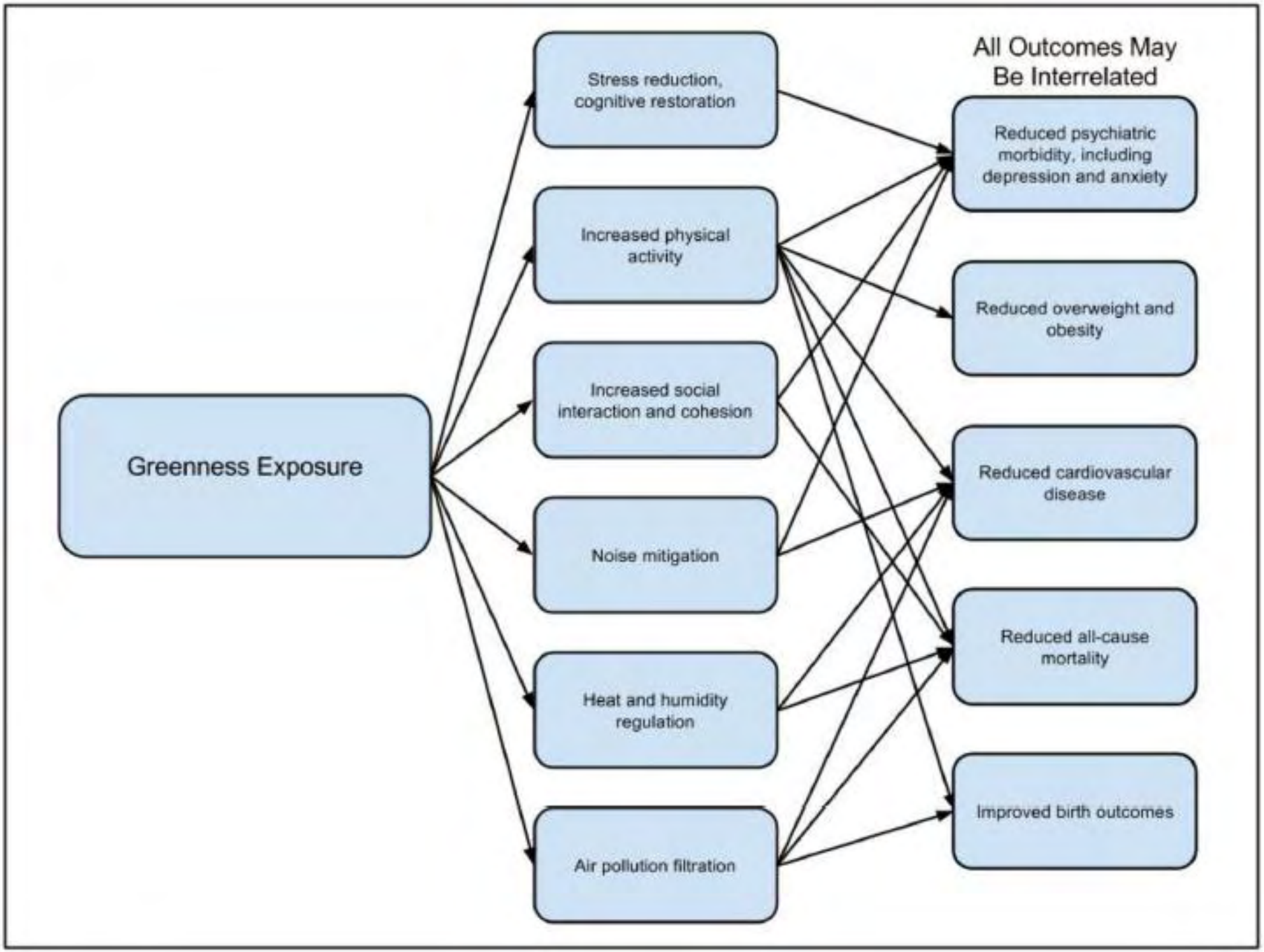
