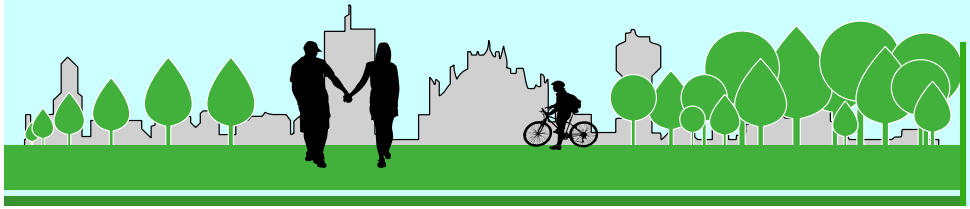
Floristic and habitat differentiation of heritage trees in Hong Kong's urban forest

C Y Jim
The University of Hong Kong
hragjcy@hku.hk
geog.hku.hk/staff_FT_jim.html



16th European Forum on Urban Forestry
Milano, Italy 7 - 11 May, 2013

EFUF European Forum on Urban Forestry

Presentation Outline

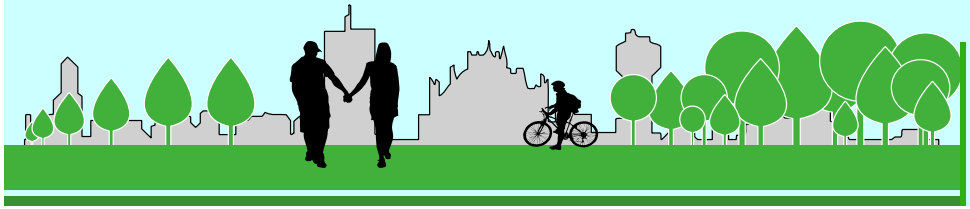
Introduction

Study area and methods

Main results

Discussion of key findings

Management implications and conclusion



Champion calibre tree

Outstanding remnants of urban trees

- Tiny cohort of meritorious trees
  - Soldier on despite heavy odds of urban living
    - Genetic superiority (genotype)
    - Freedom from grave human impacts
    - Freedom from nature's extreme impacts
    - Quality of tree management
  - Respected and sometimes revered
    - Collective memory of citizens
    - Linking present to past and future
    - Emotional attachment
  - Fine examples of nature-in-city
    - Linking people to nature

Heritage trees (HT) as outstanding members of urban forest

- Inherent tree attributes
  - Age
  - Size
  - Form
  - Health
  - Species
- Ecological function
- Landscape contribution
- Cultural & historical association
- Valuable nature-cum-culture inheritance

Study objectives

- Deep understanding of precious living resource
  - Floristic composition and diversity
  - Biomass structure
  - Importance value
  - Spatial differentiation by districts and habitats
  - Findings to inform practical management and conservation
  - Knowledge transfer to south China and other cities

Presentation Outline

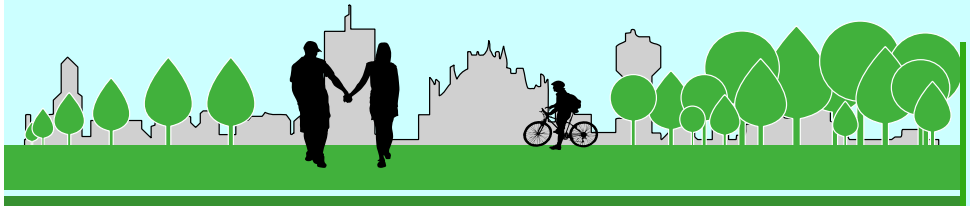
Introduction

Study area and methods

Main results

Discussion of key findings

Management implications and conclusion



Study area: Hong Kong

- South China subtropical city
  - 1104 km^2 with hilly and difficult terrain
  - 7 million population
  - Living in 22% built-up areas
  - Average urban density 33,000 persons/km^2
  - Ultra-compact and vertical city
- Focus of study
  - Official register of heritage trees
  - 9 districts in core urban areas
  - 10 main tree habitats

Limited land area and difficult terrain

Ultra-compact development mode

Study methods: Field evaluation

- Site assessment
  - District affiliation
  - Site condition
  - Habitat classification
- Tree assessment
  - Species identification
  - Tree dimensions
  - Tree performance

