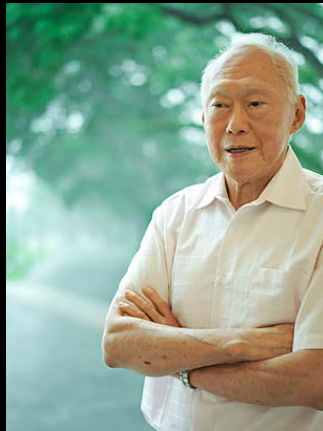


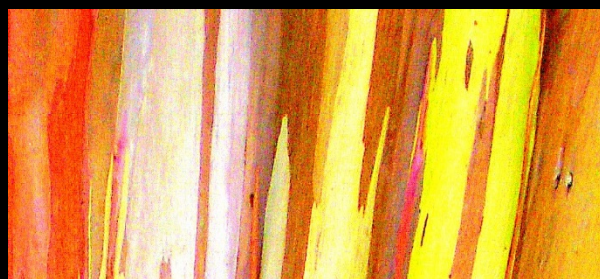
Greetings from Singapore





Singapore Today

Premier Tropical Garden



Singapore Today - A Garden City



Transforming ... “City in a Garden” CIAG 4

Our Garden City

Story

- A virgin **forest- Garden**
- **6 Feb 1819**
- **Founders:** Sir Stamford Raffles &
Major-General William Farquhar



Temasek, Singapura



A hand-coloured lithograph of "*A path across the swamp*" at Changi, eastern part of the island – by Eduard von Ransonnet 1876

- 1883 - survey was carried out and found out that only 7 % of the island remain forested
- Some urban tree planting programme was initiated as early as 1881 when Mr Nanthaniel Cantley, was the Superitntendent of SBG

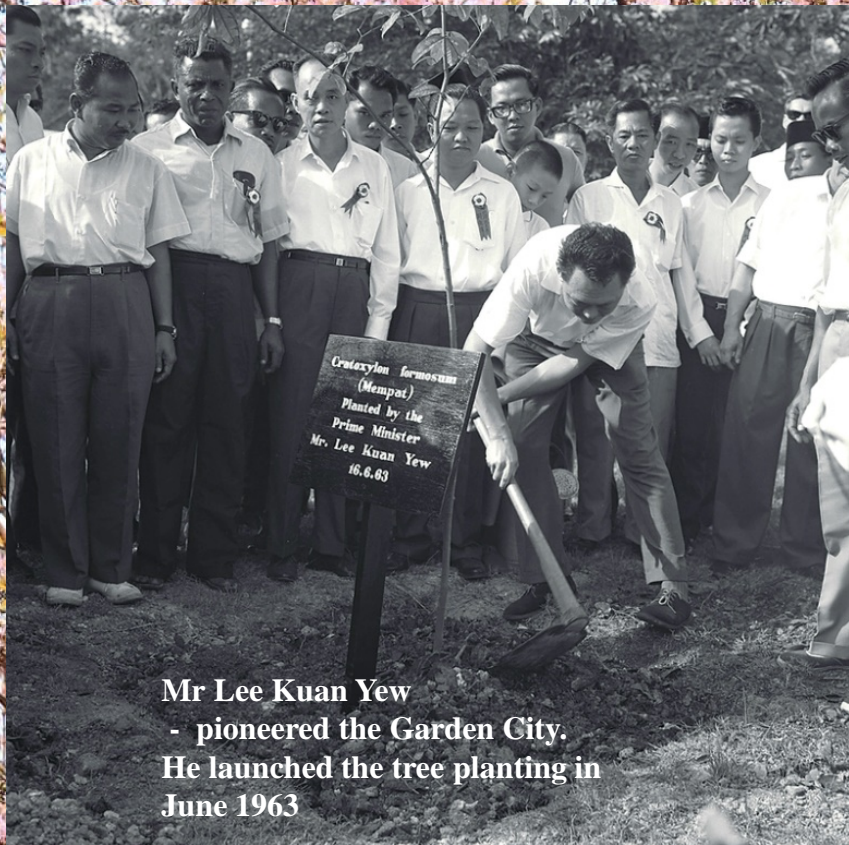






Esplanade — Singapore.

- We have had a good beginning.
- We have Mr Lee Kuan Yew ... visionary champion - with far-sighted vision - to grow Singapore into a “City in a Garden” CIAG



Mr Lee Kuan Yew
- pioneered the Garden City.
He launched the tree planting in
June 1963

"To achieve First World standards
in a Third World region, we set out
to transform Singapore into a
tropical garden city."

The early pioneers
recruited were largely
‘plant trained’.

**In the early years of
our garden city ...**

In the 60's, 70's ...



Roadside tree planting



Clifford Pier

**Angsana tree,
Pterocarpus
*indicus***





Rain tree, *Samanea saman*



Yellow Flame tree, *Peltophorum pterocarpum*





Eugenai grandis

Syzygium grande

Cinnamomum iners



In the 1980's ...





***Trumpet
tree***

***Tabebuia
rosea***





**Senegal
Mahogany tree,**
***Khaya
senegalensis***



Esplanade Drive



Golden penda

Xanthostemon chrysanthus

In the 1990's



In the 1990's



Hopea odorata





**Kasai
tree**





Common
Sterculia

*Sterculia
parviflora*



Katong
Laut

*Cynometra
ramiflora*



Sea Gutta

*Pouteria
obovata*



River
Tristania

*Tristaniopsis
whiteana*



Illawarra Flame tree,

***Brachychiton
acerifolius***

Greenery Today









**Singapore Botanic
Gardens (SBG) –
inscribed as UNESCO
Heritage Site in 2015**







What have we done right ?

**“ What defines the greenery of
Singapore today ?”**

What have we done right ?

- ❖ **Land provisions for greenery**
- ❖ **Government & public support**
- ❖ **Legislation, policies, governance**
- ❖ **People factor - passion, expertise, professionalism**

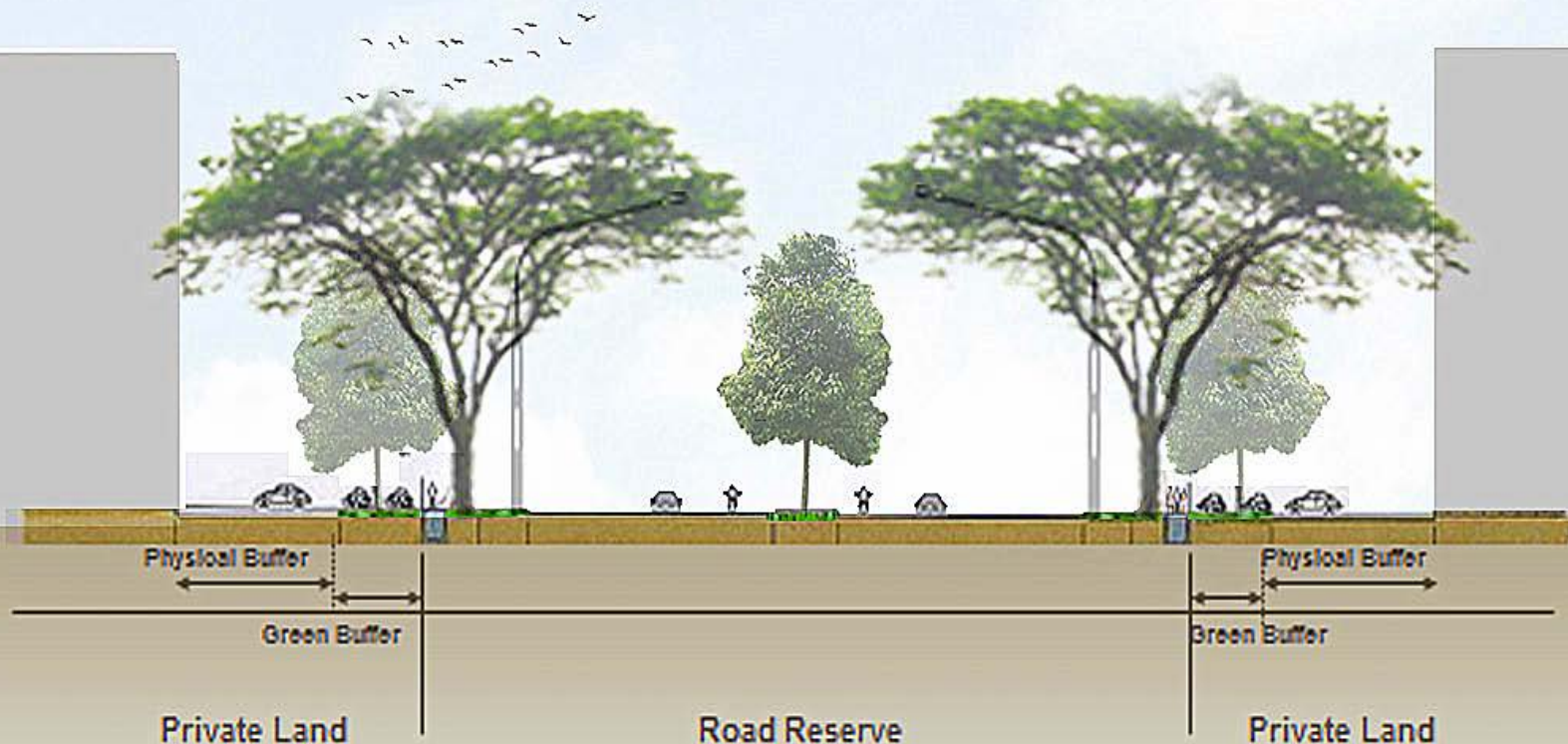
Land provisions for greenery

Planned Provision for Roadside Planting



Road Code (*Planting Verges in Road Reserves*)

Road Buffer (*Physical & Green Buffer*)



