Fragmentation and rehabilitation of urban forests in relation to new town development

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I
Introduction

Research context

Enhancing urban forest in the course of urbanization

Strategy

- Planned synergy: between nature and city
- Town plan: sympathetic to pre-urbanization ground truth
- Urban green infrastructure: inherited (remnant or relict) and created
- Geometry of forest cover: pattern and distribution
- Proximity and accessibility: between city (people) and nature
- Distribution and connectivity: peri-urban and intra-urban forests

Aims

- Quality of life and environment
- Ecosystem services
- Sustainable and smart cities
- Compact cities: more critical concern and need
- Compact cities: more physical and institutional constraints

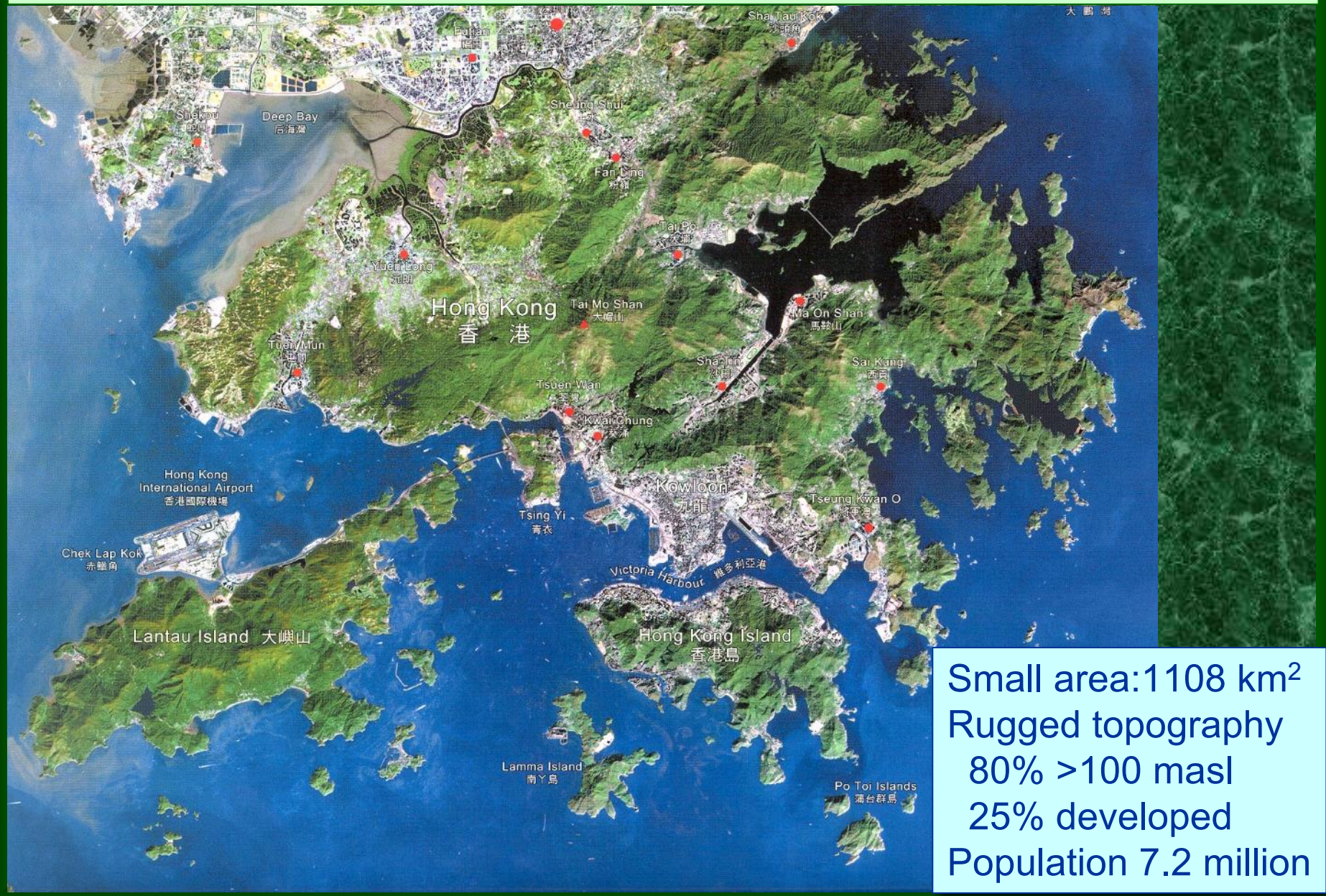
Study objectives

Effects of new town development on urban forest

- Case study: Tai Po new town in Hong Kong
- Track changes before and after urbanization
- Map spatial pattern and distribution of forest
- Assess forest condition and performance
- Explore factors and processes leading to modifications
- Apply findings to nature conservation in new town development and urban growth in developing countries

II
Hong Kong: Contrast between City and Countryside

City contrasting with countryside



Small area:1108 km^2
Rugged topography
80% >100 masl
25% developed
Population 7.2 million

