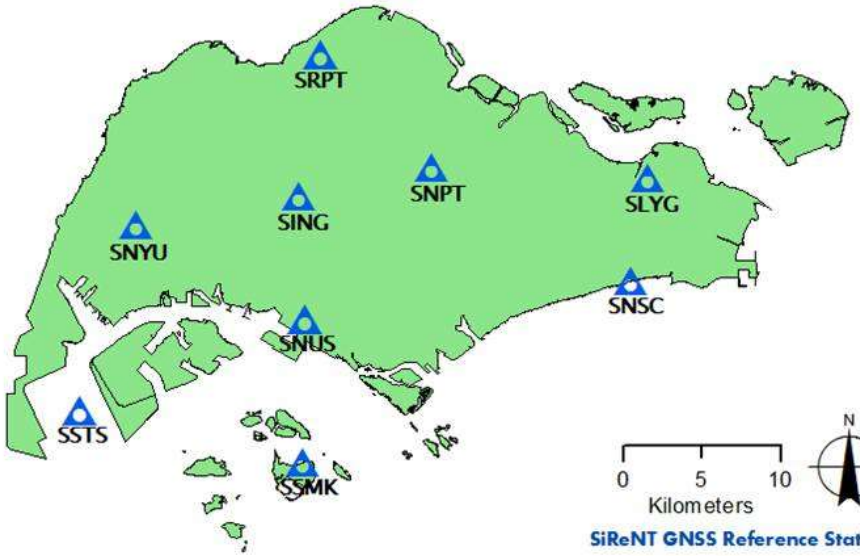




Simultaneous survey with Multibeam and LASER Scanner System

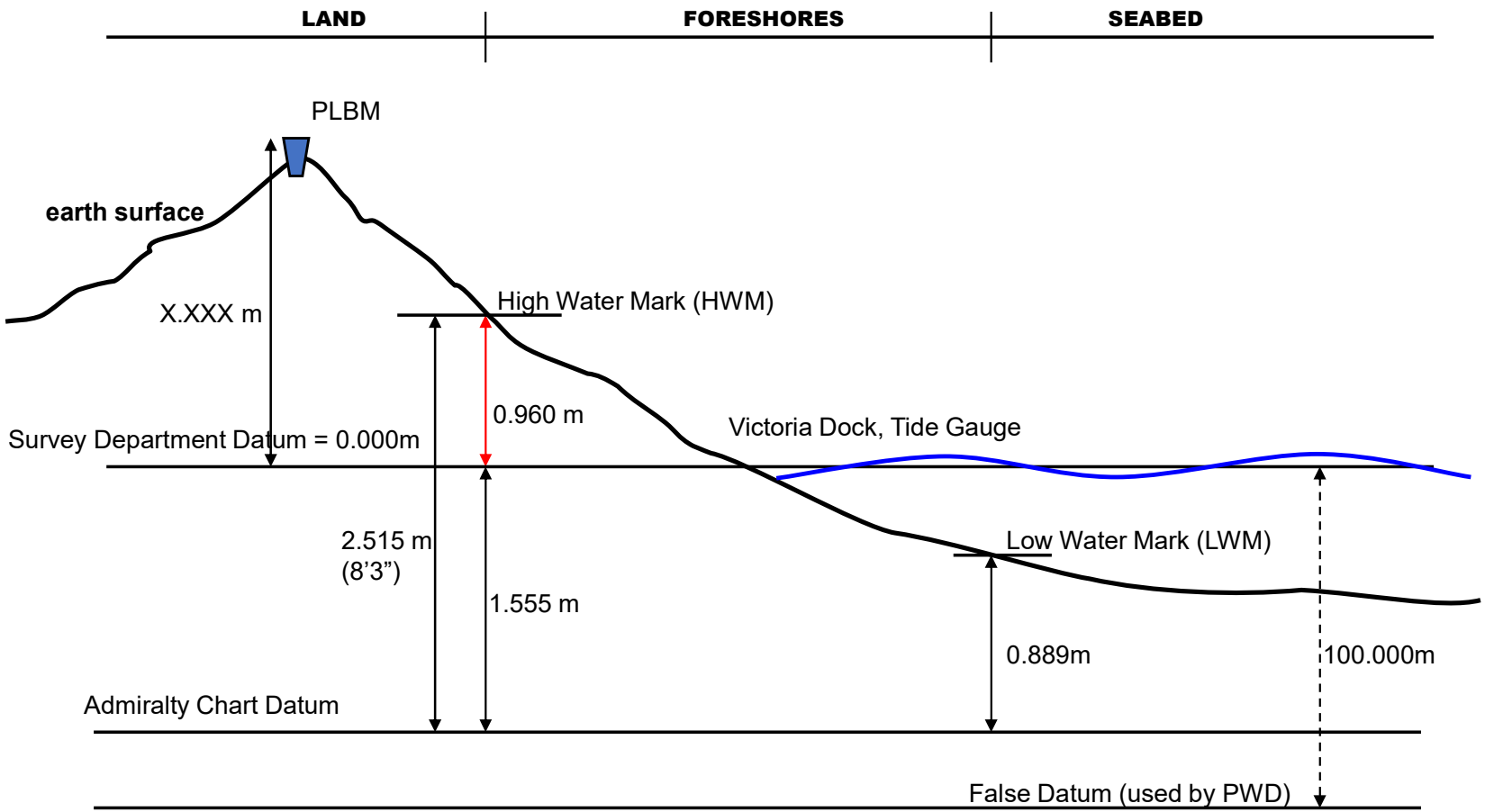
Precise GNSS Positioning

National Infrastructure - Singapore Satellite Positioning Reference Network (SiReNT)



