UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

Global Network for Advanced Management Resilience Challenge 6: Ecosystem Service Valuation

Lauren Stoneburner, Catherina (Yusi) Zhang, Bella (Ruiqi) Yu, Samrudh Pai

University of British Columbia

BA 532

Themes: Biodiversity, Climate, Land

March 16, 2018

GLOBAL NETWORK FOR ADVANCED MANAGEMENT

UBC

Resilience Challenge 6: Ecosystem Service Valuation

Lauren Stoneburner, *Yale School of Forestry and Environmental Studies, New Haven, CT*
Catherina (Yusi) Zhang, *Hong Kong University of Science and Technology, P.R.C.*
Bella (Ruiqi) Yu, *Renmin University of China, P.R.C.*
Samrudh Pai, *Indian Institute of Management, Bangalore, India*

March 16, 2018

Photo credit: Jamie Myers

What is Urban Resilience?

Urban resilience is “the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience” *(100 Resilient Cities)*

Ecosystem Service Valuation – An Introduction

What is Ecosystem Service Valuation?

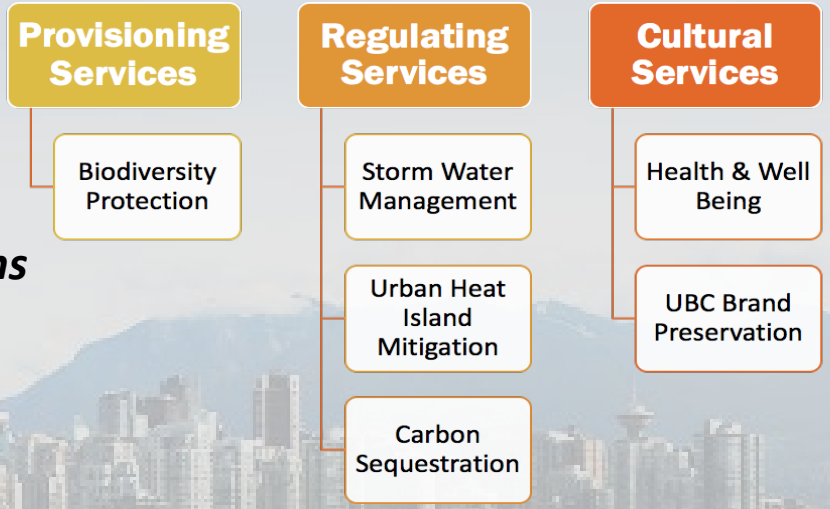
"Ecosystem services are the benefits people obtain from ecosystems" *(Millennium Ecosystem Assessment 2005)*

- Provisioning (i.e. food and water)
- Regulating (i.e. flood and disease control)
- Cultural (i.e. spiritual, recreational, and cultural benefits)
- Supporting (i.e. nutrient cycling, maintaining conditions for life on Earth)

Why do we need Ecosystem Service Valuation?

"An assessment of the condition of ecosystems, the provision of services, and their relation to human well-being requires an integrated approach. This enables a decision process to determine which service or set of services is valued most highly and how to develop approaches to maintain services by managing the system sustainably." *(Millennium Ecosystem Assessment 2005)*

Executive Summary



Summary of findings and recommendations

- UBC's Core Resilience Challenges:
  - Stormwater management and cliff erosion
  - Biodiversity protection
  - Urban Heat Island Effect (UHI)
  - Carbon sequestration
  - Health and wellbeing
  - Brand protection
- Use economic models to evaluate the monetary return on these important ecosystem services
- Assess methods for managing ecosystem services long-term and compensating for the loss of trees due to campus development
- Increase engagement with and awareness of UBC's urban forest

Current Tree Management Practices at UBC

UBC does not consider ecosystem services for tree protection

- Trees are explicitly protected for…
  - "Star tree" status
  - A few designated open spaces
- Individuals at UBC are working to develop an Urban Forest Management Plan