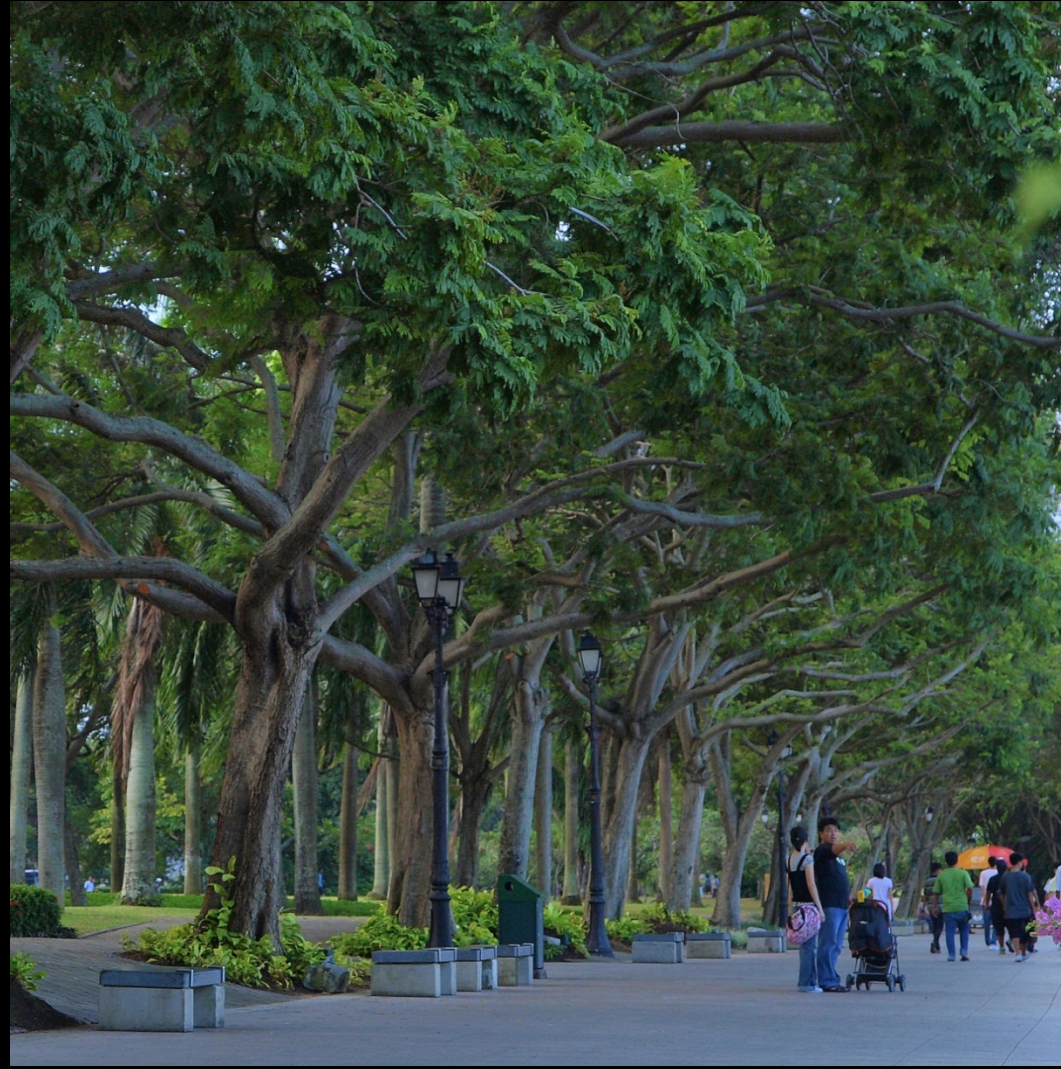
Typical Cross-Section of Major Arterial

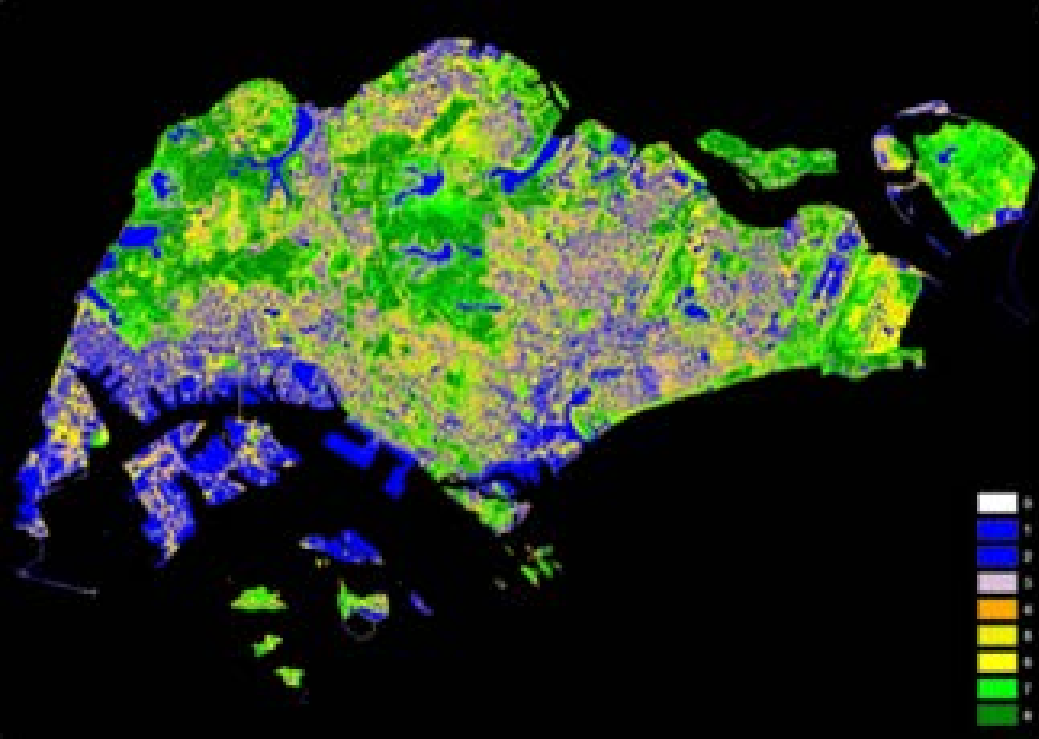
Planting in Car Parks



Provisions for Parks, Open Spaces, PCNs

Parks provision ratio ... 0.8 hectares of parkland per 1000 population





Satellite image
of
Singapore
2011

About **10%** of Singapore's total land area is currently set aside for **parks and nature reserves**, and more than **40%** is covered by greenery

Government & public \$upport

Legislation, policies, governance

➤ **Parks & Trees Act**

- **National Parks & Nature reserves,**
- **Protection and Conservation of trees & plants**
- **Planting areas, public open spaces & green verges**
- **Prevention of dangers – trees obstructing traffic, imminently dangerous trees**
- **Powers of Enforcement**

Tree Conservation Area



Heritage Roads

Approved & gazetted in 2005 (5 roads)

- **Arcadia Road**
- **Mount Pleasant Road**
- **Mandai Road**
- **Lim Chu Kang Road**
- **South Buona Vista Road**

**People factor - passion,
expertise, professionalism**

Recruitment of **passionate** people



Follow the same principle :

“Select the right tree for the right place”

People Factor



>> energy to drive
vision & mission of our
garden city

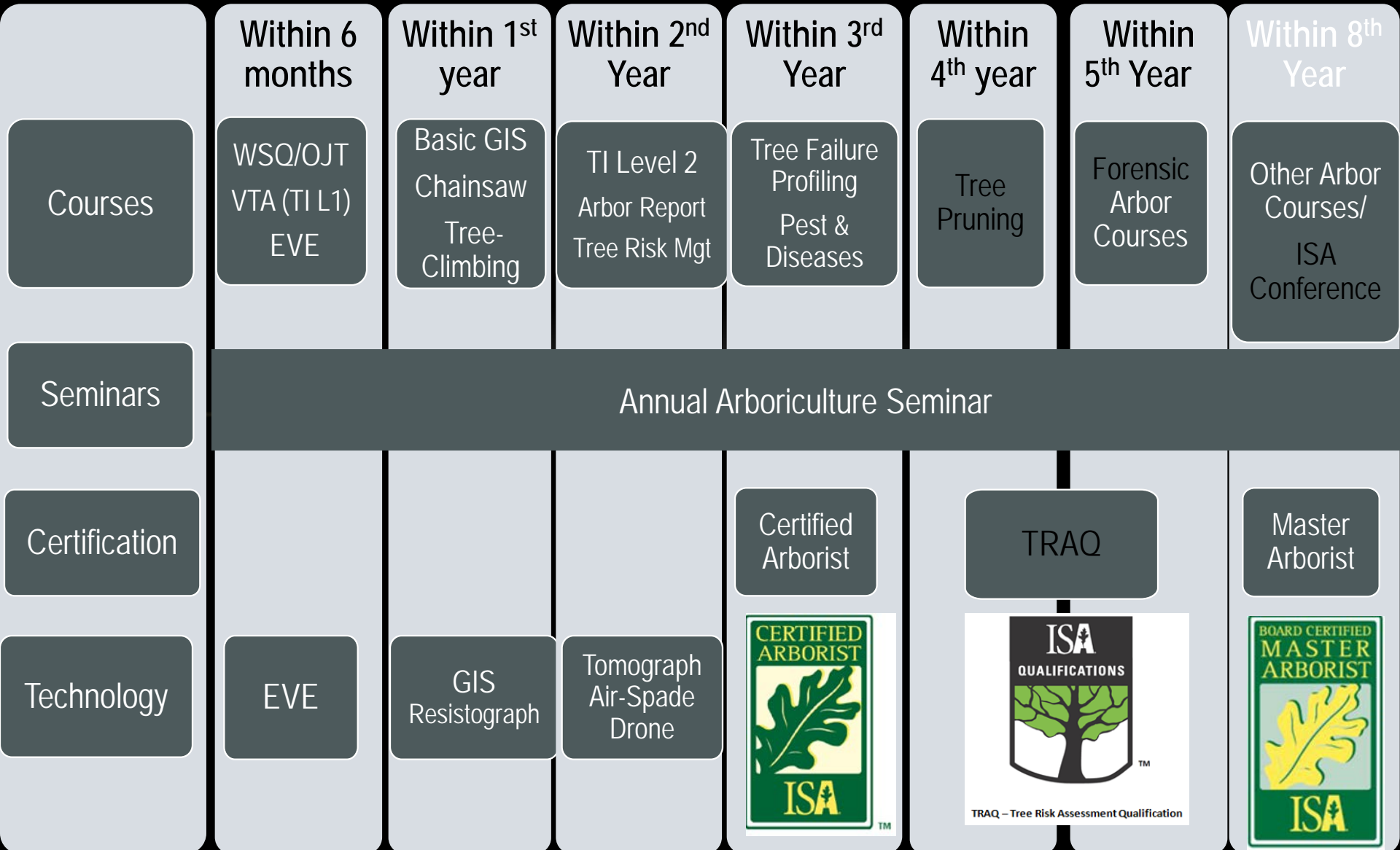
What is current ?



Tree
Management
—
It
blooms
with
Innovations &
Technologies

Professional Development

Training Roadmap for Arborists



PROFESSIONAL DEVELOPMENT

Within 6 Months

Three Days **On the Job Training** of Visual Tree Assessment
One Day Introduction to EVE (Greenery Management IT System)
Conduct 200 Inspections under Supervision
WSQ Training in Landscape Management
Two Day Refresher Course and Introduction to Tree Risk Training
~~Written and Practical Assessment~~

After 1 Year

Arboriculture Training Courses (e.g. Tree Climbing, Tree Decay Fundamentals, Chainsaw Operation).