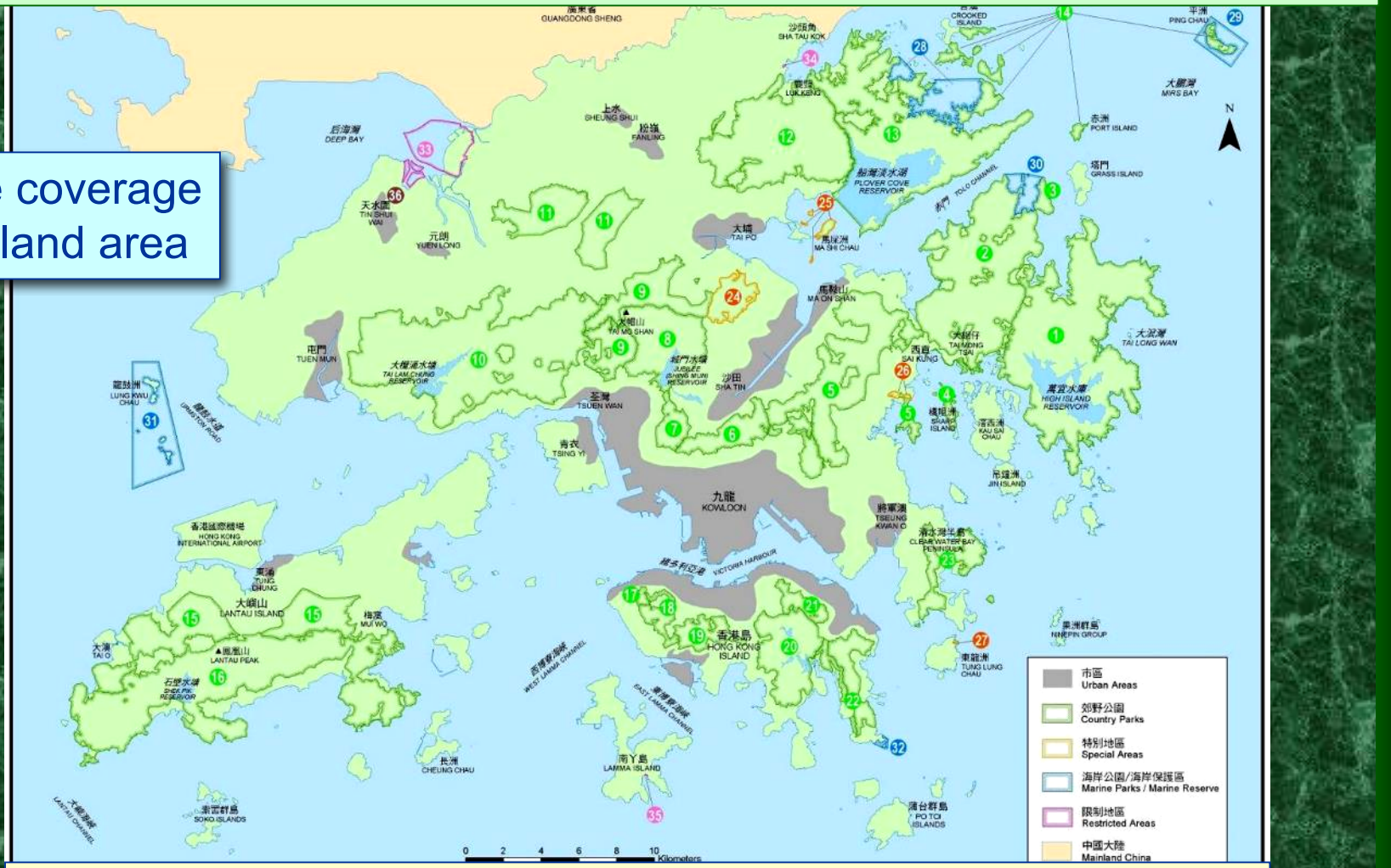
Extremely compact city

- Ultra-compact and vertical city
  - High building density
  - High population density
  - High road & vehicular density
  - High human-land ratio
- Limited open and plantable space

Scenic, bucolic & serene countryside

Comprehensive & extensive protected-area system

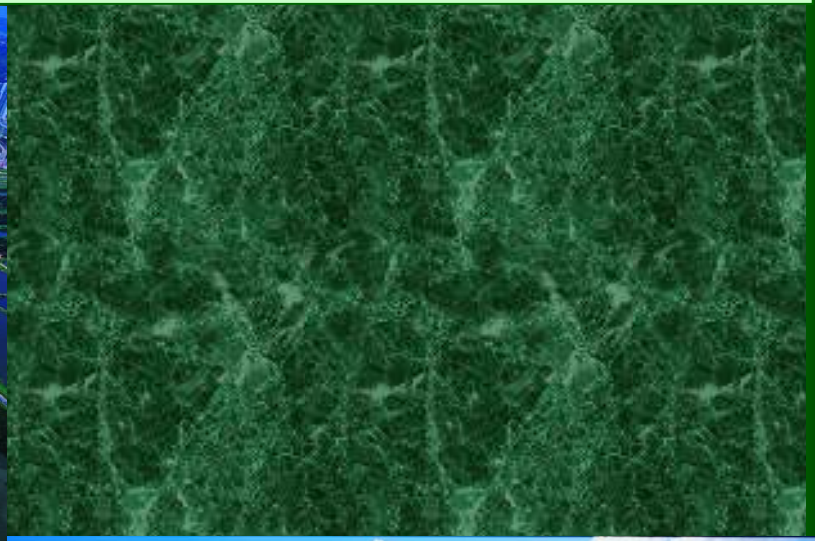
Extensive coverage
~40% of land area

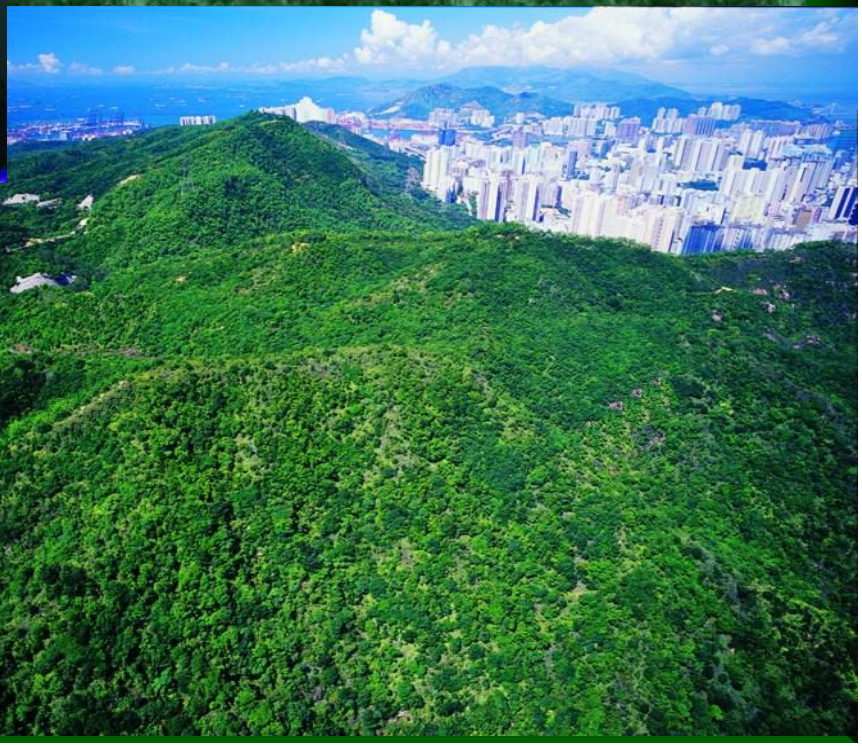


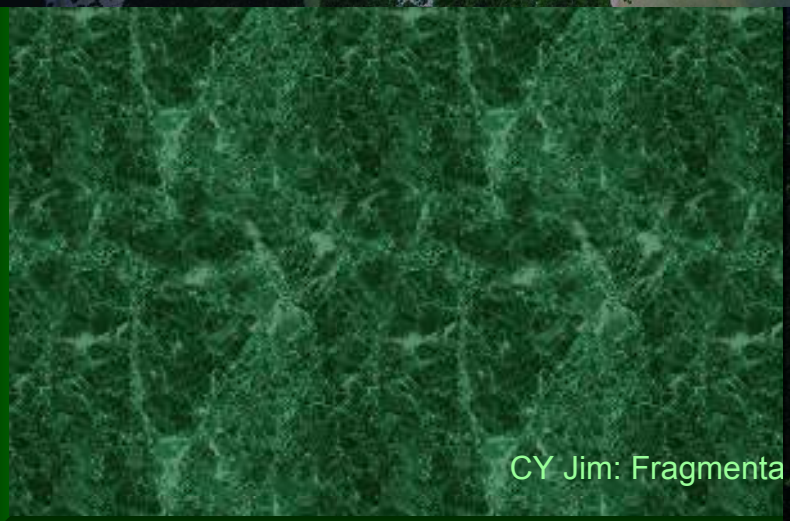
IUCN Category V Protected Areas (PA)

- Semi-natural and managed ecosystems
- Co-existence of protection, normal economic activities, recreation and tourism

