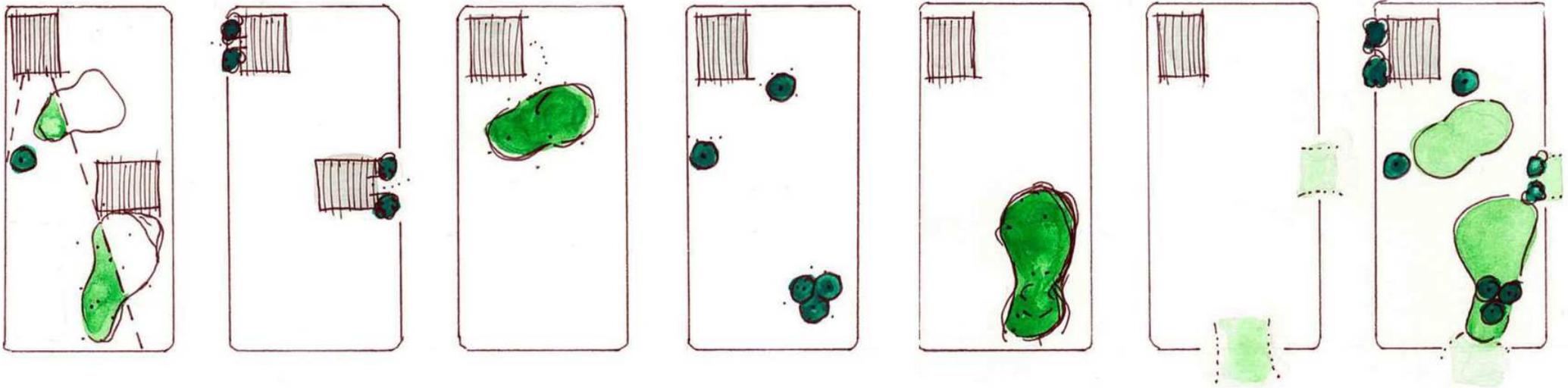# Greening Blocks.

Evidence-based design strategies to integrate health & climate resilience co-benefits of urban greening

Dr. Sara Barron. Lecturer. Master of Urban Forestry Leadership. University of British Columbia

The team.

Angie Woo
Fraser Health Authority

University of British Columbia

University of Washington

Xinke Yu
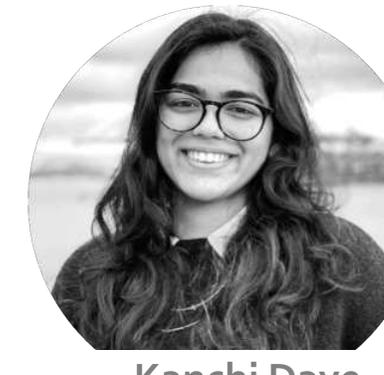University of Hong Kong

University of British Columbia

University of British Columbia

Erin Desautels
City of Surrey

Sara Barron
University of Melbourne

Kanchi Dave
University of British Columbia

The challenge.

- Urban green provides broad and diverse social, economic, & ecological **co-benefits**.
- Few studies **combine human health & climate** concerns in the context of green space.
- Few municipal plans provide **actionable strategies** for solutions targeting co-benefits.
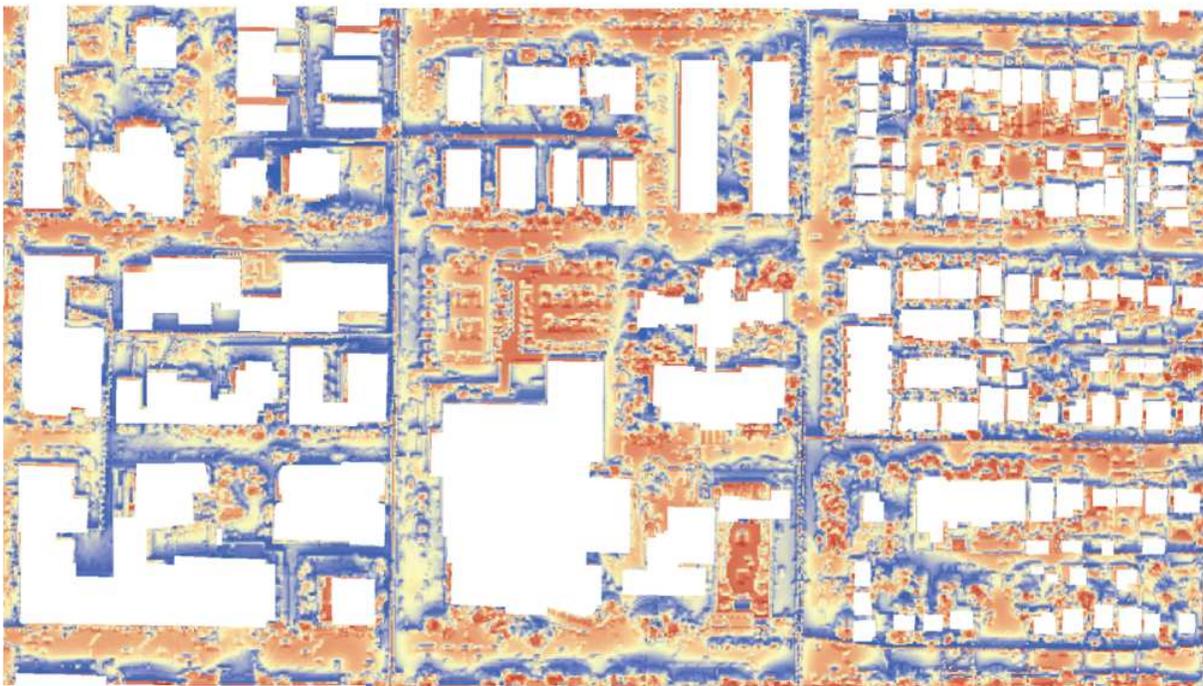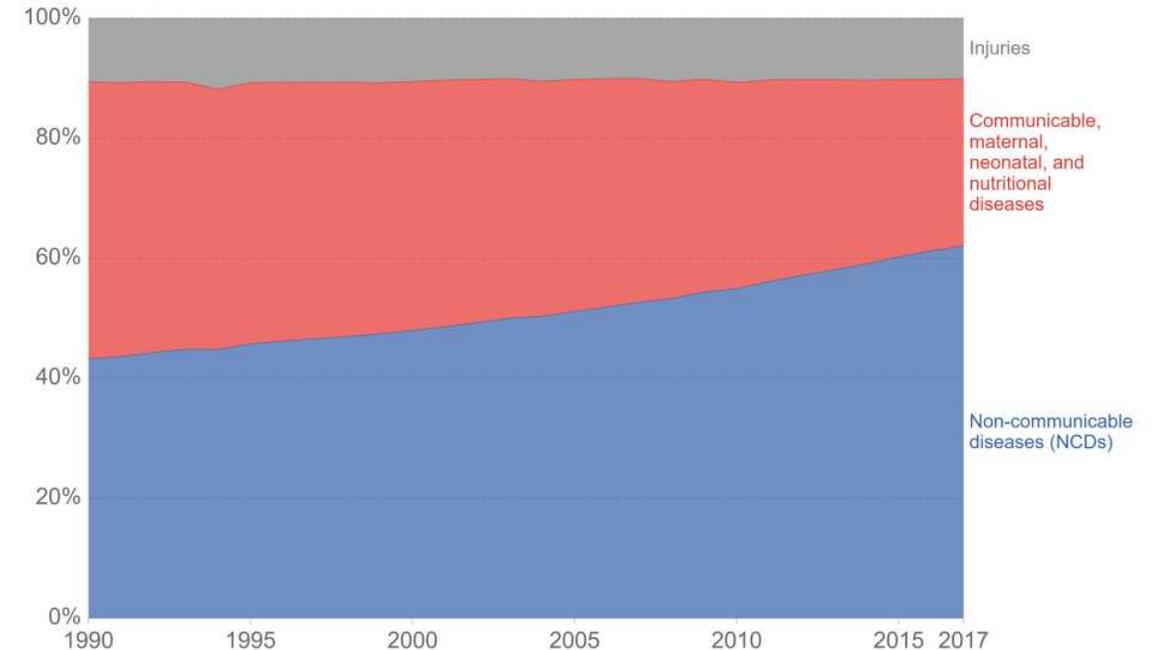

Image Credit: Collaborative for Advanced Landscape Planning (CALP) – Xinke Yu

Total disease burden by cause, World, 1990 to 2017

Total disease burden measured as Disability-Adjusted Life Years (DALYs) per year.
DALYs measure the total burden of disease – both from years of life lost due to premature death and years lived with a disability. One DALY equals one lost year of healthy life.

Injuries

Communicable, maternal, neonatal, and nutritional diseases

Non-communicable diseases (NCDs)

Source: IHME, Global Burden of Disease

Scale.

