An aerial photograph of Singapore's urban landscape. In the foreground, a dense forest of green trees and a body of water are visible. Behind the forest, a large residential area with numerous apartment buildings and houses is spread out. The city's skyline, featuring many skyscrapers, is visible in the distance under a blue sky with scattered white clouds.

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 Superintendent of SBG





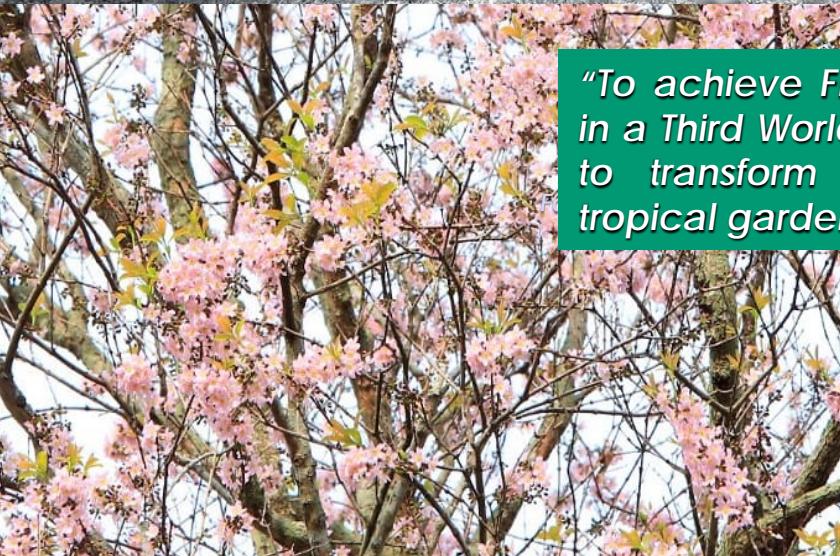


*Esplanade — Singapore.*

- 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*

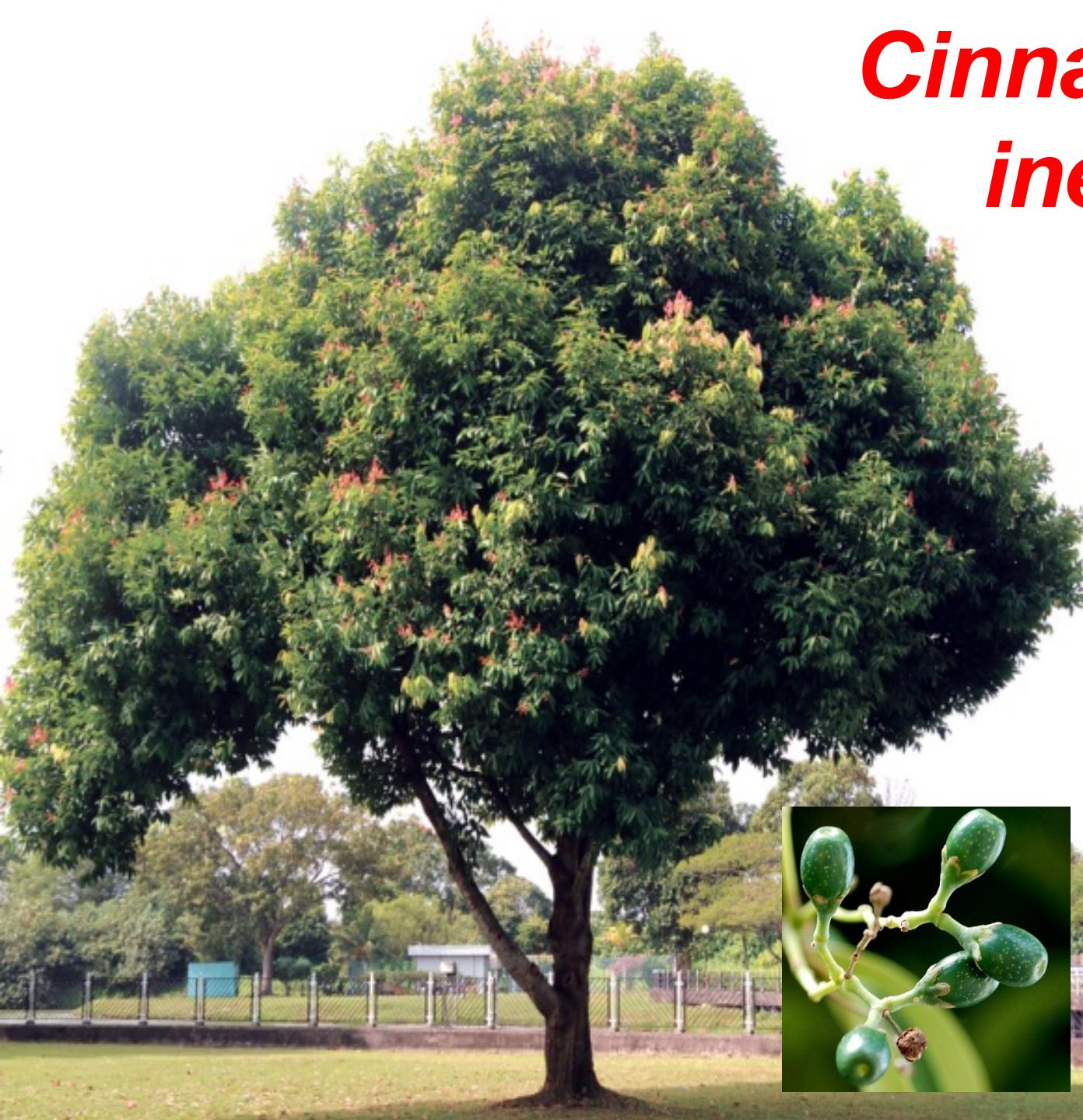




***Eugenai grandis***

***Syzygium grande***

# *Cinnamomum iners*



# In the 1980's ...





*Trumpet  
tree*

*Tabebuia  
rosea*

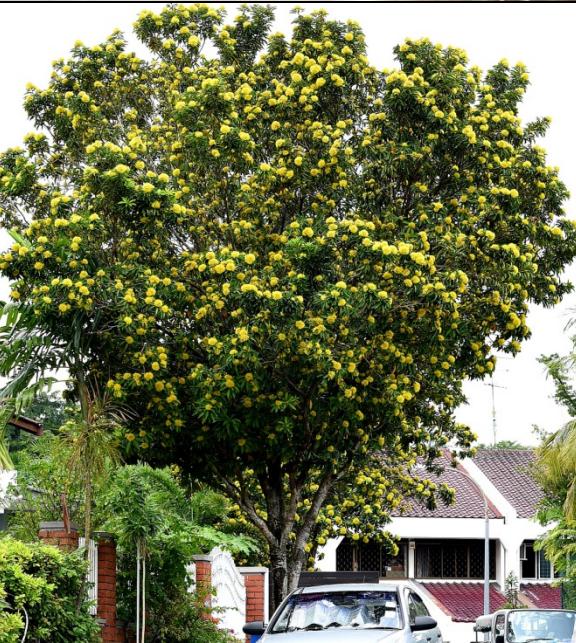




**Senegal  
Mahogany tree,**  
***Khaya  
senegalensis***



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*



Illawara Flame tree,  
*Brachychiton  
acerifolius*

# Greener 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

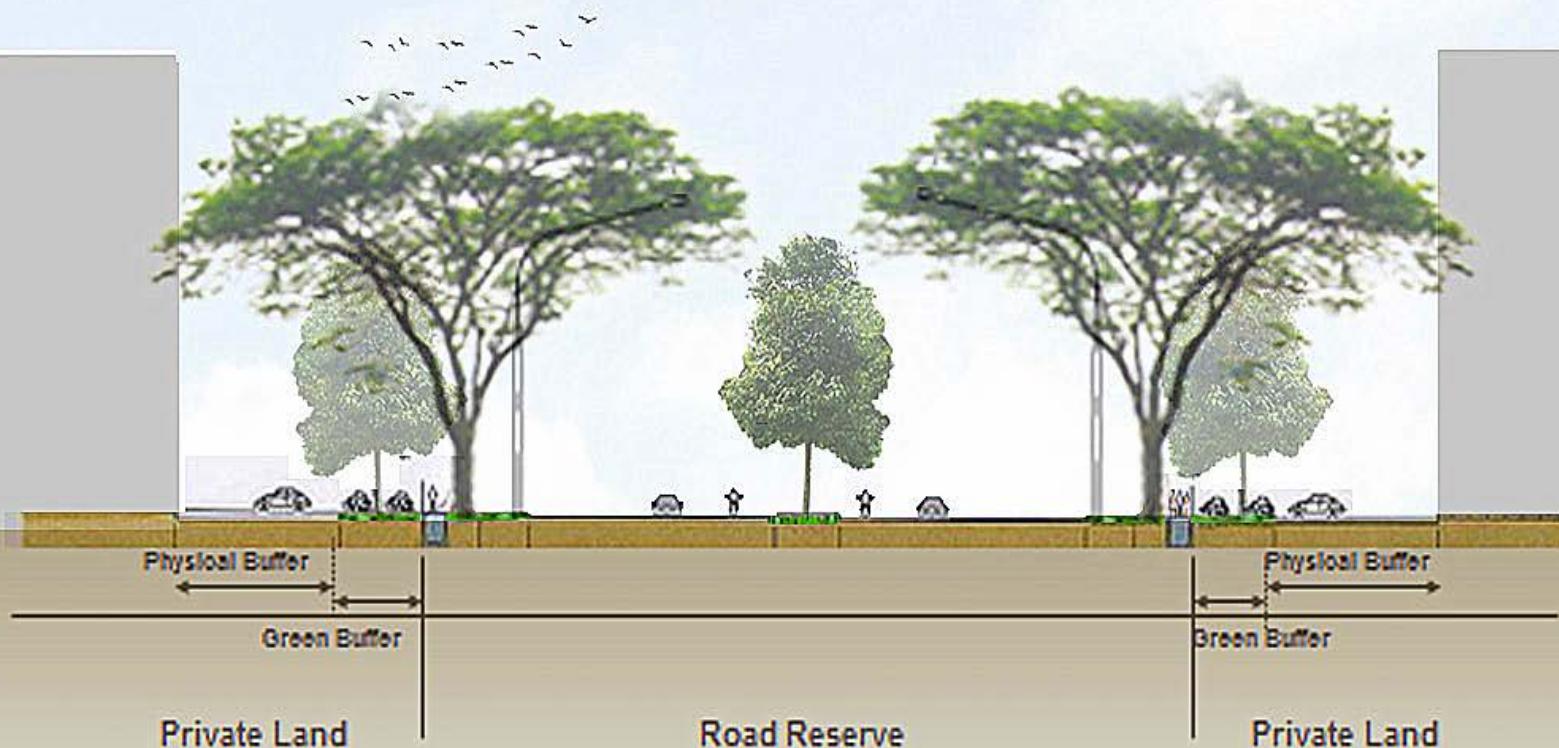
# Land provisions for greenery

# Planned Provision for Roadside Planting



Road Code (*Planting Verges in RoadReserves*)