New town in former rural and undeveloped land



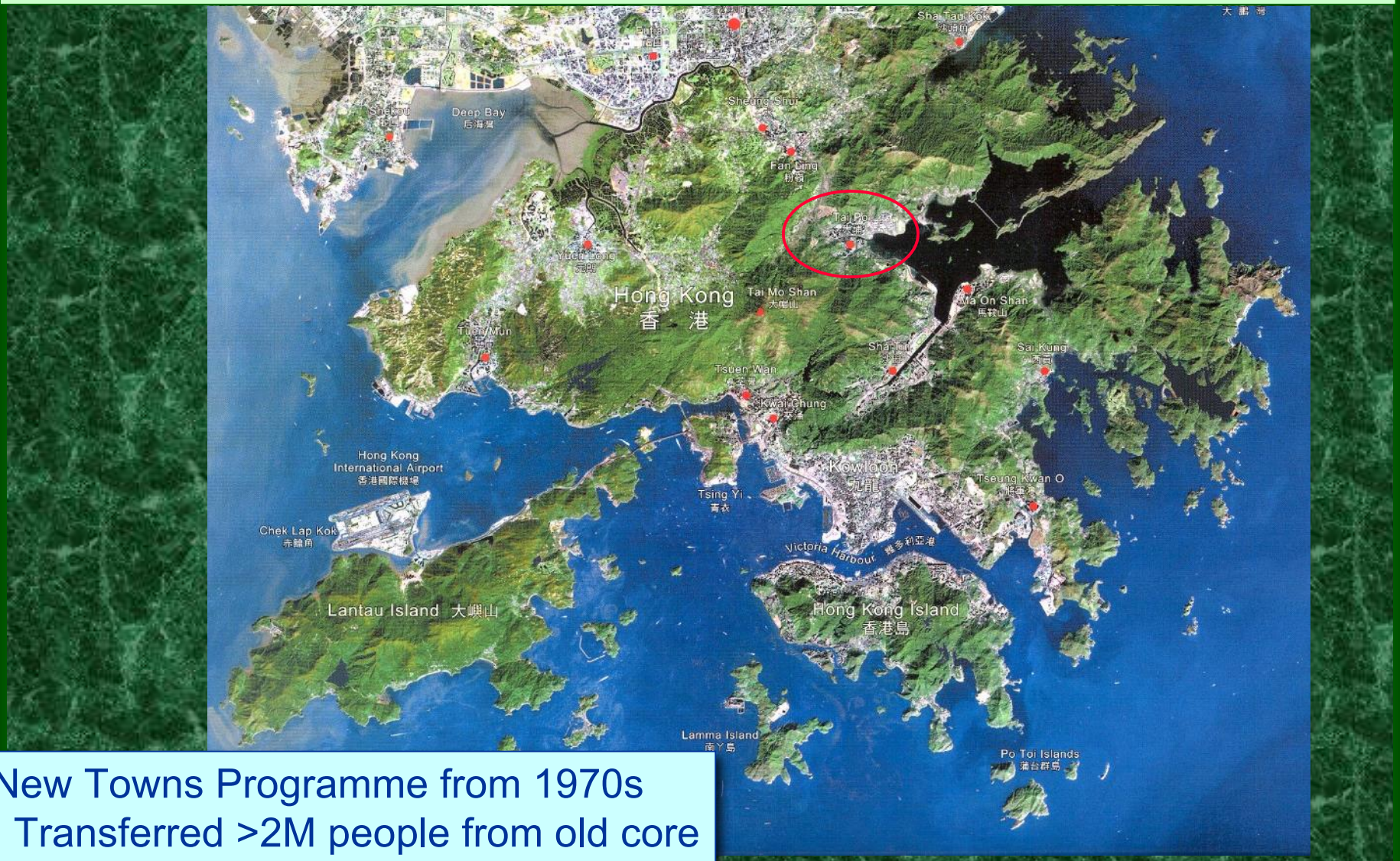




CY Jim: Fragmenta

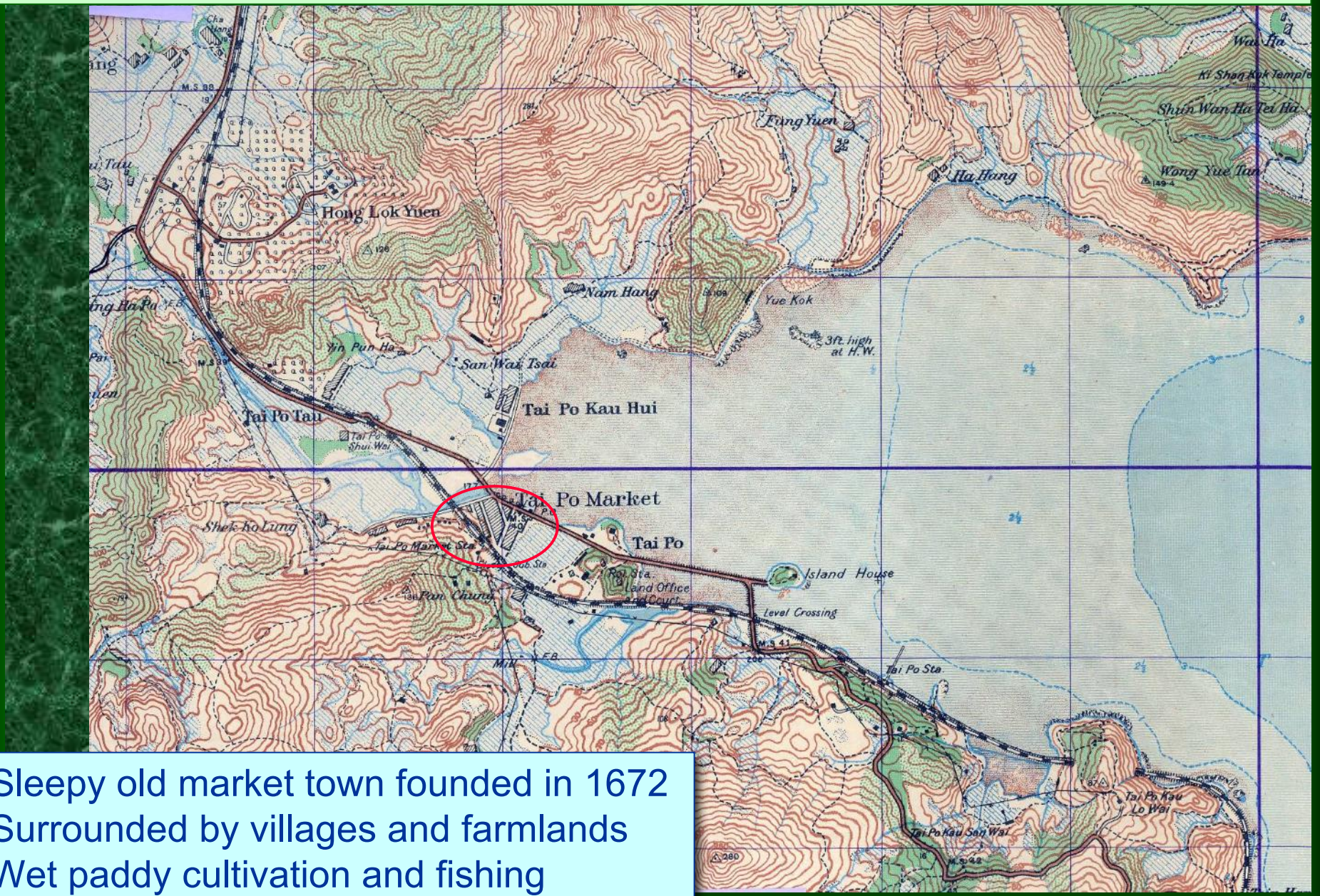
III
Study Area

Tai Po New Town: location



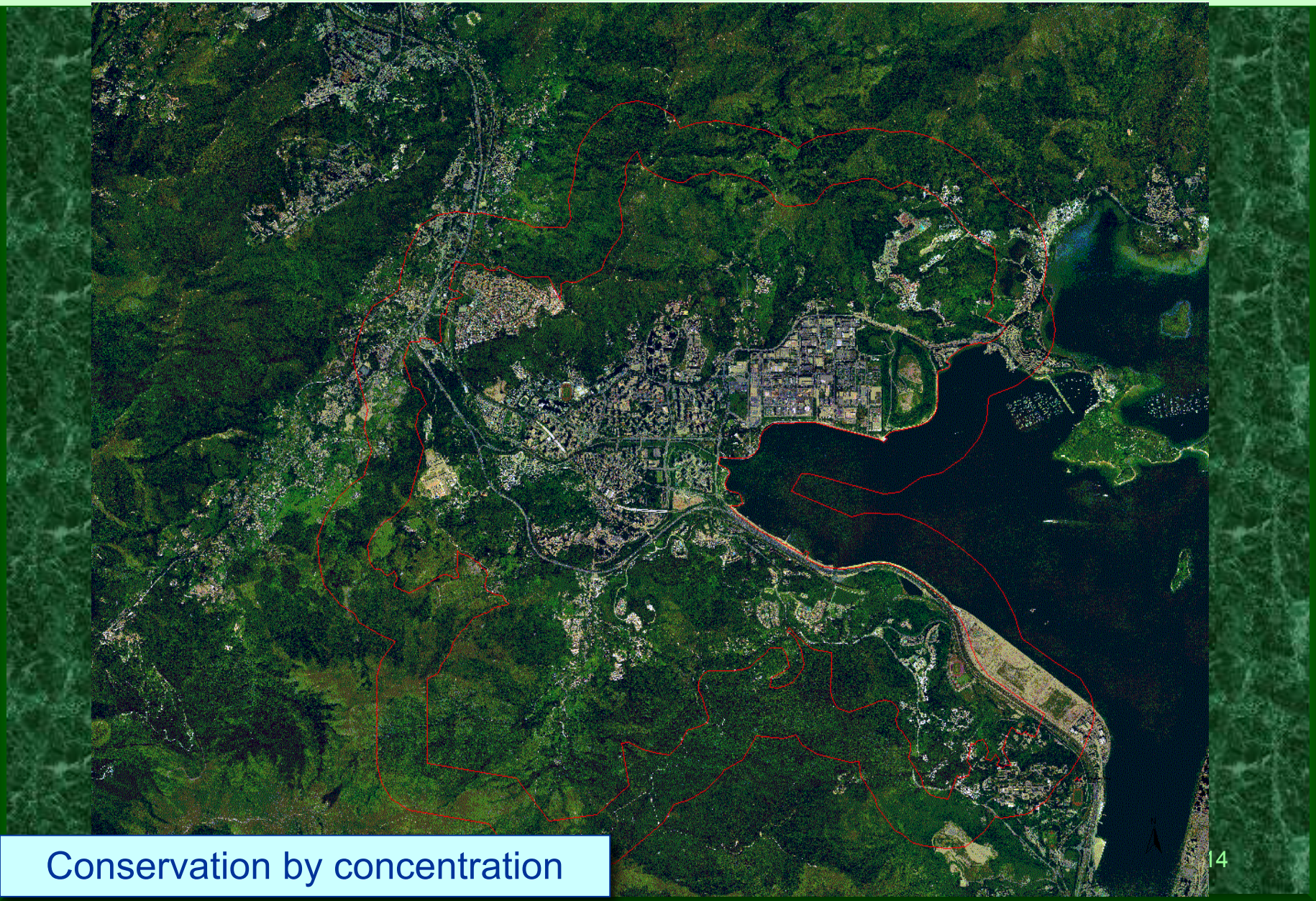
New Towns Programme from 1970s
  Transferred >2M people from old core
Tai Po New Town established in 1979
  In New Territories (rural hinterland)

Tai Po old market towns (1945 map)



Sleepy old market town founded in 1672
Surrounded by villages and farmlands
Wet paddy cultivation and fishing