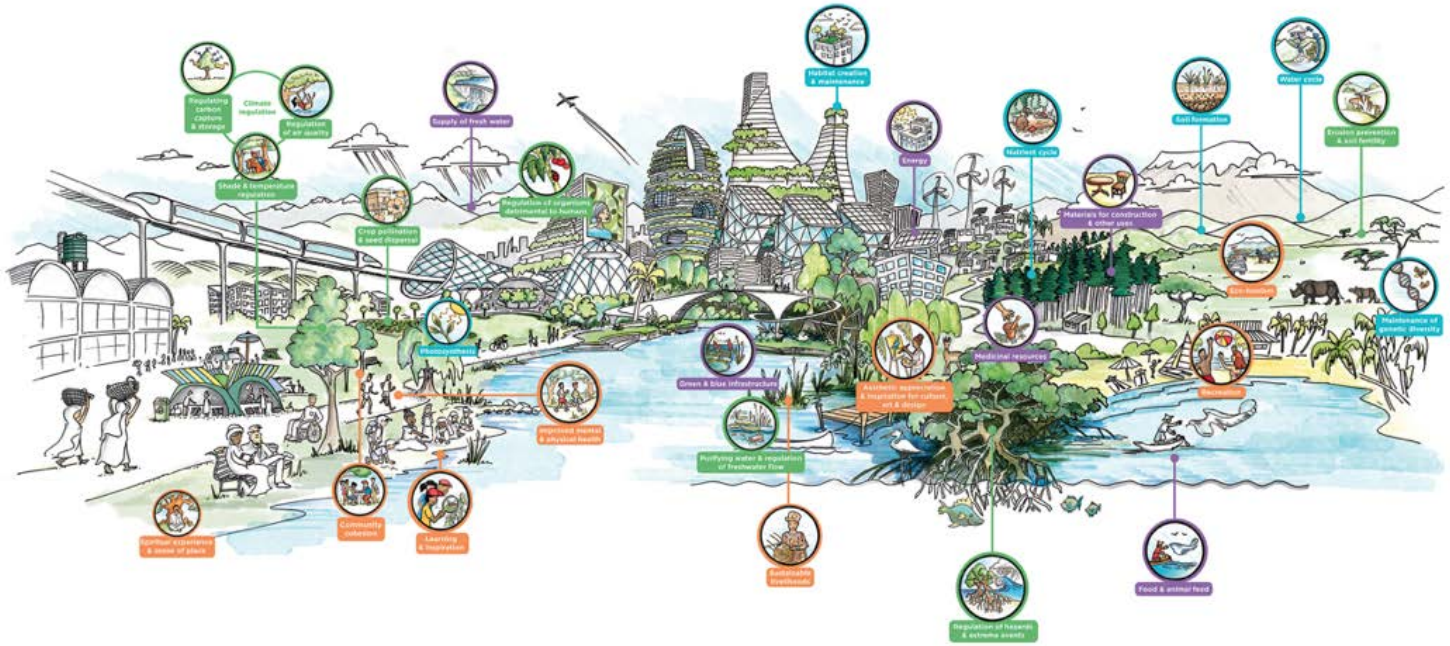
Our Resilience Challenge

Goals and Objectives

1. Identify and assess ecosystem service evaluation models
2. Identify how UBC can systematically and appropriately compensate for the loss of ecosystem services
3. Identify examples of cities and institutions that have implemented an urban forest assessment and management plan
4. Make recommendations on how to advocate for ecosystem services management and protections

THE VALUE OF NATURE IN URBAN LIFE

Nature provides many diverse life-supporting and life-enhancing contributions to people in cities and their surrounding regions.
These gifts from nature make human life both possible and worth living.



KEY:

- TANGIBLE THINGS FROM NATURE THAT MEET HUMAN NEEDS
- BENEFITS OBTAINED FROM THE PROCESSES THAT REGULATE THE NATURAL ENVIRONMENT
- NATURE'S GIFTS THAT ENRICH OUR LIVES
- SUPPORTING THE LONG-TERM HEALTH OF THE PLANET

INTERACT-Bio
Integrated action on biodiversity

ICLEI Local Governments for Sustainability

CBC Cities Biodiversity Center

Supported by:

Based on a decision of the German Bundestag

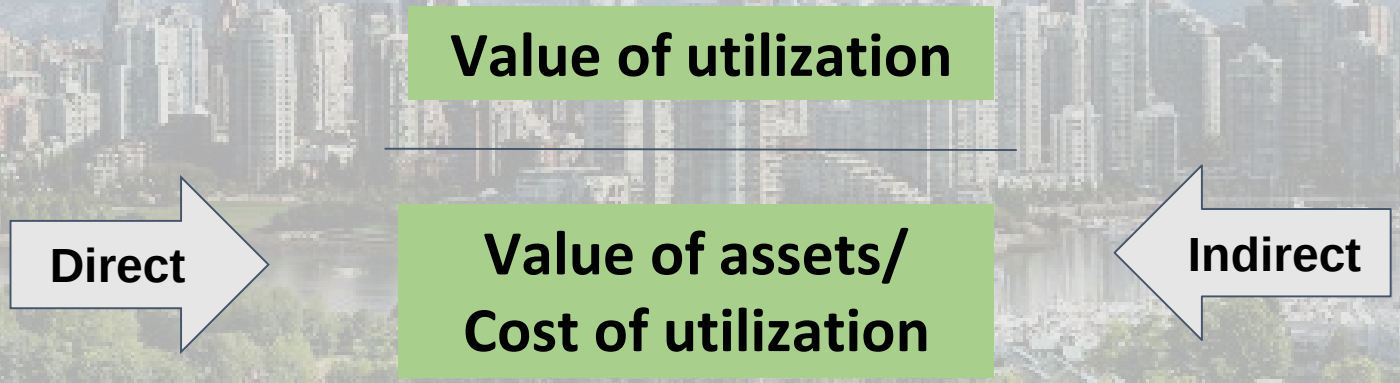
HELMHOLTZ ZENTRUM FÜR UMWELTFORSCHUNG UFZ

[ICLEI Cities Biodiversity Center](www.cbc.iclei.org)

www.cbc.iclei.org

Forest vs. Building

- Cost Benefit



	i-Tree	UTC Assessment	Center for Urban Forest Research CTCC
Ecosystem Services Evaluated	Stormwater, Energy Use, Carbon Sequestration, Air Quality	Maps land cover changes and opportunities for tree canopy and green infrastructure expansion according to specific metrics such as land use type	Carbon Sequestration, Energy Savings and CO_2 equivalents from shading buildings
Adopted By	USDA; Arbor Day Foundation; Seattle, University of Pennsylvania; London; South Australia; Mexico, etc	Toronto, Ontario, Canada Chicago, IL, USA New York City, NY, USA (see complete map by Univ. of VT)	Duke University, NC, USA Berkeley, CA, USA Charlotte, NC, USA Santa Monica, CA, USA
Data Needed	Tree inventory, Survey data, 3rd party info (Satellite, Map, Weather, Pollution, etc)	Building footprints, road polygons, parcels, public rights-of-way and target geographies, using high-resolution LiDAR imagery(explanation and more details).	Climate zone, species of interest, tree size (DBH) or age. For further energy savings analysis: tree distance from building, tree direction from building, building age, and type of air conditioning/heating equipment
Pros	1) Comprehensive with data-acquisition techniques and a methodology; 2) Ability to quantify and measure the Regulating category	Comprehensive measurement of ecosystem services	1) Ability to define the amount of CO_2 values in a particular region selected. 2) Being integrated into i-Tree (not yet available)
Cons	1) Limited on other categories 2) Quality data Requirement/GIS needed 3) Other country data beyond US to be improved	1) Long-term assessment 2) Relatively higher cost	Conditions may vary within regions, so rate of tree growth, microclimate, or building characteristics may be less accurate

Example: Urban Heat Island - Background

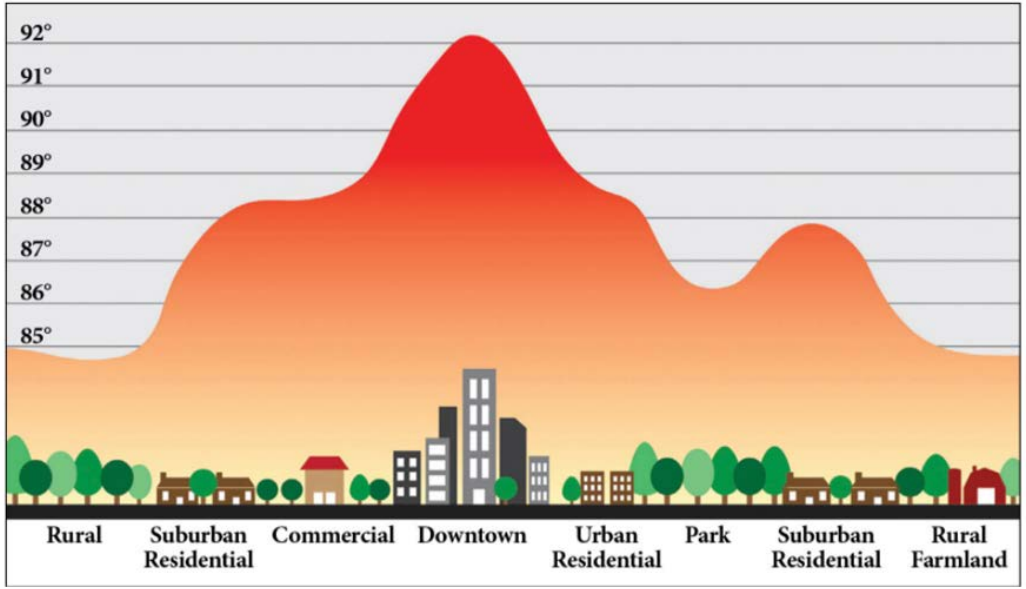
Increased Energy Bills
Health Risk – No.1 Weather Killer in US