After 2/3 Years

Certification as “**Certified Arborist**” by the International Society of Arboriculture

After 3/4 Years

Eligible for Certification as a Municipal Arborist Specialist or the Tree Risk Assessment Qualification (**TRAQ**)

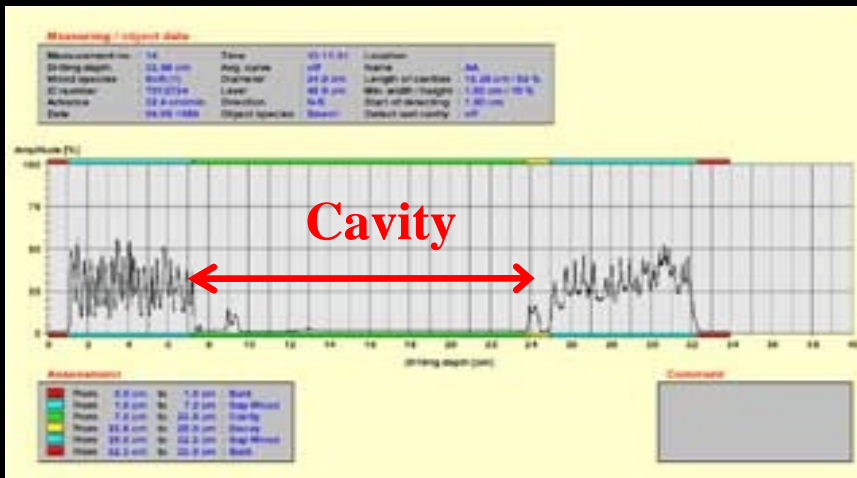
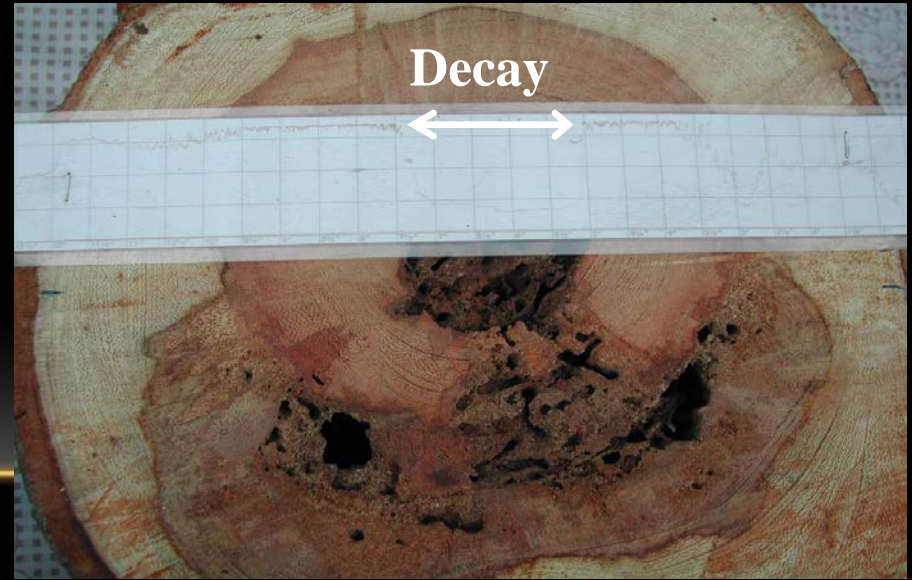


PROFESSIONAL DEVELOPMENT



Use of Specialised
Equipment like the
Resistograph

PROFESSIONAL DEVELOPMENT

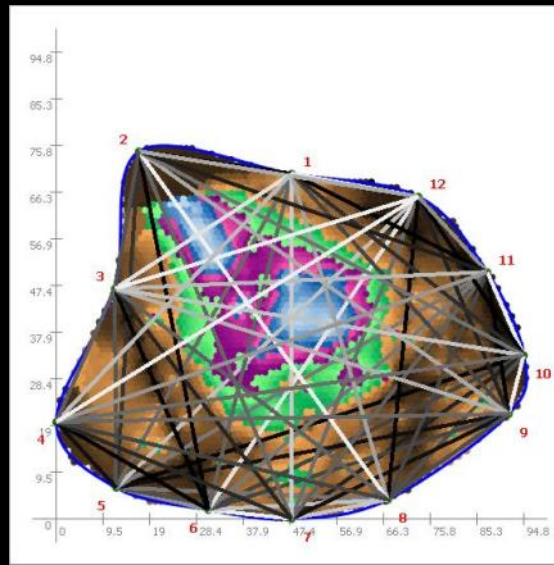


The device can measure the amount of sound wood/decay & assist to determine the trunk/branch structural integrity

Resistograph PD 500



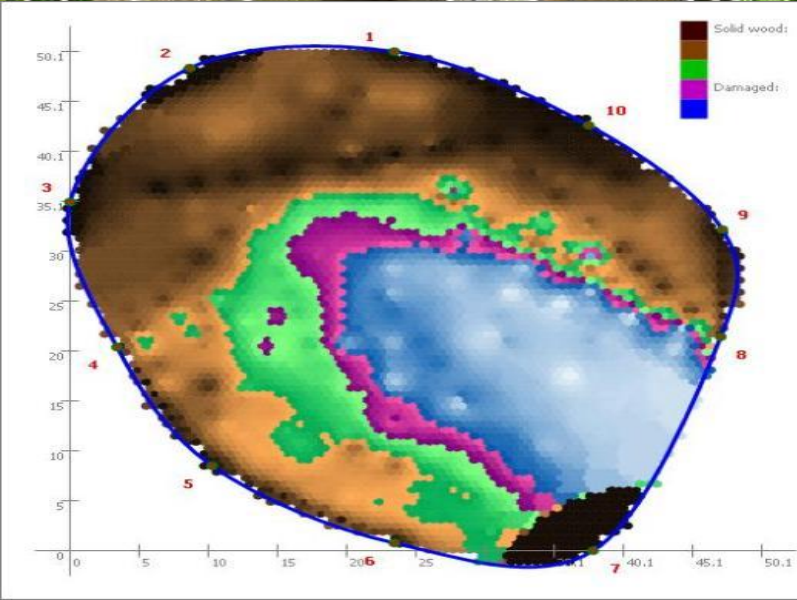
PROFESSIONAL DEVELOPMENT



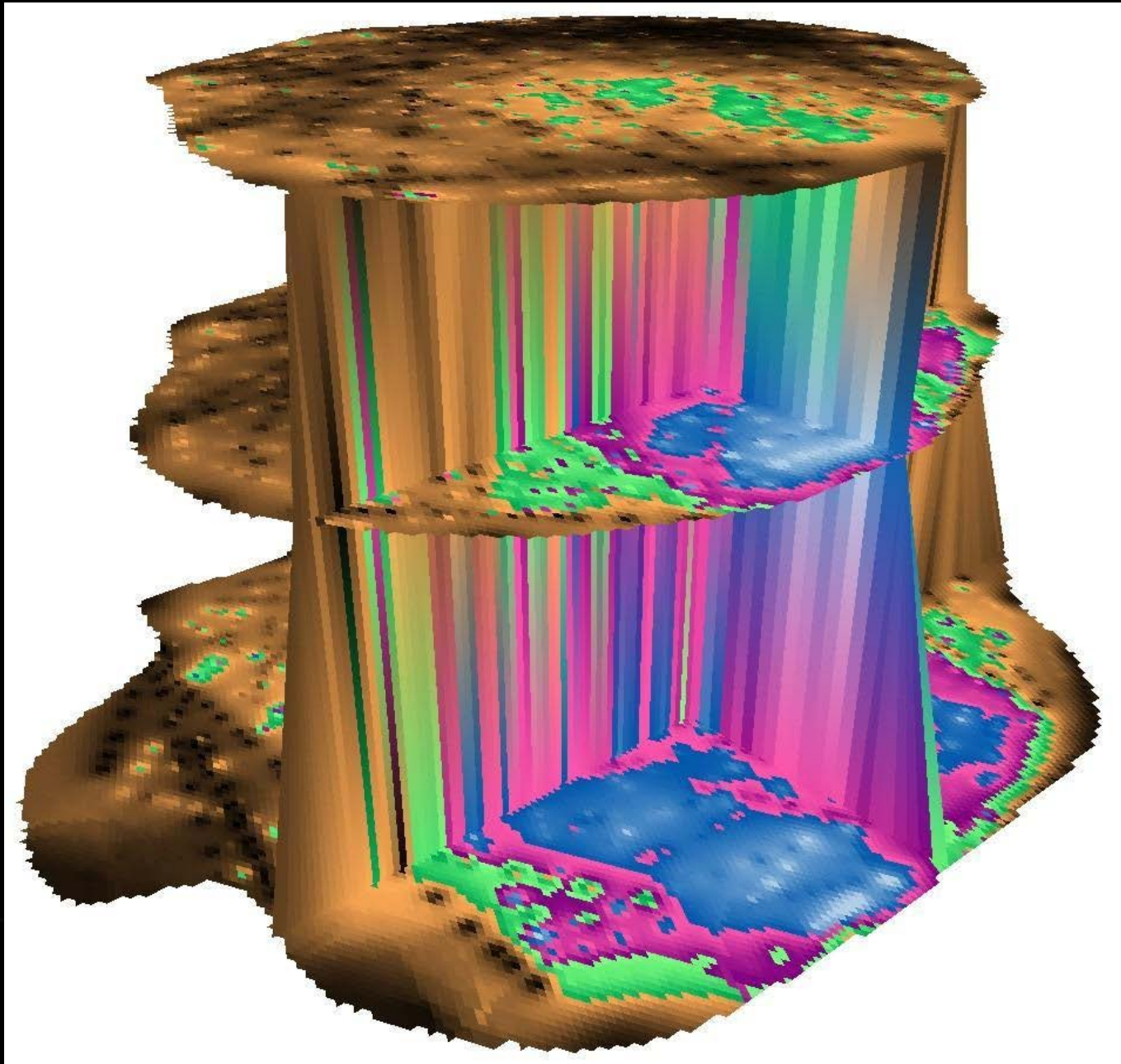
PROFESSIONAL DEVELOPMENT



- Measure time taken for sound waves to travel thro wood tissues
- It takes more time for sound to travel through decayed wood than sound wood
- Analyzes the **relative speeds** of multiple sound waves to produce a 2D tomogram



3D Sonic Tomogram



Maintainability & sustainability

-

Urban greenery

Major Operations

- tree inspection
- tree pruning
- tree planting/transplanting

BOOSTING OPERATIONAL PRODUCTIVITY

To automate & mechanise manual field operations



WOOD-CHIPPER



STUMP-GRINDER



SPIDER-LIFT



“Harvester” - exploring ...a more efficient way to carry out tree pruning and removal