Scales of urban green design: individual unit to the neighbourhood.
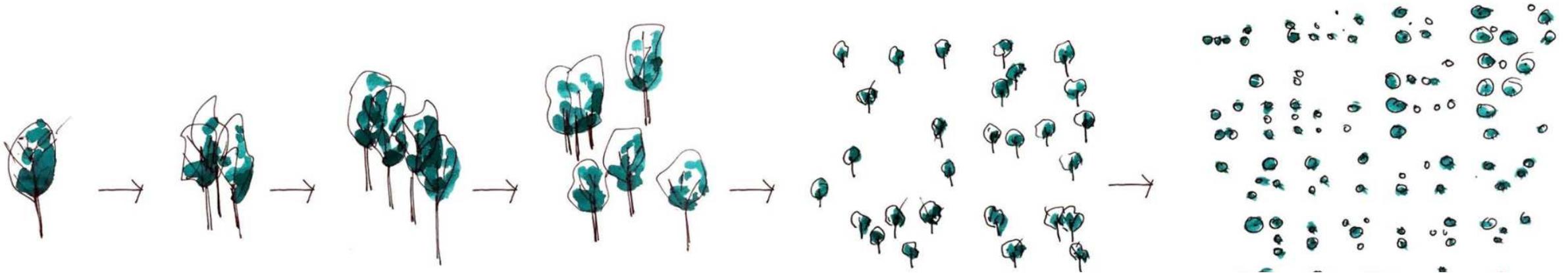
"Local communities are where humans use landscapes to make a living and contribute to their quality of life, and where they adapt landscapes to create value from landscape services or prevent loss from external pressures such as climate change" (Opdam et al. 2013, p. 1441).

Experience.

Compelling guidance to enable interdisciplinary stakeholders to apply evidence-based interventions to create, expand, or enhance urban green space in their communities.

- experiential pathway of green design interventions -
from inside a building to encounters with neighbourhood green space
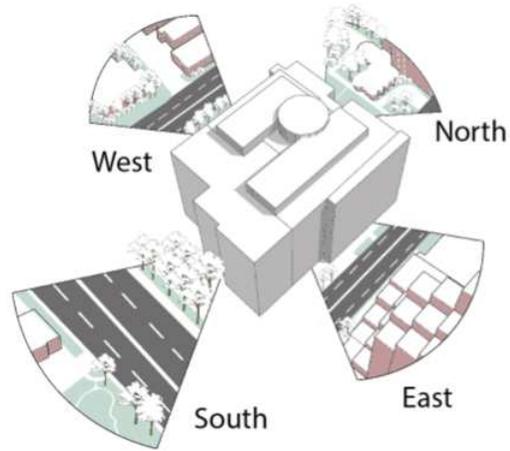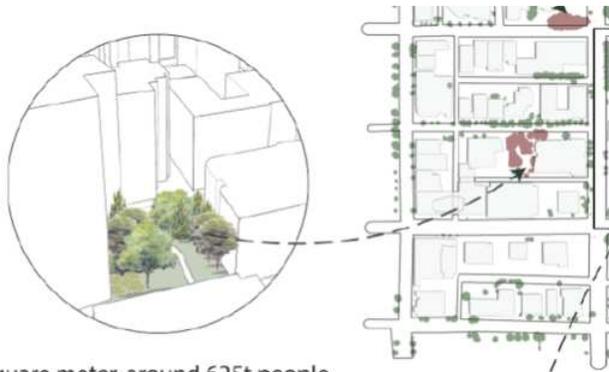
The typology.

Image Credit: CALP – Xinke Yu

1250 square meter, around 625t people
(private green space with public access)

Image Credit: CALP – Xinke Yu

Design Intervention	Anticipated Climate and Health Co-benefits
	● Visual biophilic experiences
1. View from Within	● Wildlife habitat and biodiversity
	● Stormwater mitigation
	● Social gathering space
2. Plant Entrances	● Orientation/navigation
	● Shade provisioning/cooling
	● Building energy savings (depending on aspect)
	● Social gathering space
3. Bring Nature Nearby	● Shade provisioning/cooling
	● Wildlife habitat provision and biodiversity
	● Stormwater mitigation
	● Air filtration
4. Retain the Mature	● Shade provisioning/cooling
	● Building energy savings
	● Carbon storage and sequestration
	• Visual biophilic experiences
5. Generate Diversity	● Wildlife habitat provision & biodiversity
	● Climate Resilience
	● Social gathering space for cohesion and enhanced social capital
6. Create Refuge	● Shade provisioning
	● Air filtration
	● Wildlife habitat and biodiversity
	● Visual biophilic experiences
7. Connect Experiences	● Shade provisioning/cooling
	● Wildlife habitat provision and biodiversity (e.g. ecological corridors)
	● Stormwater mitigation
	● UHI mitigation
8. Optimize Infrastructure	● Carbon storage and sequestration
	● Stormwater mitigation
	● Wildlife habitat provision and biodiversity

The methodology.

Qualifiable and easily replicable metrics that are measured against goals and visualized for easy understanding
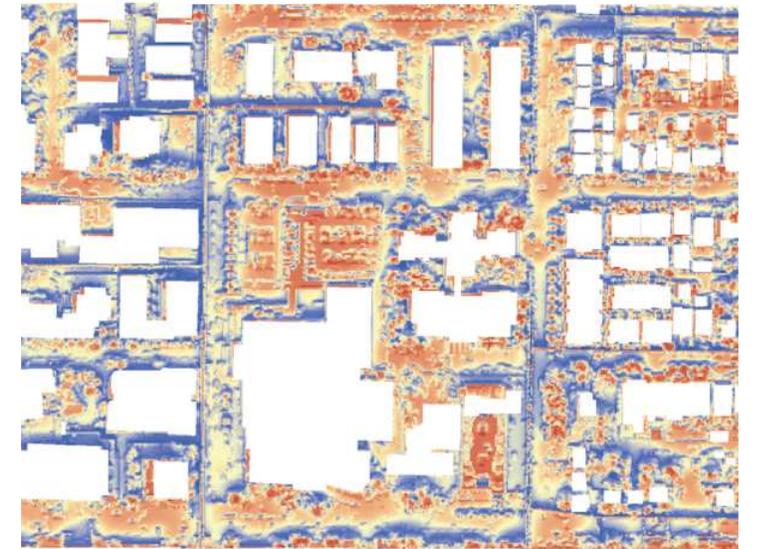

Image Credits: CALP

1 *View from Within*

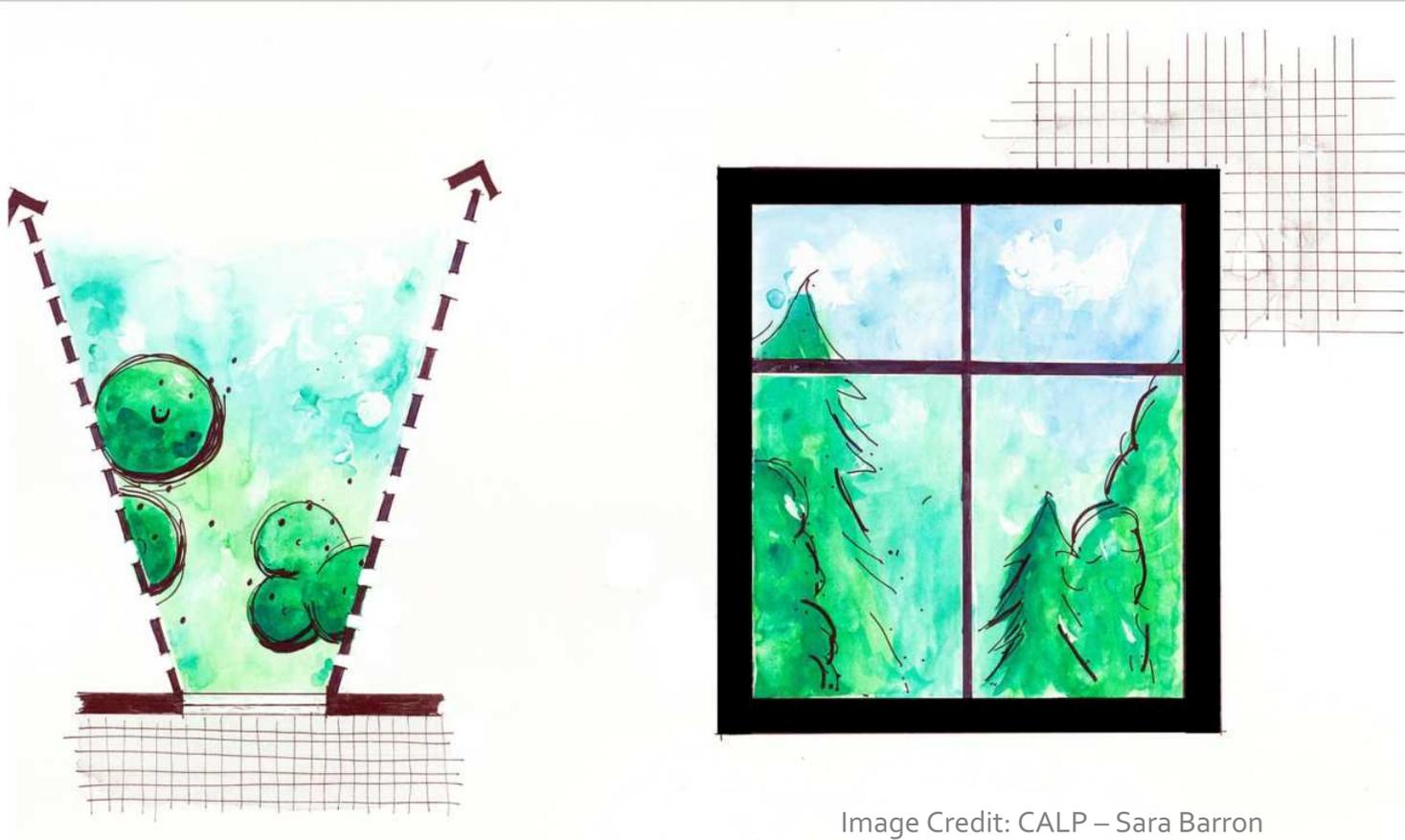Have you considered the view from within when implementing urban greening?