Camphor Trees at Haiphong Road

Ht 15 m
Cr 19 m
Dbh 1.4 m

Study methods: Data analysis

- Plant and community ecology techniques
  - Detrended correspondence analysis (DCA)
  - Similarity percentage analysis (SIMPER)
  - Other statistical tests (SPSS)
  - Species diversity indices
    - Shannon-Wiener species diversity index
    - Evenness index
    - Species importance value
  - New indices of spatial differentiation
    - District similarity index (DDI)
    - District heterogeneity index (DHI)
    - Habitat similarity index (HDI)
    - Habitat heterogeneity index (HHI)

Presentation Outline

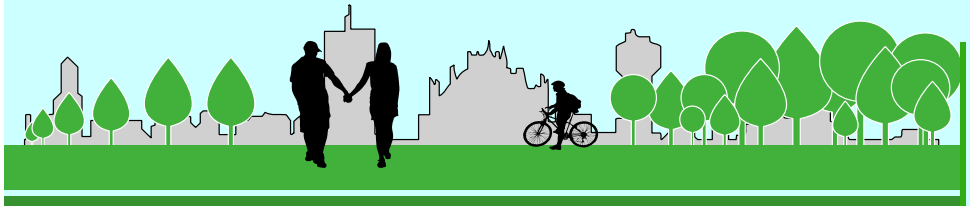
Introduction

Study area and methods

Main results

Discussion of key findings

Management implications and conclusion



Species composition and importance value

- 352 HT, 70 species, 56 genera, 35 families
  - Dominant species (> 100 trees)
    - *Ficus microcarpa* (Chinese Banyan)
    - 181 trees (51.4%)
  - Common species (10 – 100 trees)
    - *Ficus elastica* (Indian Rubber Tree, exotic)
    - *Ficus virens* (large-leaf Banyan)
    - *Cinnamomum camphora* (Camphor Tree)
  - Rare species (2 – 9 trees), 22 species
  - Solitary species (1 tree), 44 species

Species composition and importance value

- Highly uneven species frequency
  - Top 4 species: 83% trees
  - Remaining 66 species: 17% trees
- Native versus exotic species
  - Natives: 20% species, 66% trees
  - Exotics: 80% species, 34% trees
- Family and genus representation
  - Domination by Moraceae (Mulberry family)
  - Domination by genus *Ficus* (Fig)

Species differentiation by districts

- Highly uneven distribution by districts
  - Oldest CW: highest species and tree counts
- Uniqueness of species in districts (DCA)
  - Found in 8/9 districts, led by CW
  - High floristic distinctiveness or fidelity
- Spatial differentiation of species in districts (SIMPER)
  - High degree of dissimilarity amongst most districts

Distribution and characteristics of HT in 9 districts

Table 4

The frequency, dimensions and diversity of OVTs in the study area composed of nine districts in Hong Kong.

District[a]	Species count	Tree count	Mean height (m)	Total basal area (m^2)	Total crown cover (m^2)	Shannon diversity index (H')	Evenness index (E)
CW	40	121	17.04	180.92	35,144.45	2.21	0.60
YTM	13	102	12.54	147.66	25,090.17	1.22	0.48
ST	11	35	15.27	72.57	10,972.93	2.03	0.85
ET	12	31	16.67	27.63	8,128.87	2.10	0.85
WC	10	23	19.60	45.12	8,069.80	2.07	0.90
SSP	6	16	13.33	25.00	4,265.69	1.39	0.77
KC	4	12	14.25	21.05	4,805.77	0.98	0.71
WTS	2	8	16.50	18.48	3,870.05	0.66	0.95
KT	3	4	15.00	3.43	1,292.11	1.04	0.95
Total	101	352	140.20	541.86	10,1639.84	13.70	7.06
Average	11.22	39.11	15.58	60.21	11,293.32	1.52	0.78

[a]Refer to Table 1 for the meaning of the district abbreviations.

SIMPER dissimilarity amongst districts

Table 5

Dissimilarity among nine districts based on tree species composition found by SIMPER analysis.