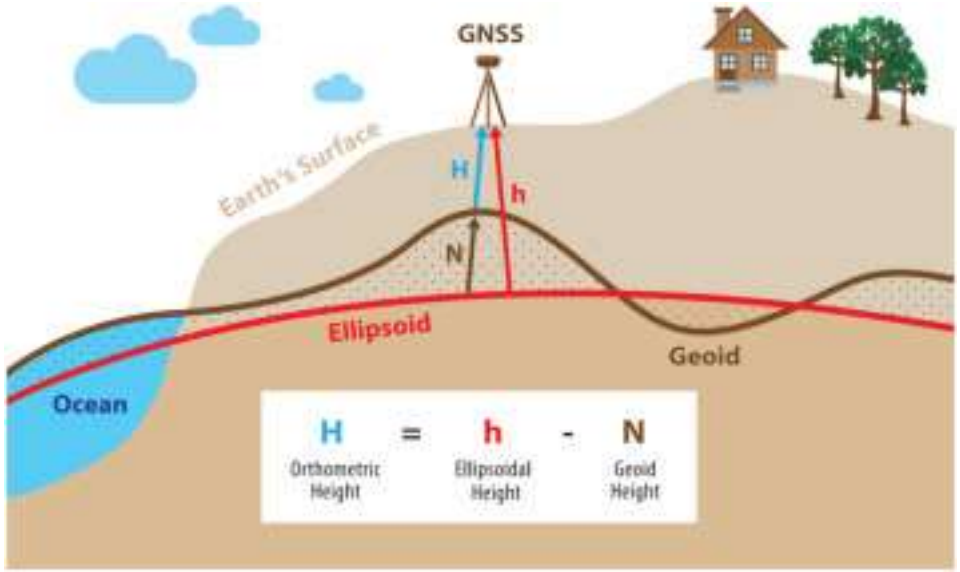
- **National Reference System** for Surveying, Mapping and GIS
- Adopt **Global Navigation Satellite Systems (GNSS)** technology
- Support up to **cm level real-time positioning** and navigation