Image Credit: CALP – Sara Barron

Studies show that green views from buildings increase productivity and provide restorative benefits. Green that shades windows will also reduce energy use of a building.
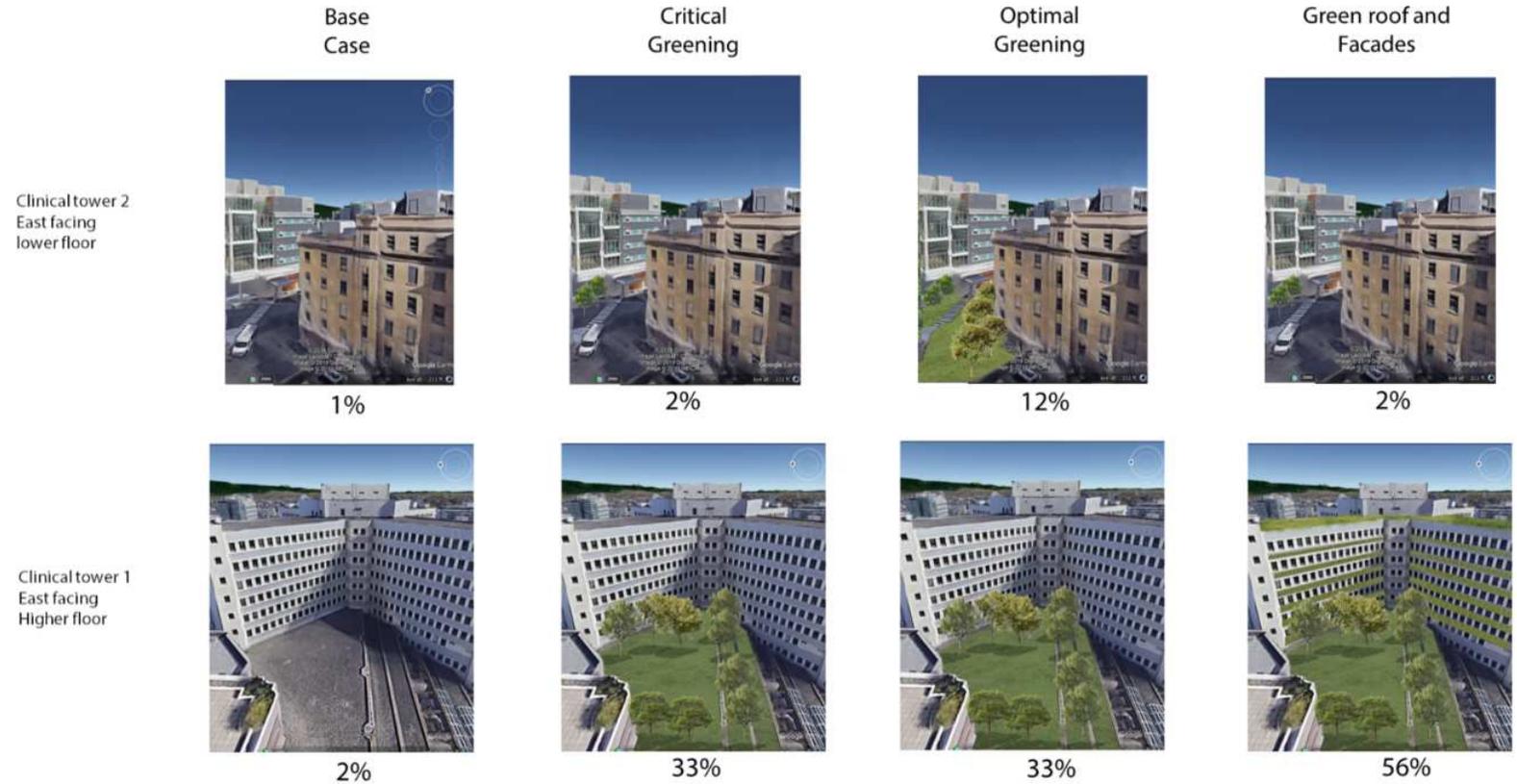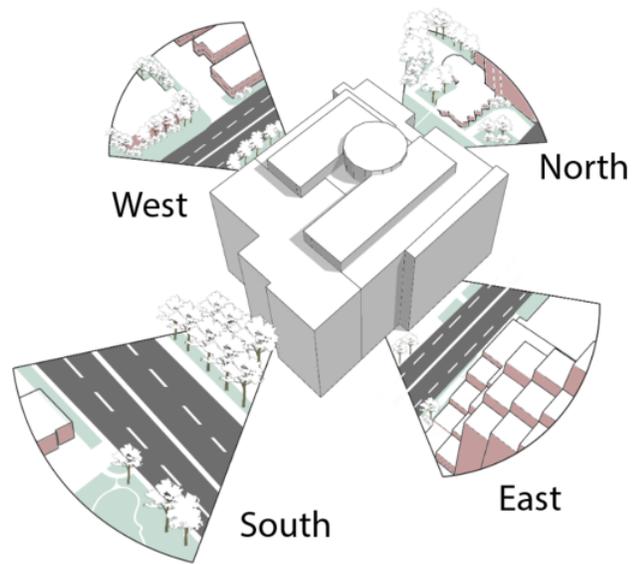Ulrich 1984
Kaplan 1993
Lee et al. 2015

1 *View from Within*

Metric: % green to grey in view
Goal: all of views with at least 30% green to grey ratio

