

Urban Forest

Storm and Community Prepare & Recover



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Basic Principle/Requirements

Trees are a valuable and publicly desirable asset

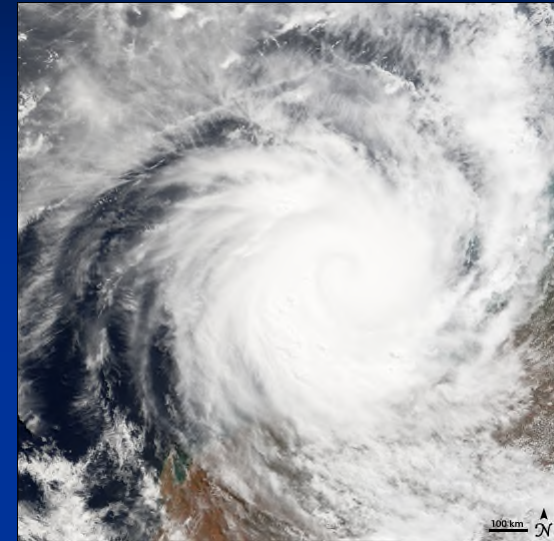
- Trees must remain healthy and structurally sound (low risk)
- Maintenance time and costs must be reasonable (low)
- Commitment (managers and public) to protect and maintain trees



Significant Challenge/Threat

Storms: High winds/heavy rain

- Break major branches
- Uproot trees
- Injure people
- Damage structures and property
- Interrupt utility services
- Obstruct roads, walkways and public use areas



Solution

Develop a Plan and Program to Minimize Exposure/Damage

1. Identify Threat and Exposure
2. Plan and Prepare
3. Effectively Mobilize, Deploy and Manage Response Forces
4. Recover and Restore Urban Forest









1. Identify Threat and Exposure

Strong winds/rain cause falling trees and tree parts

- Where are significant (large), exposed urban trees?
- Relationship to valuable targets?
 - Infrastructure
 - Vehicles
 - People



Near Gale	28 – 33 knots 50 – 61 km/h	Whole trees move	Wind impedes walking	
Gale	34 – 40 knots 62 – 74 km/h	Whole trees shake, twigs break	Windblown dust and dirt	
Strong Gale	41 – 47 knots 75 – 88 km/h	Branches start to break	Light Damage: Some damage to chimneys; twisting damage to signs; light weight awnings and canopies damaged;	
Storm	48 – 55 knots 89 – 102 km/h	Pushes over shallow-rooted trees	weak roofing lifts; windows may blow out; aircraft grounded.	
Violent Storm	56 – 63 knots 103 – 117 km/h	Broken branches big enough to cause structural damage		
Hurricane Force	≥ 64 knots ≥ 118 km/h	Mature trees uprooted	Moderate to Devastating Damage: Roofs and some walls torn off; snaps power lines; moving cars pushed off road or lifted; loose objects turned into missiles.	

Best Management Practices

Inventory: What, where, conditions

- 1. Identify significant tree locations**
- 2. Identify exposure to targets**
- 3. Develop effective management plan**

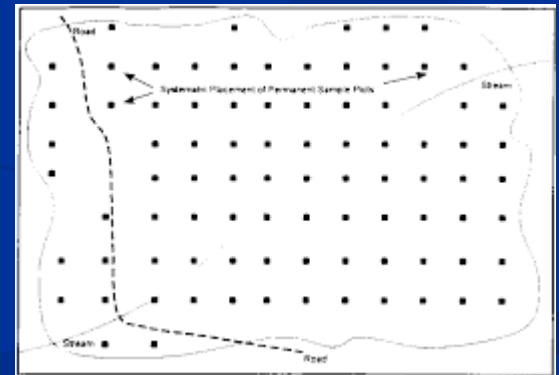
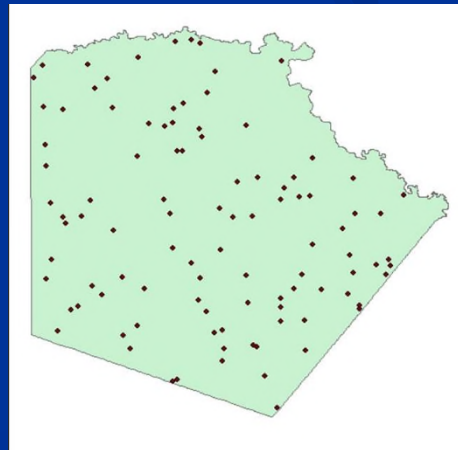