Road Buffer (*Physical & Green Buffer*)



Typical Cross-Section of Major Arterial

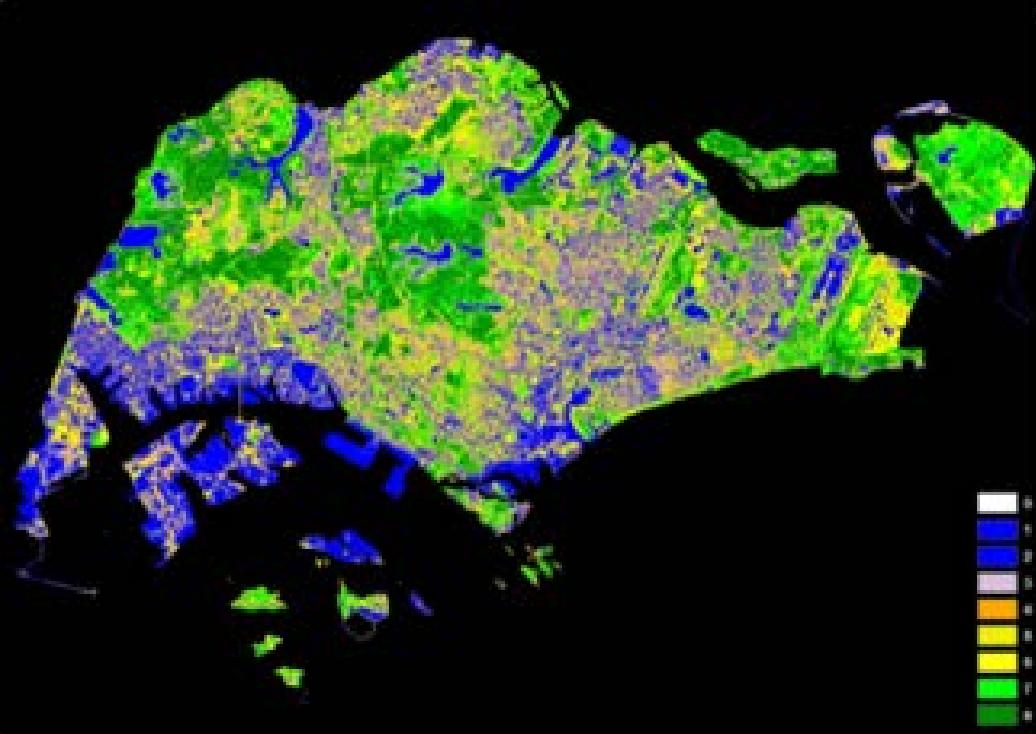
# Planting in Car Parks



# 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

Within 6 months

WSQ/OJT  
VTA (TI L1)  
EVE

Within 1<sup>st</sup> year

Basic GIS  
Chainsaw  
Tree-  
Climbing

Within 2<sup>nd</sup> Year

TI Level 2  
Arbor Report  
Tree Risk Mgt

Within 3<sup>rd</sup> Year

Tree Failure  
Profiling  
Pest &  
Diseases

Within 4<sup>th</sup> year

Tree  
Pruning

Within 5<sup>th</sup> Year

Forensic  
Arbor  
Courses

Within 8<sup>th</sup>  
Year

Other Arbor  
Courses/  
ISA  
Conference

Courses

Seminars

Certification

Technology

Annual Arboriculture Seminar

Certified  
Arborist



TRAQ



Master  
Arborist



# PROFESSIONAL DEVELOPMENT

## **Within 6 Months**

*Three Days On the Job Training of Visual Tree Assessment*

*One Day Introduction to EVE (Greener 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)*

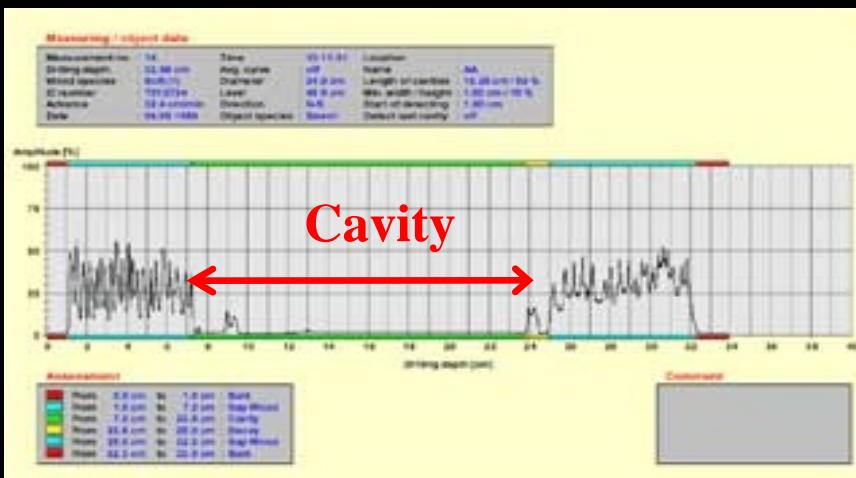
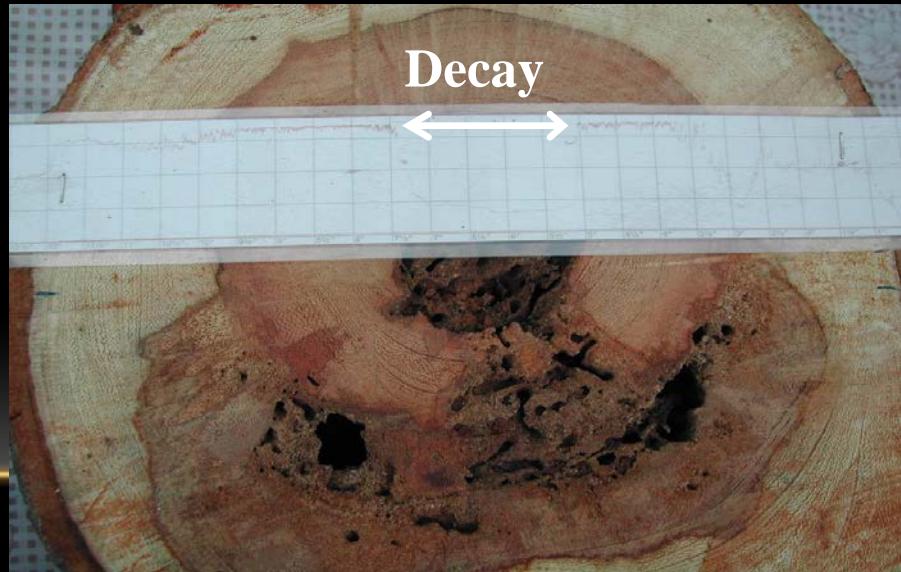


# PROFESSIONAL DEVELOPMENT



Use of Specialised  
Equipment like the  
Resistograph

# PROFESSIONAL DEVELOPMENT

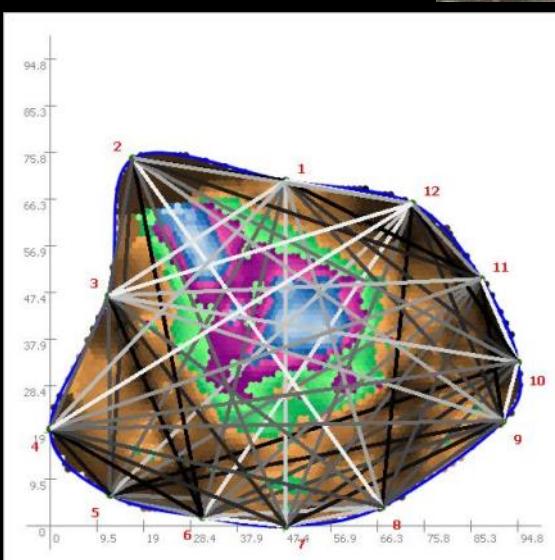


The device can measure the amount of sound wood/decay & assist to determine the trunk/branch structural integrity