Image credit: CALP - Xinke Yu and Kanchi Dave

2 *Plant entrances*

Green entrances create opportunity for all building visitors to experience some nature in their day. Do your entrances have a welcoming green frame?
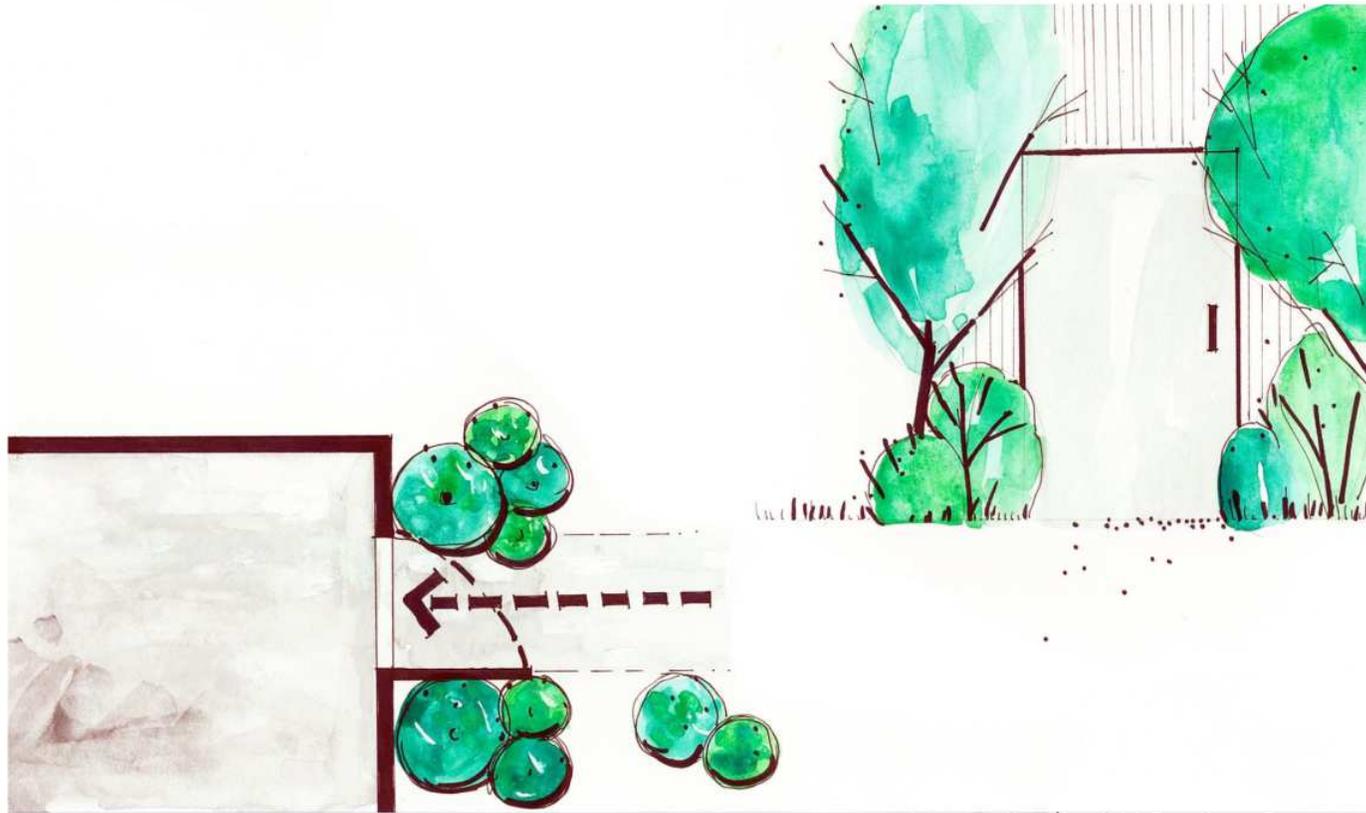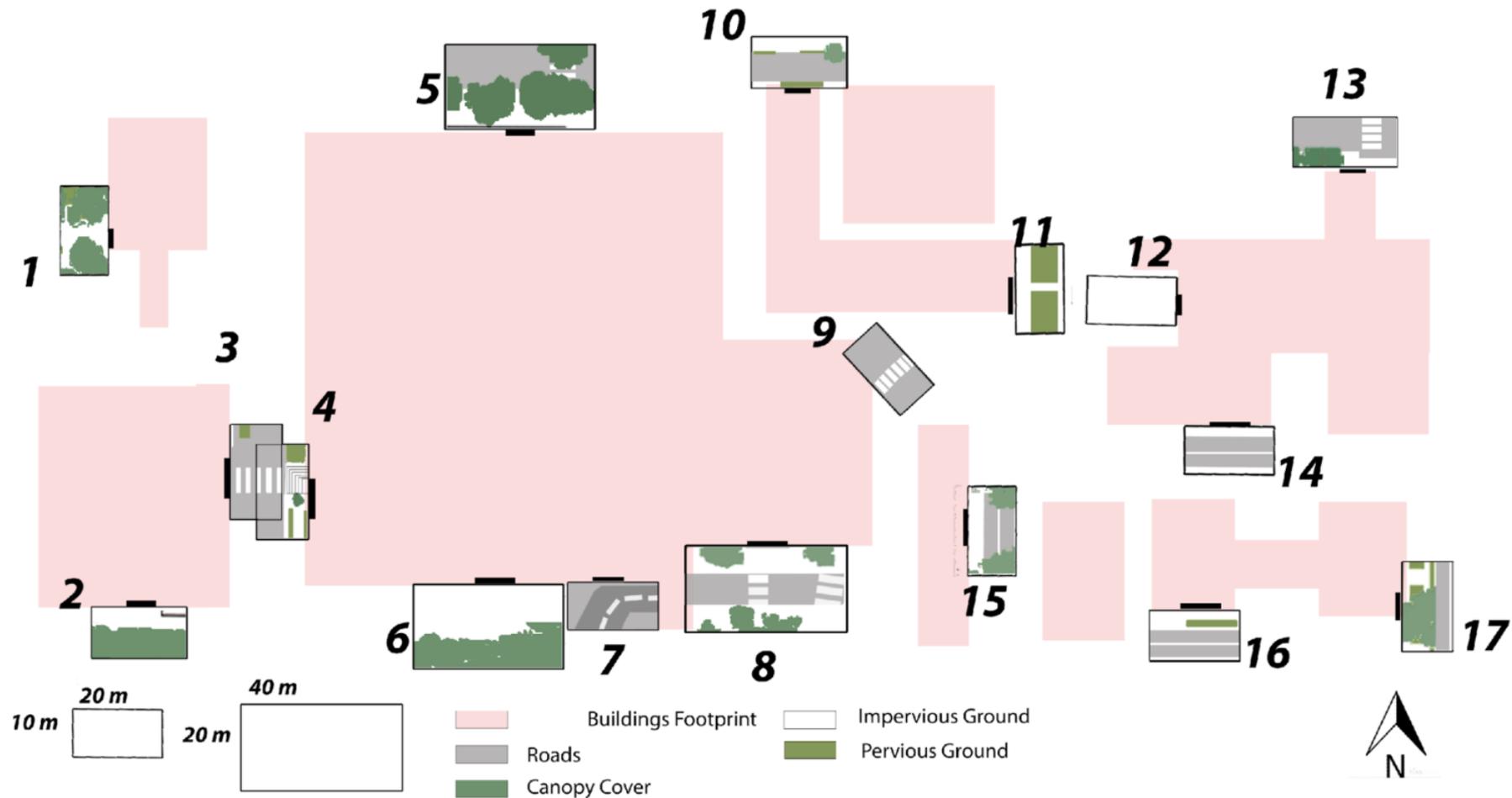
Image Credit: CALP – Sara Barron

Studies show that green near entrances increases social activity. Green entrances may also clean and cool air before it enters a building

Kuo 2002

2 *Plant entrances*

Metric:% green grey in immediate surrounding of entrance + evocative description entrance experience
Goal: all of entrances 50% green

Image credit: CALP, Xinke Yu & Kanchi Dave

3 *Bring nature nearby*

Not everyone can travel to a park or garden. Are there spaces near your building that can provide an opportunity to relax surrounded by plants?
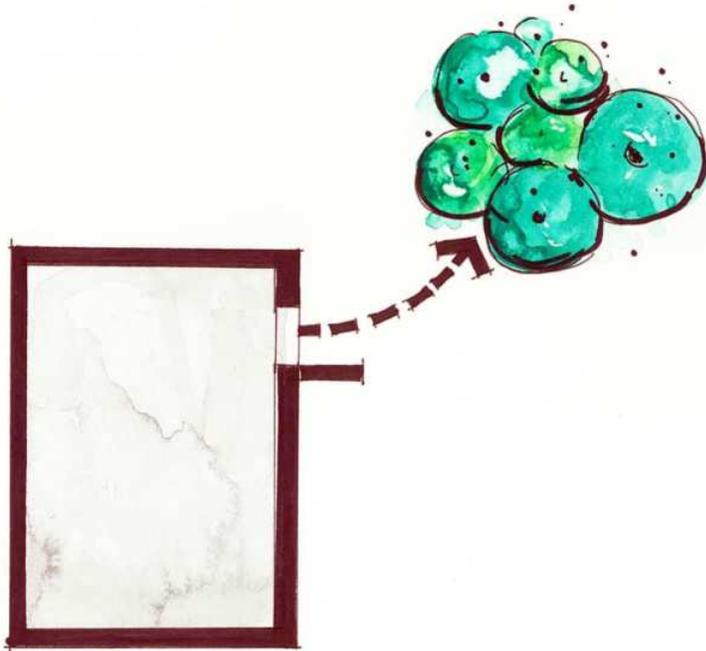
Image Credit: CALP – Sara Barron

Nearby green during pregnancy has been shown to increase health at birth. Having small greenspaces throughout a community can help manage stormwater locally.

Davadand 2014
Donovan 2014

3 *Bring nature nearby*

Metric: travel time to reach closest green space
Goal: all of floors <2 mins from nearby green