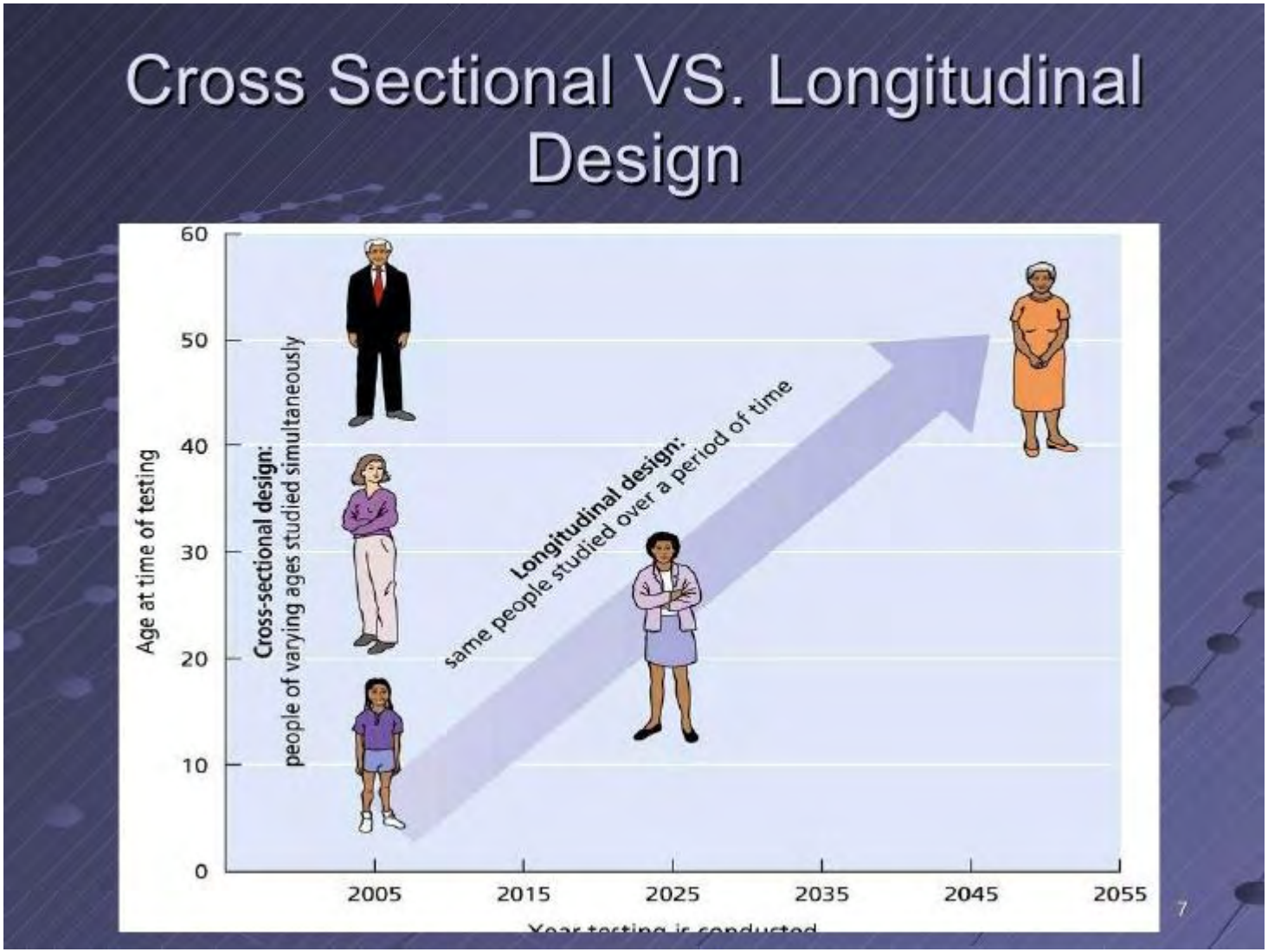
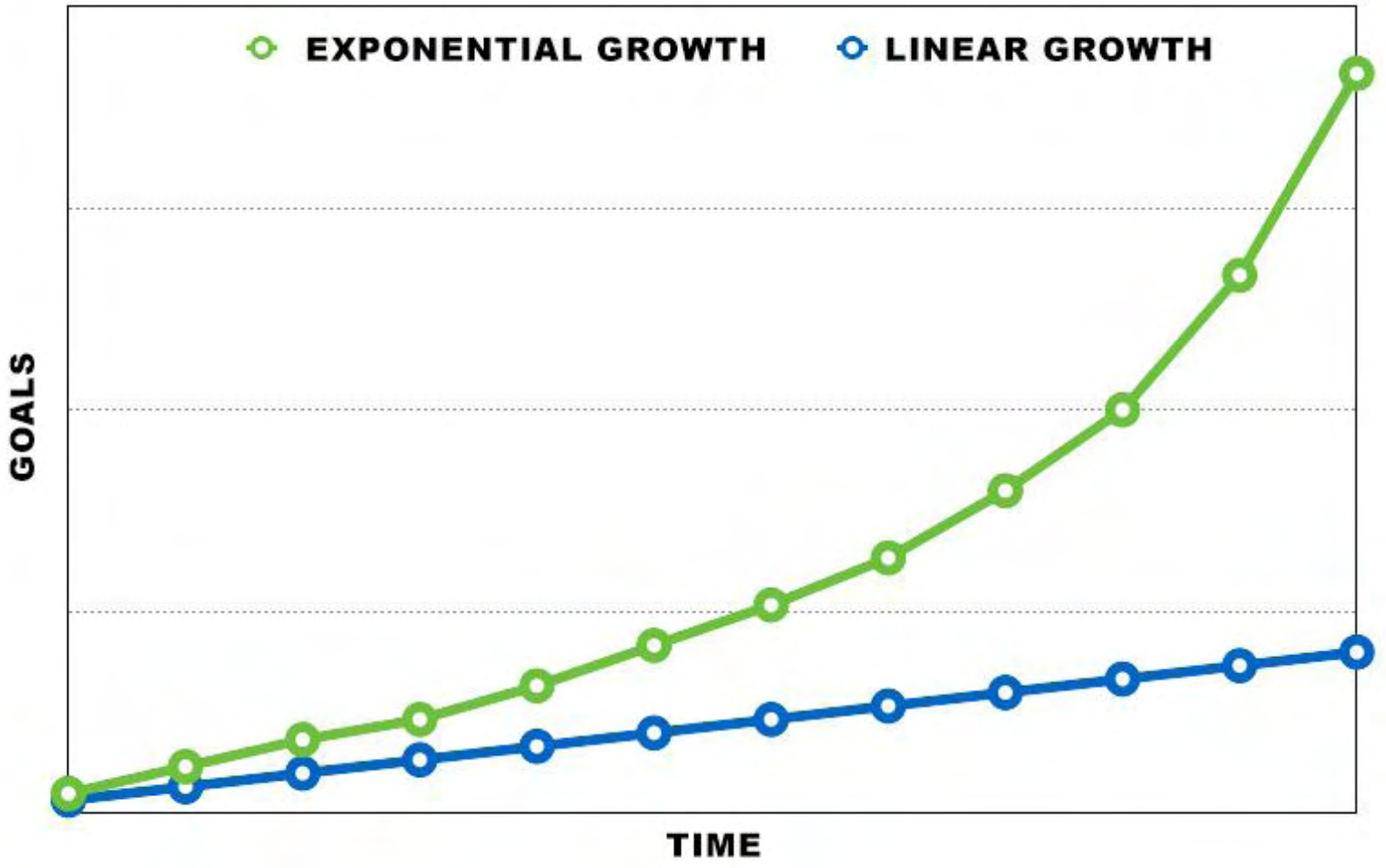
INDICATORS FOR URBAN FORESTS AND PUBLIC HEALTH