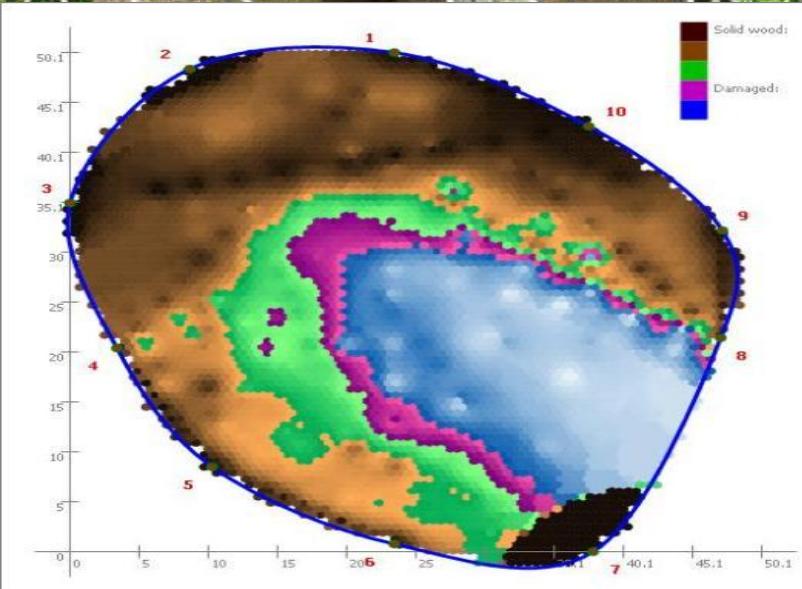
# Resistograph PD 500



# PROFESSIONAL DEVELOPMENT

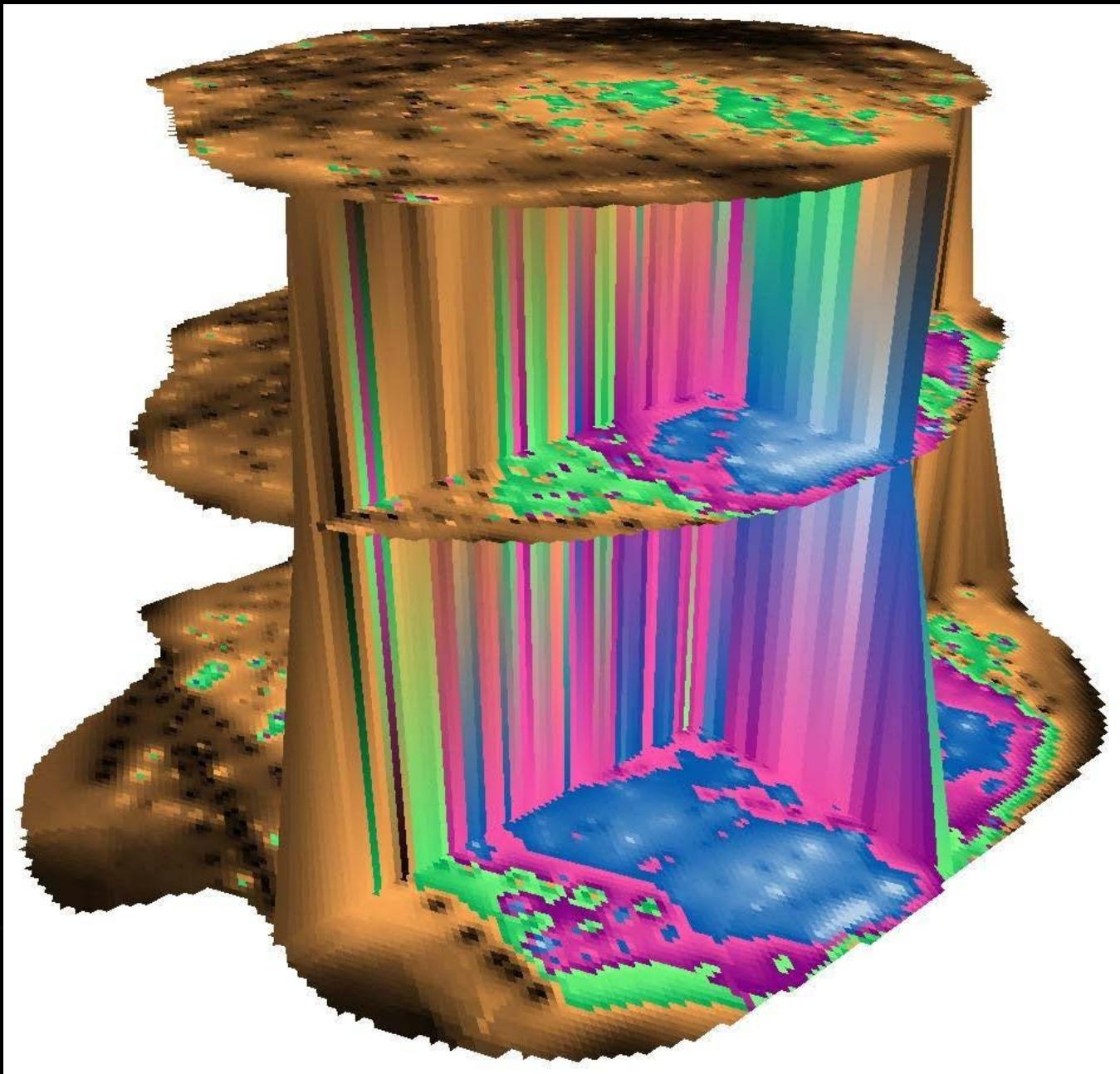


# PROFESSIONAL DEVELOPMENT



- 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

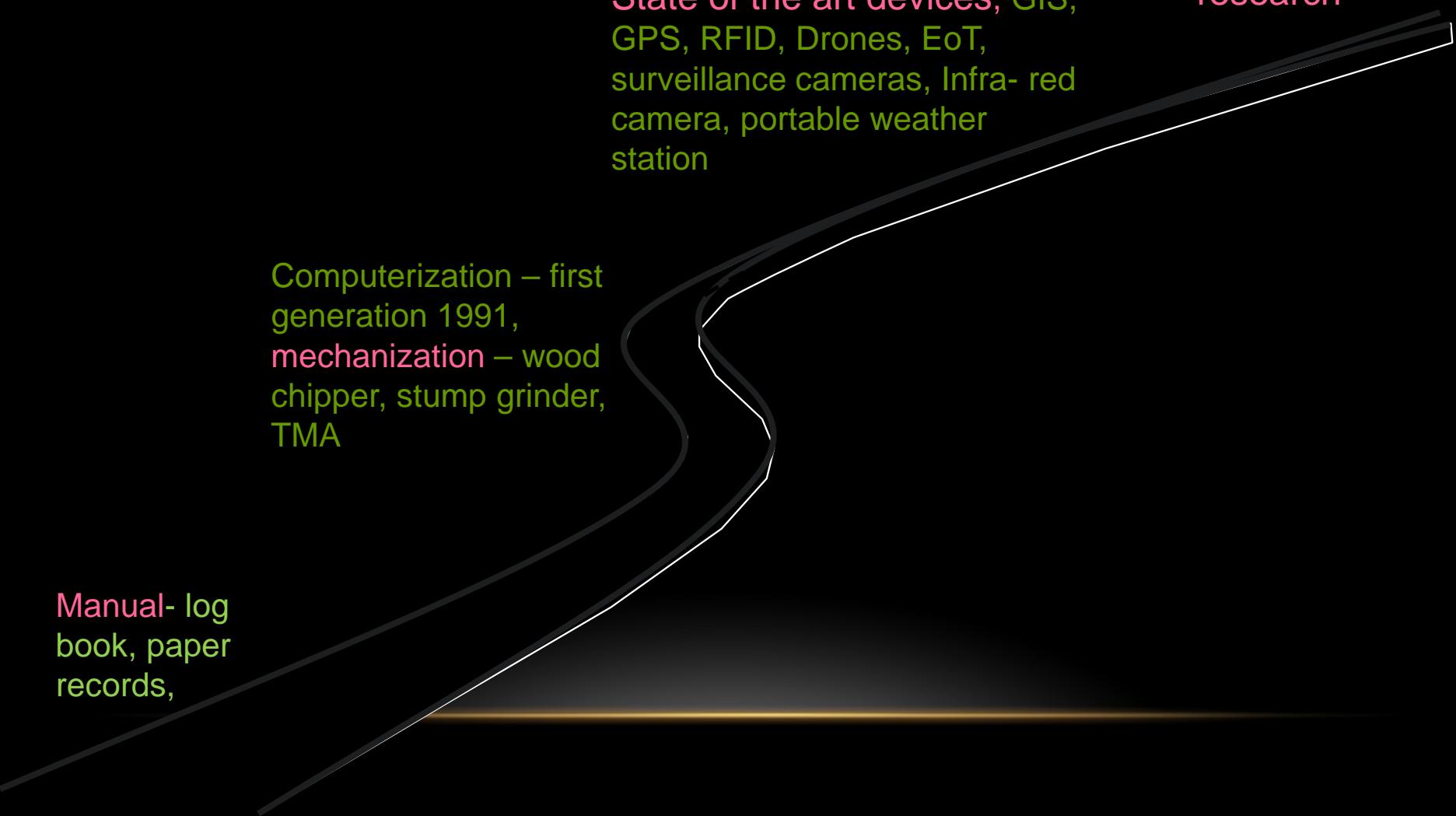


# **Vehicle Monitoring /Fleet Management System**

- >> 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



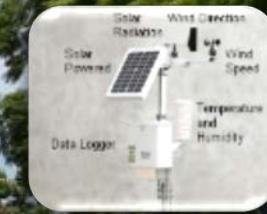
# New Generation NParks Arborist



Autonomous drone



Mini-drone



Portable weather station



Satellite



Tree Tilt Sensors



Connectivity



Sensors on Trees pruning vehicles



NFC/RFID Tree Tagging



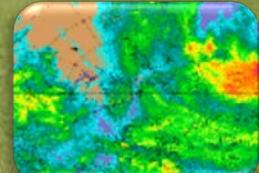
NCMS,  
Media Centre



Arbo Team



GIS Hub



Research:  
CUGE, NBC



# Field Datalogger

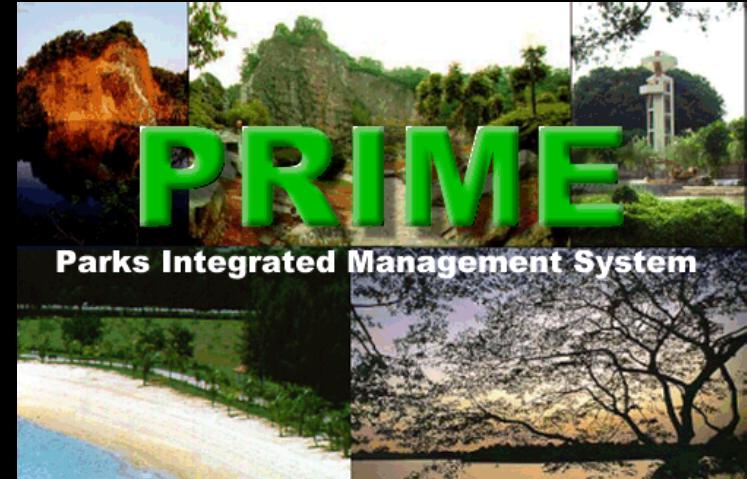
- **iPad Air**
- SIM card (fitted in iPad Air)
- **ruggedised case** (fitted onto iPad Air)
- one shoulder strap and one hand strap
- power adaptor & other miscellaneous tools