Datum Relationships

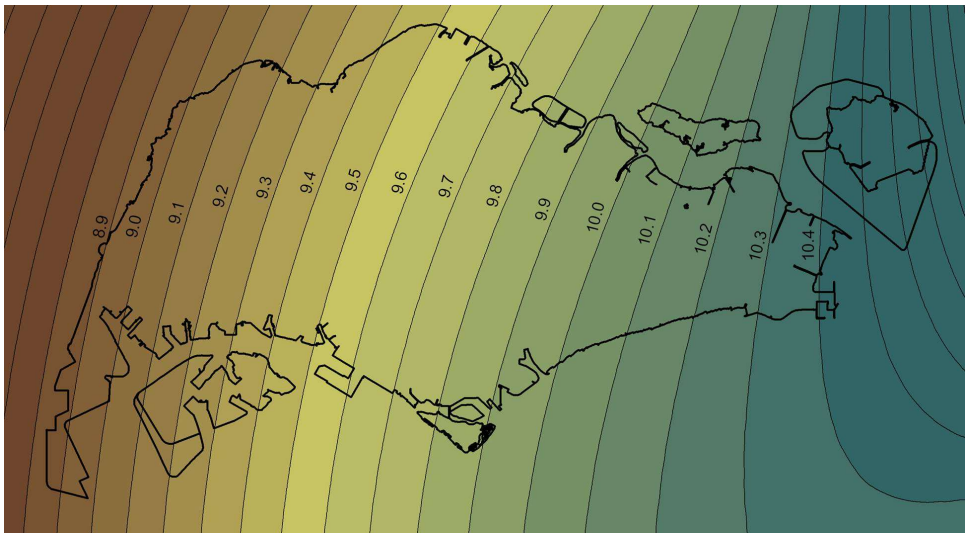


Development of Geoid Model

Datasets



Relationship between Orthometric and Ellipsoidal Height



Geometric Geoid Model of Singapore

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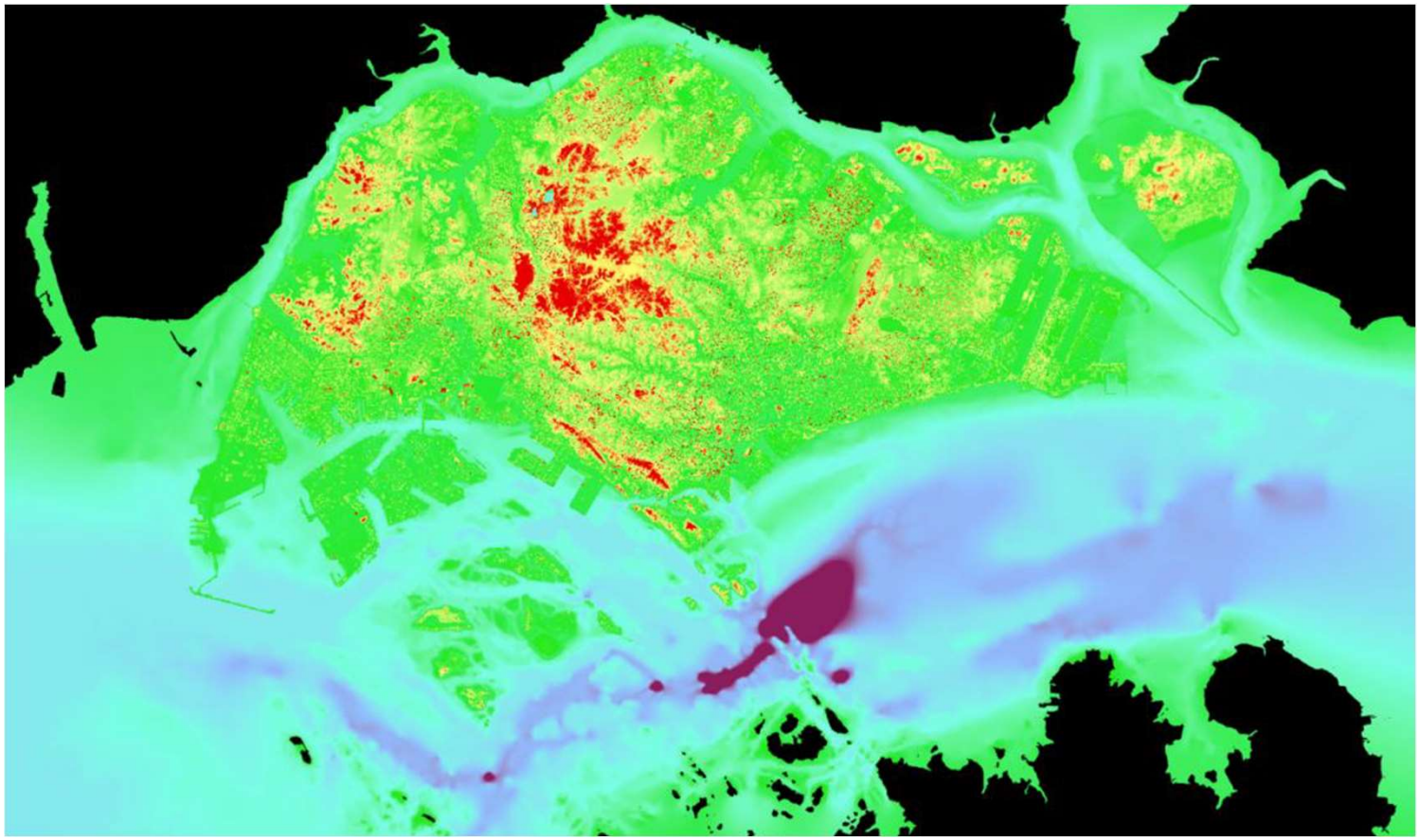
Integration of Topographic and Bathymetric Data