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Inventory Method

Level 1

- Basic information
- Fast, efficient



Identify Exposure - Targets

People within fall zone of trees and tree parts

- People not outside when high winds present
- Large trees/parts capable of penetrating structures



Identify Exposure - Infrastructure

Infrastructure near trees

- Overhead utilities
- Vehicles
- Significant structures
 - Buildings
- Access routes
 - Roads
 - Walkways
- Areas likely obstructed
 - Parks



Inventory Requirements

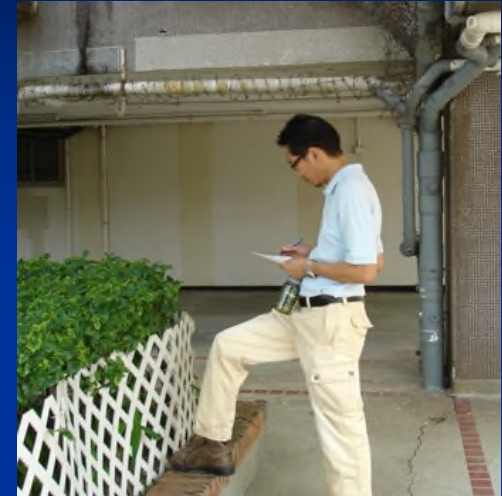
1. Qualified field data collectors
2. Satisfactory format/data collected
 - Correctly identifies subject trees and targets
 - Provides satisfactory information and metrics to develop meaningful conclusions



Qualified Field Data Collectors

Demonstrated, technical knowledge/ability

- Related formal education and training
 - Tree ID
 - Tree inventory
 - Basic Tree Risk Assessment
- Demonstrated, successful experience
- ISA Certification?.



Tree Failure Database

Identify trees that are failing

- Species
- Parts



Tree Failure Database

Define timing of failures

- Wind strength
- Rainfall
- Morning/afternoon



Tree Failure Database

Describe common failure locations

- Geographically
- Topographically
- Regionally



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Tree Failure Database

Specify the number of failures

- Total trees
- Tree parts
- Species/Families
- Similar conditions



Tree Failure Database

Identify the root cause of failure

- Trigger trends?
 - Wind speeds
 - Water magnitude
 - Certain defects/Conditions
 - Human factors
 - etc.



Common Tree Failure Triggers – What Learned

Most common structural and site defects that indicate higher risk of failure during typhoons and other exceptional conditions:

- Experience
- Research



Common Tree Failure Triggers

Trenching within structural critical root zone

- Reduced structural root plate = Increased uprooting risk



Common Tree Failure Triggers

Significantly restricted critical root zone

- Paving up to root collar
- Obvious walls or underground root restrictions within $> 30\%$ of CRZ



Common Tree Failure Triggers

Lion-tail structure

- Usually from pruning, natural also
- Especially weak structured trees



Common Tree Failure Triggers

Edge trees, especially newly exposed trees and branches

- Especially weak structured trees



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Common Tree Failure Triggers

Descending roots lost (down side)