# 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 ?

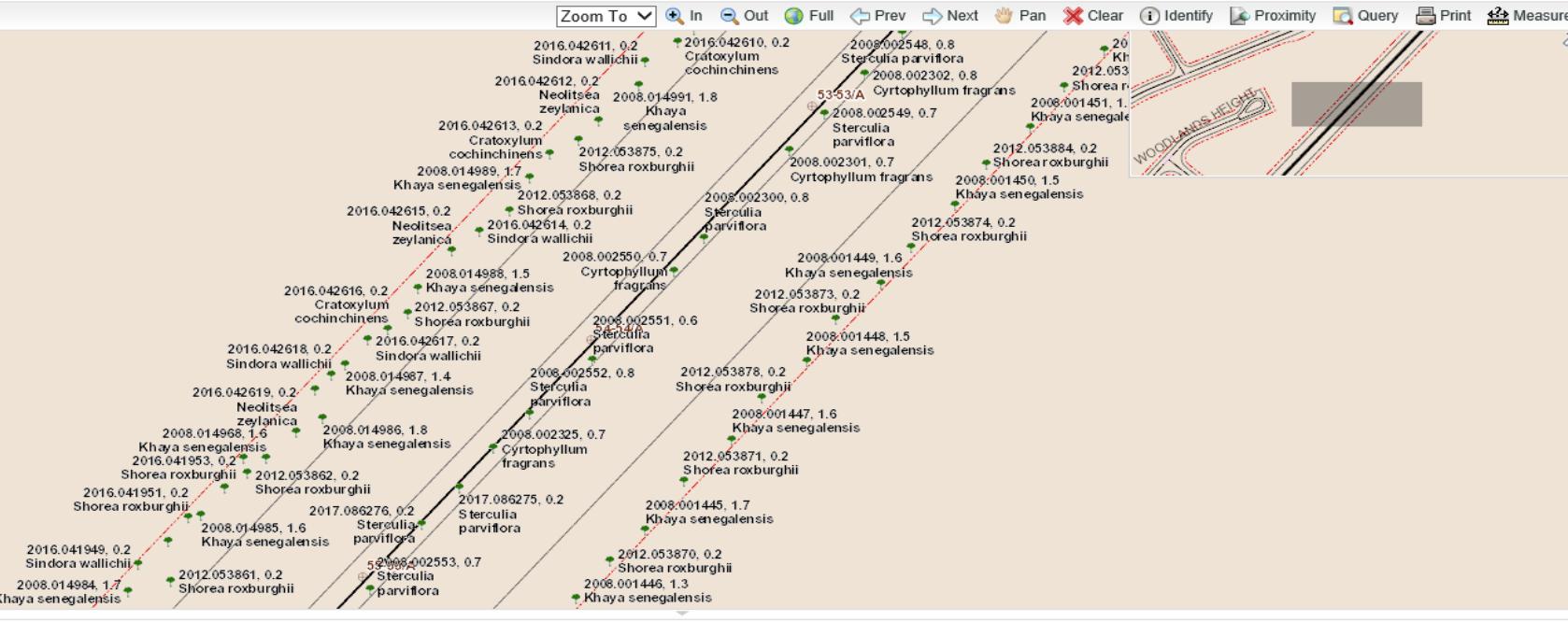
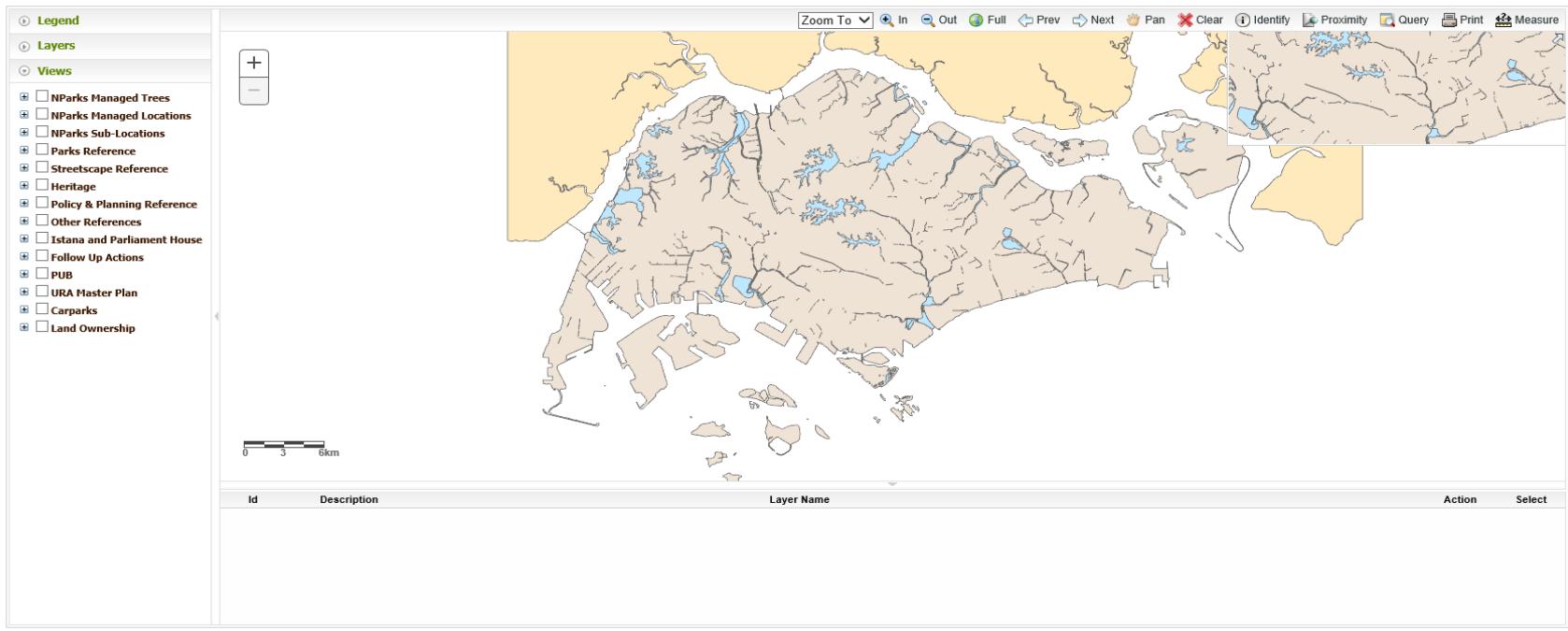


# GIS - Geographic Information System

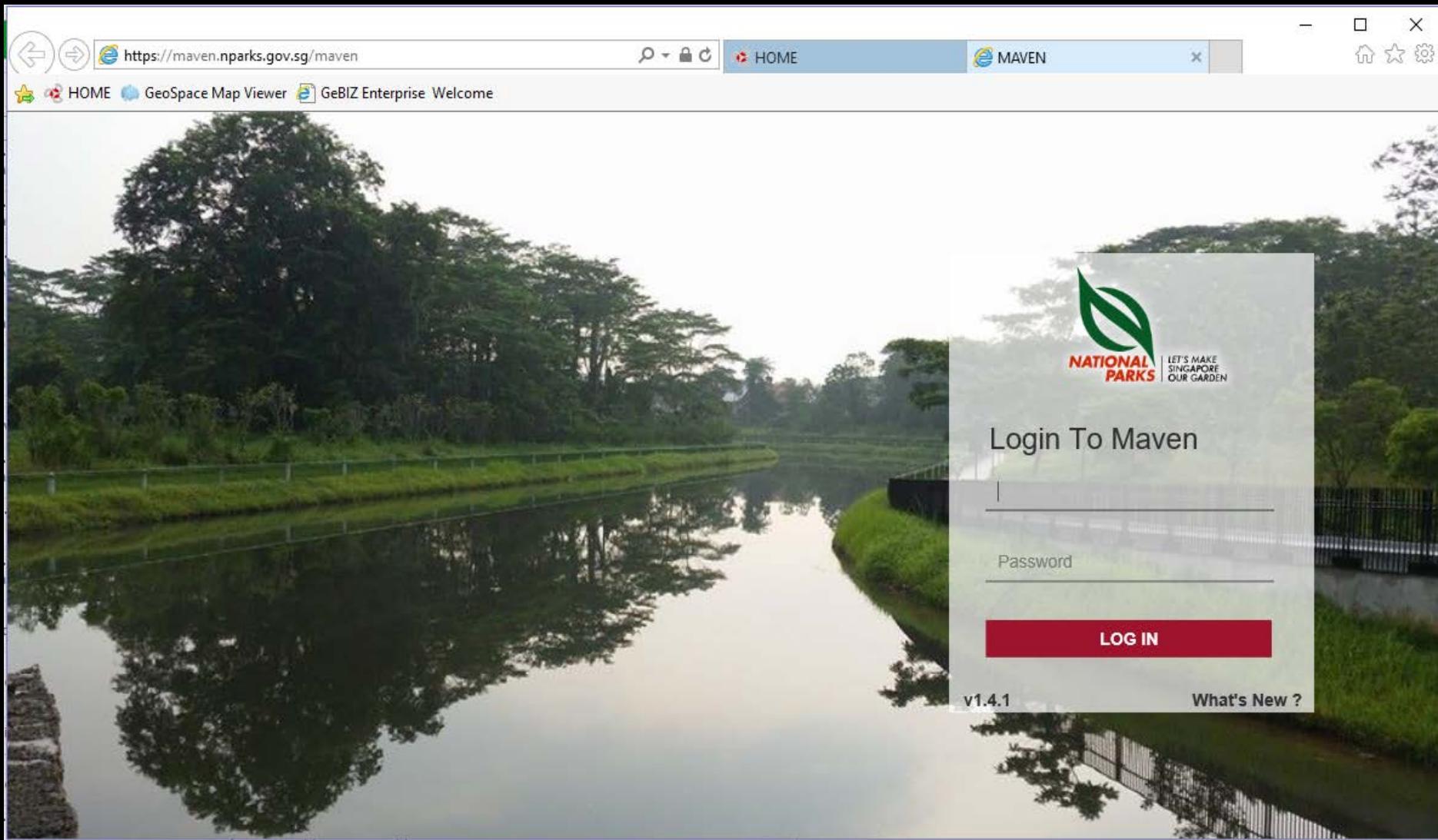
Designed to capture, store, manipulate, analyze, manage and present geo-spatial data