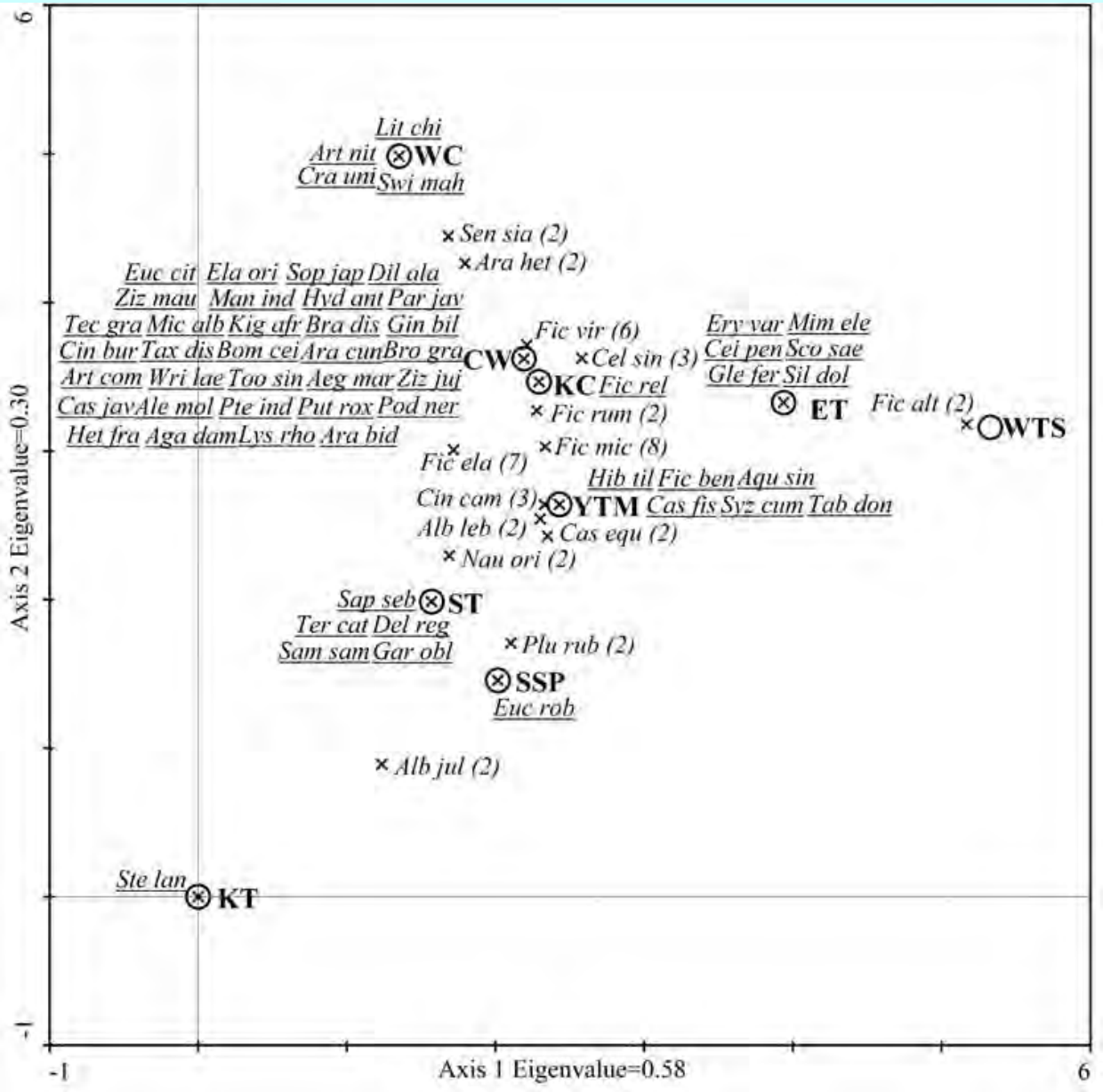
District[a]	CW	WC	ET	ST	KT	KC	WTS	YTM	SSP
CW	0.00								
WC	73.77	0.00							
ET	84.11	60.14	0.00						
ST	70.01	62.16	70.21	0.00					
KT	97.21	88.33	92.21	92.28	0.00				
KC	81.78	50.68	39.59	64.11	81.02	0.00			
WTS	94.56	80.53	74.68	86.23	100.00	69.18	0.00		
YTM	35.39	88.35	84.77	75.85	100.00	83.97	93.54	0.00	
SSP	83.02	61.98	50.43	63.82	79.29	27.69	73.03	81.46	0.00
DDI[b]	77.48	70.74	69.52	73.08	91.29	62.25	83.97	80.42	65.09
DHI[c]	22.55	20.12	25.93	21.94	9.95	24.85	18.32	22.38	20.49

[a]Refer to Table 1 for the meaning of district abbreviations.

[b]DDI denotes district dissimilarity index, computed by summing the dissimilarity values of a given district and then average it.

[c]DHI denotes district heterogeneity index, computed by summing the difference between the highest dissimilarity value of a given district and the remaining seven values and then average it.