Vancouver Usual Temp:
17 – 22°C

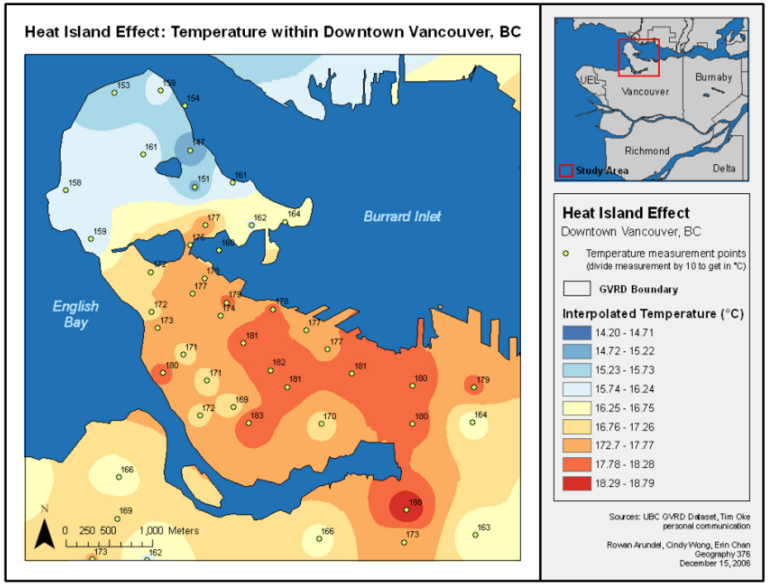
Vancouver Airport 2009 Temp:
34.4°C

Vancouver 24°C+ Frequency:
2X

Aug-Sept/2017, Bay Area/US

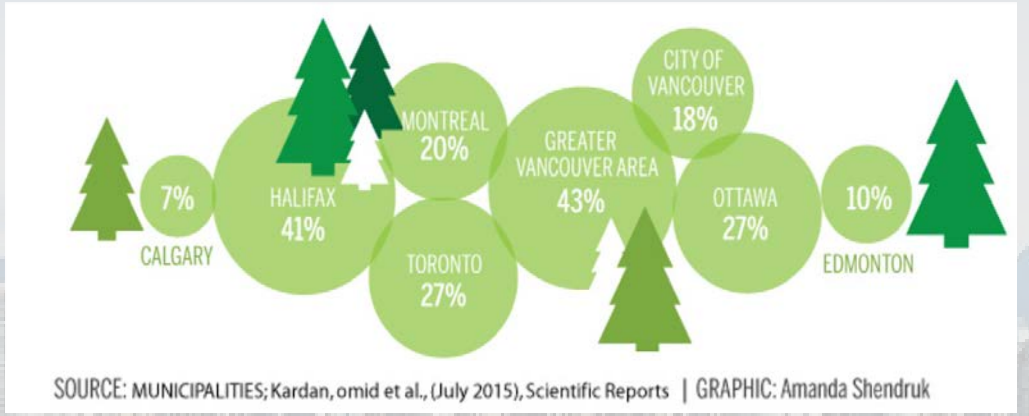


2005, Downtown/Vancouver



https://www.epa.gov/heat-islands/measuring-heat-islands
https://open.library.ubc.ca/cIRcle/collections/graduateresearch/310/items/1.0075852
http://www.cityofsydney.nsw.gov.au/__data/assets/pdf_file/0003/132249/Urban-Forest-Strategy-Adopted-Feb-2013.pdf
http://bayareamonitor.org/summer-in-the-city-seeking-relief-from-urban-heat-islands/

Example: Urban Heat Island - Urban Forest Contribution Evaluation



★ **Energy Savings:**

- Toronto 2008: 99,277 trees; 23% UTC; 749K MBTU, 41.2K MWH & CAD $9.7M
- UBC Estimation: CAD $1M