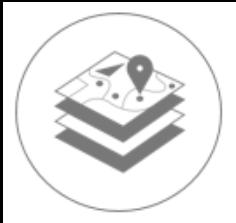


- Alerts (2196)
- Global Search
- Global Reports
- Parks Management
- Tenders
- Contracts
- Projects
- Land Use Consultations
- Handover Submissions
- Parks and Greenery Management
- Assets
- Stakeholders
- Nursery
- Tree Inspections
- Population Reports
- Big Map**

[Show Big Map](#) [Show Small Map](#)


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



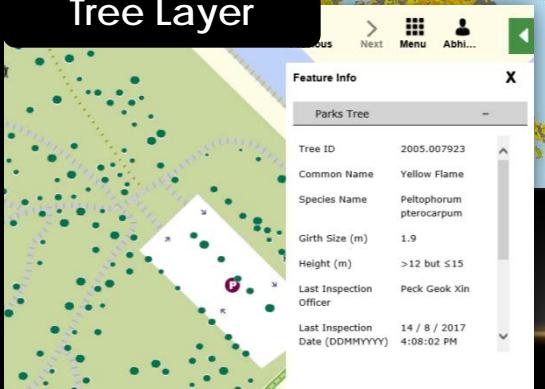


# MAVEN - Common GIS Platform

Number of layers in MAVEN Database: 750



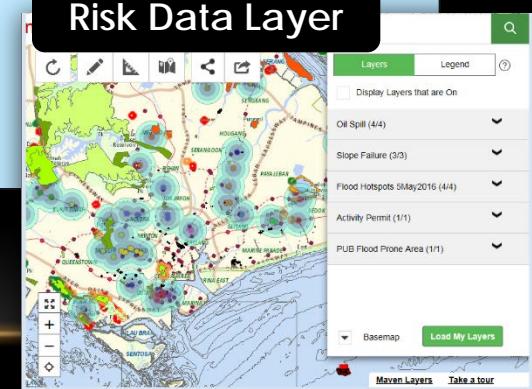
Tree Layer



Park Facilities Layer



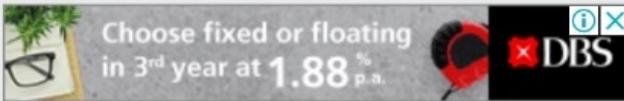
Risk Data Layer



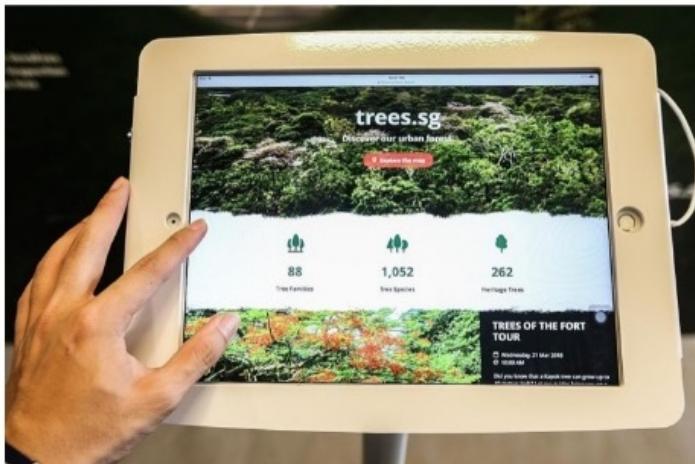
# Citizen-centric E-services

## THE STRAITS TIMES

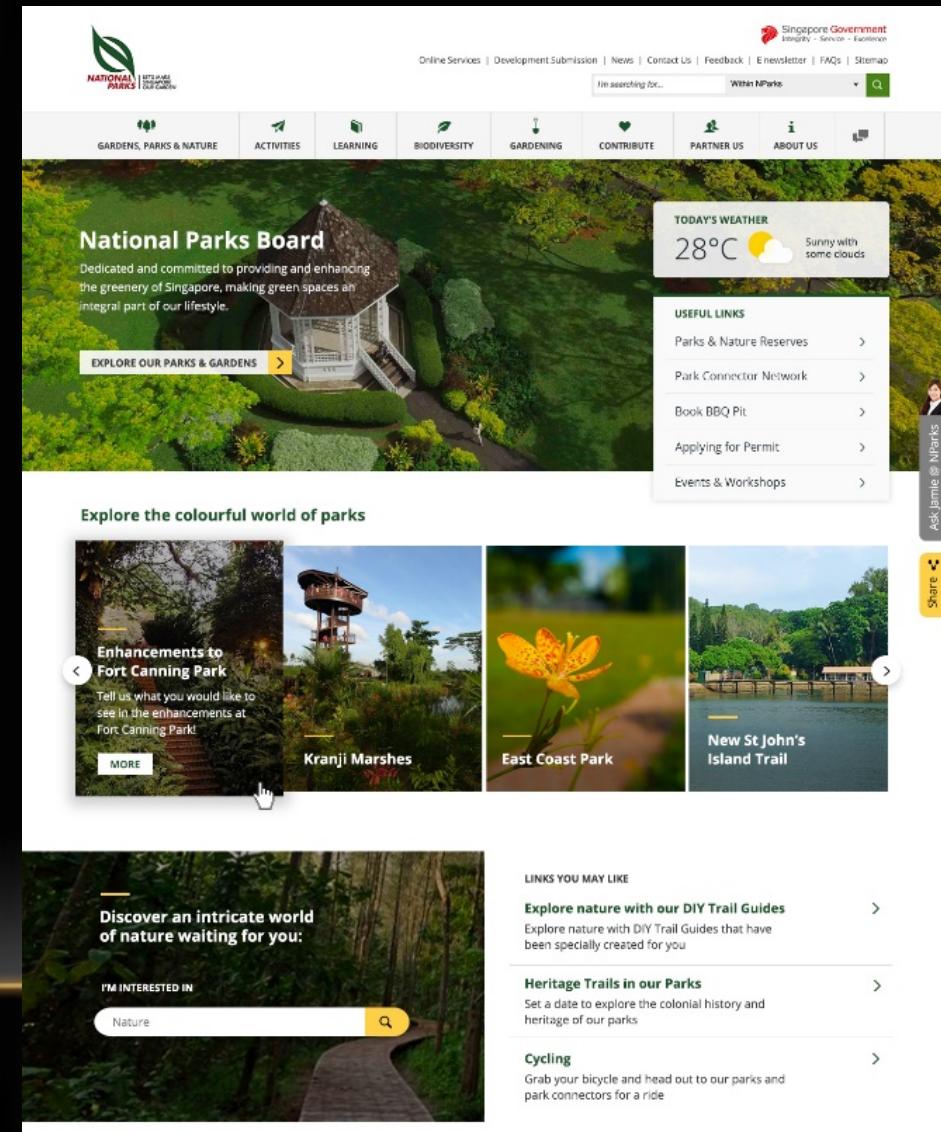
SINGAPORE > Courts & Crime Education House



### 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



The screenshot shows the homepage of the National Parks Board website. At the top, there's a navigation bar with links to Online Services, Development Submission, News, Contact Us, Feedback, E-newsletter, FAQs, and Singapore Government. Below the navigation is a search bar and a dropdown menu for "Within NParks". The main content area features a large image of a park with a gazebo, followed by a section titled "National Parks Board" with a sub-section "Explore our parks & gardens". To the right, there's a weather box showing 28°C and sunny conditions, and a sidebar with "Useful Links" for Parks & Nature Reserves, Park Connector Network, Book BBQ Pit, Applying for Permit, and Events & Workshops. Further down, there's a section titled "Explore the colourful world of parks" with images of Fort Canning Park, Kranji Marshes, East Coast Park, and New St John's Island Trail. At the bottom, there's a "LINKS YOU MAY LIKE" section with links to DIY Trail Guides, Heritage Trails, and Cycling.

# Tree Research ....



# **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.

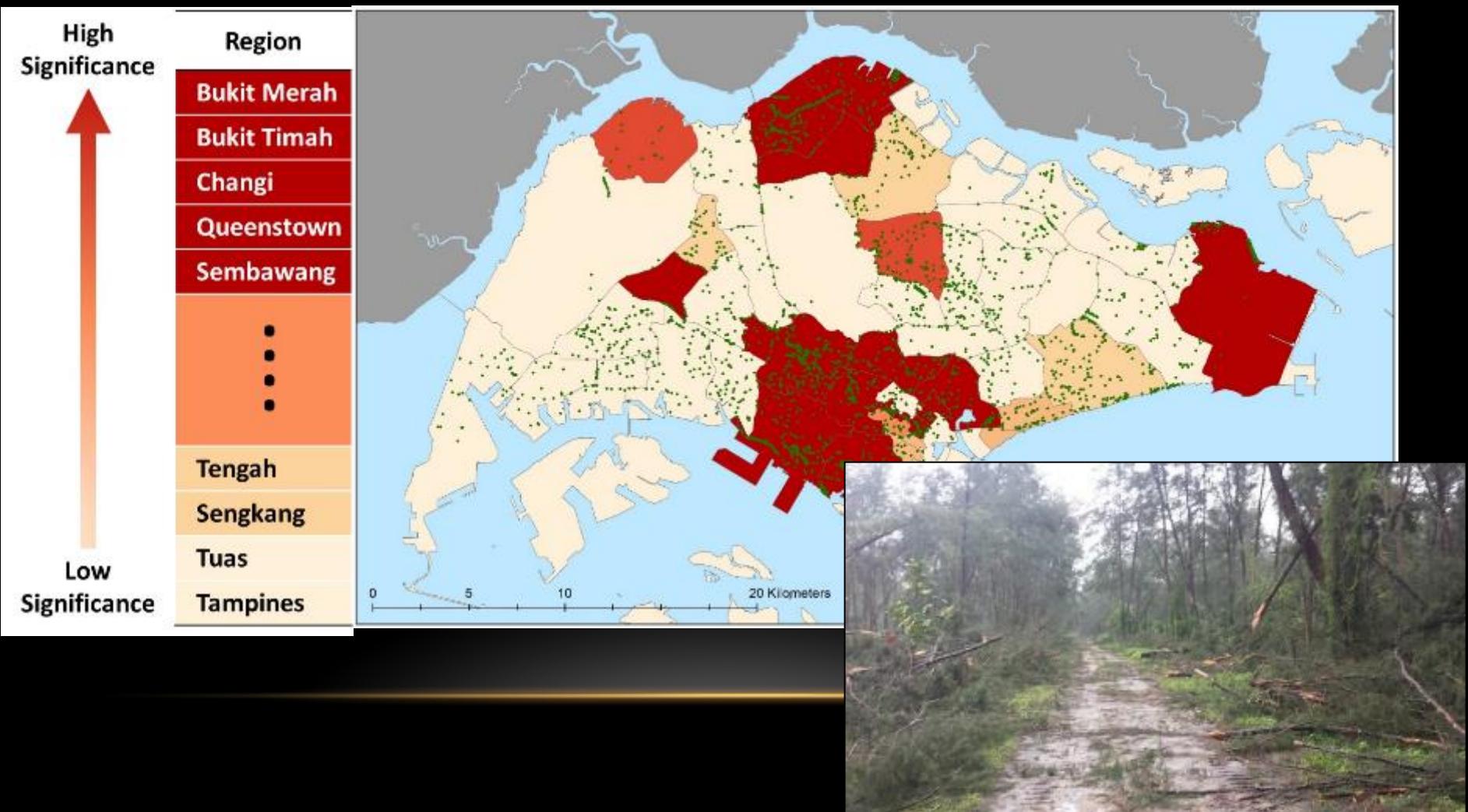
**Collaboration** with other institutions like NTU, NUS, SIT, SUTD, Polytechnics, GovTech, GeoSpace of SLA