DCA ordination of 9 districts by HT species



Species differentiation by habitats

- Variations by habitats
  - Public parks and gardens (PPG): highest species and tree counts
  - Followed by: GIC, residential, roadside tree pit
- Uniqueness of species in habitats (DCA)
  - Found in 5/10 habitats, led by PPG
  - High floristic distinctiveness or fidelity
- Spatial differentiation of species in habitats (SIMPER)
  - Highest dissimilarity: public housing (PH)

Distribution and characteristics of HT in 10 habitats

Table 7

The frequency, dimensions and diversity of OVTs in ten main tree habitats in urban Hong Kong.

Tree habitat[a]	Species count	Tree count	Mean height (m)	Total basal area (m^2)	Total crown cover (m^2)	Shannon diversity index (H')	Evenness index (E)
PPG	53	144	15.82	172.15	38,114.11	2.90	0.73
RTP	12	36	15.46	42.36	11,553.63	2.05	0.82
OT	10	19	18.21	29.81	7,537.77	1.73	0.75
GIC	9	23	16.22	31.27	7,979.53	1.75	0.80
RS	8	27	15.24	64.96	8,006.22	1.46	0.70
RTS	3	45	14.24	89.01	9,081.86	0.59	0.53
PH	3	4	15.25	14.23	1,982.91	1.04	0.95
RP	3	19	17.47	34.44	7,108.96	0.71	0.64
RTI	2	7	13.57	12.28	2,014.31	0.41	0.59
SW	2	28	16.46	51.34	8,260.56	0.34	0.49
Total	105	352	157.94	541.86	10,1639.84	12.98	7.00
Average	10.50	35.20	15.79	54.19	10,163.99	1.30	0.70

[a] GIC denotes government, institutional and community land; PH public housing estate; PPG public park and garden; RP roadside planter; RS roadside slope; RTI roadside traffic island; RTP roadside pavement tree pit; RTS roadside tree strip; SW stone wall; and OT others.

SIMPER dissimilarity amongst habitats

Table 8

Dissimilarity among ten main tree habitats based on tree species composition found by SIMPER analysis.

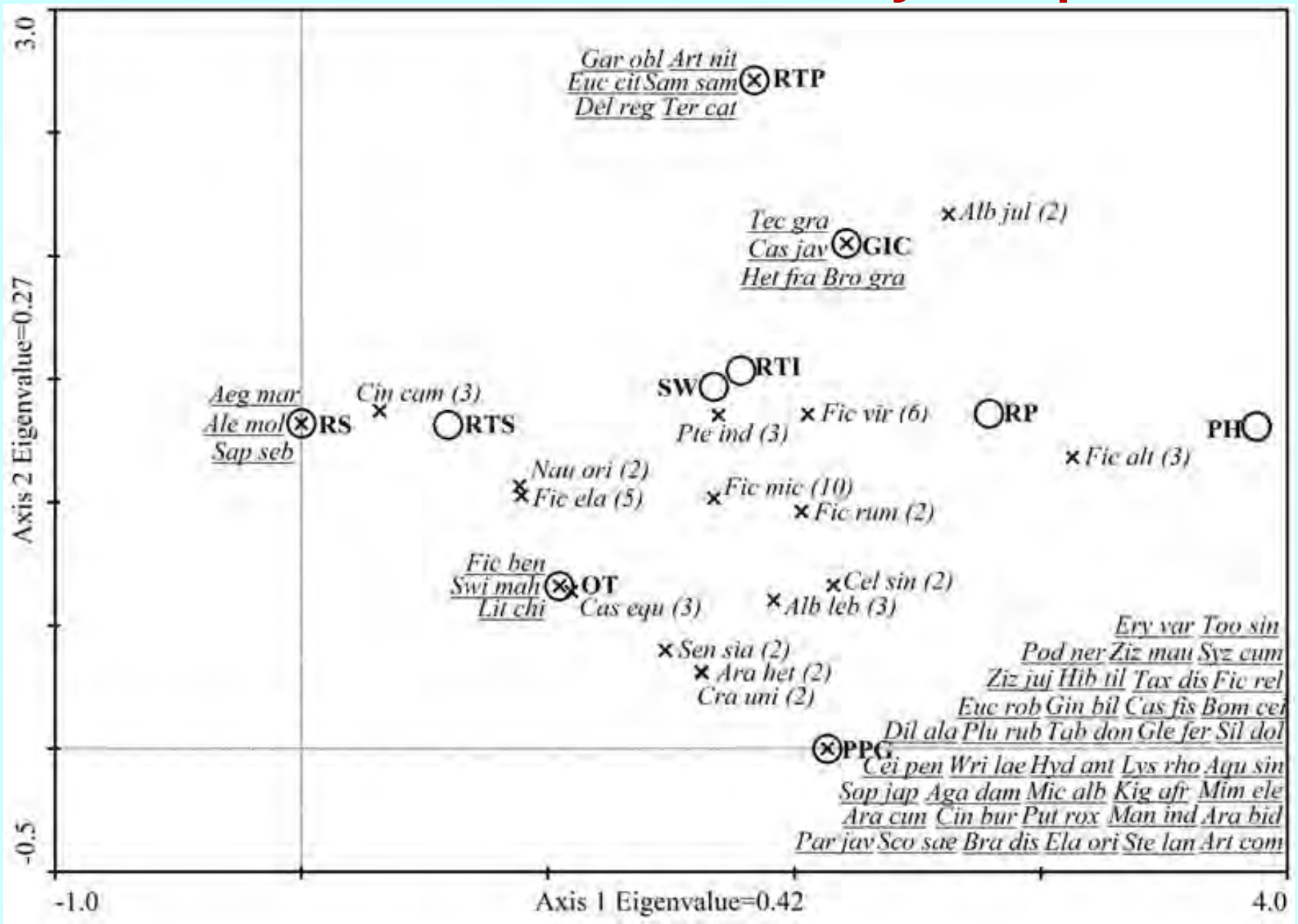
Tree habitat[a]	RTP	RTS	RTI	PPG	GIC	PH	RP	RS	SW	OT
RTP	0.00									
RTS	68.75	0.00								
RTI	61.85	78.02	0.00							
PPG	74.79	54.79	88.93	0.00						
GIC	53.97	74.57	48.55	75.84	0.00					
PH	80.04	89.69	57.66	94.30	78.84	0.00				
RP	47.17	55.25	47.94	75.99	58.27	57.63	0.00			
RS	63.59	59.50	69.24	75.36	64.09	85.49	61.88	0.00		
SW	48.28	32.95	60.72	61.32	57.48	83.96	33.81	67.71	0.00	
OT	54.75	65.34	51.39	78.10	54.44	76.79	46.20	52.27	56.98	0.00
HDI[b]	61.47	64.32	62.70	75.49	62.89	78.27	53.79	66.57	55.91	59.28
HHI[c]	20.90	28.54	29.51	21.16	17.94	18.04	24.97	21.29	31.55	20.83