Datasets



Singapore ETH-Centre
Natural Capital

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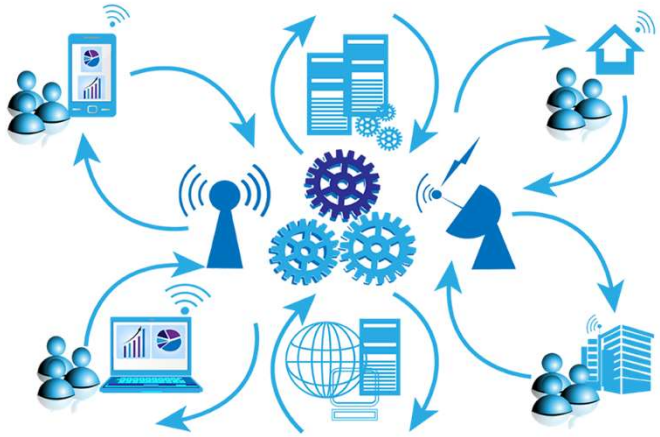
TopoBathy Map of Singapore
Map of Singapore for modelling elevation continuum in Coastal Areas

System of Systems

Systems

- ❑ Nexus of multiple Spatial Data Infrastructures (SDIs)
- ❑ FAIR (Findable, Accessible, Interoperable and Reusable)
- ❑ Open Geospatial Consortium (OGC) standards
- ❑ International Standards Organisation (ISO) standards
- ❑ Web Services for Interoperability



System of Systems

Purpose-built Digital Twins

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Challenges

- Data Acquisition “Gap”
  - Coverage of Foreshore
- Data Conversion or Harmonisation
  - Horizontal Control
  - Vertical Control
- Data Sharing
  - Platforms
  - Standards

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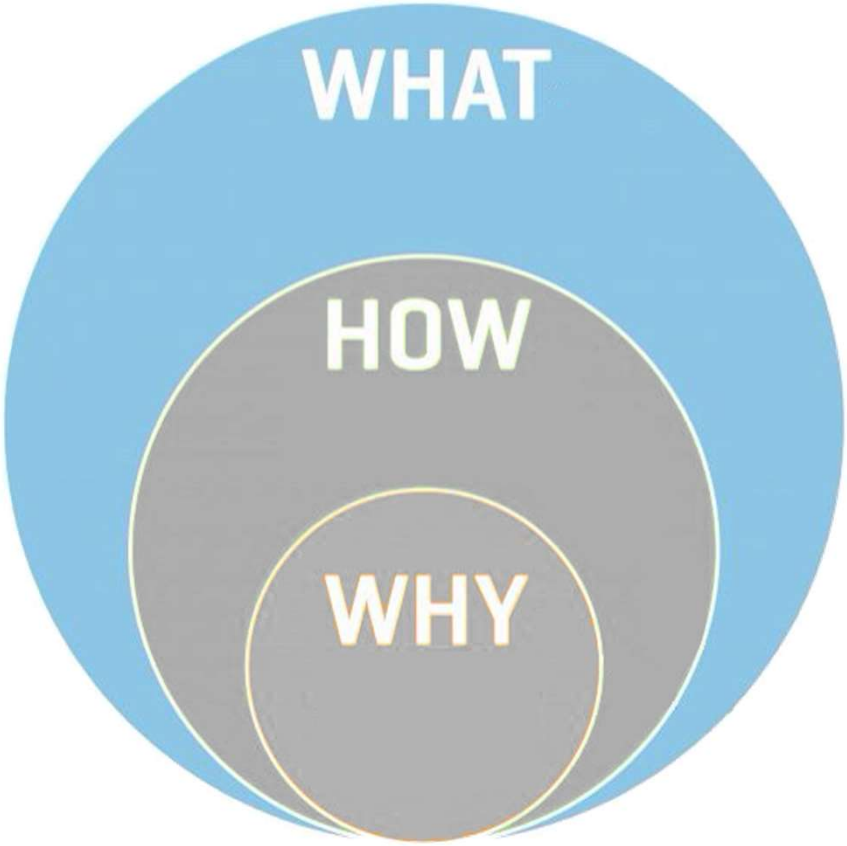
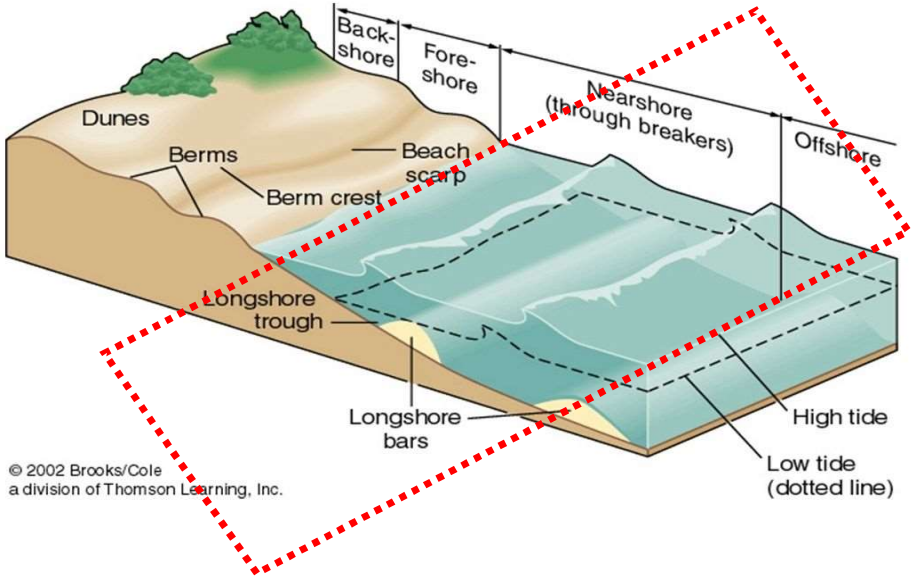
What we do to overcome the Challenges



