

***VULNERABILITY AND RISK ASSESSMENT – A
PILOT STUDY FOR CENTRAL REGION OF
SINGAPORE”.***

**Durairaju Kumaran Raju
Geoscience Consulting, Singapore**

Introduction

- **Singapore** officially the **Republic of Singapore**, is a Southeast Asian island city-state off the southern tip of the Malay Peninsula, 137 kilometres (85 mi) north of the equator.
- An island country made up of 63 islands, it is separated from Malaysia by the Straits of Johor to its north and from Indonesia's Riau Islands by the Singapore Strait to its south.
- The country is highly urbanised with very little primary rainforest remaining, although more land is being created for development through land reclamation.



Singapore – Urban setup



High rise residences



Commercial/Hotel



Central Business District



Coastal properties

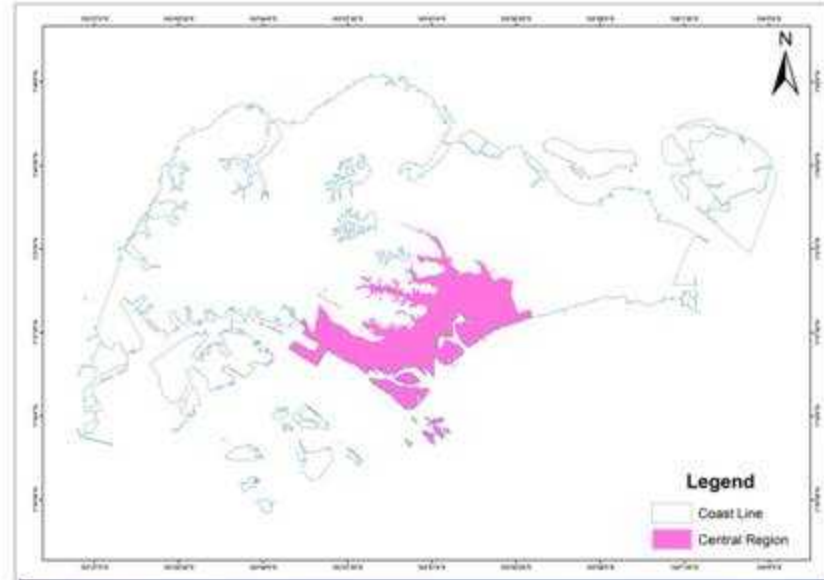


Flood scenarios



STUDY AREA

- Study Area - Central Region covers the Central Business District (CBD), a wide range of commercial buildings, Residential apartments, recreational facilities, hospitals etc.
- Area Coverage is 80 Sq.Km.

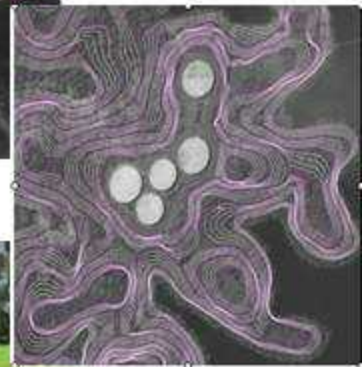
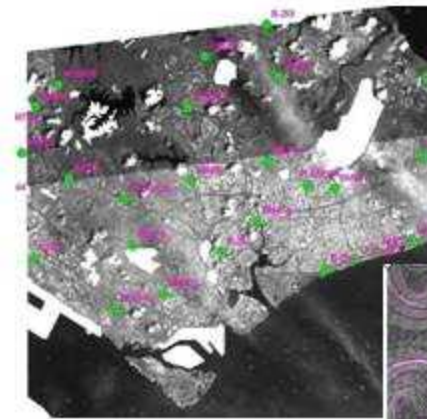


STUDY HIGHLIGHTS

- Examine coastal characteristics
- Document coastal land use and facility class distribution
- Assess vulnerability (inundation)
- Loss assessment
- Risk assessment methodology (HAZUS –MH)

ROLE OF EARTH OBSERVATION

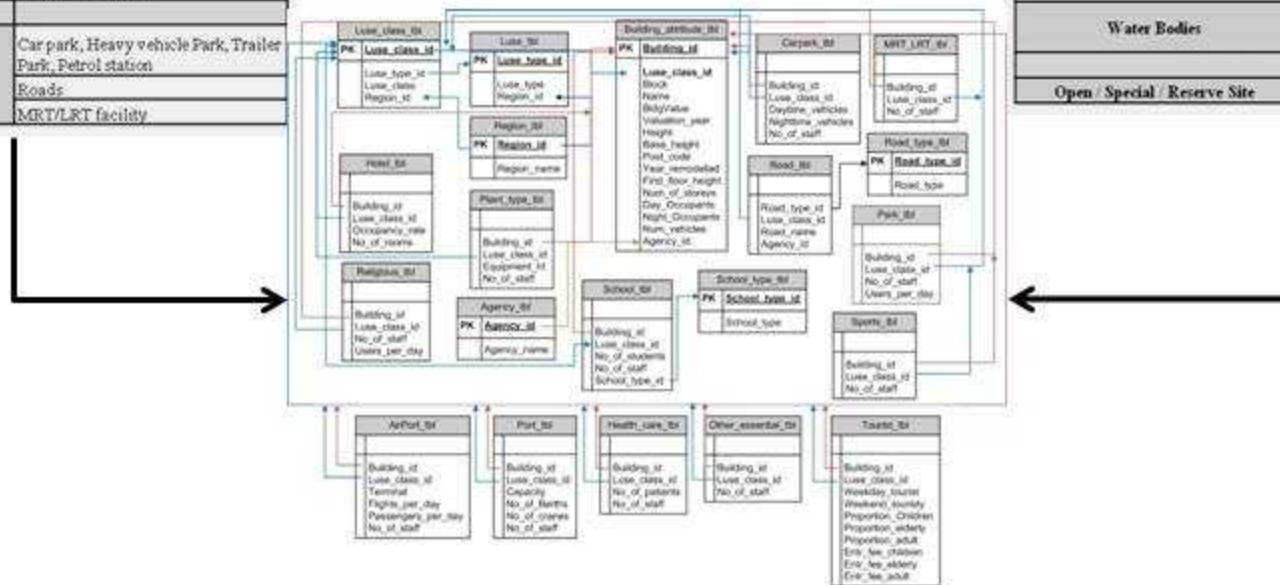
- The High Res - Digital Elevation Model (DEM) was generated by combining (hybrid) the data from satellite and ground based surveys:
 - Elevation derived from Satellite stereo
 - Integrated field based surveys (Mobile Lidar & GNSS surveys)
- The achieved vertical accuracy after compilation is at the range of 0.30 to 0.70 cm.