[a]Refer to footnote of Table 7 for the meaning of tree habitat abbreviations.

[b]HDI denotes habitat dissimilarity index, computed by summing the dissimilarity values of a given habitat and then average it.

[c]HHI denotes habitat heterogeneity index, computed by summing the difference between the highest value of a given habitat and the remaining nine values and then average it.

DCA ordination of 10 habitats by HT species



Presentation Outline

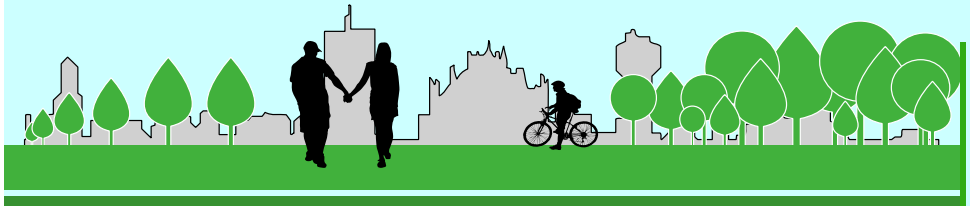
Introduction

Study area and methods

Main results

Discussion of key findings

Management implications and conclusion



Key features of HT

- Domination by *Ficus* species
  - Robustness and tenacity in stressful urban sites
- Strong presence of large trees
  - Contradicts shrinkage and degradation of habitats
    - Linger despite harsh urbanization impacts
    - Preferential preservation of large trees
- Land allocation for trees in urbanization
  - Protect existing HT
  - Nurture future cohort of HT

Roadside habitat: Outstanding Chinese Banyan

Common occurrence of minority members

- 66/70 rare and solitary species
  - Botanical, ecological & landscape diversity
- Genuine rare
  - Pre-urbanization inheritance
    - Woodland relicts (spontaneous)
  - Post-urbanization enrichment
    - Ruderal colonization (spontaneous)
    - Idiosyncratic choice (cultivated)
    - Accidental substitute (cultivated)
    - Garden vestige (cultivated)
- Selected rare
- 55/66 species: exotic & not naturalized
  - Cultivated & post-urbanization enrichment