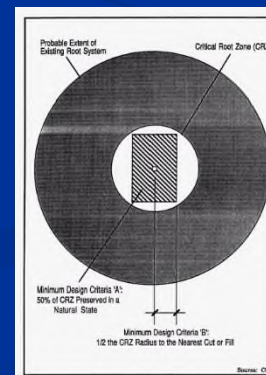
- Within 1 meter of trunk



Common Tree Failure Triggers

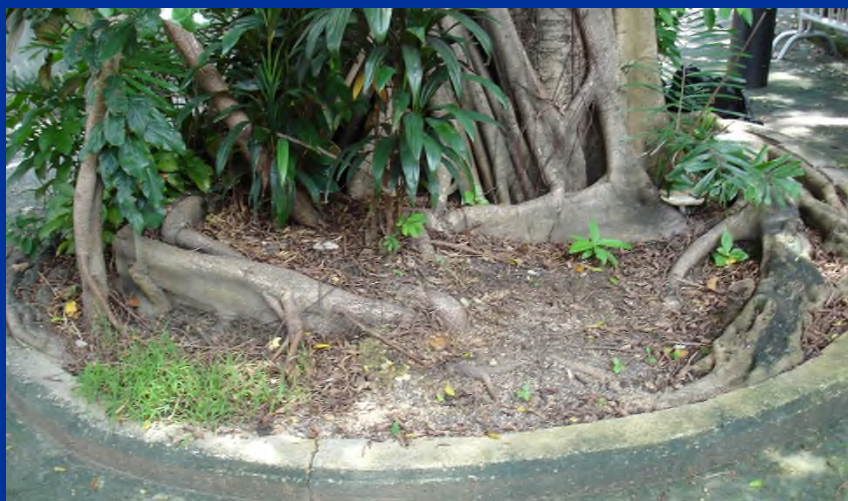
Significant damage or decay to lateral roots

- Within CRZ
- Recognize potential for asymmetry in CRZ



Common Tree Failure Triggers

Girdling roots



Common Tree Failure Triggers

Soil compaction near to trunk

- High clay and shallow soils
- Observe crown weight reduction?



Common Tree Failure Triggers

Waterlogging near to trunk

- Shallow soils
- Restricted CRZ
- Whole slope may slide with trees



Common Tree Failure Triggers

Wind tunnel areas

- Structure-related corridors that focus and swirl winds.



2. Plan and Prepare

- Incident Command System/Structure (ICS)
- Define Potential Workload
- Technology tools and processes
- Communication
- Mutual Assistance Agreements
- Training and Drills
- Tree Management – Storm-proofing



Urban Forest Strike Teams

- UF response role must be recognized within ICS
- Urban foresters need to learn and be part of ICS system
- Facilitate: Identify UF stakeholders and resources
 - Internal
 - External



Define Potential Workload

Potential magnitude of damage - Inventory-based

- Likely and potential tree failure magnitude
- Locations prioritized and stratified



Define Potential Workload

Debris collection and disposal sites



Define Resources Required

Type and sources defined

- Labor requirements
- Tools/equipment.



Tree Management – Storm-Proofing

Prepare trees/urban forest

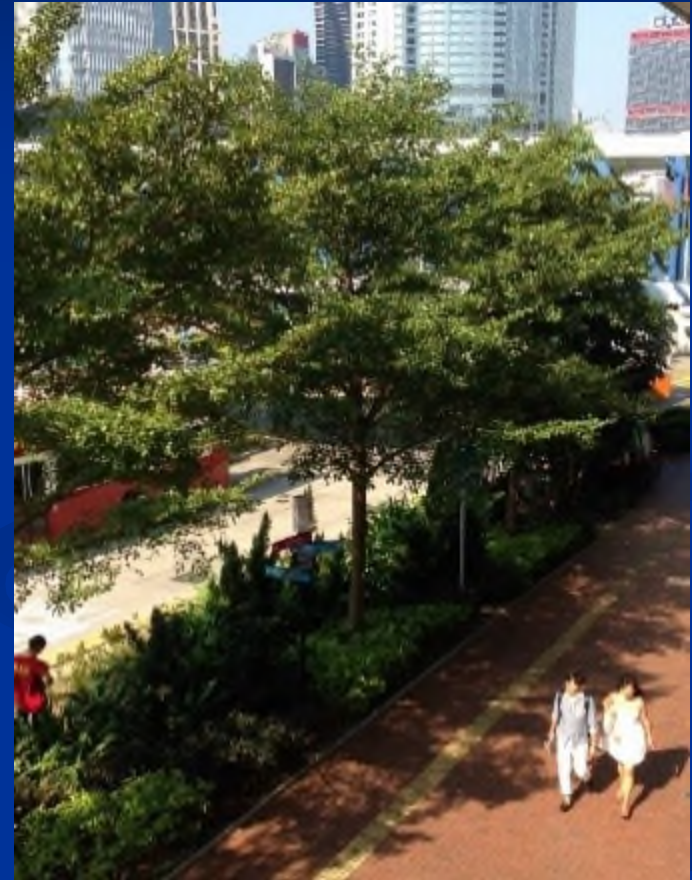
- Prevention is most effective
- Proper maintenance to minimize damage and resulting problems