★ **Next Step suggested for UBC to conduct i-Tree :**

Tree Inventory (#,Size,Species)

Building (%,Type,Distance)

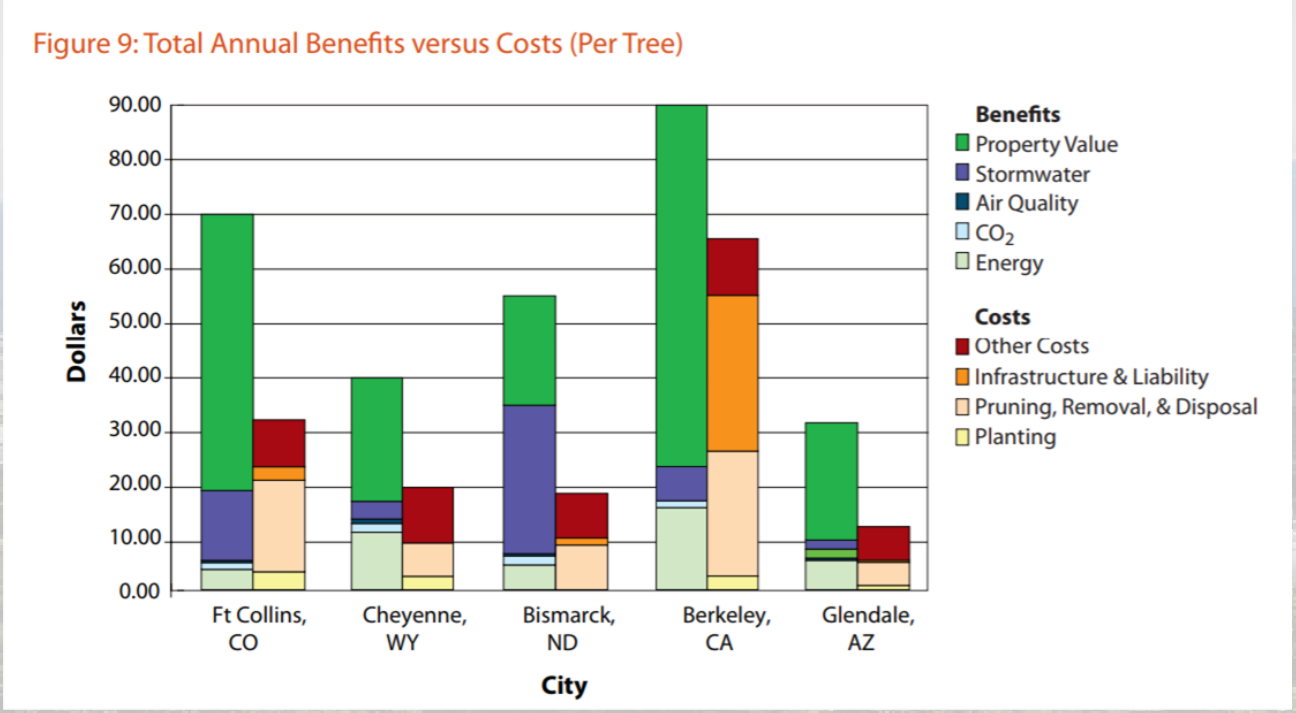
Heating Source Type

i-Tree Canopy & Eco

P.S. Accuracy affected by classifying & Distance to the buildings mattered

https://www.epa.gov/air-research/models-tools-and-databases-air-research
https://www.fs.fed.us/psw/publications/mcpherson/psw_2003_mcpherson003_maco.pdf
https://ageconsearch.umn.edu/bitstream/150567/2/Maher_AAEA_P3348_TreeShade.pdf
https://www.arb.ca.gov/nsr/erco/erc00.pdf

Urban Forest Cost-Benefit Overview



Cost
$15-65/tree/yr

Net Profit
$30-90/tree/yr

Utility Cost by Removing
3-5% UP/tree

USDA Forest Service:

- ❑ The net cooling effect of a young, healthy tree = 10 roomsized air conditioners operating 20 hours a day
- ❑ Trees properly situated around buildings: reduce air conditioning needs by 30%; save 25% of energy used in heating

https://www.epa.gov/sites/production/files/2014-06/documents/treesandvegcompendium.pdf