Greenness Exposure
Stress reduction, cognitive restoration
Increased physical activity
Increased social interaction and cohesion
Noise mitigation
Heat and humidity regulation
Air pollution filtration
All Outcomes May Be Interrelated
Reduced psychiatric morbidity, including depression and anxiety
Reduced overweight and obesity
Reduced cardiovascular disease
Reduced all-cause mortality
Improved birth outcomes

CROSS SECTIONAL AND LONGITUDINAL STUDIES

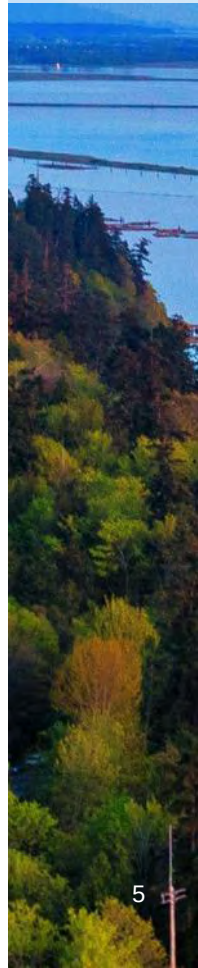


LINEAR AND EXPONENTIAL EFFECTS



POPULATION INTERVENTION

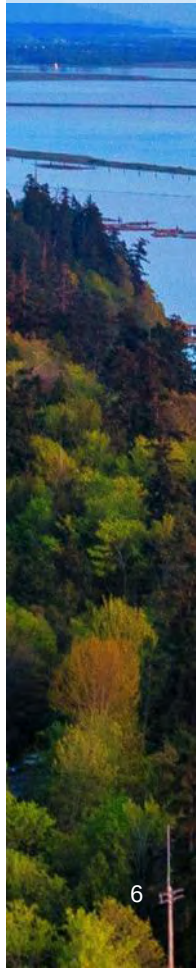
- Large **public health** gains even when small effect sizes of an intervention
- Even if urban forests only contribute to **small increases** in physical activity, it has a **substantial effect** on a population level
- By improving opportunities for physical activity in **targeted areas** significant health gains can be reached
- Physical inactivity is a complex issue with **vast negative impacts**, requires a multitude of **different approaches** –urban forests is one such approach.



FOR EXAMPLE

1% increase in physical activity. Small effect.

20,000 more physically active individuals in Vancouver. Large effect.



The importance of early life interventions

- Epigenetics
- Setting habits
- Preventing later life chronic disease

Intervene where it is most needed!