Tai Po location: aerial photo



Conservation by concentration

Tai Po: oblique aerial view

Compact development
- High density
- High rise

Green belt in urban fringe

IV
Forest Canopy Changes

Evaluation of peri-urban and intra-urban forest cover

Macro-scale forest canopy cover

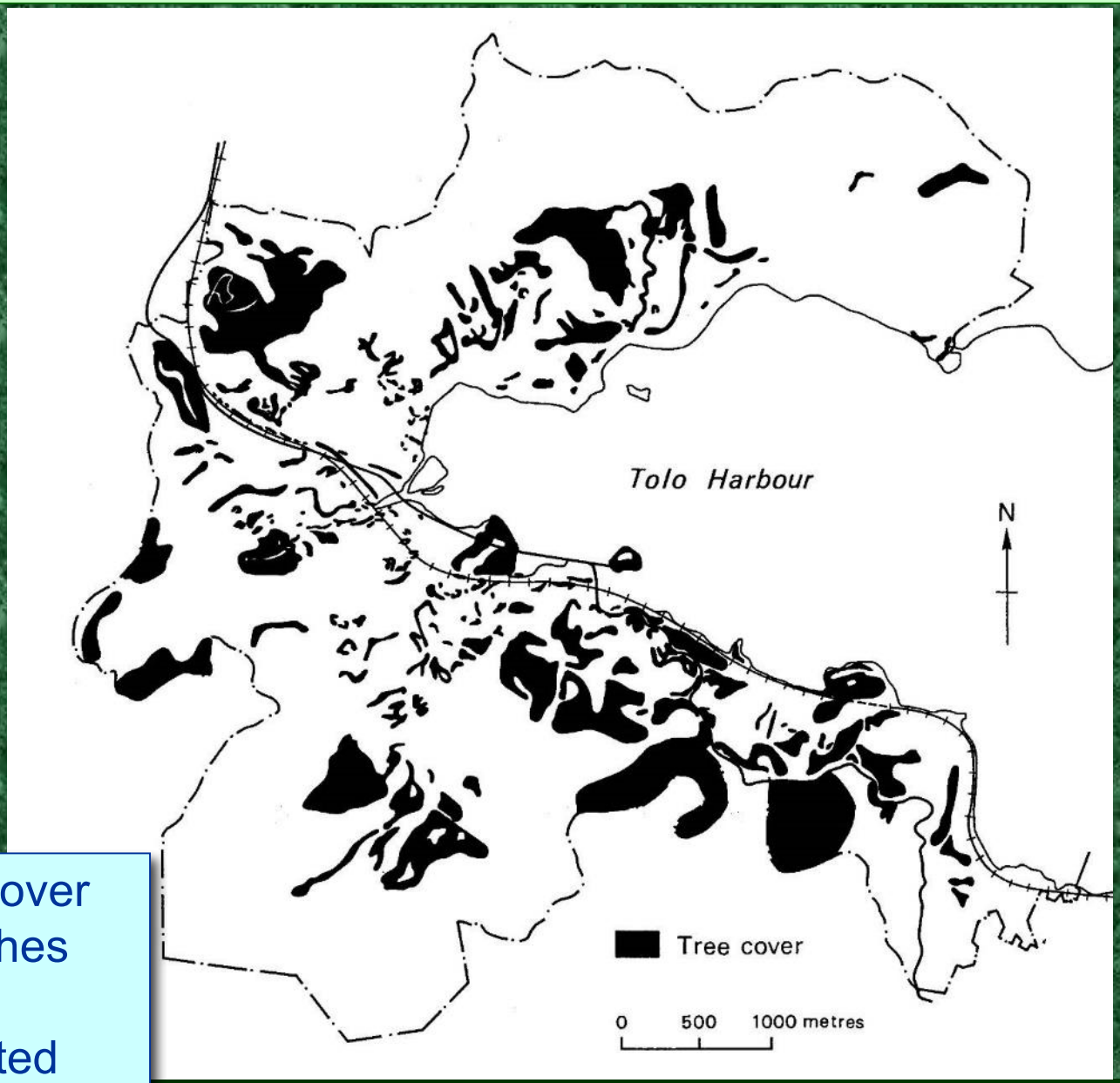
Scope

- Pre-urbanization (3 phases) and post-urbanization (2 phases) periods from 1950s to 2000s
- Reconstruction of forest cover in landmark years
- Size, shape, continuity and fragmentation of forest patches
- Town core area (intra-urban) and hinterland envelope (peri-urban)

Data sources

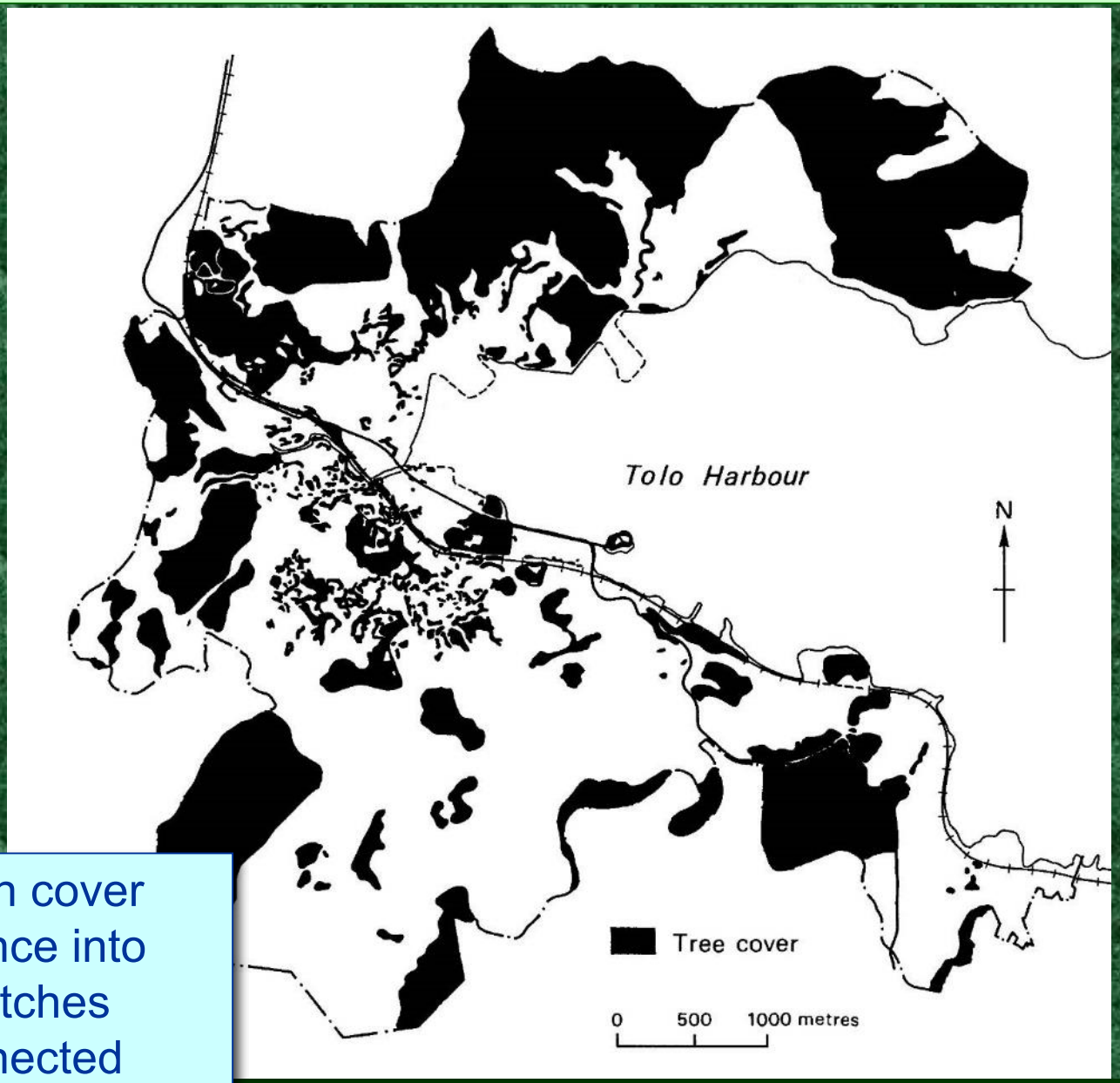
- Large-scale sequential aerial photographs
- Topographic maps of different years
- Land use maps
- Government documents and records
- Field studies