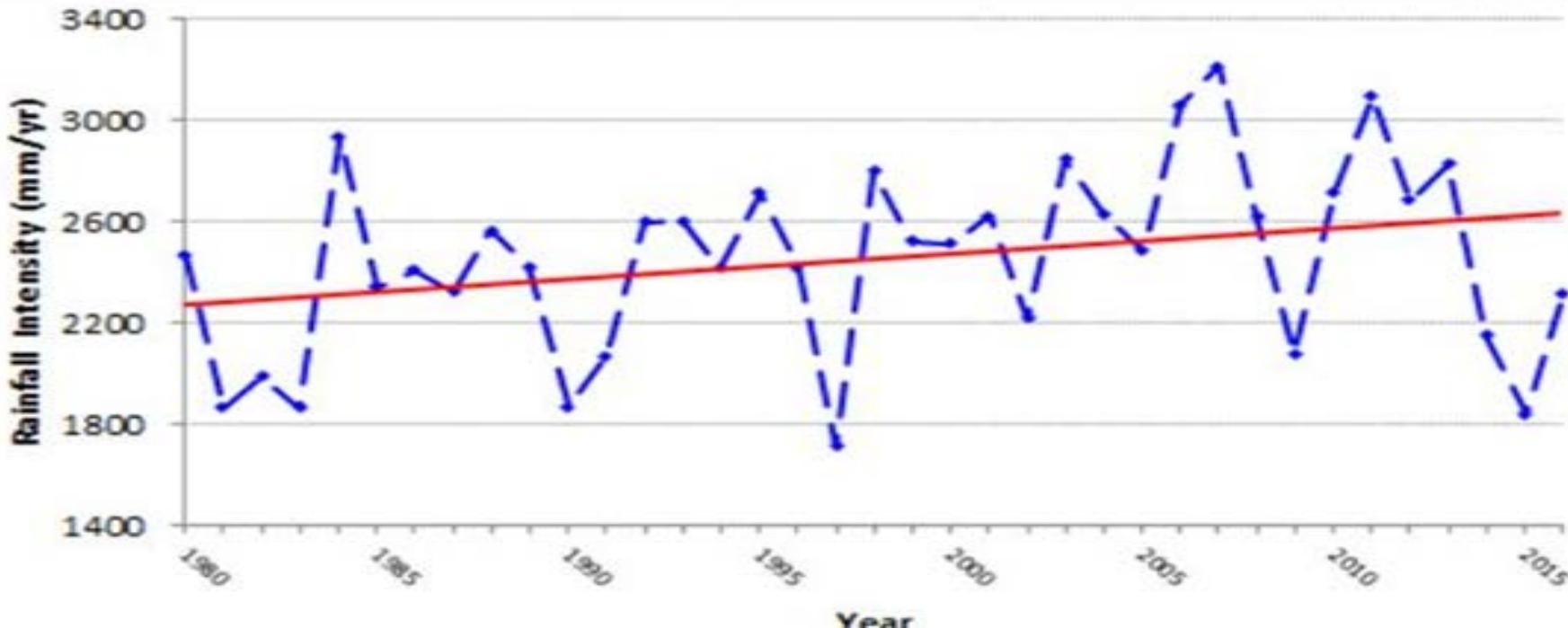
- MOUs, studies, research projects

# 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 95<sup>th</sup> and 99<sup>th</sup> 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)

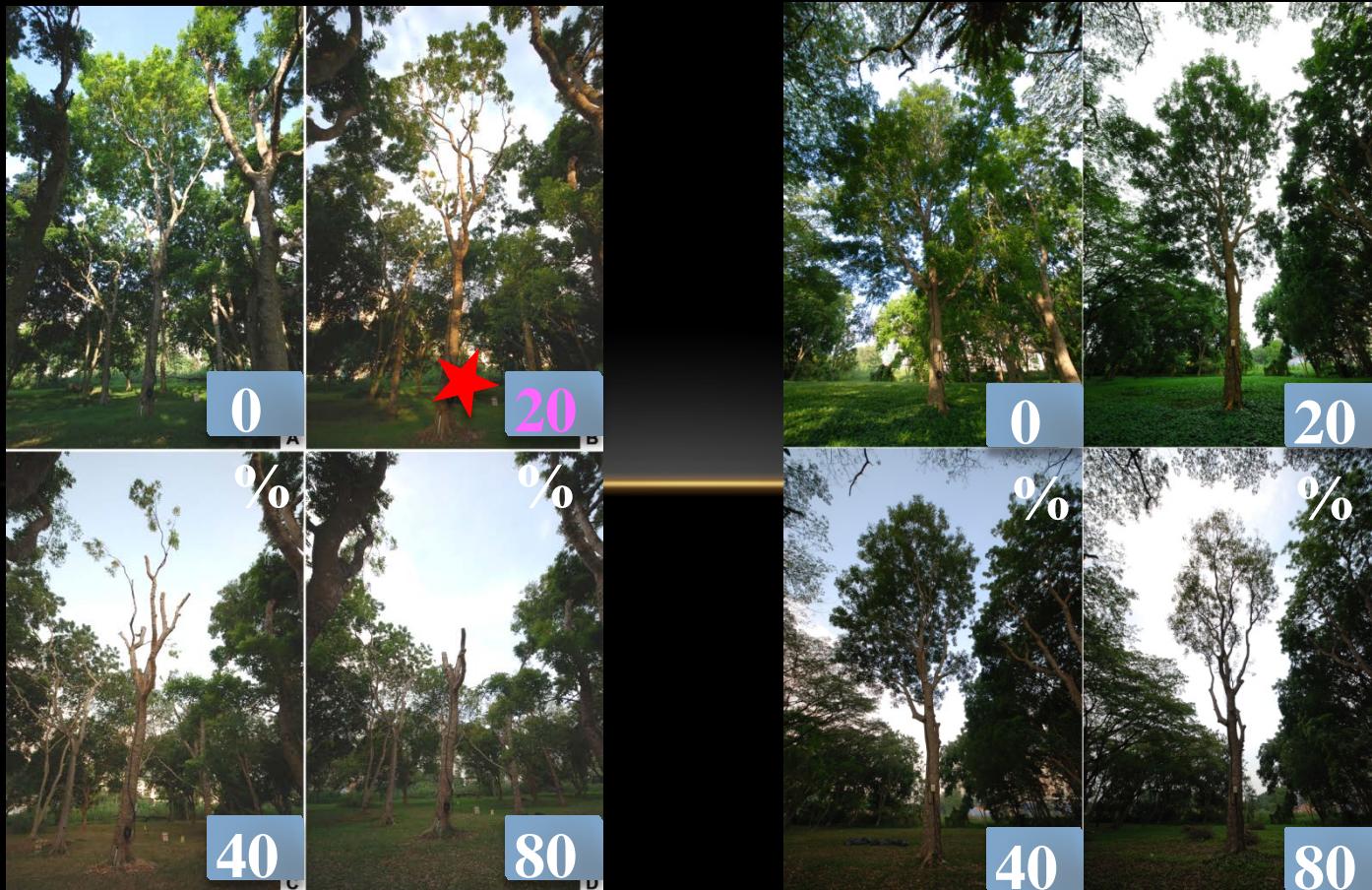
**Joint study with Met Services, PUB**

**>> 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

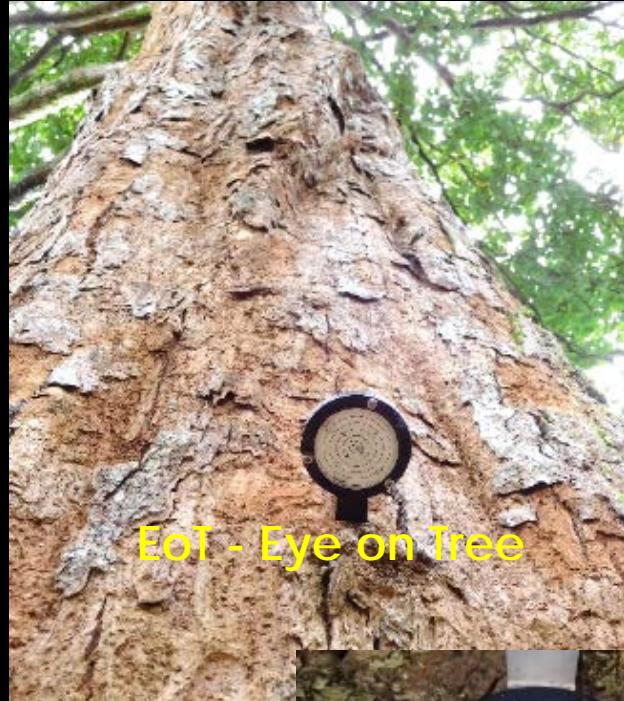


\* **A collaborative** project  
to design & build a  
specialised drone to fly  
safely within tree crown to  
'inspect' branches &  
foliages