Feasibility Study on Nearshore Mapping with PUB and MPA (Ongoing)

What we do

- No data available at nearshore due to challenges to acquire the data
- Aims: To determine the best survey method to collect the topographic and bathymetric data at nearshore
- To harmonise Singapore Height Datum and Chart Datums



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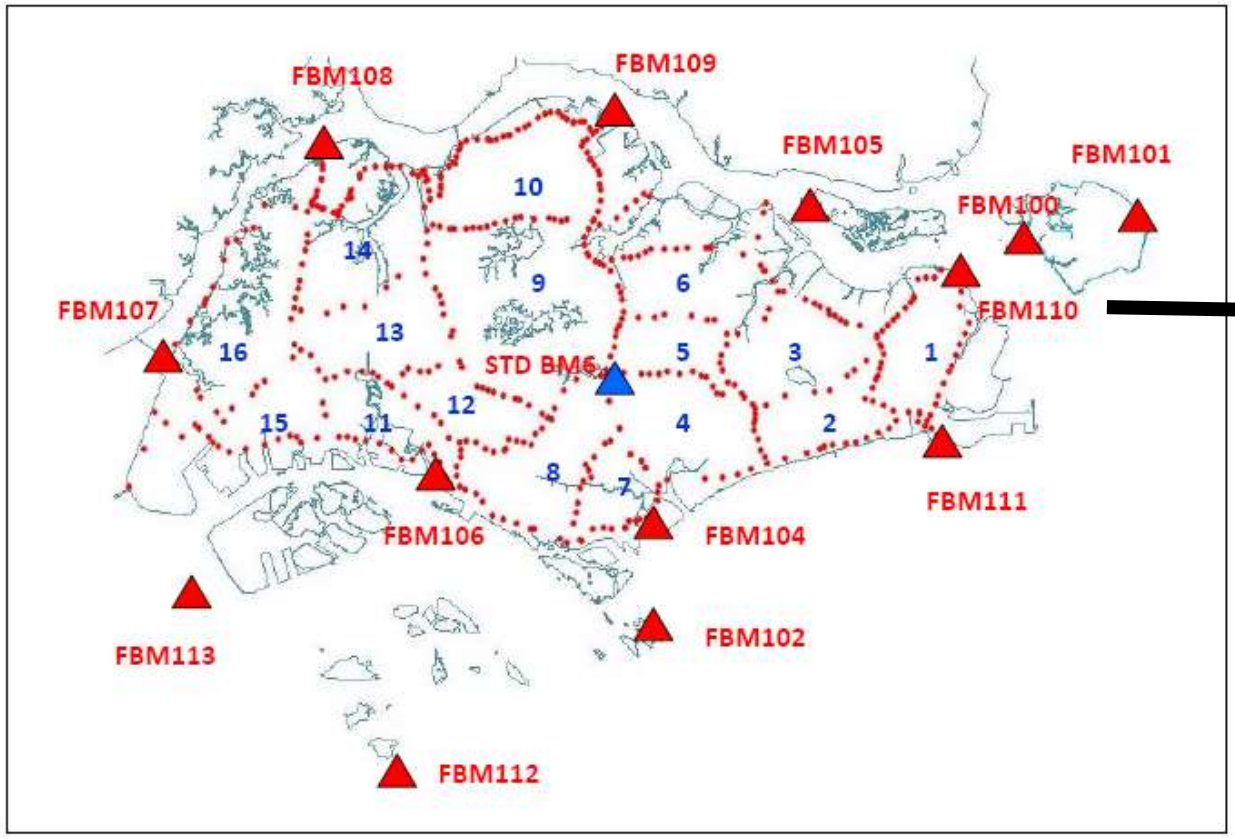
New Vertical Control Infrastructure