Forest canopy in 1956



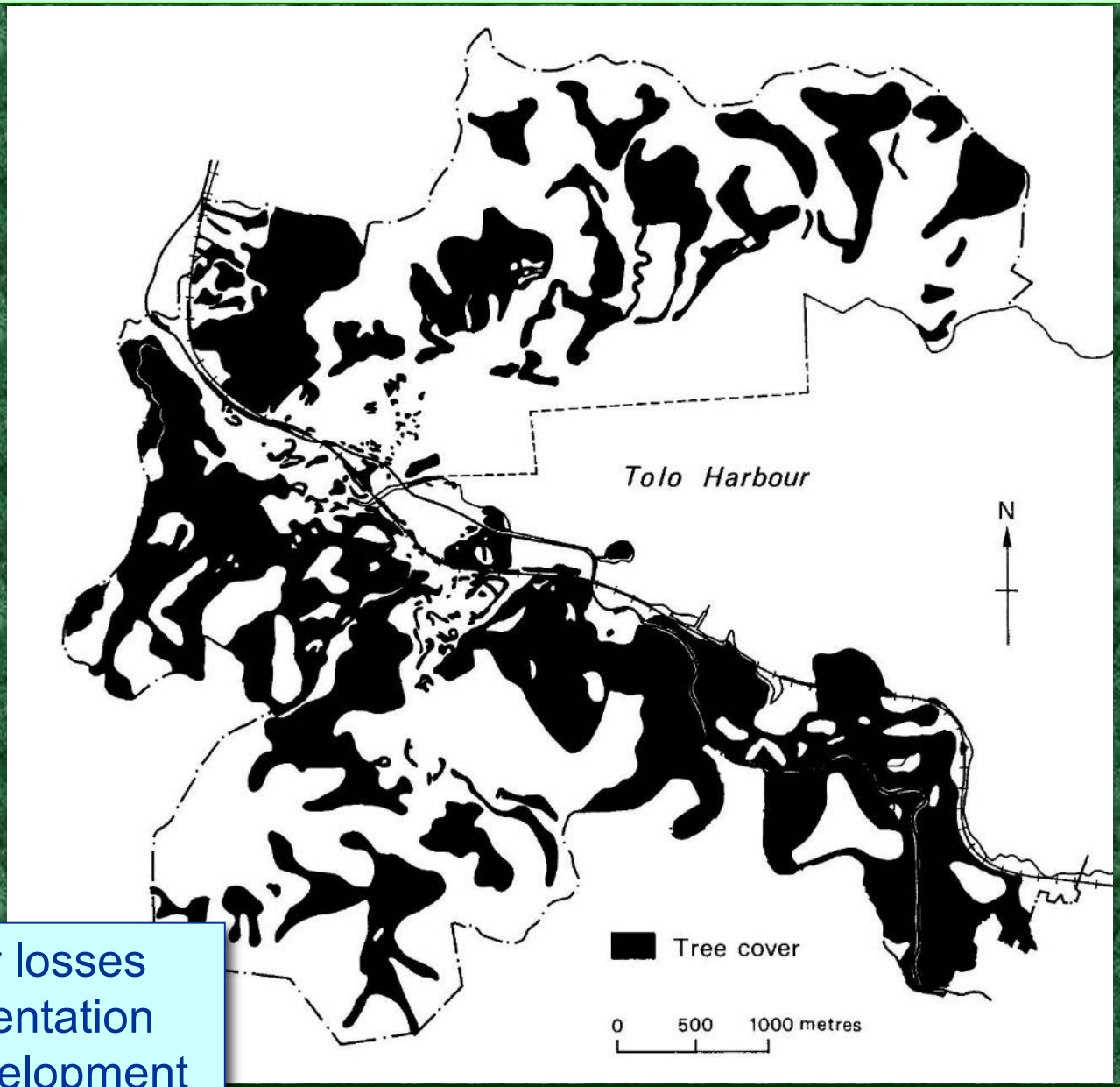
Low total cover
Small patches
Scattered
Disconnected

Forest canopy in 1969



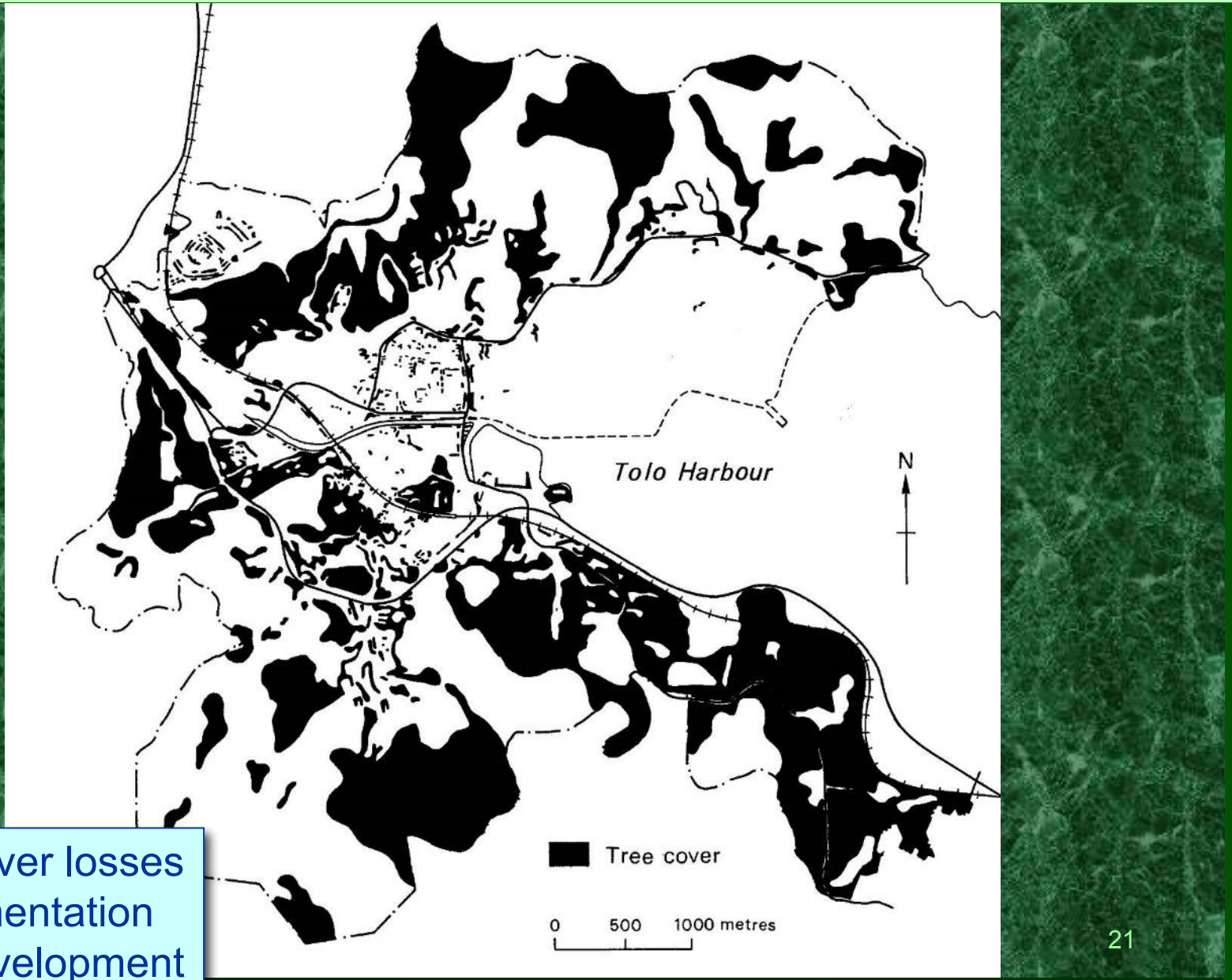
Increase in cover
Coalescence into larger patches
More connected