Base Case

Optimal Greening

Critical Greening

Green Roofs and Facades

Image credit: CALP, Kanchi Dave & Xinke Yu

4 *Retain the mature*

Large trees provide aesthetic and emotional benefit to people. When designing a landscape, have you retained mature trees?
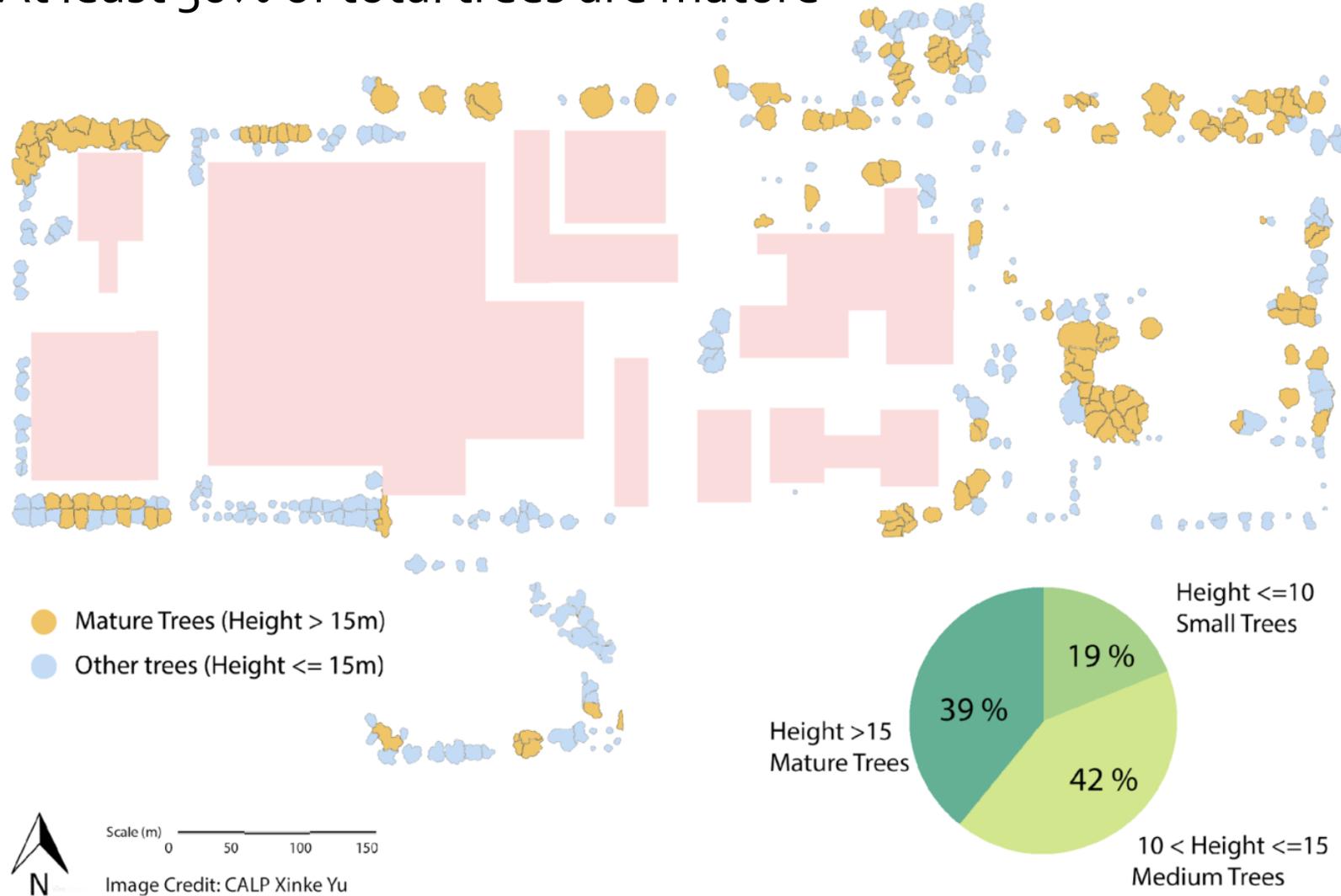
Studies have shown that people have a heightened response to large mature trees. Large trees also provide significantly higher ecosystem services than small trees.

Wolf 2004
Schroeder et al. 2006
Stagoll et al. 2012
Jim 2017

Image Credit: CALP – Sara Barron

4 *Retain the mature*

Metric: % of mature trees
Goal: At least 30% of total trees are mature

Mature Trees (Height > 15m)
Other trees (Height <= 15m)

Scale (m)
0   50   100   150

N

Image Credit: CALP Xinke Yu

Height <=10
Small Trees

19 %

39 %

Height >15
Mature Trees

42 %

10 < Height <=15
Medium Trees

5 *Generate diversity*

A more diverse urban forest will be more resilient to pests and diseases. Have you measured diversity in your greenspaces?
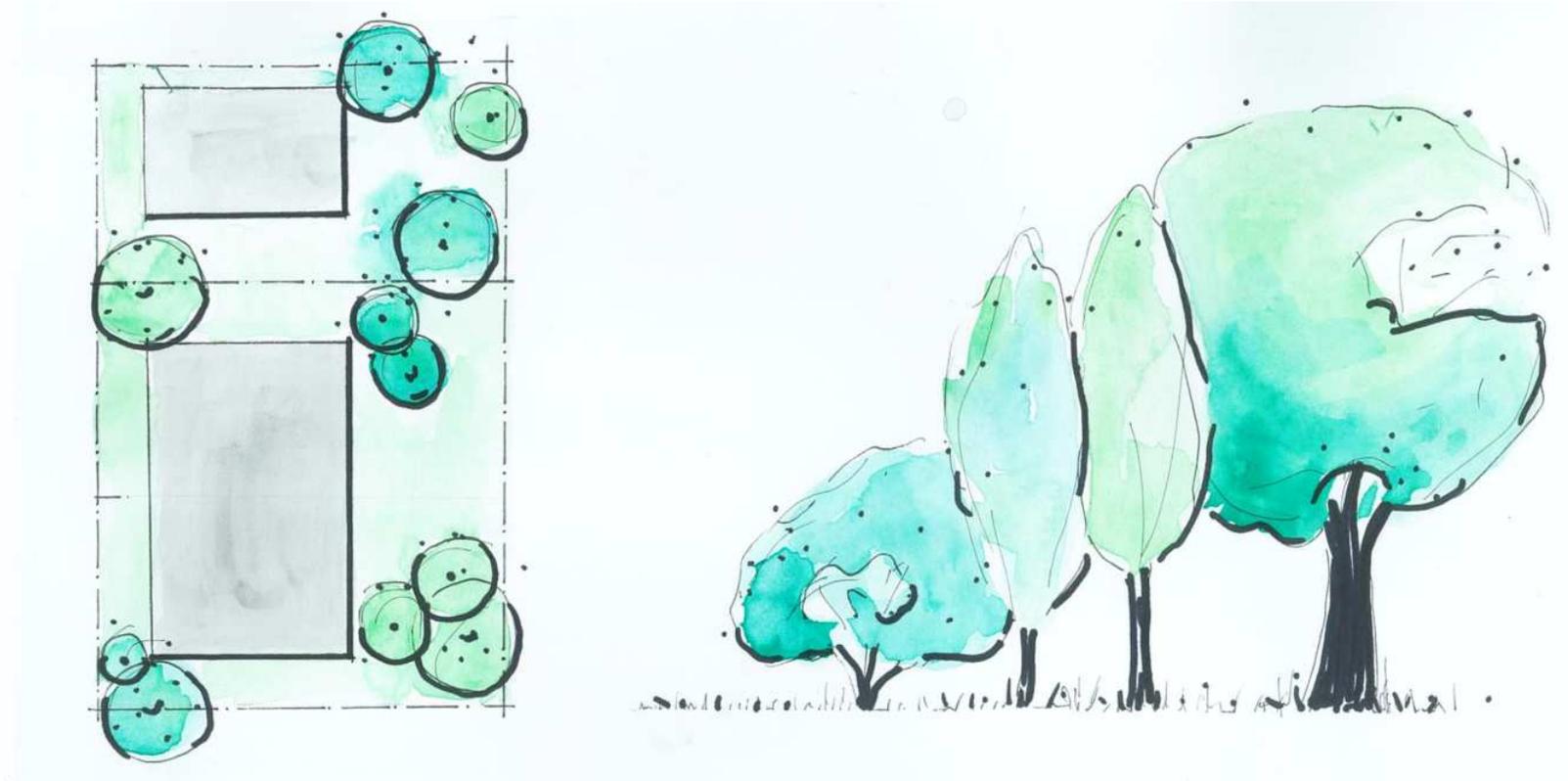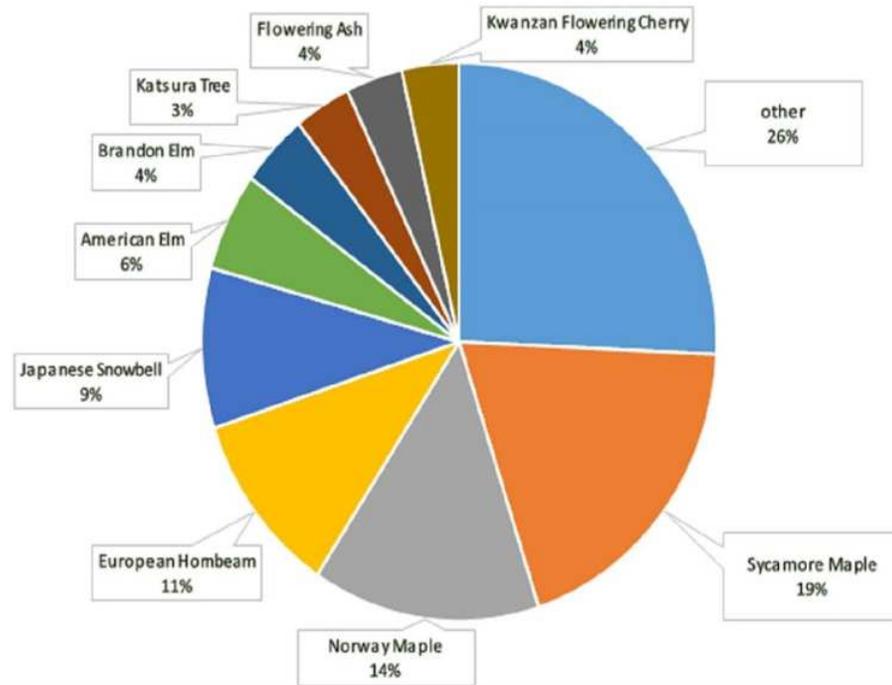
A more diverse urban forest will be more resilient to pests and diseases. Greater diversity could also provide aesthetic benefits.