# DIAGNOSTIC TOOLS & SENSORS

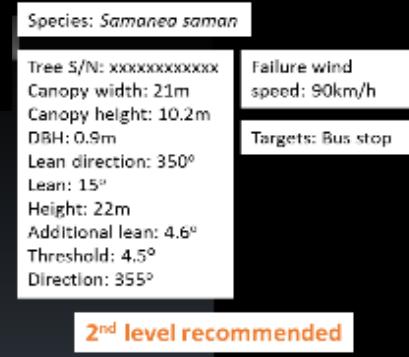
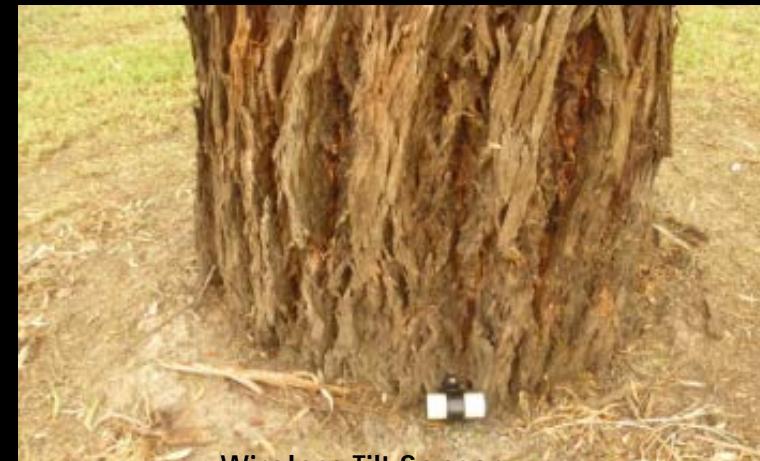
13:17