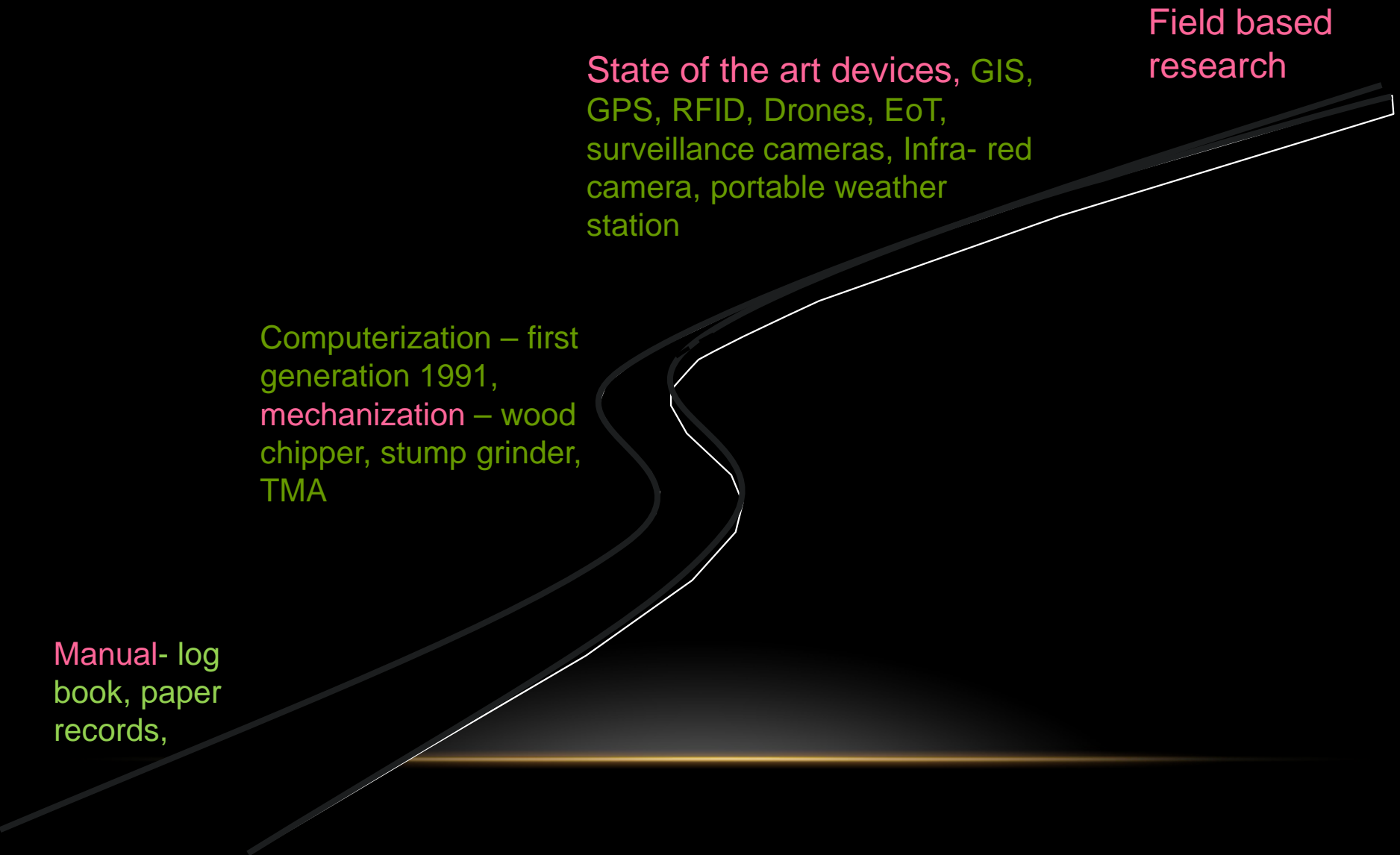
Vehicle Monitoring /Fleet Management System

>> contractor vehicles will be installed with **GPS trackers & video cameras** – enhance productivity: monitoring of asset/vehicle deployment, real-time monitoring of work on the ground

- Real time streaming – GPS tracking
- Saving of useful work time
- More effective deployment - enhanced productivity

Going Digital

Innovation & smart technology for tree management



New Generation NParks Arborist



Satellite



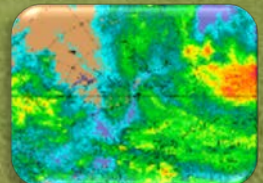
Portable weather station



Sensors on Trees pruning vehicles



NFC/RFID Tree Tagging



Research: CUGE, NBC



GIS Hub



Arbo Team



NCMS, Media Centre



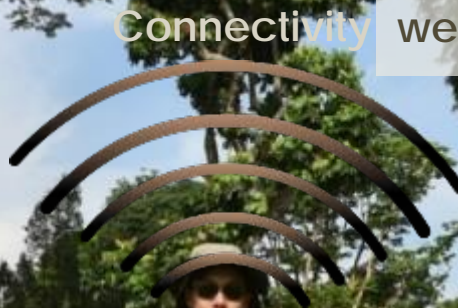
Tree Tilt Sensors



Autonomous drone



Mini-drone



Connectivity

Field Datalogger

- **iPad Air**
- SIM card (fitted in iPad Air)
- **ruggedised** case (fitted onto iPad Air)
- one shoulder strap and one hand strap
- power adaptor & other miscellaneous tools



Computerisation journey

...

- Before 1985 - Manual/paper records (Tree Dossier System)
- 1985 - CHIS (Computerised Horticultural Information System) – for textual data only
- 1999/2000 – PRIME
- 2010 – EVE system
- ? - EVE II ?



GIS - Geographic Information System

Designed to capture, store, manipulate, analyze, manage and present geo-spatial data

Alerts (2196)

Global Search

Global Reports

Parks Management

Tenders

Contracts

Projects

Land Use Consultations

Handovered Submissions

Parks and Greenery Management

Assets

Stakeholders

Nursery

Tree Inspections

Population Reports

Big Map

[Show Big Map] [Show Small Map]

Legend

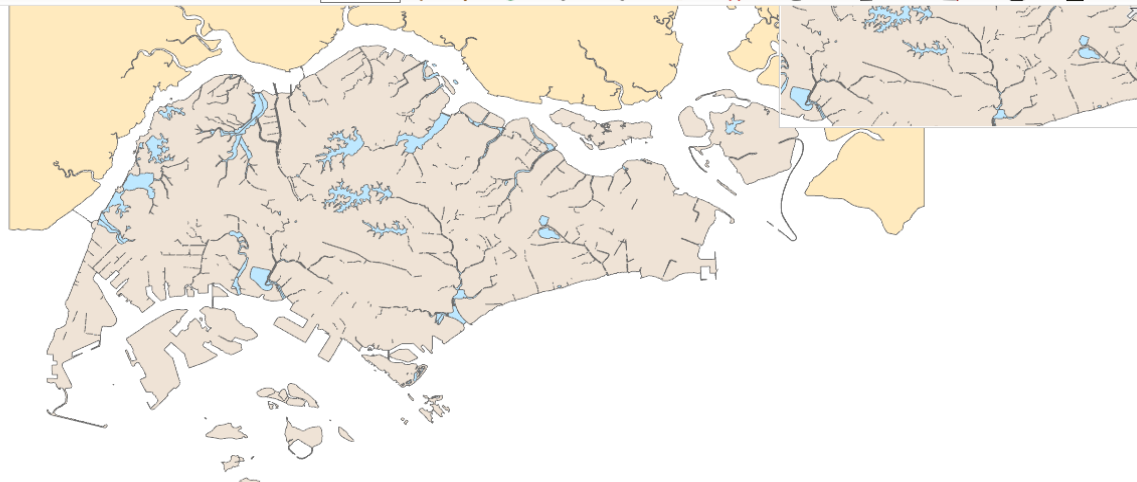
Layers

Views

- ☐ NParks Managed Trees
- ☐ NParks Managed Locations
- ☐ NParks Sub-Locations
- ☐ Parks Reference
- ☐ Streetscape Reference
- ☐ Heritage
- ☐ Policy & Planning Reference
- ☐ Other References
- ☐ Istana and Parliament House
- ☐ Follow Up Actions
- ☐ PUB
- ☐ URA Master Plan
- ☐ Carparks
- ☐ Land Ownership



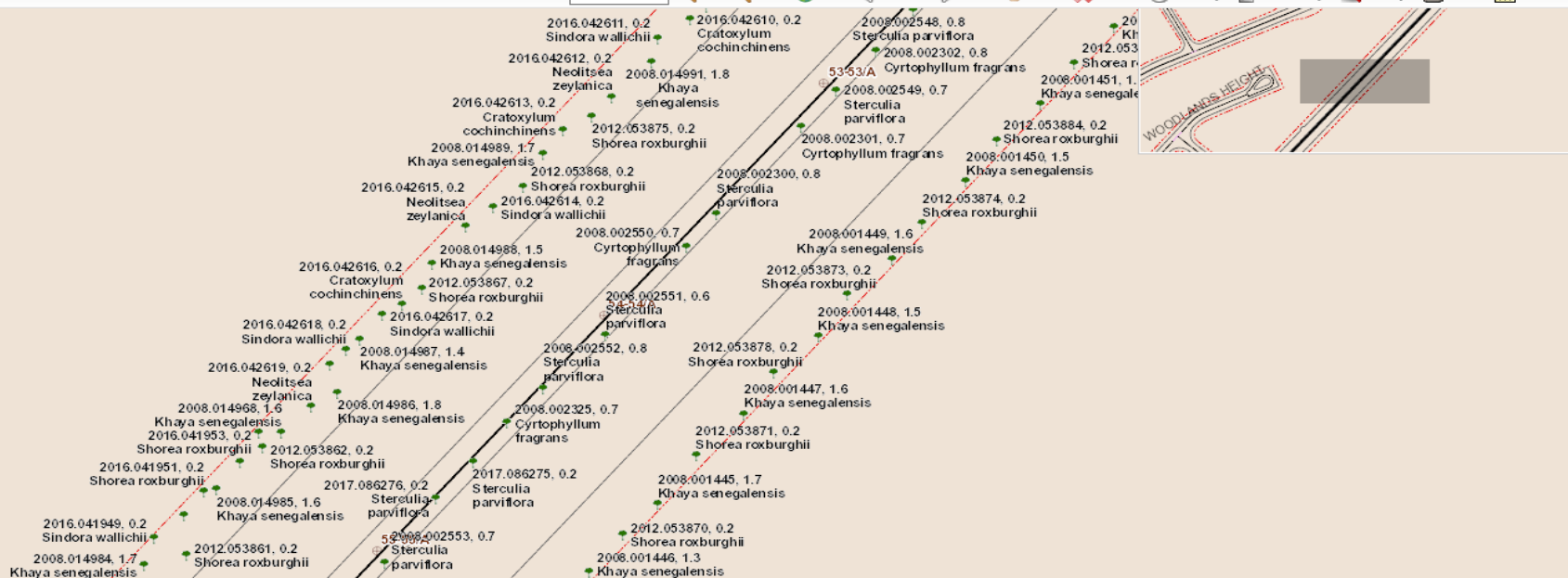
Zoom To [In] [Out] [Full] [Prev] [Next] [Pan] [Clear] [Identify] [Proximity] [Query] [Print] [Measure]