Image Credit: CALP – Sara Barron

5 *Generate diversity*

Metric: Diversity of trees
Goal: Trees that are diverse, climate resilient and avoid eco-system disservices

street tree (public tree) species

Most common species of trees:

Sycamore Maple — **19%**

Norway Maple — **14%**

European Hornbeam — **14%**

6 *Create refuge*

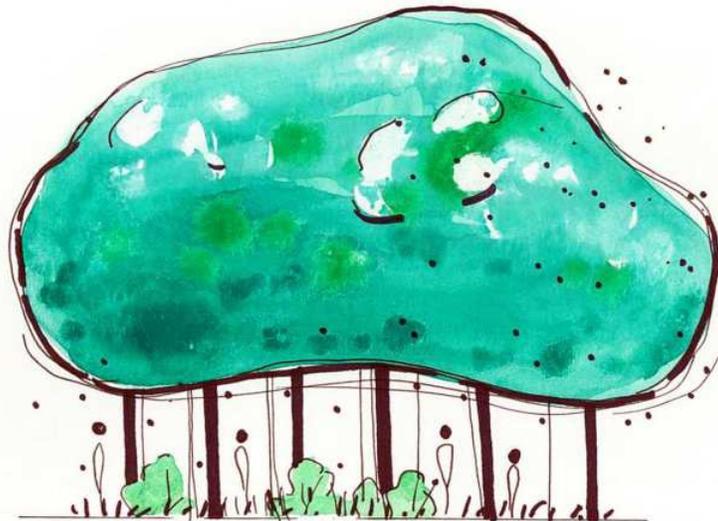Can green shade accommodate the population of an area during an extreme heat event?

Image Credit: CALP – Sara Barron

What happens in an urban heat wave if the power goes out? Shade from a large area of continuous canopy can provide a solution for shelter during a heat wave. Studies have also shown that large groups of trees provide higher cooling benefits..

Shanahan et al. 2015
Morakinyo et al. 2017

6 *Create refuge*

Metric: # of people accommodated under canopy
Goal: Enough refuge for daytime population

Crown Area
Refuge Area

1.

2. 1555 square meter, around 777 people

3. 2558 square meter, around 1279 people

4. 1814.5 square meter, around 907 people

1949 square meter, around 974 people

8.

2197 square meter, around 1098 people
- public green corridor

5. 6063 square meter, around 3031 people
- private green space with public access
- green corridor

7. 2141 square meter, around 1070 people
- green space near the parking lot

6. 563 square meter, around 281 people
- private green space with public access

4789 square meter - public greenway corridor
(**may not considered as a common refuge spot**
due to limited walking space on the street)

Scale (m)
0   50   100   150

N

Image Credit: CALP, Xinke Yu

7 *Connect experiences*

Can people walk continuously along a shaded pathway?
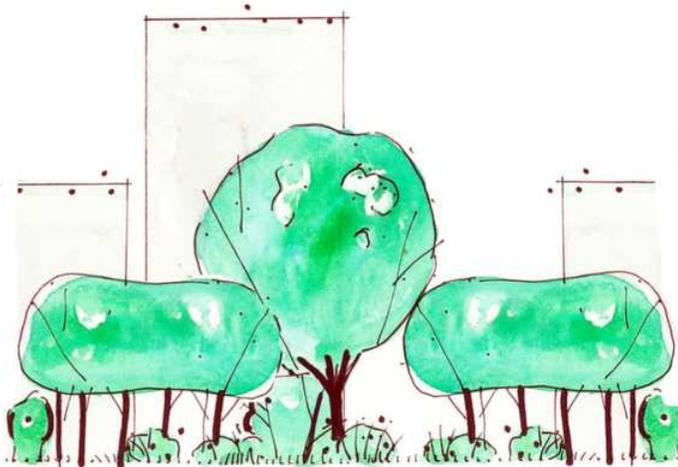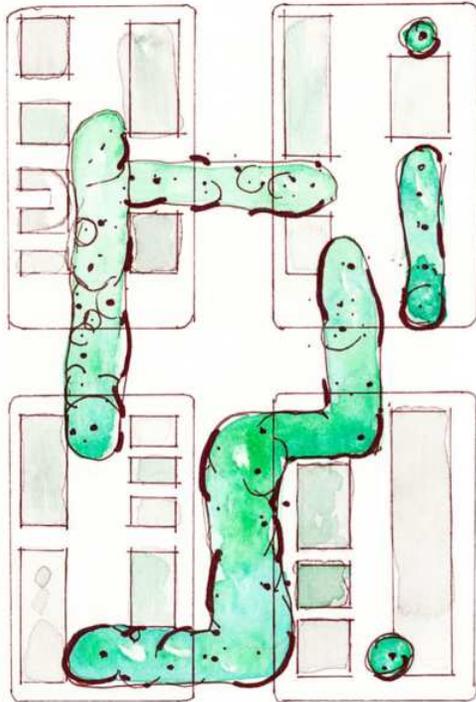

Image Credit: CALP – Sara Barron

Having a continuous pleasant walking environment can increase physical activity.

Groome 1990
Sarakar et al. 2015
Lu et al. 2018

7 *Connect experiences*

Metric:% of shaded pathways
Goal: all of major pathways green

Green Space
Site   campus property
Canopy Cover
Connected Green Space

Scale (m)
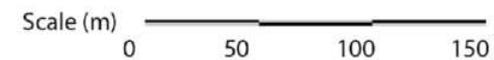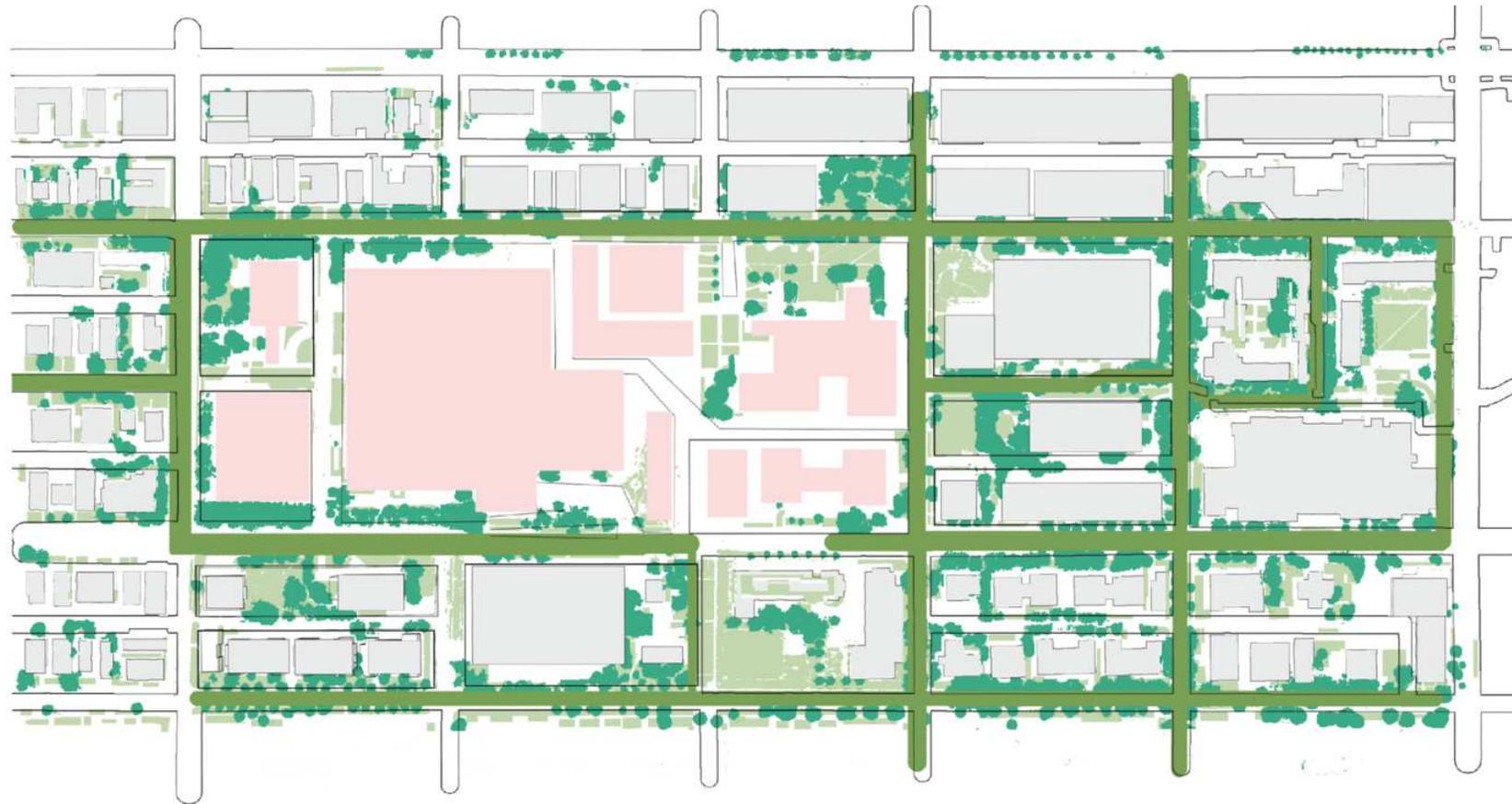0   50   100   150