What we do



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What we do

Basemaps | Administrative | Physical | Ecological | Human

geospace sea

Driven by:

MPA SINGAPORE

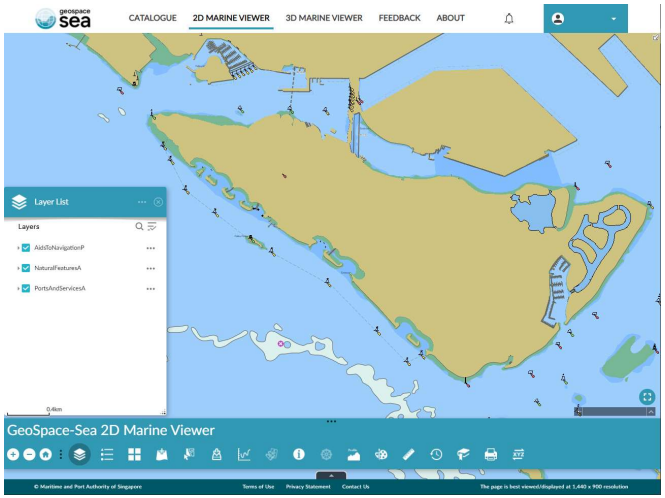
In joint collaboration with:

Building and Construction Authority
CENTRE for LiveableCities SINGAPORE
HOUSING & DEVELOPMENT BOARD
jtc
National Environment Agency
National Research Foundation Prime Minister's Office Singapore
PUB SINGAPORE'S NATIONAL WATER AGENCY
Singapore Food Agency
SLA SINGAPORE LAND AUTHORITY
URA URBAN REDEVELOPMENT AUTHORITY
To make Singapore a great city to live, work and play