Id	Description	Layer Name	Action	Select

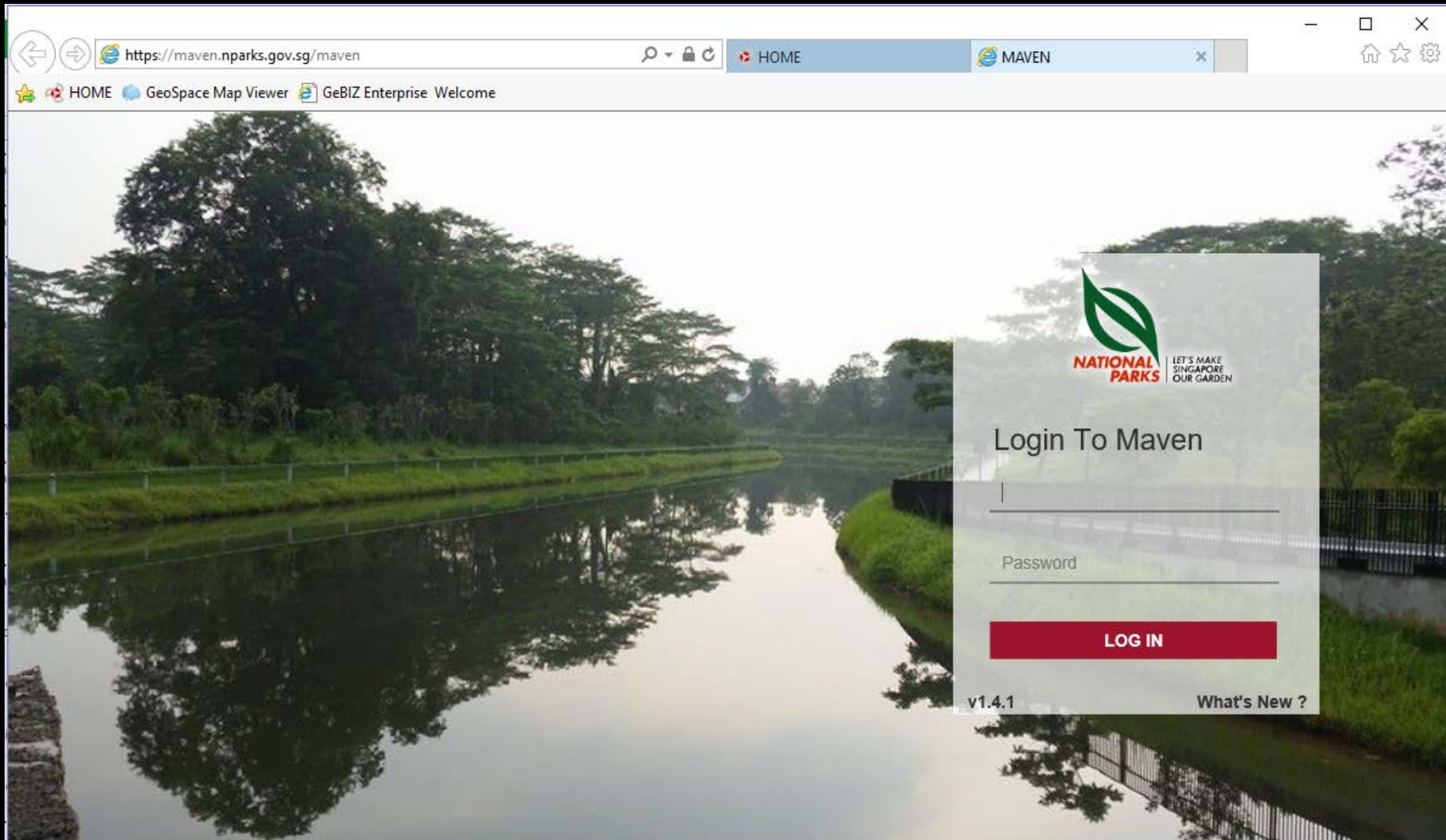


Zoom To [In] [Out] [Full] [Prev] [Next] [Pan] [Clear] [Identify] [Proximity] [Query] [Print] [Measure]



Id	Description	Layer Name	Action	Select

Internally we have **MAVEN**, a dashboard specially created for NParks staff - to access useful info quickly



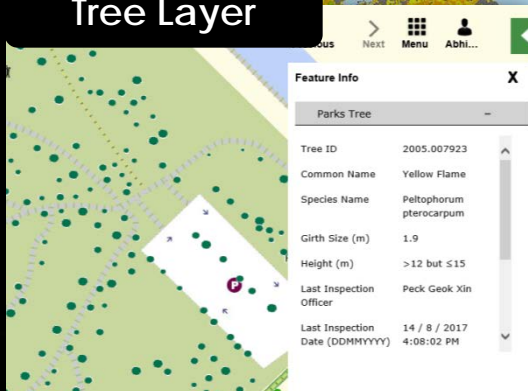


MAVEN – Common GIS Platform

Number of layers in MAVEN Database: 750



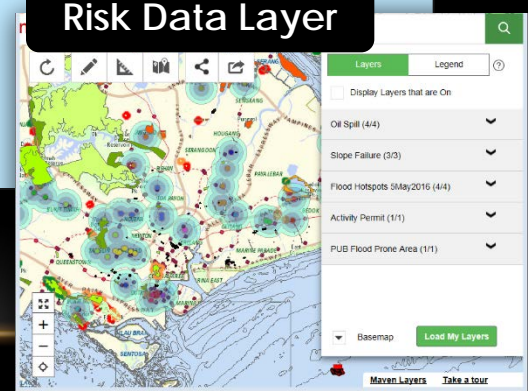
Tree Layer



Park Facilities Layer

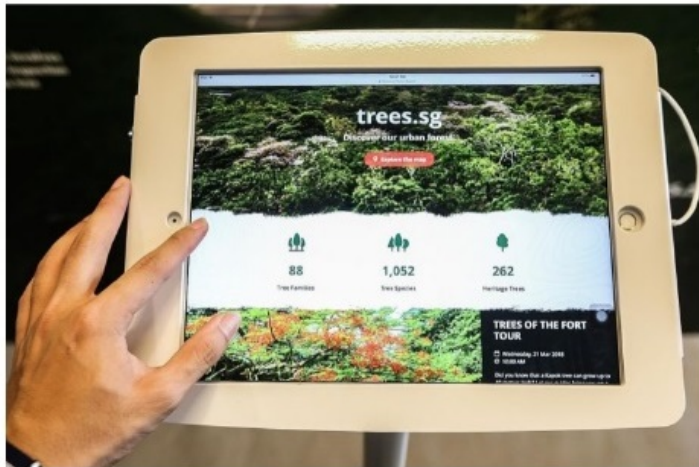


Risk Data Layer



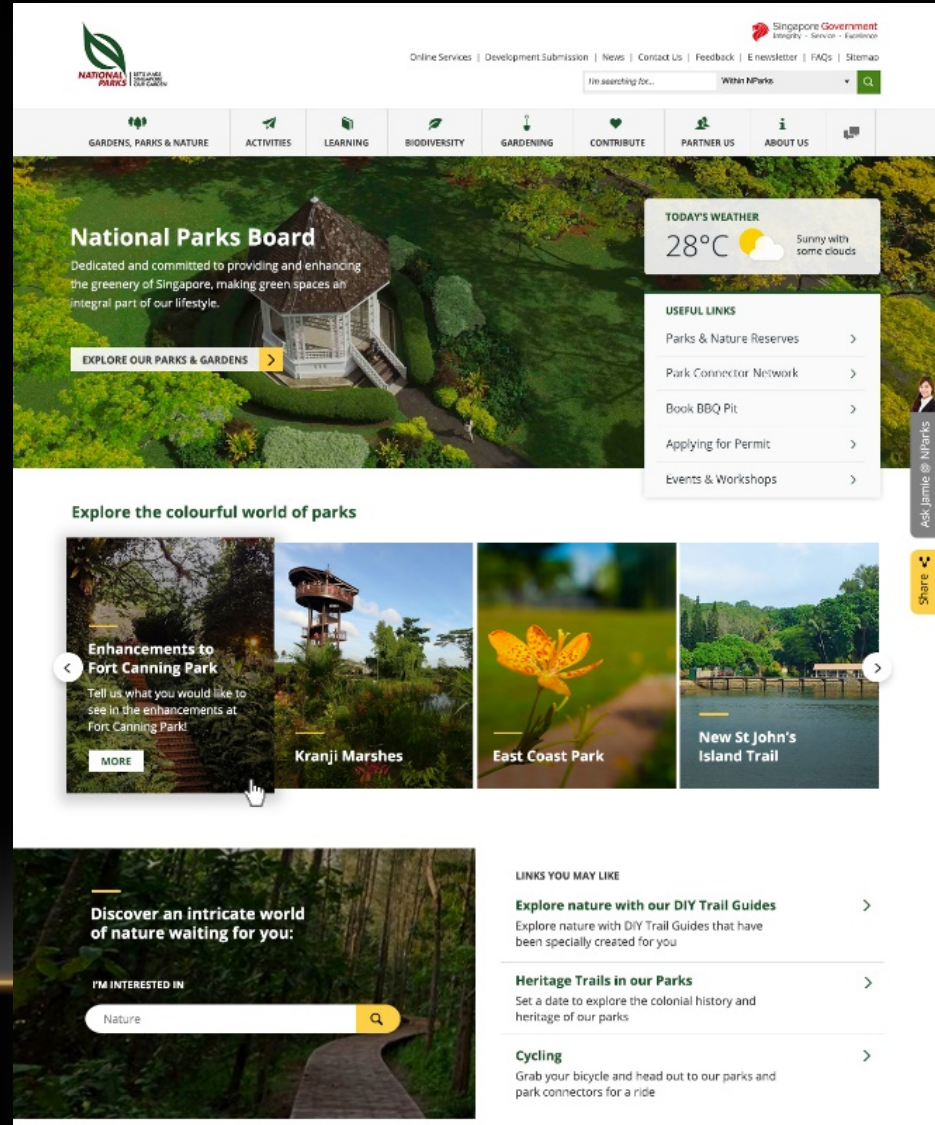


What's that tree? New map tells all



NParks bills its online map as the most extensive tree map in Asia. It hopes to get users excited about the environment. PHOTO: LIANHE ZAOBAO

Citizen-centric E-services



Tree Research

An aerial photograph of a lush green urban park. A wide road with several cars runs through the center of the park. To the right, there is a large, multi-story white building with many windows. The park is filled with dense, mature trees and greenery.

CUGE

(Centre for Urban Greenery and Ecology)