FACILITY CLASS DISTRIBUTION & EXPOSURE DATABASE

Facility type	Facility Distribution
Residential	Residential
	Residential with Commercial at First Storey
Essential Facilities	Fire Stations
	Police Stations
	Schools/Universities
	Health and Medical care
	Courts
	Prison
	Drug Rehabilitation Centre/Half way House
Commercial	Business
	Business Park
	Industrial
	Commercial
	Hotels
PORT/Airport Facility	PORT, AIRPORT
Transportation Facilities	Car park, Heavy vehicle Park, Trailer Park, Petrol station
	Roads
	MRT/LRT facility

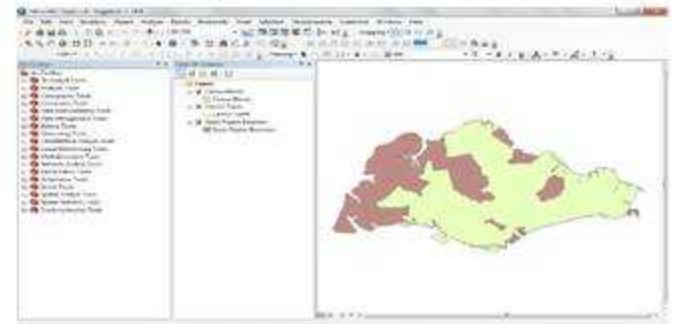
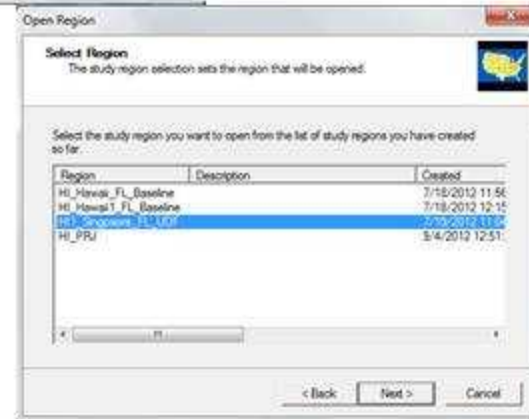
Facility type	Facility Distribution
Critical facilities	Electric Substation
	Power Station
	Gas Installation
	Water Treatment Plant
	Water Pump House
	Sewage Pumping Station
	Incineration Plant
	Desalination Plant
	Earth Satellite Station
	Communication Facility
Religious Facility	Religious: Church, Mosque, Temple, Cemetery
Sports & Recreational Facility	Gardens/Parks, Theme parks, Recreation clubs, Sports Complex/Indoor Stadium, Swimming Complex, Golf Course, Golf Driving Range
Water Bodies	River, Major Drain & Canal, Reservoir, Pond
Open / Special / Reserve Site	Open Site, Reserve Site, Special Use



HAZUS SETUP

■ HAZUS Setup:

- The study region created for HAWAII to accommodate the Singapore data set.
- The data were then migrated using FME tools.



Hazard Score (“100 year”)

What is the likelihood of a “100-year” event occurring within 100 years?

- “100-year” event = 1% annual chance (or 0.01)
- Likelihood = $1 - (1 - \text{AEP})^N = 63\%$
- **Hazard Score = 3**

Hazard Score	Description	Probability of occurrence within planning timeframe (likelihood)
5	Highly unlikely, but conceivable. Extreme intensity event.	1-10%
4	Unlikely to occur. Very high intensity event.	10-33%
3	About as likely as not (possible). High intensity event.	33-66%
2	Likely to occur. Moderate intensity event.	66-90%
1	Very likely or expected to occur. Low intensity event.	>90%

CONCLUSION

- Based on the evaluation through preliminary study conducted for the central region:
 - Comprehensive Data Management System data dictionary for Flood risk was very useful tool to classify the facility types
 - US Army Corps Damage functions can be adopted for damage assessment
 - The HAZUS workflow in GIS can be followed to assess the Risk for other facility types.

Ongoing initiatives

- Disaster Risk Modelling Techniques: A Common Methodology for Countries to Apply
 - To extend further the methodology for regional countries through collaborative projects and capacity building programs
 - Regional capacity building and training programs
 - Sri Lanka
 - Thailand

A photograph of the Singapore skyline at dusk. The Merlion statue is illuminated in the foreground, with water spraying from its mouth. A boat with blurred lights is in the water. The background features several skyscrapers, including the Maybank building and the UBS building. The sky is a mix of blue and orange.

Thank You