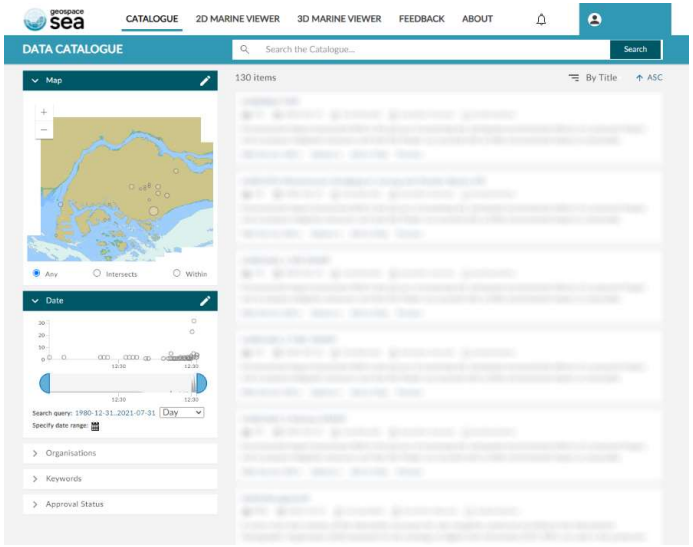
MPA SINGAPORE

GeoSpace-Sea's Featured Applications

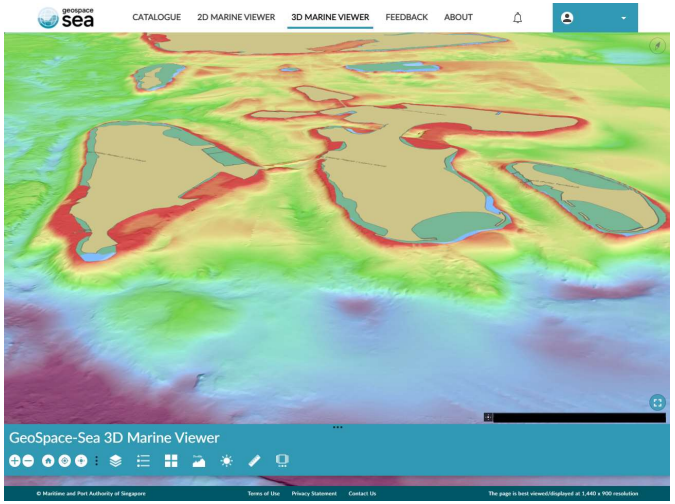
What we do



2D Marine Viewer



Data Catalogue



3D Marine Viewer

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GeoSpace-Sea's linkage with OGC

- ❑ Ensuring that GeoSpace-Sea's data is FAIR (Findable, Accessible, Interoperable and Reusable).
- ❑ Alignment with the publicly available geospatial standards in the form of web services, API, metadata etc.
- ❑ Active participation within the Maritime/Marine Science Domain with OGC.
- ❑ Supporting the development of Marine Spatial Data Infrastructure (MSDI).

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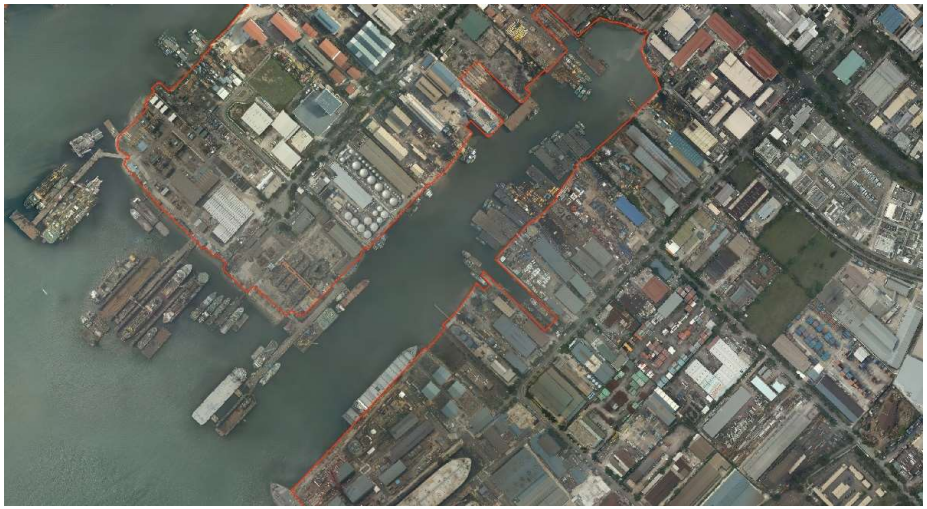
What we do

Coastal Protection Baseline Mapping

- Determine Coastal Protection Baseline using combination of Aerial Images, Cadastral Survey Data and Terrain Model
- Collaborate with BCA/PUB to demarcate and classify the Coastal Protection Baseline that will be used by WOG in 2018
- In the process of setting up
  - Authoritative database for the
  - a workflow for updating through our Surveyors QP framework



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PUB Water for All: Conserve, Value, Enjoy

Building and Construction Authority

Coastline Protection Baseline Mapping

What we do

COASTLINE CLASSIFICATIONS

- Barrier Lagoon
- Natural Beach
- Headland
- Mangrove
- Reclaimed Coast
- Seawall
- Unclassified
- Wharf