Woodland relict

Spatial differentiation by districts

- Old districts: better HT inheritance
  - Old town plan, park and barracks
    - European avenue planting tradition since 1840s
    - Intra-site interstitial spaces: off-road trees
  - Endurance of town plan
    - Allow persistence of trees in townscape
  - Unique species composition
    - Bygone landscape preference, fad and fashion
- Later districts: less HT inheritance
  - High-density development mode and infilling
  - Departure from tree-planting tradition
  - Less plantable spaces for new trees
  - Loss of existing plantable spaces and trees

Reduction in plantable space

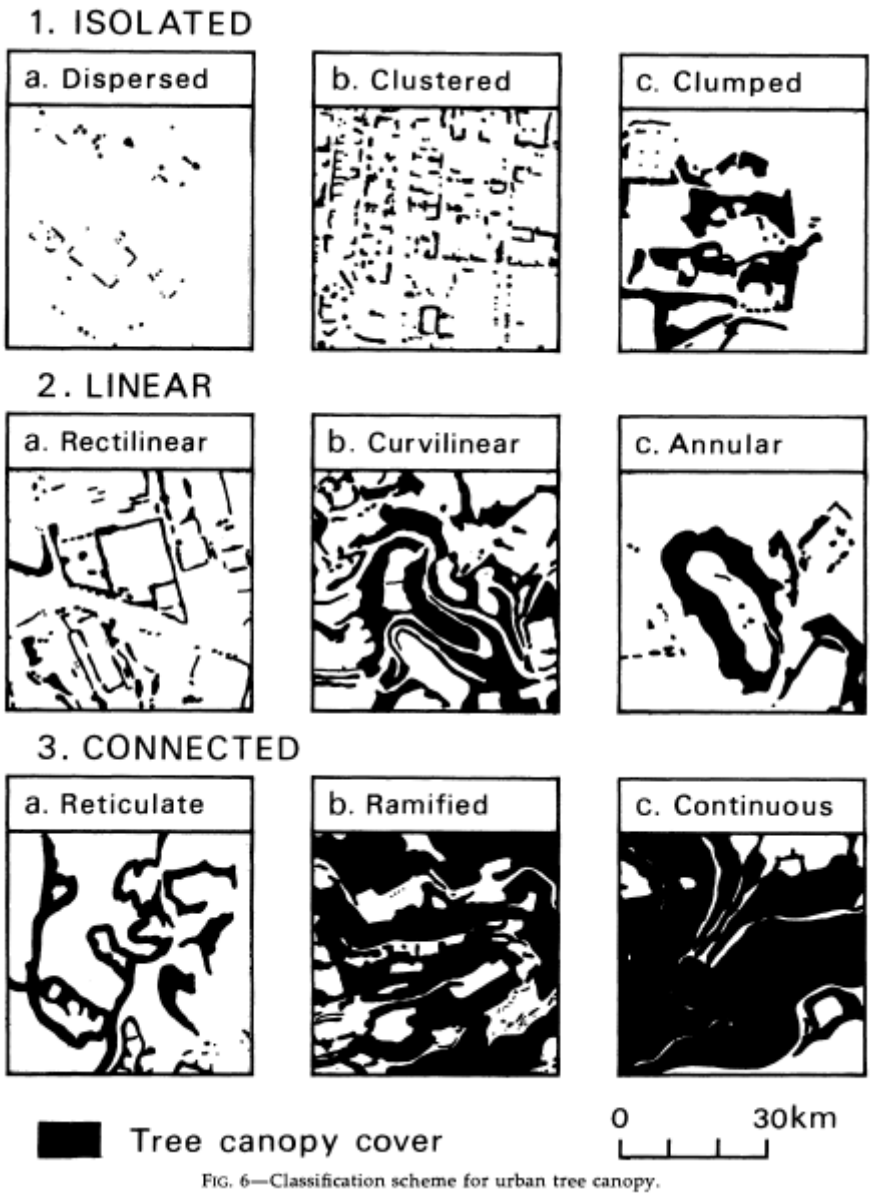
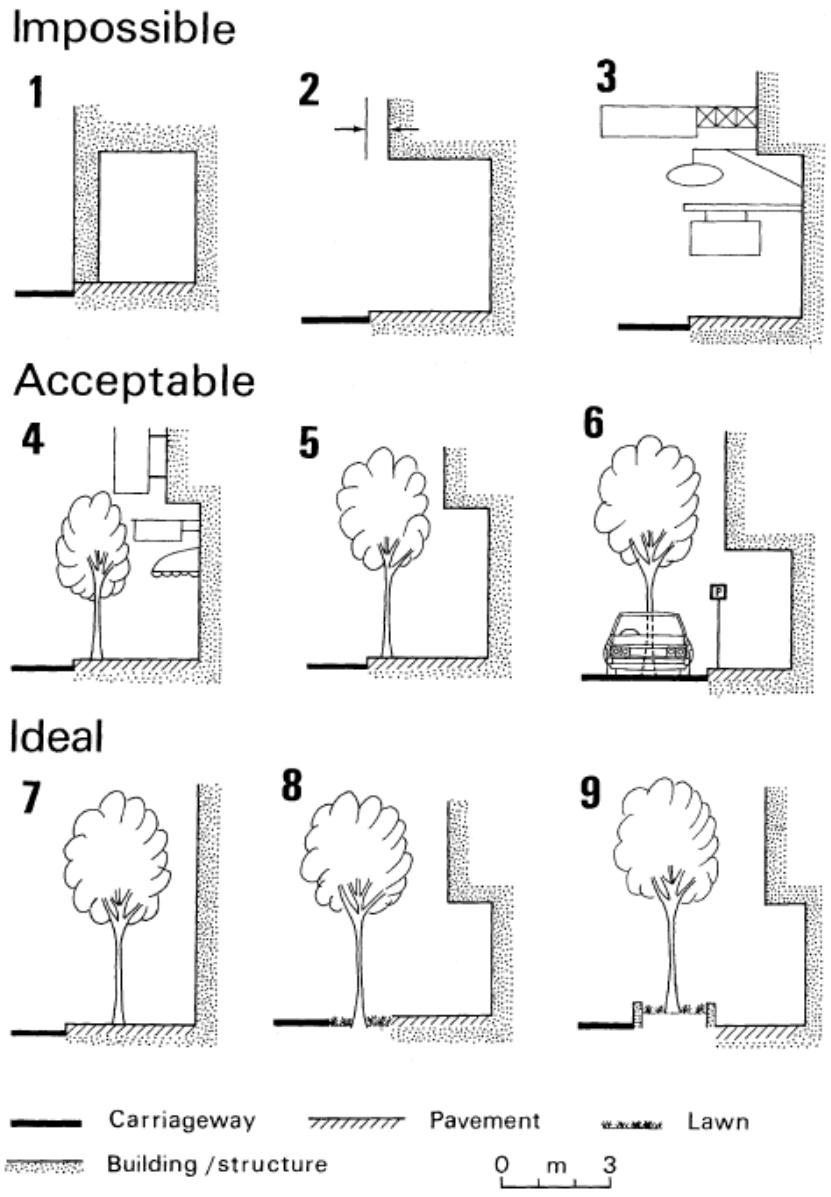