N

Image Credit: CALP, XInke Yu and Kanchi Dave

8 *Optimize green infrastructure*

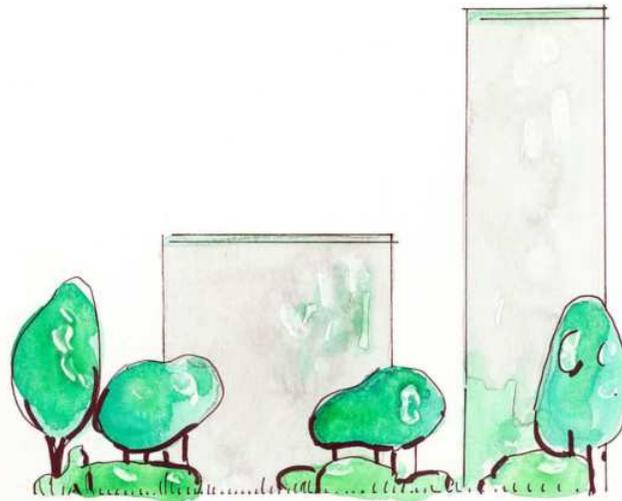Have you left room for enough green, permeable spaces to manage stormwater and cool the air?
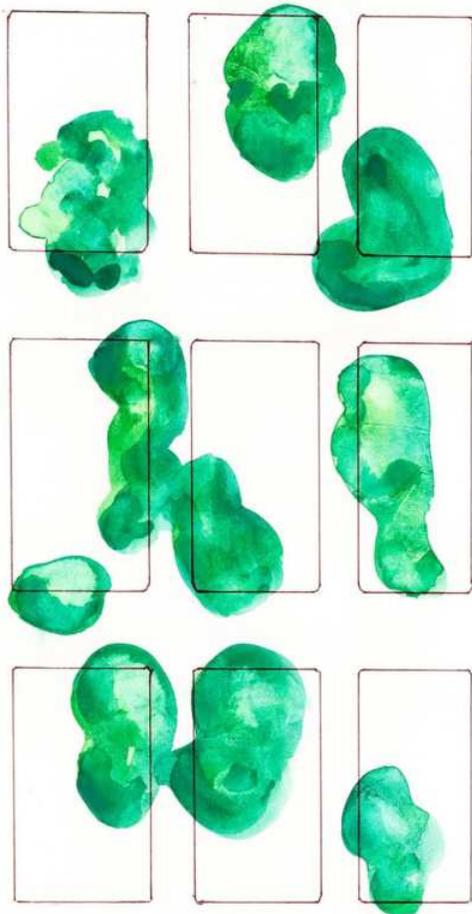

Image Credit: CALP – Sara Barron

Recent studies have found that 40 percent canopy cover makes an important contribution to urban cooling and increased stress reduction.

Jiang et al. 2016
Ziter et al. 2019

8 *Optimize green infrastructure*

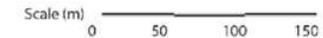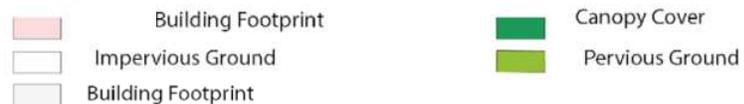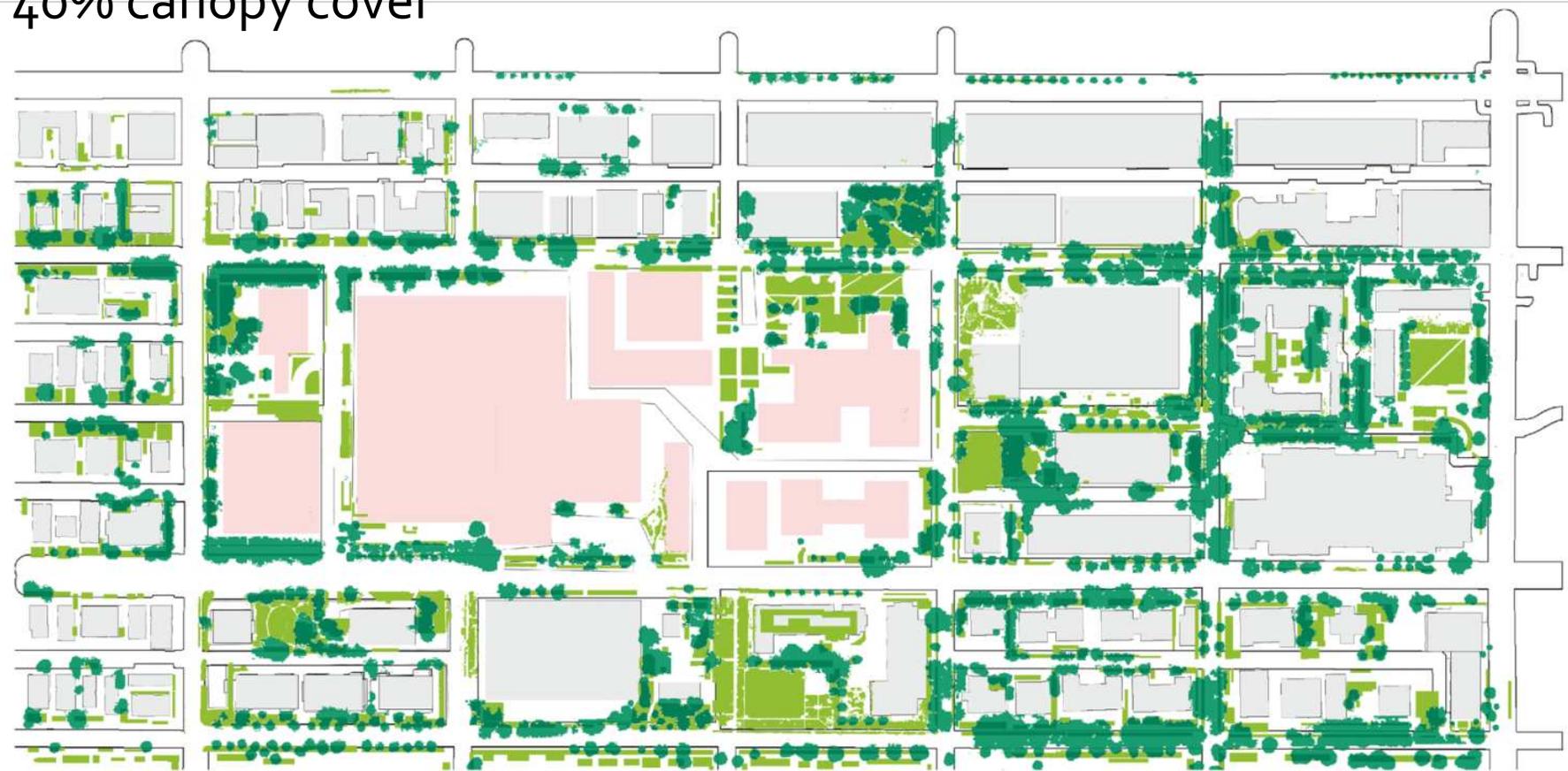Metric: % canopy cover and % pervious ground
Goal: 40% canopy cover

Building Footprint
Impervious Ground
Building Footprint
Canopy Cover
Pervious Ground

Scale (m) 0   50   100   150

Image Credit: CALP XInke Yu & Kanchi Dave

N

Near city neighbourhood

- Apartments and commercial
- Daily population: >4,000

Image Credit: CALP – Xinke Yu
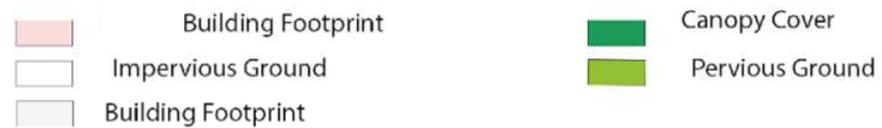
Intervention assessment.
- Visible green
  - Top floors: 14 – 37% average green
  - Lower floors: 12 – 37% average green
- Entrance green: 6/17 entrances with > 50% green
- Nearby green: 25 – 131 s to occupiable greenspace
- Mature green: 39% trees over 15 metres
- Refuge green: 9418 people under tree shade
- Connected green: 84 % greenspaces are connected
- Enough green: 12% canopy cover