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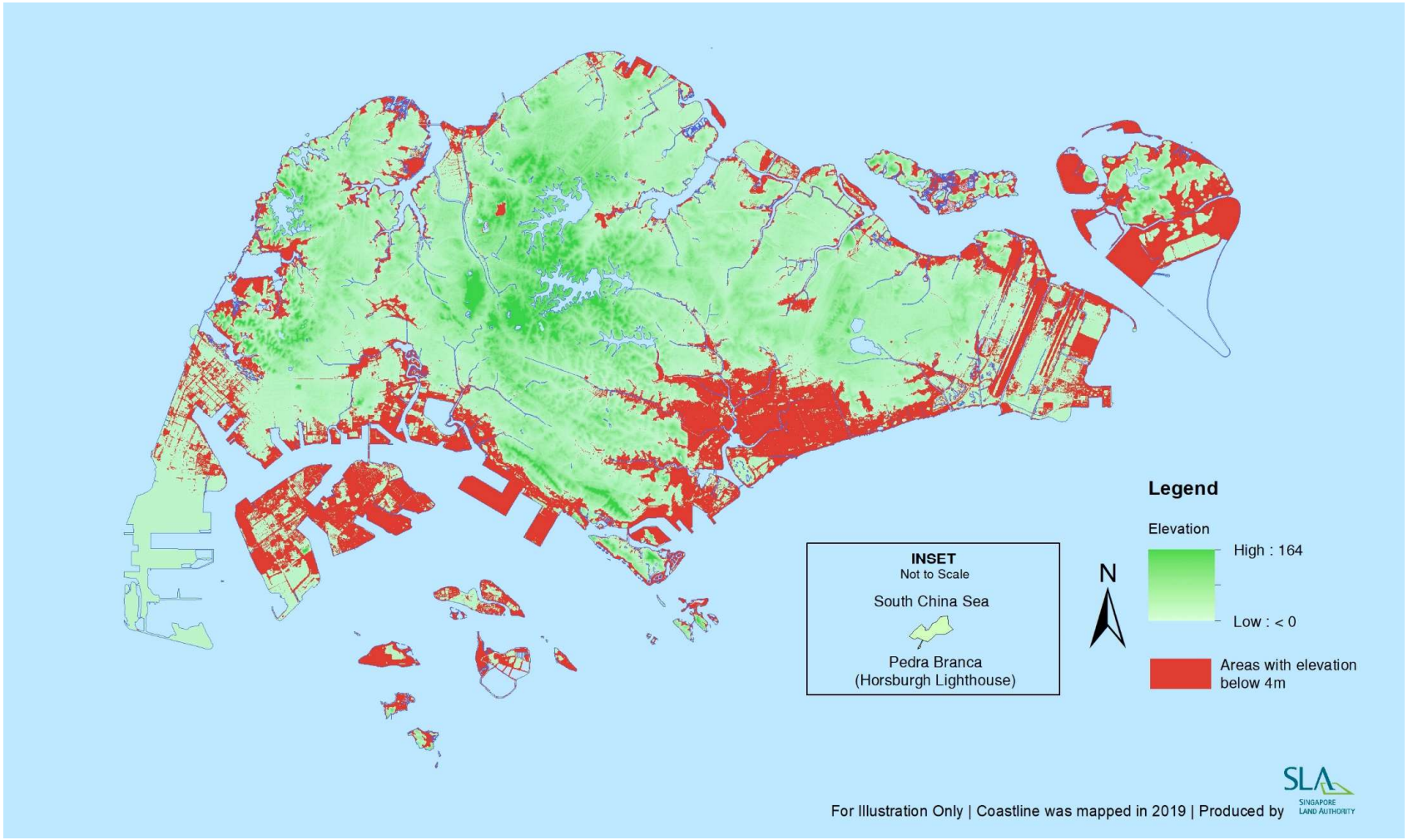
Development of terrain model and sea water rise map

What we do



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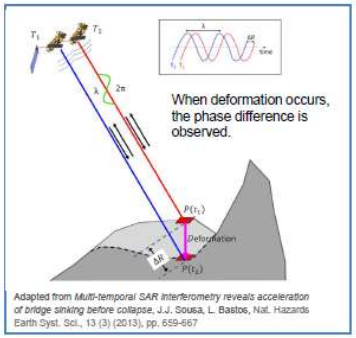
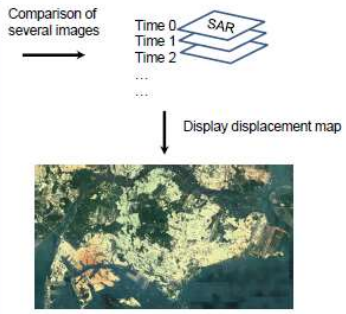
SLA to lead Vertical Land Motion (VLM) Monitoring

What we do

- Support WOG national effort in adaptation and monitoring of sea level rise
  - National Sea Level Research Programme
  - IAC (Inter-agencies Adaptation Committee)
  - RWG (Resilient Working Group)
- Adopt integrated geodesy and mapping techniques in monitoring
  - GNSS reference station long-term monitoring using SiReNT
  - Vertical Control Network data from SGD
  - Airborne laser scanning point cloud data from N3DMP
  - Satellite data and InSAR technique

SiReNT GNSS monitoring





InSAR technique

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SUSTAINABLE DEVELOPMENT GOALS
17 GOALS TO TRANSFORM OUR WORLD

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