Forest canopy in 1978



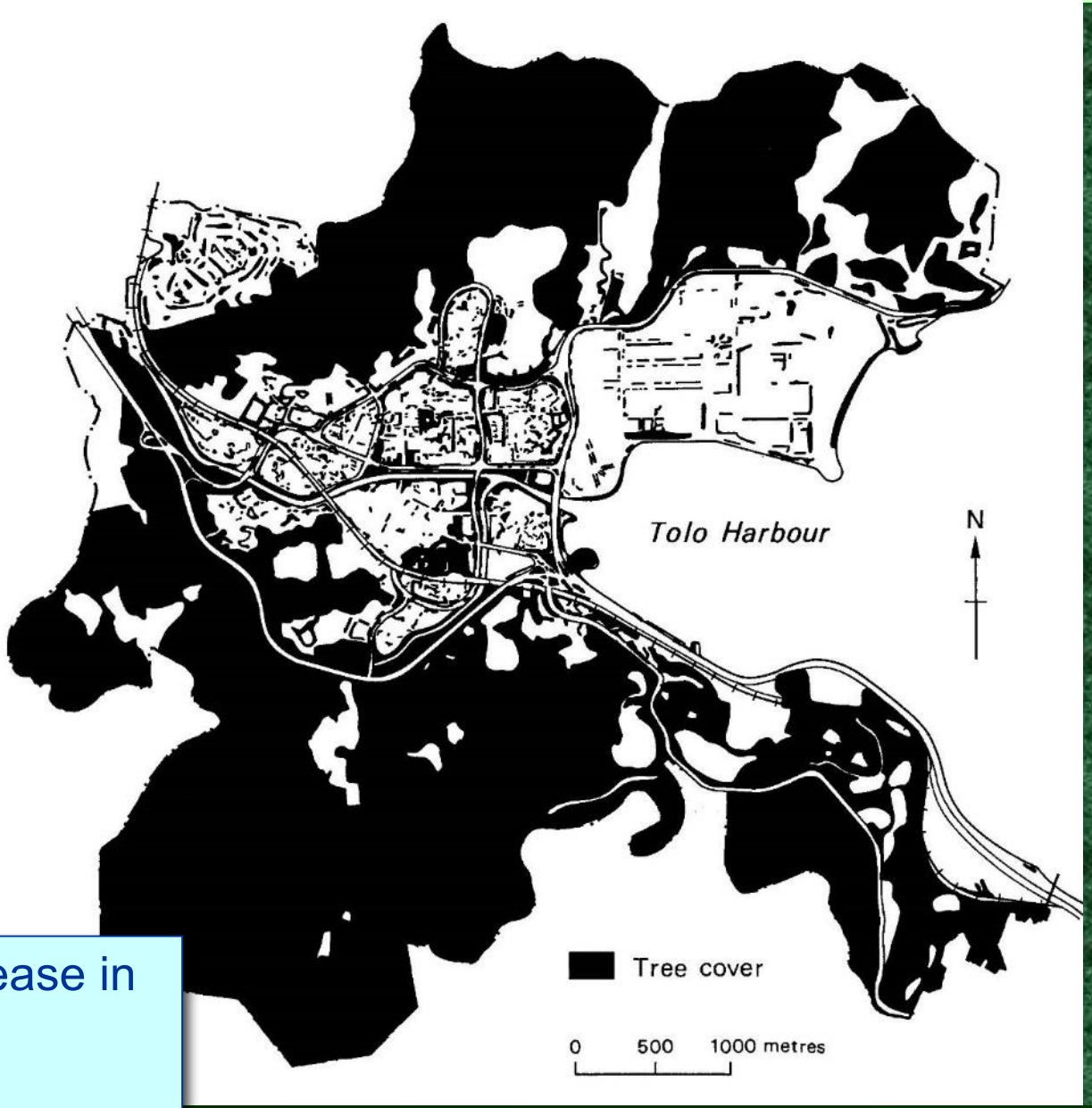
Some cover losses and fragmentation due to development