Compensation or Substitution: A reactive approach

Issues with compensating or substituting for the loss of ecosystem services

- "Substitutes are available for some ecosystem services, although often the cost of a technological substitution will be high and it may not replace all the services lost"
- "Individuals gaining the benefits are not those who originally benefited from the ecosystem services."
- To fully assess the ecosystem services, the model must consider:
  - The cost of a substitute
  - The opportunity cost of maintaining the service
  - Cross-service costs and impacts
  - The geographic distributional impacts of any substitution

(Millennium Ecosystem Assessment 2005)

Alternative to a Compensation Model: Proactive Management

Urban Tree Canopy (UTC) Targets

- Tree canopy cover in the U.S. averages 27% in urban areas and 33% in metropolitan areas *(Dwyer and Nowak 2000)*
- Urban trees are subject to many stressors that shorten tree lifespan *(Center for Watershed Protection)*
- Therefore, UTC Targets is a critical tool for protecting and enhancing an urban forest
    1. Measure Current UTC
    2. Estimate Potential UTC
    3. Adopt a UTC Goal
- American Forests' Vibrant Cities Lab
    - Includes research, case studies, and tools resources

Alternative to a Compensation Model: Proactive Management

Biodiversity Targets

- City of Melbourne:
  - "increasing forest diversity with no more than five percent of one tree species, no more than ten percent of one genus and no more than 20 percent of any one family" *(Melbourne Urban Forest Strategy)*
- University of Melbourne:
  - Conducting a baseline biodiversity assessment, so that it can implement a "no net loss" policy
  - Maintain or increase tree diversity, while particularly selecting species with climate resilience in mind
  - *(University of Melbourne Biodiversity Management Strategy)*

Case Studies

City or Institution	Current canopy cover	Canopy cover target	Hyperlink
Vancouver, Canada	18 %	Plant 150,000 trees by 2020	link
Edmonton, Canada	10.3 %	20 %	link
Kelowna, Canada	13 %	25 %	link
Oakville, Canada	29.1 %	30 %	link
Ottawa, Canada	25 %	30 %	link
Toronto, Canada	26.6 - 28 %	30%	link

Case Studies *(continued)*

City or Institution	Current canopy cover	Canopy cover target	Hyperlink
Portland, OR, USA	26.3 %	35-40% (residential areas), 15% (industrial/commercial), 30% (parks, open space), and 35% (rights-of-way)	link
Seattle, WA, USA	18 %	30 % (with specific targets for each land use category)	link
Vancouver, WA, USA	19.7 %	28 %	link
Melbourne, Australia	22 %	40 %	link
University of Washington	28.6 %	[In research phase]	link
University of Maryland	24 %	40 %	link
Univ of California, San Diego	12 %	40 %	link

Campus Engagement

Current Students

- Arbor Day or National Forest Week
  - E.g. Pennsylvania Horticultural Society's award-winning Flower Show
  - Recommendations from Canadian Forestry Association
    - Tree plantings
    - Nature walks
    - Tree care
    - Identify all the things at home or school that are made of wood
    - Tour forest sector industry or processing site
- Tree planting events at orientation
- Tree adoption for residential colleges
- Campus tree signage

** Coordinate tree plantings / adoptions on sites that provide disproportionately concentrated ecosystem services *(e.g. areas critical for stormwater management or vulnerable to UHI)*

Campus Engagement

Alumni and donors

- Guided campus nature walks
  - Highlighting the university's history in arboriculture and forestry history
- Opportunity to sponsor tree protection
- Include tree protection in development projects that are sponsored by donors and offer installation of a commemorative plaque

Summary of Recommendations

- Economic models for consideration
  - i-Tree, UTC Assessment, and CTCC
- Proactive urban forest management strategy
  - Tree canopy cover targets
  - Biodiversity targets
- Community engagement can inspire community awareness and support for planning and protections

Areas for future investigation

- Evaluate ecosystem services of the forest as a system, in addition to the benefit of each tree independently
- Identify priority areas for urban forest protection and management
- Decide on urban forest management goals and objectives
  - What ecosystem services are more or less valuable? What are you managing for?
- Consider potential opportunities to explore forested roofs, which could integrate the built and forested environments

Acknowledgements

We'd like to send a special thank you to all who have supported the development of our team's recommendations. In particular, we appreciate the guidance and support from our instructors, José Puppim de Oliveira and Murali Chandrashekaran, as well as the opportunity to investigate this resilience challenge from John Madden. Individuals such as Jeffrey Nulty, Dean Gregory, Cathy Pasion, David Gill, Jennifer Rae Pierce and Doug Doyle were also indispensable during our learning and discovery process.