CUGE Research

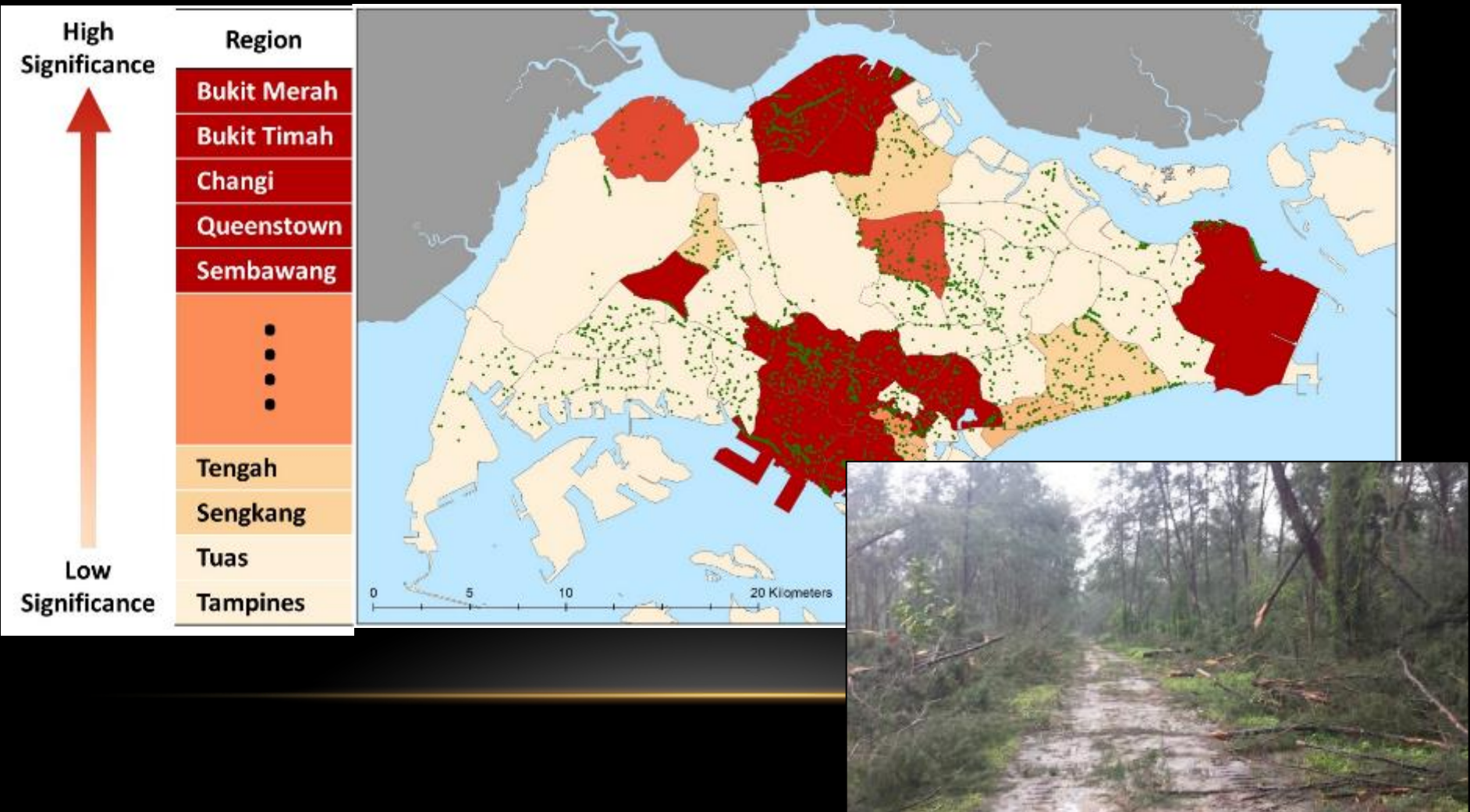
undertakes scientific research & translates the research outcomes into **guidelines** and **standards** for industry's application. Its research focuses on **application** of greenery in highly urbanized settings for the benefit of the city dweller.

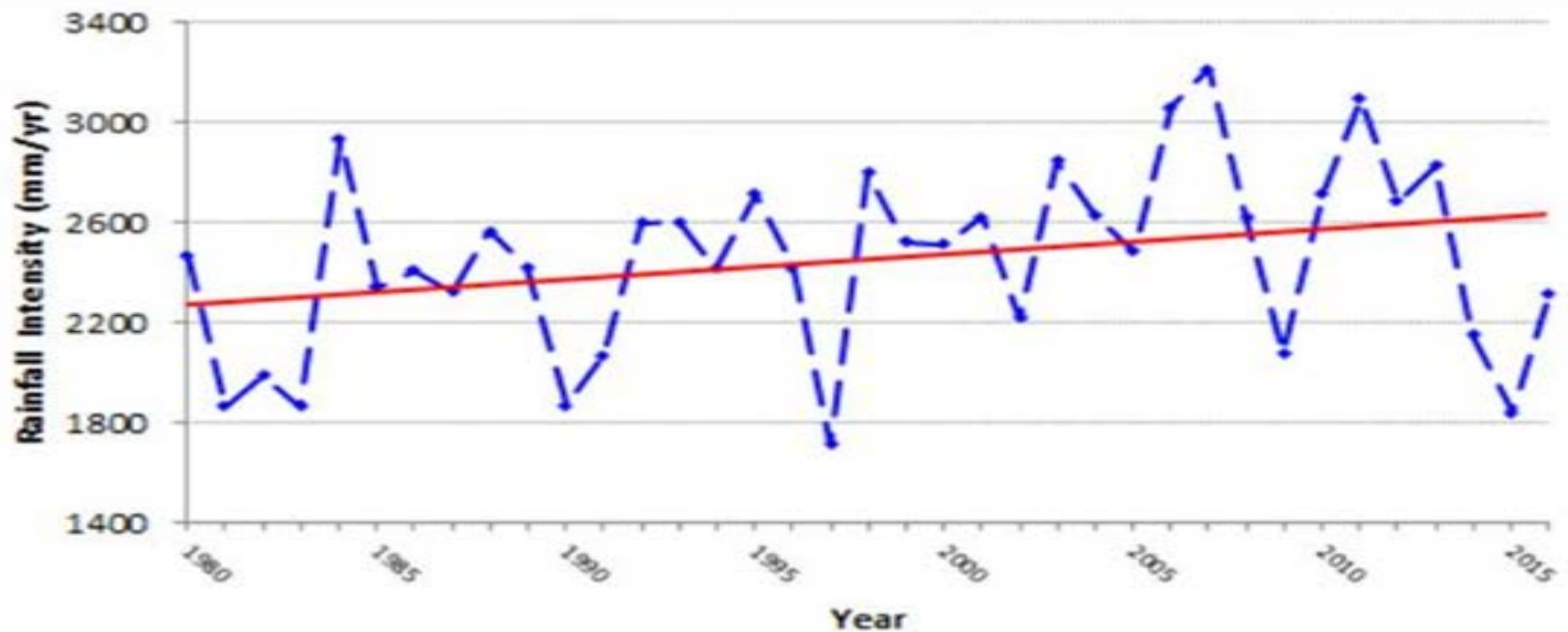
Collaboration with other institutions like
NTU, NUS, SIT, SUTD, Polytechnics,
GovTech, GeoSpace of SLA

- MOUs, studies, research projects

Some examples of projects ...

Tree Incidents Analytics – baseline data being built from historical failure cases, on-going cases from also other government agencies ... database





** Data based on **28 rainfall stations** across the island that have continuous records from 1980 onwards. (To account for the spatial variation in rainfall over Singapore, more stations were used for the trend analysis, but not all selected stations have records before 1980, resulting in the shorter period of available data.)*

Fig 2 – Annual rainfall total in Singapore from 1980 to 2016
(Data based on climate station)

Rainfall	
	Change per decade (1980-2016)
Annual number of days with hourly rainfall totals exceeding 40 mm (heavy rain)	+ 2.6 days per decade
Annual number of days with hourly rainfall totals exceeding 70 mm (very heavy rain)	+ 0.9 days per decade

** 40mm and 70mm are the 95th and 99th percentile value respectively for the daily maximum hourly rainfall recorded during the period from 1981 to 2010 (based on 28 rainfall stations across the island)*

Joint study with Met Services, PUB

>> Maps of hotspots : flooded areas &

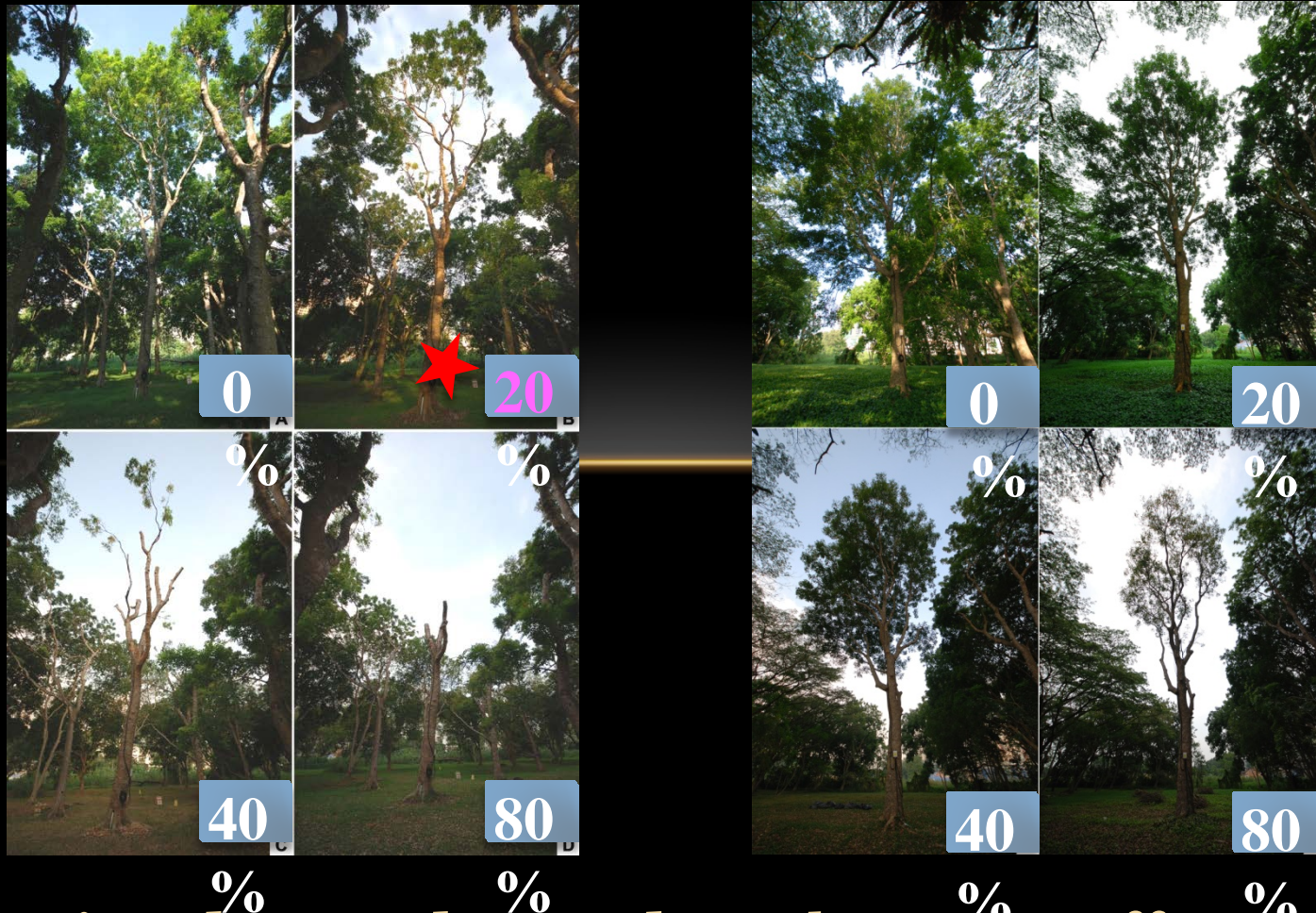
Maps of wind and rain patterns

>> where additional tree pruning is required

>> Time pruning operation before on-set of
monsoons

FIELD-BASED RESEARCH

20% REDUCTION IN *KHAYA* TREE HEIGHT IMPROVES SWAY BEHAVIOR AND REDUCES WIND LOADS



Pruning lower branches does not affect sway behavior or wind loading

Use of Drones





Tree Inspection via Micro-drones

Reduce tree climbing risks through the use of drones

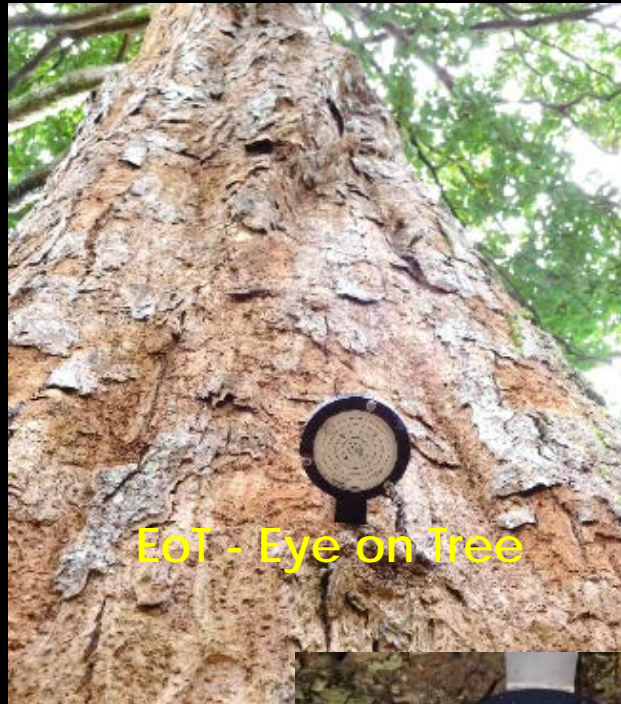


*** A collaborative project**
to design & build a
specialised drone to fly
safely within tree crown to
'inspect' branches &
foliages