Forest canopy in 1986



Further cover losses and fragmentation due to development

Forest canopy in 1998

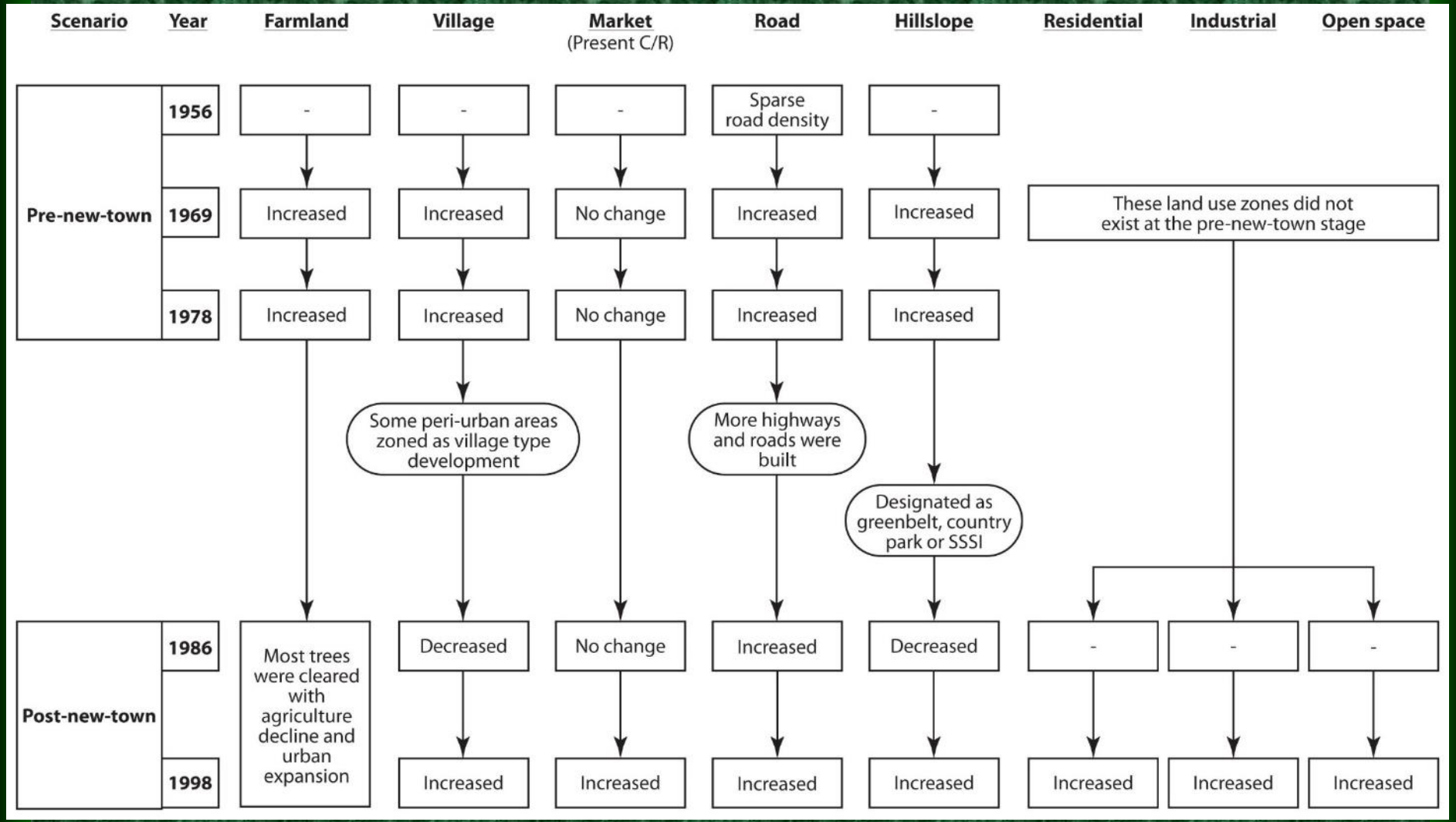


Notable increase in cover and continuity enveloping the

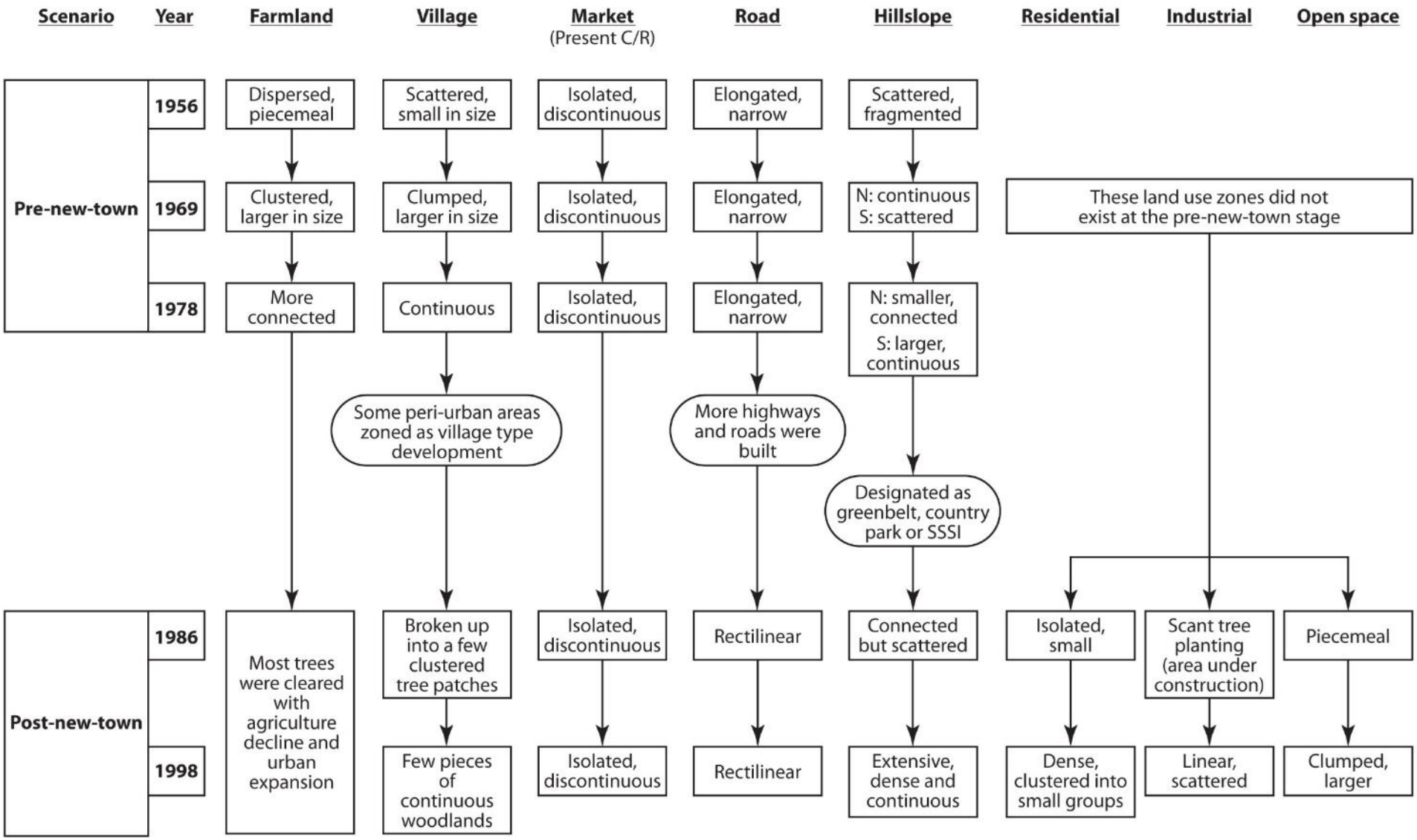
Forest canopy changes through time

Year	Tree canopy cover		
	Area (km ^{2})	Change between periods (%)	Change from 1956 (%)
Pre-new-town scenario			
1956	3.7	-	100
1969	8.5	+129.7	129.7
1978	9.0	+5.9	143.2
Post-new-town-scenario			
1986	7.7	-14.4	108.1
1998	15.5	+101.3	318.9

Forest canopy changes in configuration



Forest canopy changes in distribution pattern



V
Synopsis of findings

Synopsis of spatial changes in forest cover

Initial drop followed by significant enhancement

After 30 years of intensive new town development

- ~3 times increase against 1956 baseline
- ~1.5 times increase against 1979 (initiation of new town)
- Maturity and stability: town plan and fabric, greenery cover

New town area at 3500 ha

- Total urban forest cover at 1550 ha (44.3% of new town area)
- Peri-urban forest alone at 1220 ha
  - 34.9% of new town area
  - 78.9% of total urban forest area

Critical contribution of urban fringe slope

- Green belt
- Conservation area (country park and SSSI)

CY Jim: Fragmentation and rehabilitaton of urb

Synopsis of spatial changes in forest cover

Enhanced urban-forest attributes and functions

Geometric aspects

- Coverage
- Patch size
- Patch connectivity (linkage)
- Patch coalescence (aggregation)
- Tree size and biomass volume

Ecological and landscape aspects

- Vegetation structural complexity
- Species richness and diversity
- Ecological value
- Ecosystem services
- Landscape and scenic quality

Synopsis of spatial changes in forest cover

Main losses and fragmentation of pre-urbanization vegetation

Former farmlands in lowlands

- Few trees were preserved in new-town fabric
- Un-accommodating grade raising to form development land

Lower slopes at town fringe

- Earth fill borrow areas (can be rehabilitated)
- Urban incursion (permanent loss)

Synopsis of spatial changes in forest cover

Successful *green infilling*

Human input

- Afforestation in urban-fringe slopes
- Enrichment planting in simple or degraded forests (assisted succession)
- Planting in urban parks and greenspaces
- Planting at roadsides

Natural process

- Forest succession
- Continued growth of inherited trees

Urban-forest configuration

- Penetration and permeation of forest in urban matrix
- Allocating planting spaces with appropriate size, shape and location
- More tree cover than previous rural landscape

Ecological engineering of afforestation

Two-stage ecological-engineering approach to afforestation

- **Harsh initial site conditions**: eroded skeletal soil, moisture and nutrient deficit, hot and dry microclimate, windy exposure
- **Start with exotic pioneer species**: resistance to drought, fire, nutrient deficiency; nitrogen-fixing; fast-growing; high survival rate
- **Seedling planting method**: rather than direct seeding
- **Silvicultural input**: initial watering and weeding; thinning
- **Fast establishment** of woodland cover
- **Nursing crop**: trigger self-sustaining improvement in nutrient-capital accumulation, water-holding capacity, and microclimate conditions
- **Replacement of weaklings**: enrichment or fill planting by native equilibrium species; natural seed rain from proximal source areas
- **Simple exotic-pioneer floristic** to **diverse relay native floristic**
- **Enhance forest restoration**: pace, quality and diversity

The End
Thank You

Questions and Comments are Welcome