Tree Management – Storm-proofing

Start now!

- Requires years
- Faster start, sooner completed



Tree Management – Storm-proofing

Remove weak trees

- Dead
- Poor performing species
- Defective trees that cannot be corrected
 - Included bark
 - Decay/cavity
 - Unnatural, very low LCR

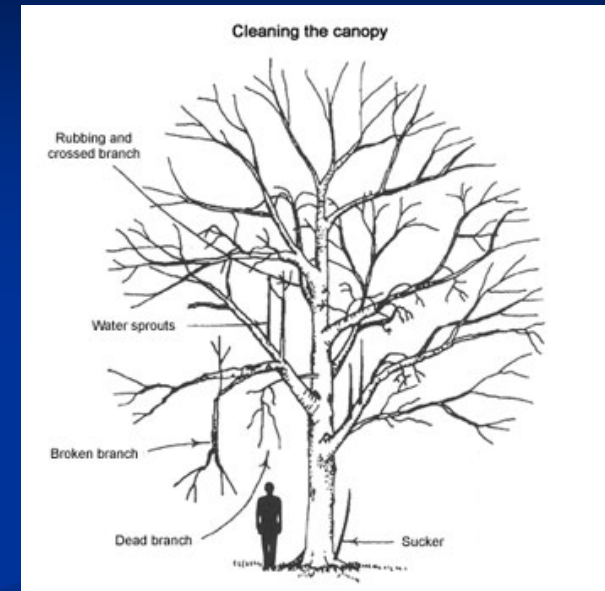


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Tree Management – Storm-proofing

Prune trees

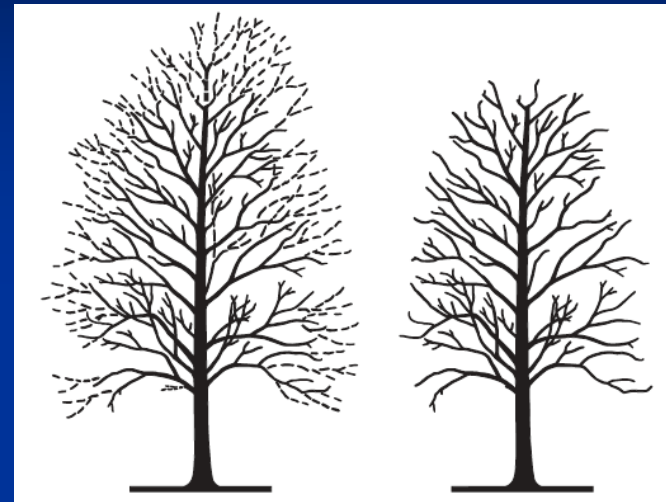
- **Crown clean**
 - Dead, diseased, crossing, over-extended
 - Heavy epiphytes and vines