Base case
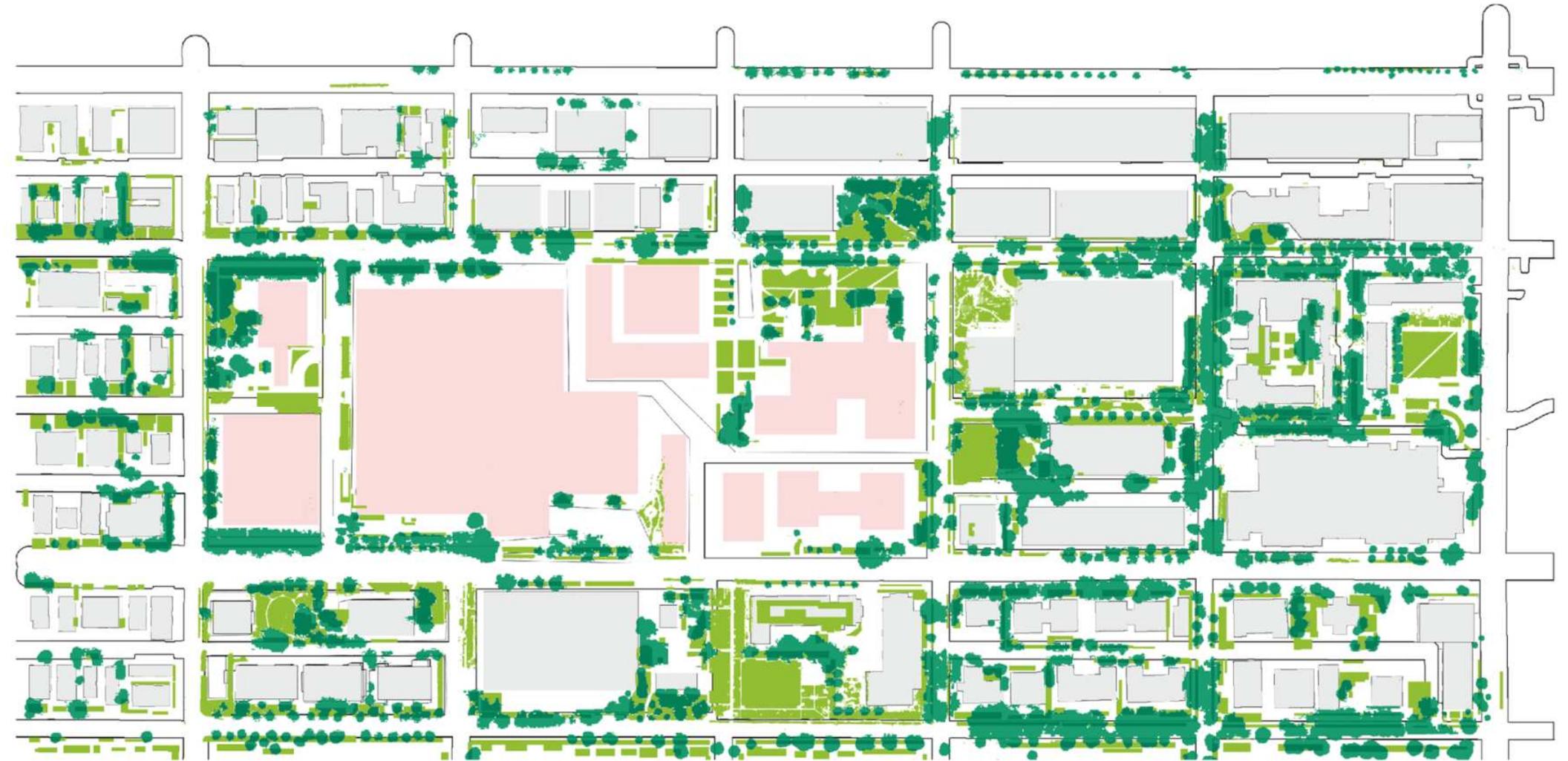
Building Footprint | **Canopy Cover**
Impervious Ground | Pervious Ground
Building Footprint

Scale (m)
0   50   100   150

Image Credit: CALP XInke Yu & Kanchi Dave

N

Critical greening

Building Footprint
Impervious Ground
Building Footprint
Canopy Cover
Pervious Ground
Scenario 2 Trees

Scale (m) 0 50 100 150

Image Credit: CALP XInke Yu & Kanchi Dave

N

Optimal Greening

Site | Building Footprint
Impervious Ground
Building Footprint
Canopy Cover
Pervious Ground
Scenario 2 Trees
Scenario 3 trees

Scale (m)
0   50   100   150

Image Credit: CALP, Xinke Yu & Kanchi Dave

N

Green roofs and facades

Site Building Footprint

Impervious Ground

Building Footprint

Canopy Cover

Pervious Ground

Scenario 2 Trees

Scenario 4 Green roof

Scenario 4 Green facade

Scale (m)
0   50   100   150

N

Image Credit: CALP, Xinke Yu & Kanchi Dave

Case study results.

	Base Case	Critical Greening	Optimal Greening	Green roof
1. View from within 100% views with atleast 30% green	36	50	57	54
2. Plant entrances 100% entrances 50% green	47	71	88	71
3. Bring Nature Nearby 100% floors <2 mins to green	69	69	100	100
4. Retain the mature 30% trees >15metres	39	31	27	31
5. Generate Diversity Diversity of tree species	60	70	100	80
6. Create refuge Enough refuge for daytime population	63	64	66	64
7. Connect the canopy 100% major corridors connected	57	68	73	68
8. Optimize green infrastructure 40% canopy cover	16	17	19	17
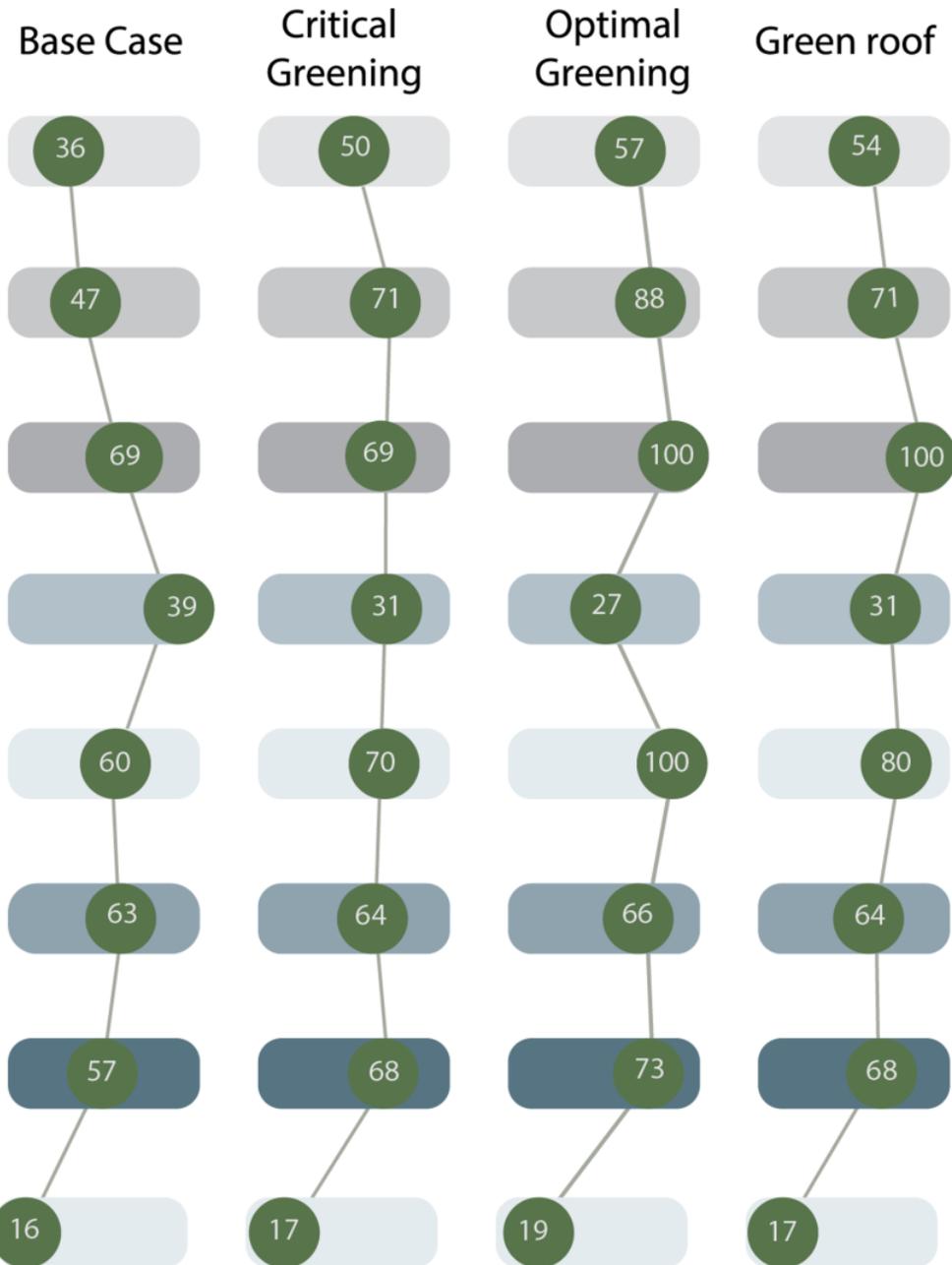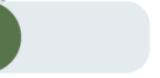
Conclusion.

- Integrates co-benefits into urban green space design and planning
- Provides evidence-based guidance to maximize co-benefits for human health and climate resilience
- Responds to experiential qualities of green space
- Introduces novel metrics to communicate success
- Reveals additional research needs in green space design, particularly in neighbourhood contexts

Crown Area
Refuge Area

2558 square meter, around 1279 people

1814.5 square meter, around 907 people

4789 square meter - public greenway corridor
(may not considered as a common refuge spot
due to limited walking space on the street)

6063 square meter, around 3031 people
- private green space with public access
- green corridor

Thank you!

Contacts:
sara.barron@ubc.ca
kanchi.dave@ubc.ca

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