FIG. 6—Classification scheme for urban tree canopy.



Loss of plantable space

Spatial differentiation by habitats

- Public parks and gardens & barracks
  - Islands of nature in congested city
    - Less physical and physiological stresses
    - Nurture ground and refuge for HT
    - More species
    - More species exclusiveness (dissimilarity index)
    - Larger trees
  - Continual emergence of next generation of HT?
    - Contingent upon critical links and conditions
    - Soil and site quality
    - Planting material quality
    - Match between site and species
    - Tree care quality

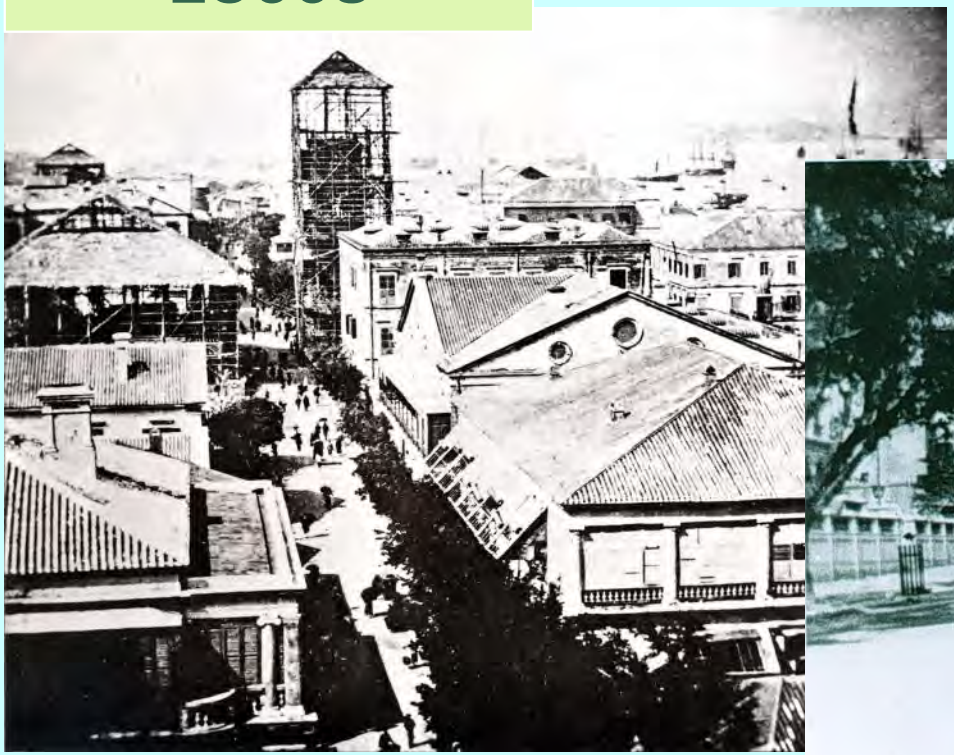
Public park

Spatial differentiation by habitats

- Roadside habitats
  - Relicts of European avenue planting tradition
    - Mainly planted in the 19th century
    - Lower development density
    - Less conflicts between buildings, roads and trees
    - Degraded growth spaces and conditions
    - Persistence of exceptionally tenacious trees
  - Continual emergence of next generation of HT?
    - Grave limitations
    - Discontinuity in tree populating structure
    - Lack of successors
    - Need conscious efforts to create enabling conditions

European avenue planting tradition

Queen's Rd C
1860s



Nathan Rd
1900s

Roadside habitat

Roadside habitat

Spatial differentiation by habitats

- Government institutional & community habitat
  - Low building site coverage
    - Generous ground-level spaces
  - Disappointing HT quantity and performance
    - Almost ubiquitous pour-concrete paving
    - Catering to car-parking and other activities
    - Wasted greening opportunities

Government institutional community habitat

Government institutional community habitat

Spatial differentiation by habitats

- Public housing estates
  - Accommodate nearly half of population
    - More and better ground-level spaces
    - Generous use of spaces for greening
  - Highest dissimilarity index
    - Species make-up stands aloof and alone
    - Autonomous operation outside government regime
    - Escape from bondage and baggage burden
    - Enlightened attitude and policy towards greening
    - Relatively young HT
    - Pool of potential HT for future contributions

Public housing estate

Public housing estate

Spatial differentiation by habitats

- Old stone retaining walls
  - Highest habitat heterogeneity index
    - Special vertical artificial-cliff habitat
    - Unusual ecological habitat for unusual trees
    - Spontaneous colonization by strangler figs
    - Mainly native *Ficus* species
  - Sustainability of stonewall HT?
    - Relict construction material and method
    - Superseded by reinforced concrete walls
    - Degradation and destruction by adjacent urban redevelopment and stabilization works
    - Threatened heritage

Old stone retaining wall

Presentation Outline

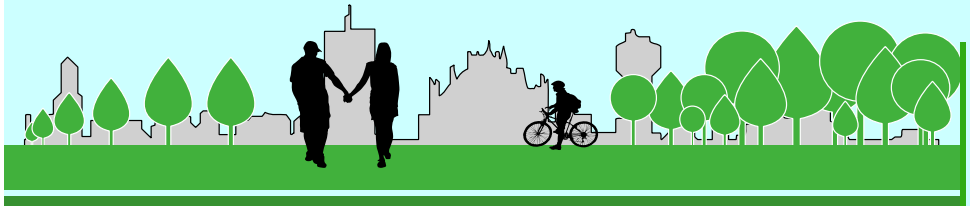
Introduction

Study area and methods

Main results

Discussion of key findings

Management implications and conclusion



Optimize tree-city-people complex

- Evident failure of some later districts and habitats to rear HT
  - Defend HT against negative forces
  - Ameliorate limitations in different habitats
  - Protect and provide conditions for HT
  - Create high-quality planting sites
  - Nurture proactively the future crop of HT
  - Treat trees as indispensable urban infrastructure
  - Establish professional-scientific arboricultural team
  - Enact tree ordinance
  - Improve and consolidate tree management structure

Conclusion

- Conspicuous urban landscape elements
  - Antithesis of urbanization
  - Needs extra efforts and ingenuity to sustain
- A precious inheritance
  - Product of fortuitous and serendipitous circumstances in the past
    - Normally inheritable and should be inherited to future generations
  - Overhaul attitude and mentality
    - Arrest the decline
    - Replenish and refurbish the HT stock
    - Act before it becomes irreversible
    - Wise and visionary application of knowledge

The End
Questions and Comments are Welcome