Tree Management – Storm-proofing

Crown reduction

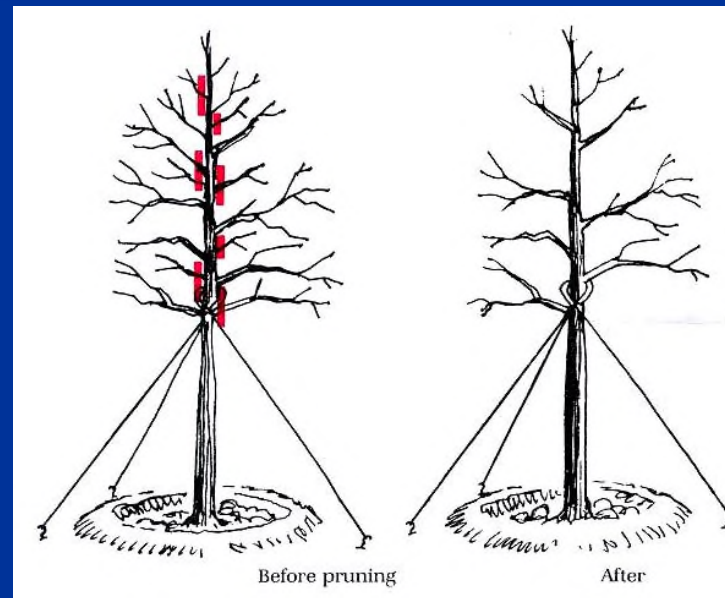
- Lower tips and tops correctly
- Reduces lever arm load



Tree Management – Storm-proofing

Structurally prune to develop correct, strong architecture

- May be conducted relatively quickly for young trees
- Prevents significant future problems



Tree Management – Storm-proofing

Replace trees correctly

- Right tree in right place
- Select best species
 - Proven storm resistance
- Proper installation
- Plant in groups, not individually.



3. Effectively Manage Response

- Safety
- Damage Assessment
- Deploy and Manage Resources (Tree crews)



Safety

Always first consideration

- Electric contacts
 - Lines down
 - Contact with trees
 - Energizing other objects, including ground
- Tree and part instability
 - Hanging
 - Unstable on ground or obstacle

High diligence and attention

- Do not take unreasonable risks



4. Recover and Restore Urban Forest

1. Debris Disposal
2. Restore Green Infrastructure



Debris Disposal

Not practical during initial restoration

- Clear and restore utilities and roads immediately



Debris Disposal

Remove and dispose debris.



Damage Assessment

Identify and assessed damaged trees

- Qualified inspectors
 - Ability to recognize hazards
 - Skill to assess and recommend practical mitigation
- Prioritize work



Restore Green Infrastructure

- Remove/Replace irreparably damaged trees
- Repair sustainable trees
- Fill gaps in canopy