DIAGNOSTIC TOOLS & SENSORS

13:17

Eye on Tree/Wireless Tilt Sensor



Eye on Tree



Monitor **lean** or movement in and around tree bases

- Allow **early intervention**
- Potential use for **big mature trees** with conservation value



Species: *Samanea saman*

Tree S/N: xxxxxxxxxxxx

Canopy width: 21m

Canopy height: 10.2m

DBH: 0.9m

Lean direction: 350°

Lean: 15°

Height: 22m

Additional lean: 4.6°

Threshold: 4.5°

Direction: 355°

Failure wind speed: 90km/h

Targets: Bus stop

2nd level recommended



Wireless Tilt Sensor

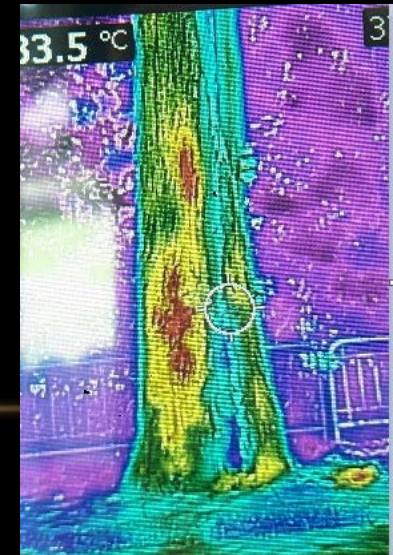
GPR

Ground Penetrating Radar

- noninvasive,
to map out tree
root distribution



Infra Red Camera

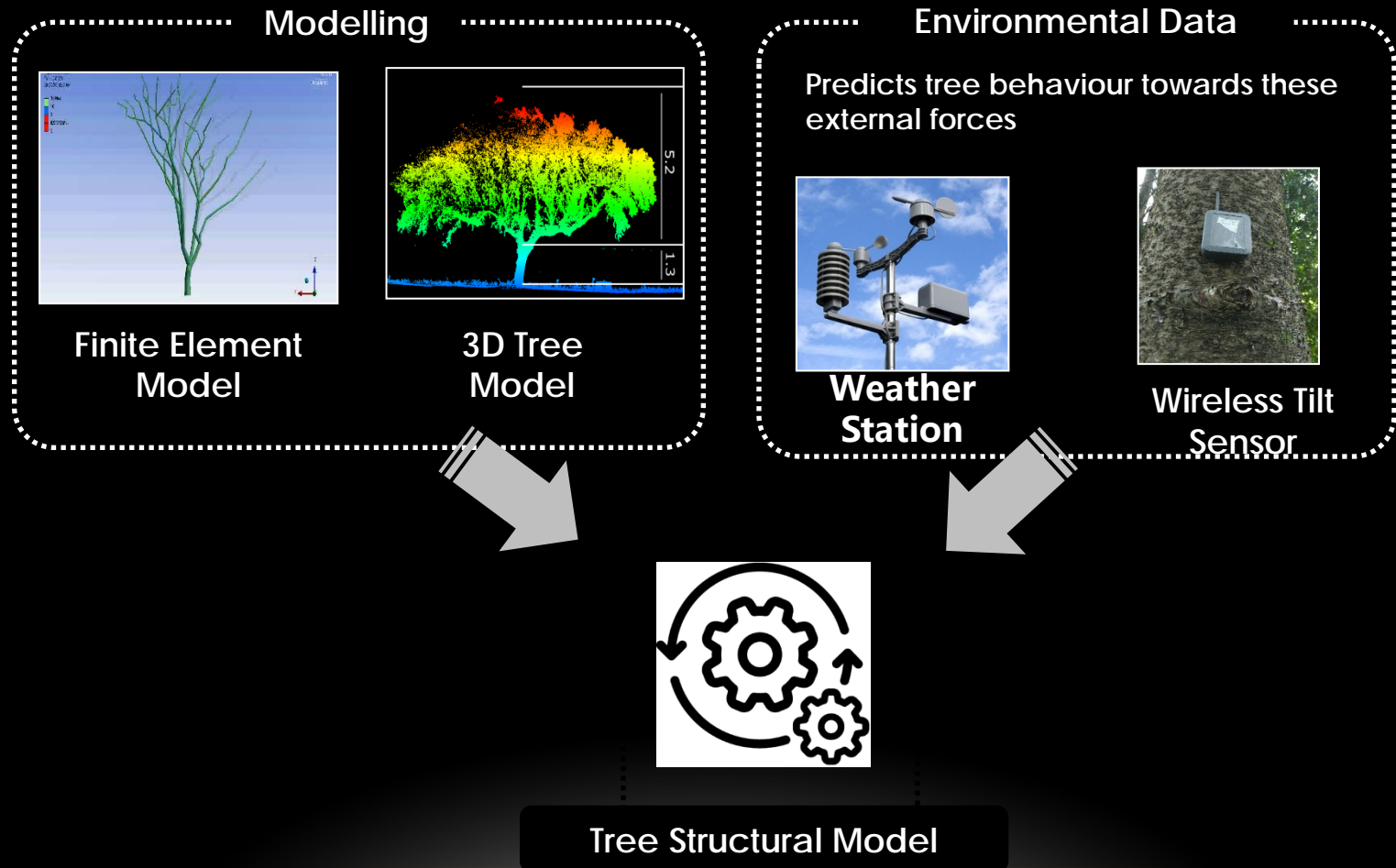


Portable e-noses

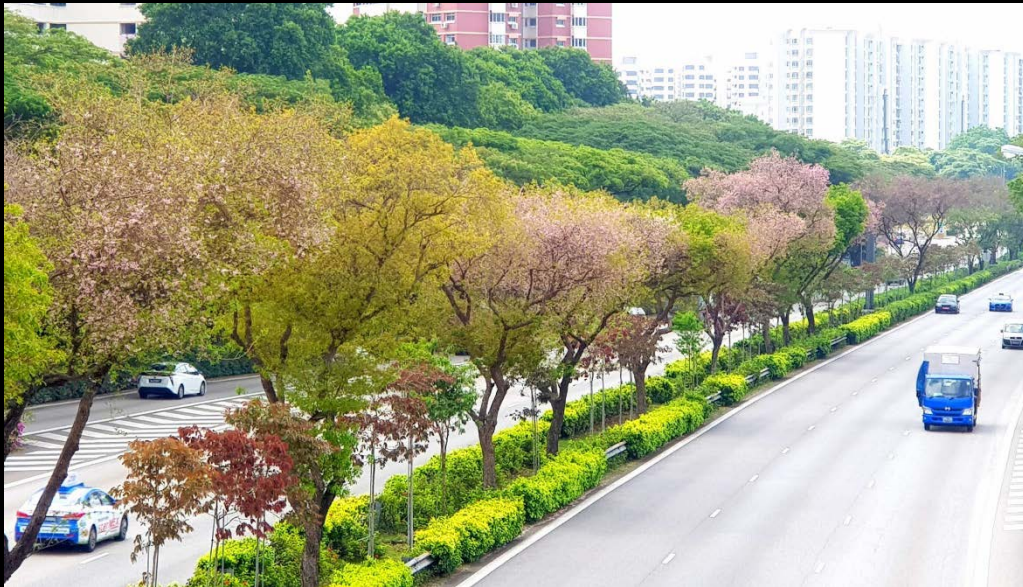
- **nondestructive** sampling & can produce rapid accurate determinations
- for **early diagnosis & detection** of wood decay in high-value standing trees
- **Predictive tool** for decision making ... to take down defective trees before they fail

Tree Structural Model

Prediction of possible tree failures under different wind speeds using real-time inputs of tree parameters



Urban trees in streetscapes & parks



**The cultivation of trees is
the cultivation of
the good,
the beautiful &
the ennobling
in man**

~J. Sterling Morton

Trees form the backbone
of
our Garden City





**Trees are
always good !**

**>>>> Bring much benefits to
our environment**

Urban landscape is evolving



NParks in 2002 developed & conceptualized the Streetscape Greenery Master Plan (SGMP) – island wide macro guiding tree planting plan

5 landscape treatment types – to achieving different identity & ambience, based on plant species selection & planting design pattern.