## Eye on Tree/Wireless Tilt Sensor



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

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



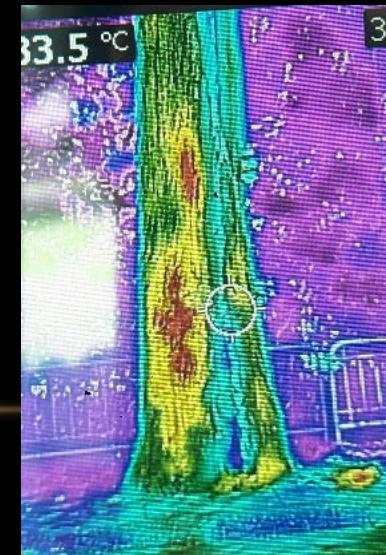
# GPR

Ground Penetrating Radar

- noninvasive,  
to map out tree  
root distribution



# Infra Red Camera

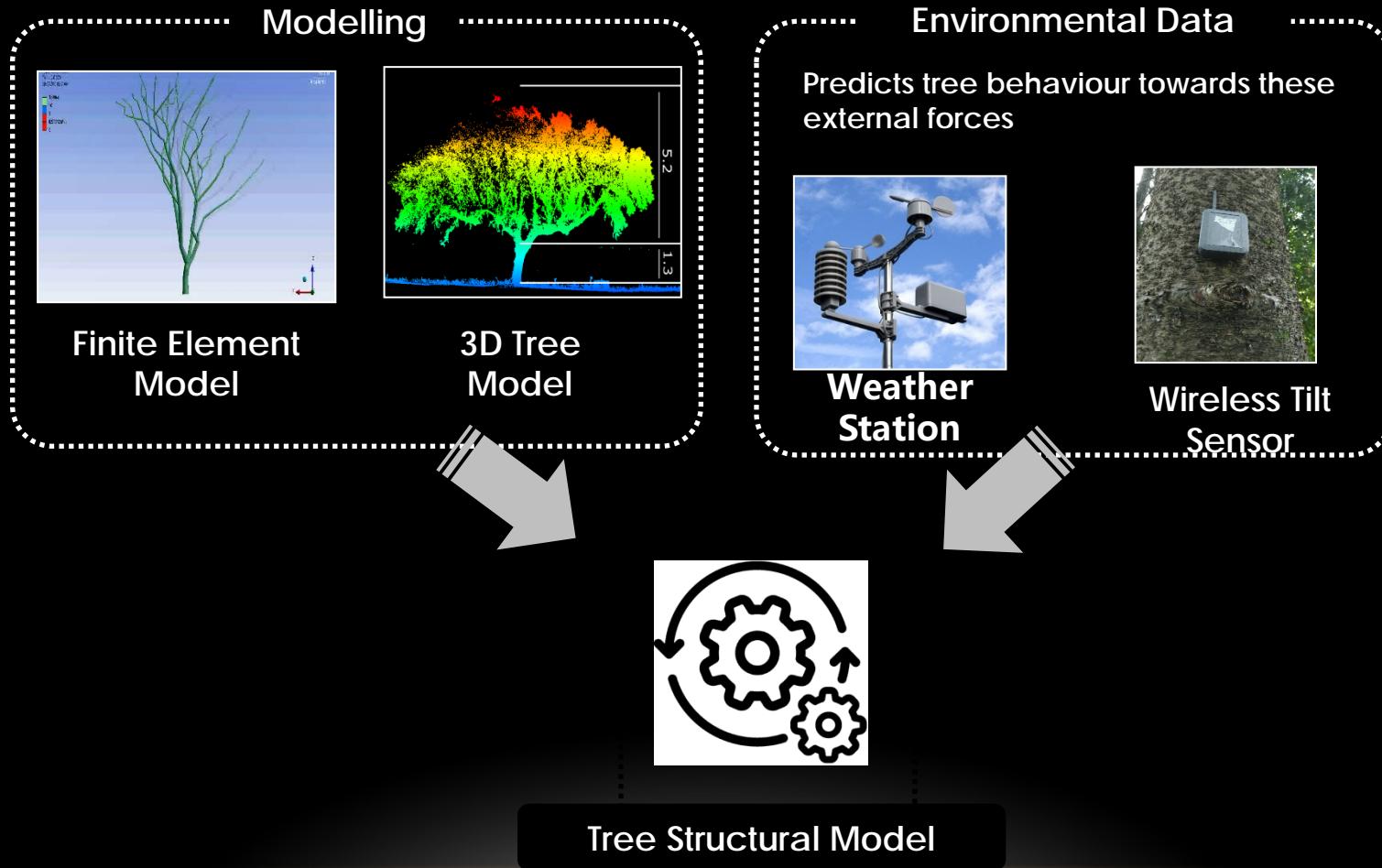


# Portable e-noses

- 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

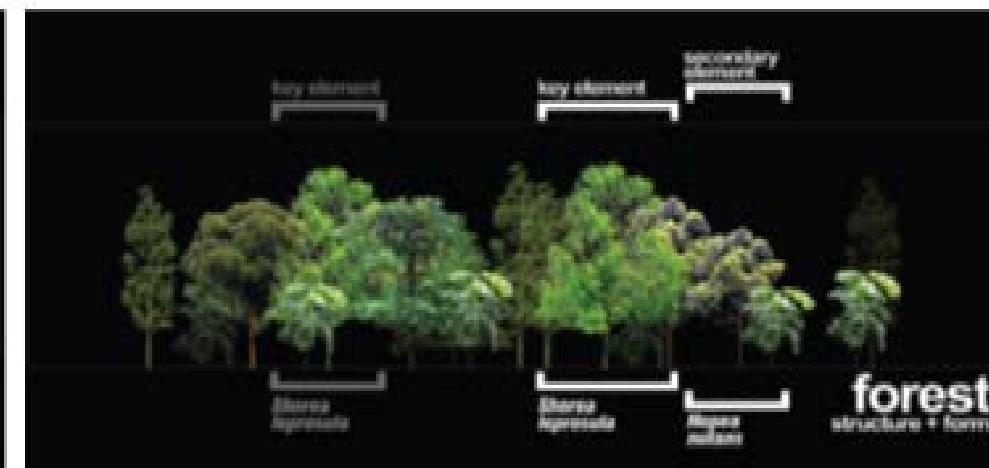
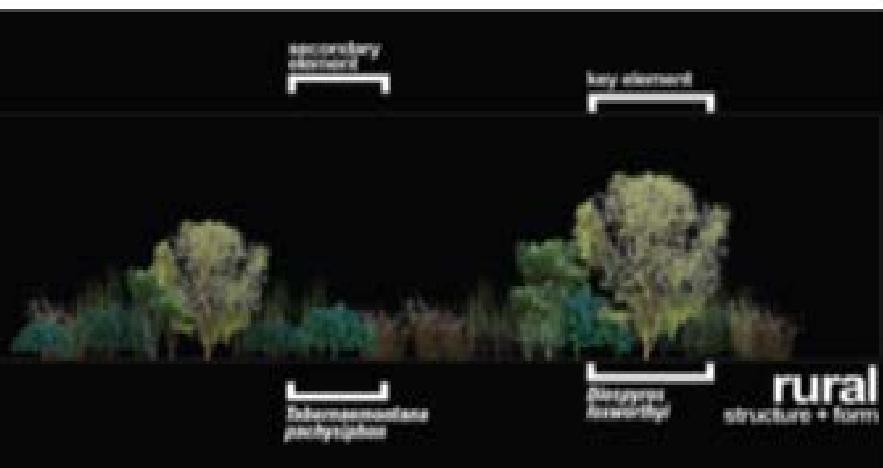
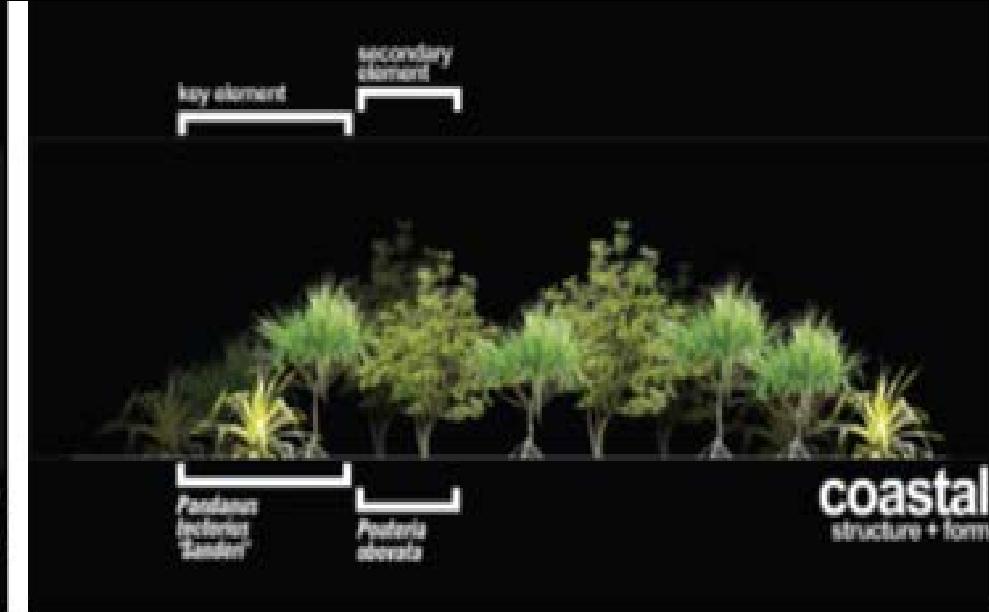
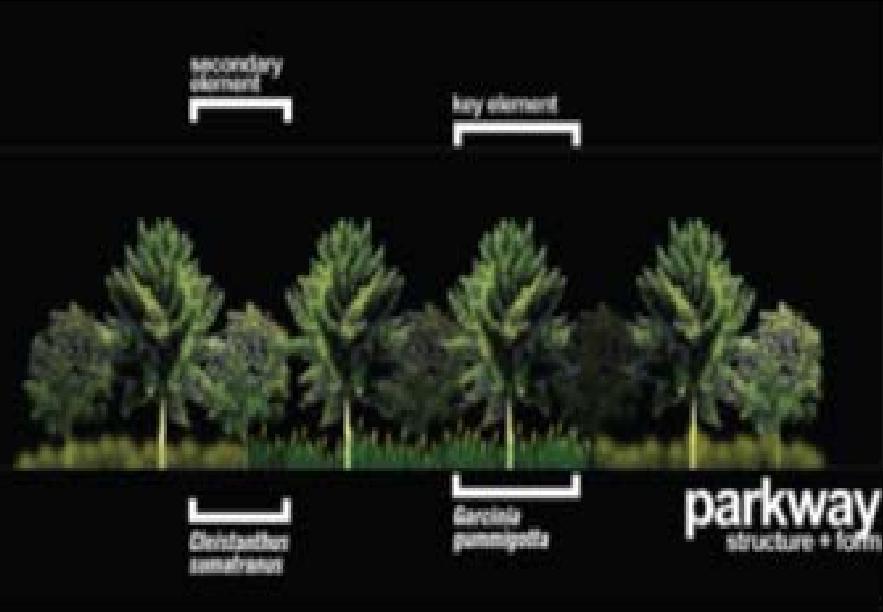
**3. Rural Treatment**

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

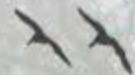


Habitat DeFragmentation

# 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)

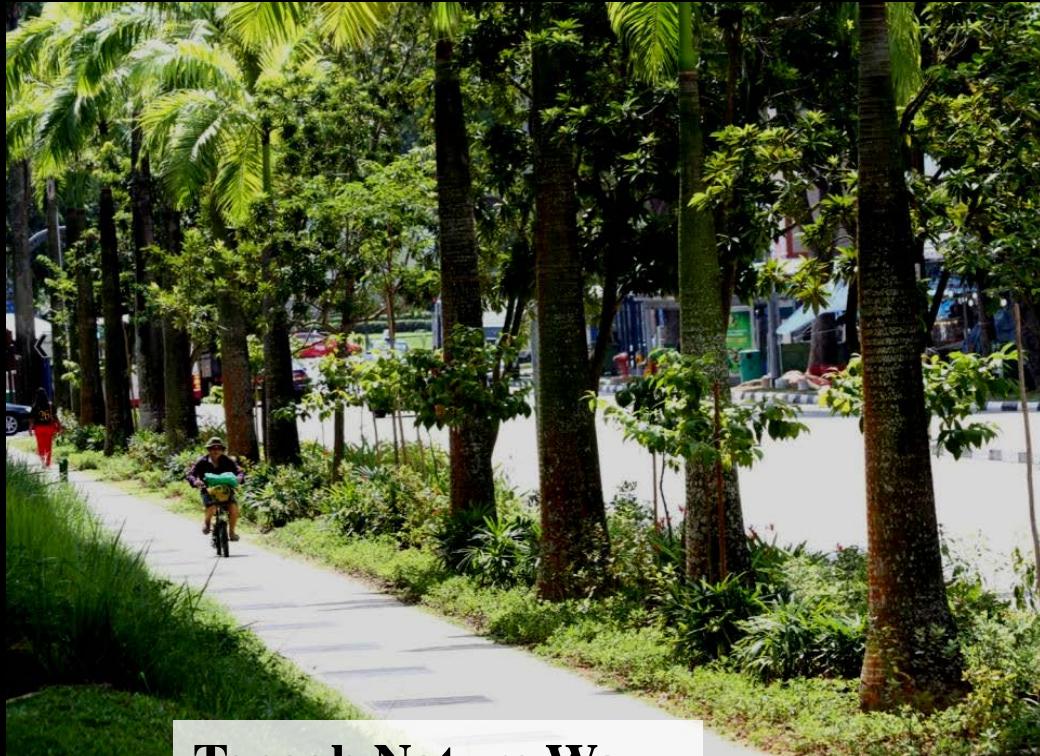
Existing trees that forms the canopy for the new planting scheme

structure

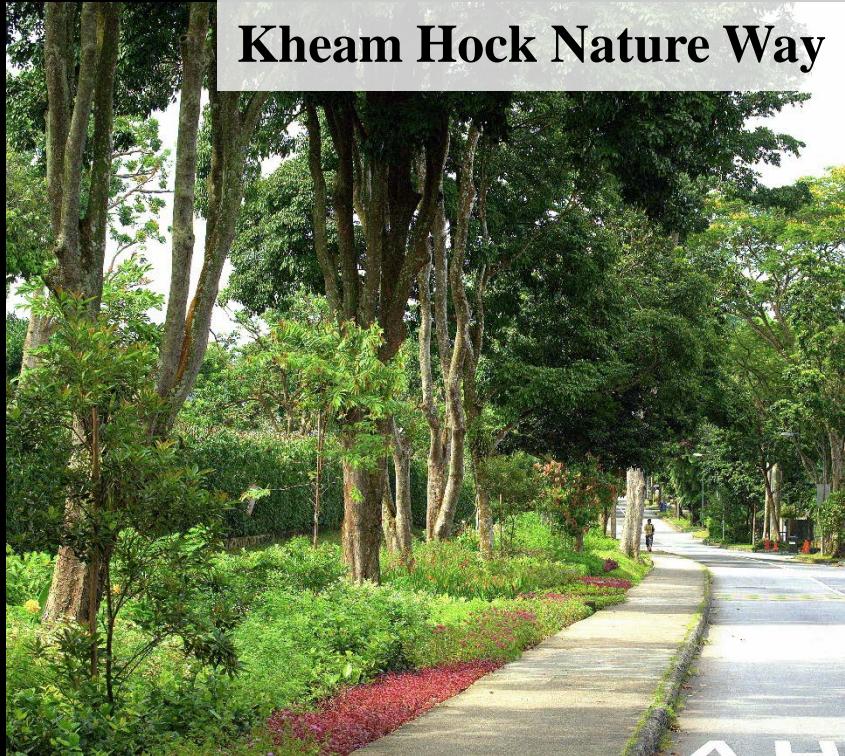


Undergrowth/ Shurbs Layer  
Flowering shrubs that provide aesthetic values for road users at eye level. Also attract butterflies.

**Kheam Hock Nature Way**



**Tengah Nature Way**



**Tanglin Nature Way**



- Planting along Nature Way by Hillgrove Sec

- Chalk



# Biodiversity sighted



Blue-eared kingfisher



Blue-throated bee-eater

Asian Brown Flycatcher

Sooty headed Bulbul

Brown shrike



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 photograph of a large tree with a dense canopy of green leaves. The tree's branches are thick and many of them hang down, some with long, hanging green seed pods. The background is a clear, light blue sky.

**Touch the trees !**

# Come visit Singapore !

The screenshot shows a web browser window with the following details:

- Address Bar:** National Parks Board [SG] <https://www.singaporgardenfestival.com>
- Toolbar:** Apps, Google, The Straits Times, Christian, Botany Plant Trees, Chrome, BBC CNN TwinFounts, Science Daily, Stephen Olford, BBC TwinFountains, Other bookmarks
- Page Content:**
  - Header:** SINGAPORE GARDEN FESTIVAL logo, navigation menu with links to Plan your visit, Festival Highlights, SGF 2018 Designers, MarketPlace, Media Centre, and About SGF.
  - Image:** A vibrant, colorful illustration of a garden scene. In the foreground, a green frog character with a blue hat and a bee character with a yellow and black striped hat are pushing a wooden wheelbarrow. The wheelbarrow is filled with various gardening tools like a spade, a fork, and a watering can. The background features a lush green field with a winding path, colorful flowers (pink, yellow, orange), and the iconic Supertree Grove in the distance under a blue sky with white clouds.
  - Text:** "WELCOME TO" and "Singapore Garden Festival 2018" in large white letters on the left side of the image. At the bottom left, it says "Journey into a world of colours" followed by the event dates "21 July - 3 August 2018".

# *Thank you*