Repair Remaining Trees

Crown clean damaged and hazard parts



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Conduct Restoration Pruning

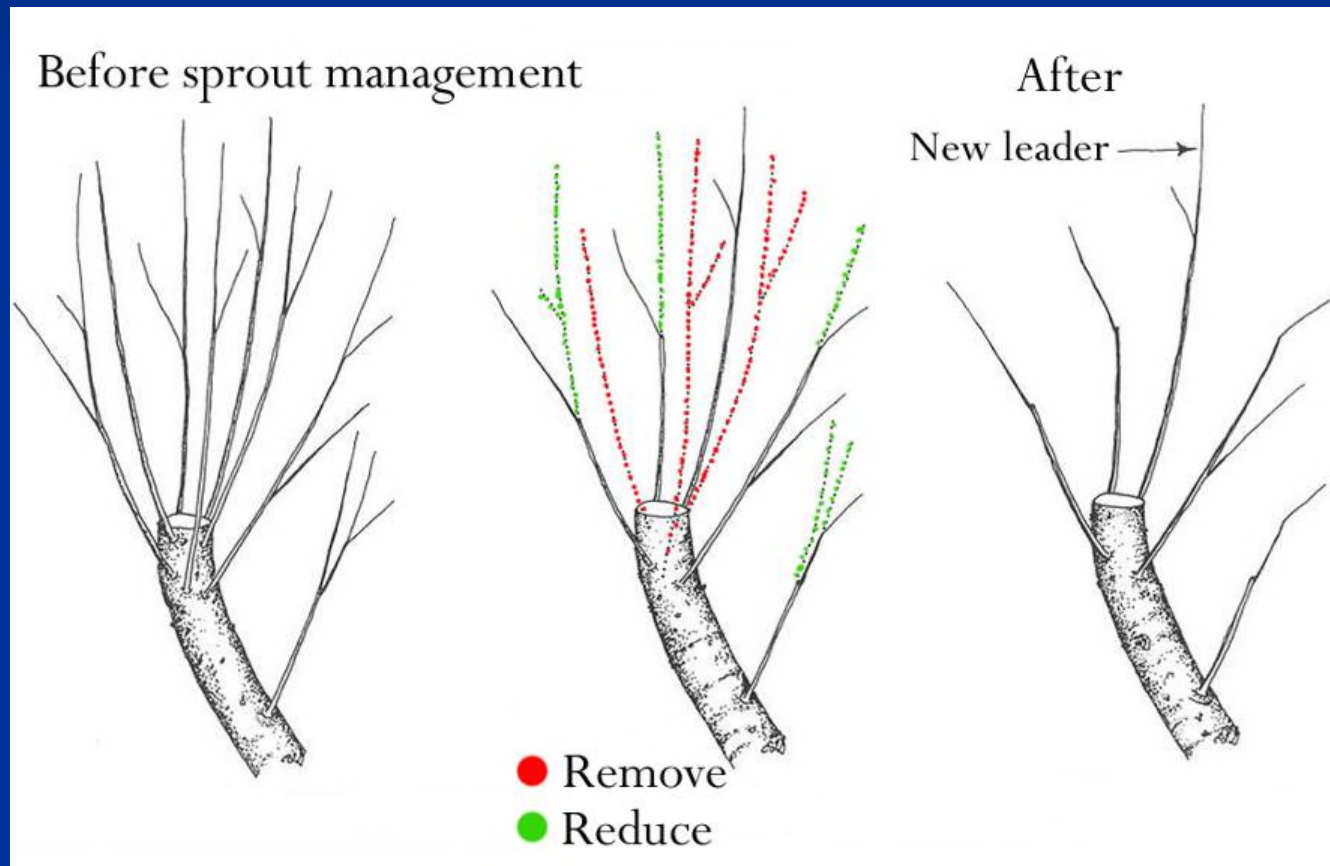
- Permit trees to recover from damage (1 to 2 years)
- Highly technical
 - Only qualified, experienced arborists should conduct!



Restoration Pruning Process

1. Sprout management

- Remove/thin ~ 30% of resprouts, selecting for strong, future branches



Restoration Pruning

2. Establish new leaders/continue sprout management
 - 2nd – 3rd visits (each visit ~ 1 year cycle)



Restoration Pruning

3. Commence preventative “storm-proofing” pruning

- ~2 – 3 years after storm – new leaders establishing.



Repair Remaining Trees

Small, leaning trees – stake if appropriate

- Large trees assessed to determine practicality



Repair Remaining Trees

Tree support systems: only in special cases



Remove Irreparably Damaged Trees

Remove hazard/irreparable



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Restore Lost Trees

Select, Install & Establish replacement trees

1. Right tree in the right place
2. Healthy, strong, properly structured nursery stock
3. Correct installation practices
4. Early establishment care



Right Tree in the Right Place

- Growing space above and below
- Soil conditions
- Desired amenity values



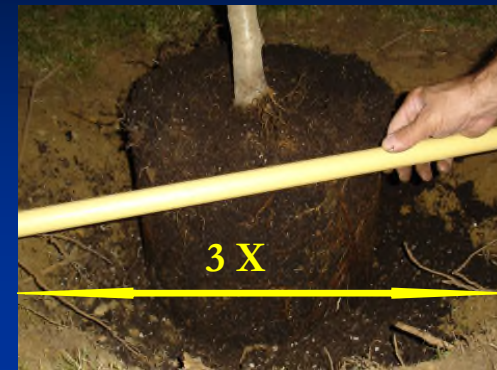
Good Nursery Stock

- Structure: stem, branches and roots
- Health
- Root ball size



Correct Installation

- Planting pit size
- Depth
- Backfill
- Only if required
 - Fertilization
 - Support system



Early Establishment Care

- Water
- Structural pruning
- Protection.



Key to Success?

- **Arboriculturally correct practices**
- **Demonstrably qualified professionals**
- **Regular assessment and restoration management**
- **Adequate resources (\$\$\$)**
- **Patience**



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Questions?



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