1. Parkway Treatment

Urban areas – Roads in a parkland setting

2. Coastal Treatment

The Tropical Seashore – Roads near the sea

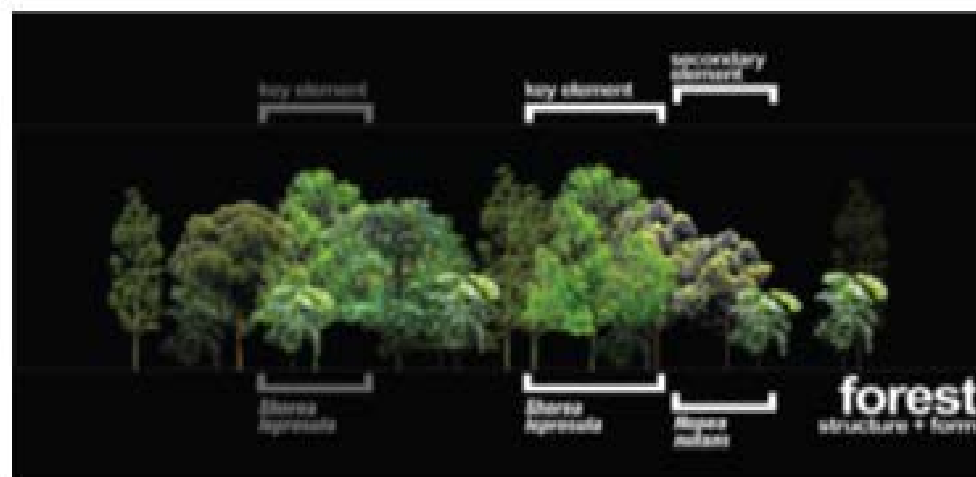
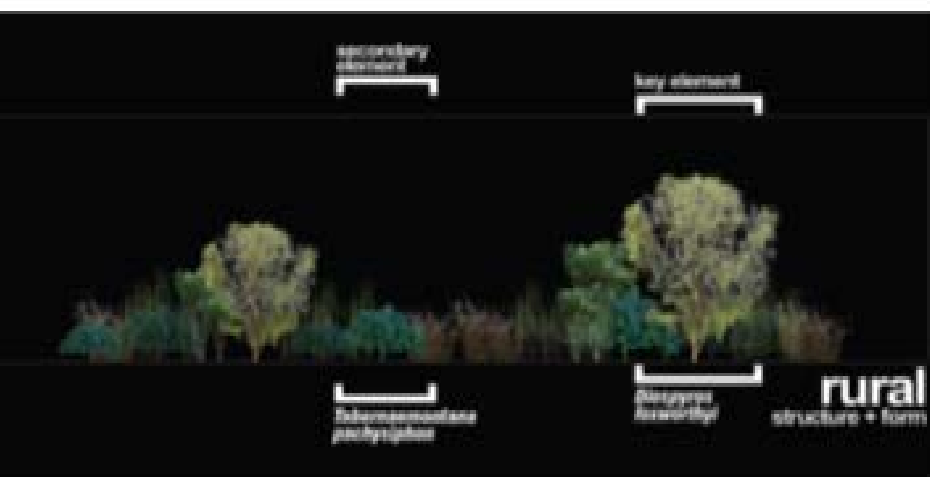
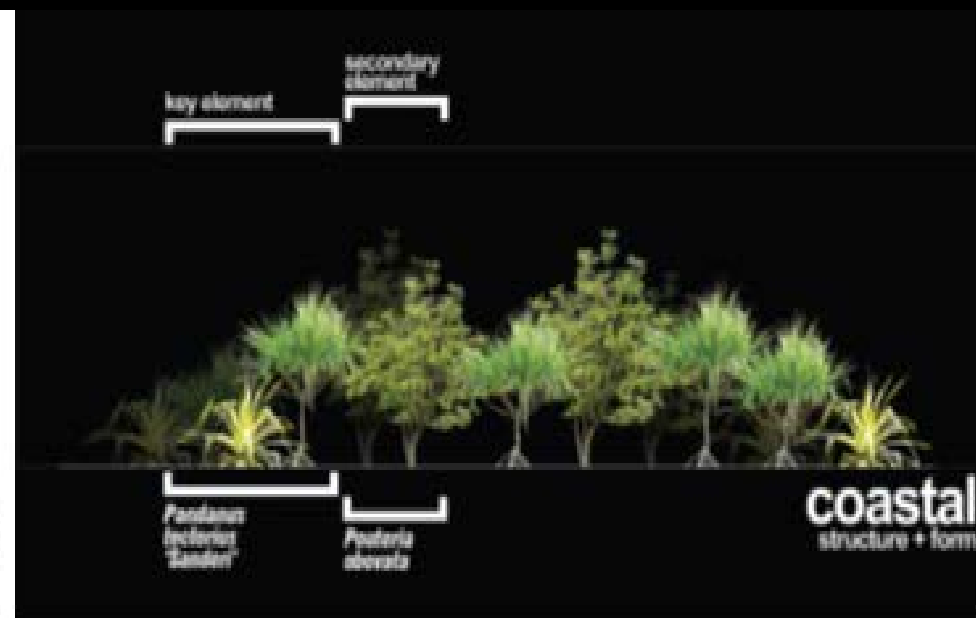
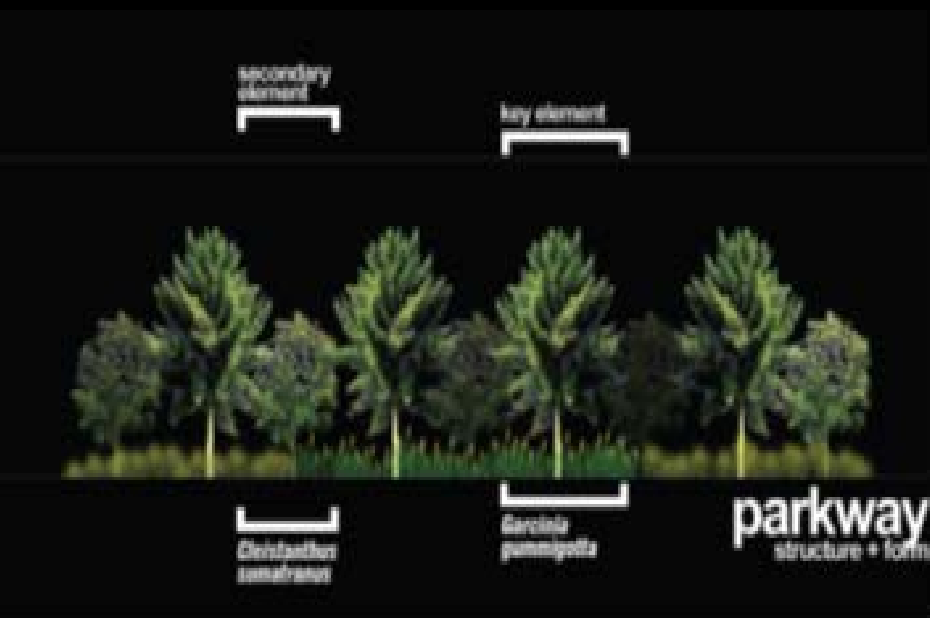
3. Rural Treatment

Away from the City – Roads through the open countryside

4. Forest Treatment

The Natural Heritage – Roads beside/through the tropical rainforest

5. Gateway Treatment Points of Entry – Dramatic gestures



Habitat DeFragmentation

NATURE WAYS

Tall emergent species

Mainly Dipterocarps, interplanted between existing trees. Attracts insects, which represents a source of food for bird species

Mid-canopy (Existing)

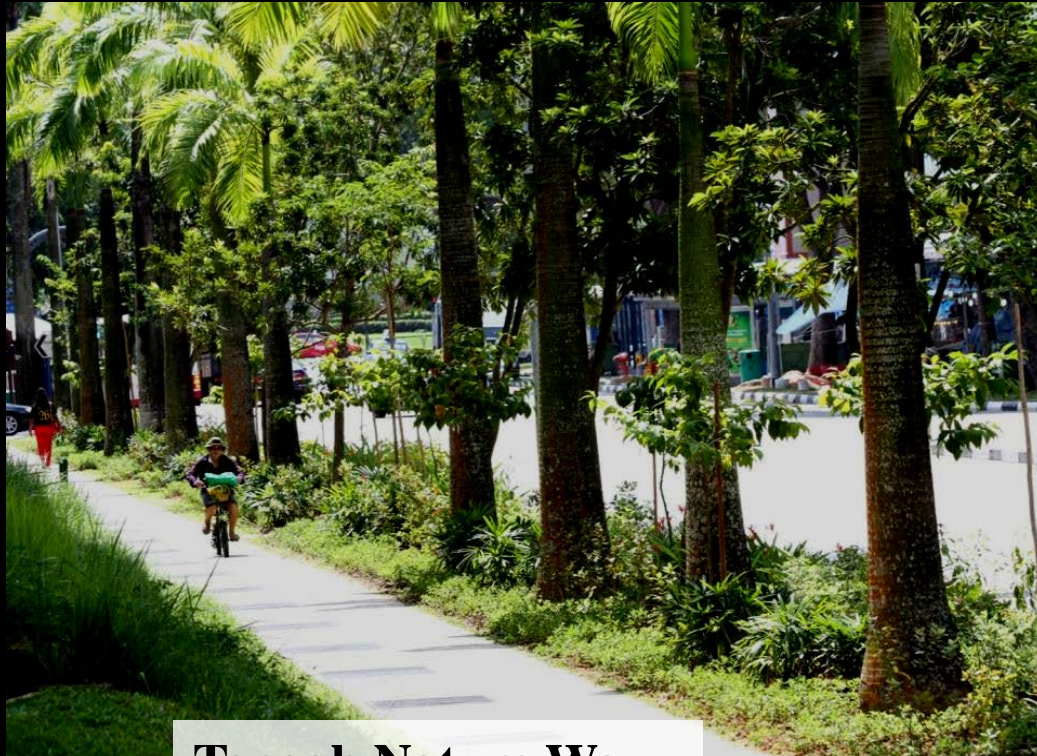
Existing trees that forms the canopy for the new planting scheme

structure



Undergrowth/ Shrubs Layer

Flowering shrubs that provide aesthetic values for road users at eye level. Also attract butterflies.



Tengah Nature Way



Kheam Hock Nature Way



Tanglin Nature Way



• Planting along Nature Way by Hillgrove Sec



Biodiversity sighted



Asian Brown Flycatcher



Sooty headed Bulbul



Brown shrike



Blue-eared kingfisher



Yellow-vented
Bulbul



Blue-throated
bee-eater



Blue Pansy (male)



Blue Pansy (female)



Lemon Emigrant



Crimson Dropwing

Challenges to our Garden City efforts ...

Balancing ...

- urban development,
 - conservation of urban greenery,
 - natural habitats & enhancement/rehabilitation/restoration of biodiversity ...
- with limited land space

**Going
beyond the
horizon**



**Kampung Admiralty – Outstanding and Excellence Award
(Community Facility)**

Many large cities are greening up Expanding the green canopy

Global green cities ... planting additional trees will cool the city and improve the health, well-being and happiness of urban dwellers

The order of the 15 cities on the Treepedia are as follows:

•1. Singapore 29.3%

- 2. Vancouver 25.9%
- 3. Sacramento 23.6%
- 4. Frankfurt 21.5%
- 5. Geneva 21.4%
- 6. Amsterdam 20.6%
- 7. Seattle 20.0%
- 8. Toronto 19.5%
- 9. Boston 18.2%
- 10. Tel Aviv 17.5%
- 11. Turin 16.2%
- 12. Los Angeles 15.2%
- 13. New York 13.5%
- 14. London 12.7%
- 15. Paris 8.8%

•Study by MIT Senseable City Lab
– info as of 9 Feb 2017

*"If what I say
resonates with you,
it is merely because
we are both
branches on the
same tree."*

~ W. B. Yeats

A large, ancient tree with thick, gnarled branches and dense green foliage. The tree's branches are thick and dark, with many smaller, thinner branches extending from them. The leaves are a vibrant green, creating a dense canopy. In the background, a body of water is visible, reflecting the sky and the tree's branches. The overall scene is peaceful and natural.

Touch the trees !


Come visit Singapore !

→ ↻ National Parks Board [SG] <https://www.singaporegardenfestival.com> ☆ 🔍

Apps Google The Straits Times Christian Botany Plant Trees Chrome BBC CNN TwinFounts Science Daily Stephen Olford BBC TwinFountains » Other bookmarks

SINGAPORE GARDEN FESTIVAL A A A 🔍

🏠 Plan your visit Festival Highlights SGF 2018 Designers MarketPlace Media Centre About SGF



The banner features a vibrant garden scene with a winding path, a green alien-like figure sitting in a wooden cart with a pitchfork, a bee wearing a hat, and a ladybug. The background is a lush field of colorful flowers under a blue sky with clouds.

WELCOME TO

Singapore Garden Festival 2018

Journey into a world of colours 21 July - 3 August 2018

Thank you