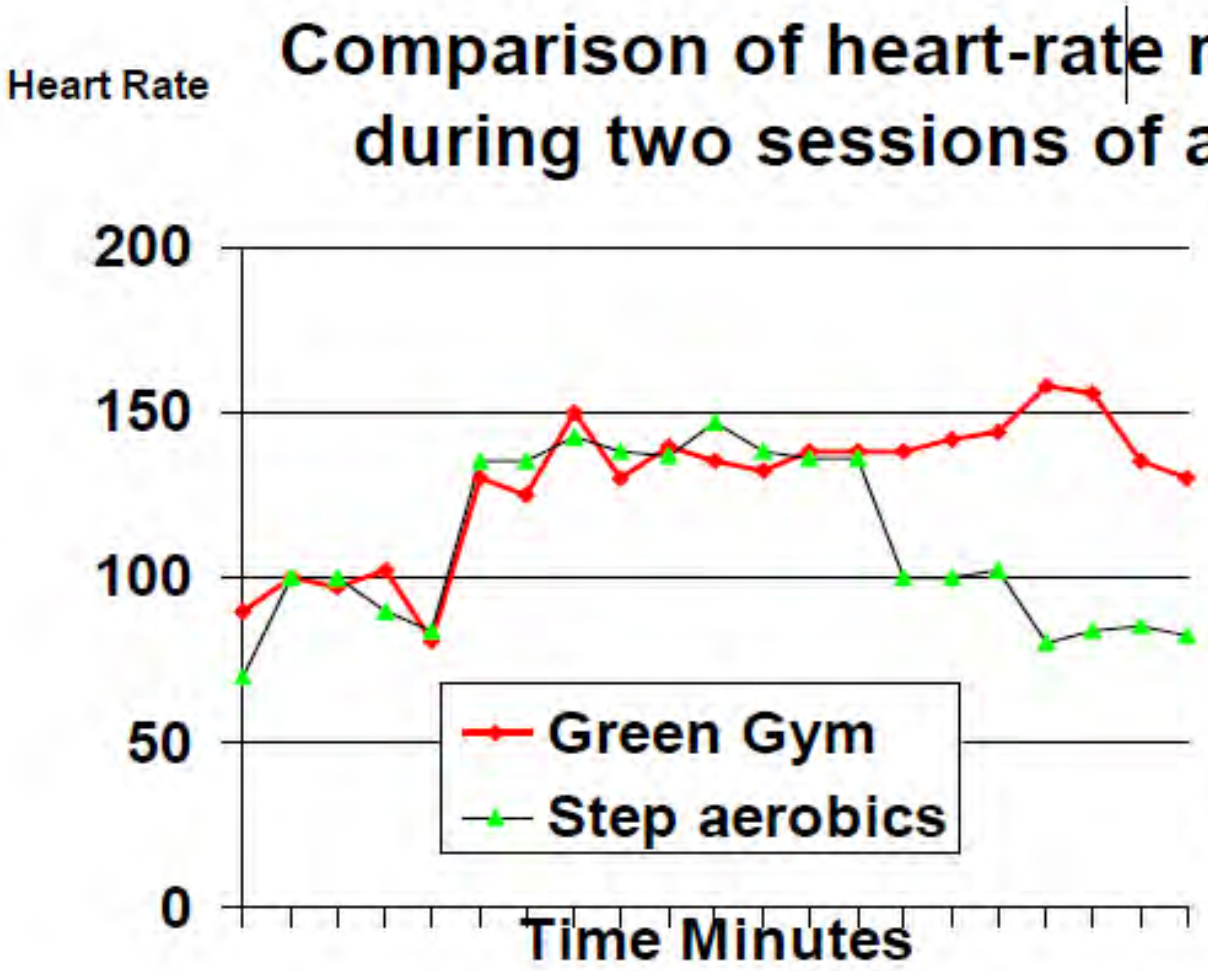
GREEN SPACES AD PHYSICAL ACTIVITY

“The study concludes that physical activity in natural environments is associated with a reduction in the risk of poor mental health to a greater extent than physical activity in other environments” (Mitchell et al. 2013)

“We surveyed 319 members of fitness centers in Zurich that offer indoor and outdoor exercise alternatives. Outdoor settings were rated as more restorative” (Hug et al. 2009)

“The runners preferred the park over the urban environment and perceived it as more psychologically restorative.” (Bodin & Hartig, 2003)

Green Gym Vs Aerobics



V Reynolds 1999
OCHRAD

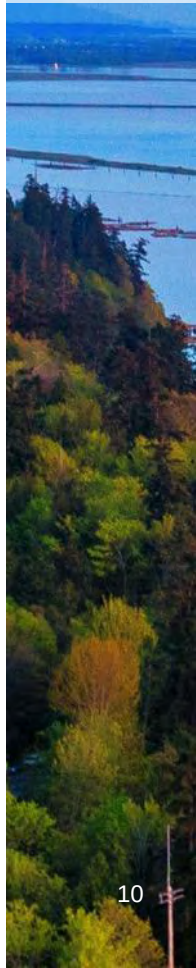
Slide courtesy of William Bird

IN SUMMARY, GREEN SPACES:

- Reduce stress
- Increase physical activity
- Improve social interactions

AND

- Provide ecosystem services

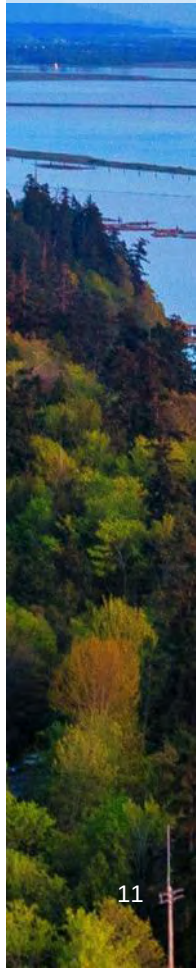


WHAT DO WE DO WITH ALL THIS KNOWLEDGE?

We want to

- have an impact
- improve urban development
- improve human health everywhere and for everyone
- protect the environment

We need to communicate and translate science to policy and practice



INDICATORS CAN HELP US

TO COMMUNICATE

Science

Policy

Practice

Communication by uncoolbob
CC BY-NC 2.0

CURRENTLY, TRANSLATION IS INSUFFICIENT

"…scientific knowledge about ES [Ecosystem Services] continues to have **limited impact** on policy and decisions." (*Posner et al. 2016*)

Urban tree canopy is declining: **4.0 million trees** per year in US (*Nowak & Greenfield, 2012*)

Poor green planning in rapidly urbanizing countries in developing parts of the world (*Quereshi et al. 2010*).

WHY DO WE FAIL?

1. Cognitive bias.
2. Different languages.
3. Unbalanced messages
4. Competing interests.

Failure by Mate McBean_CC BY-NC-ND 2.0

1. COGNITIVE BIAS

- The knowledge is not part of the **normative agenda**
- the common position is shaped by **tradition**
- Politicians and/or decision-makers are used to solutions within a **different paradigm** .
- Tendency towards **“quick-fix”** or technological solutions.
- **Short term gains,** long term losses (“Late lessons from early warnings”)

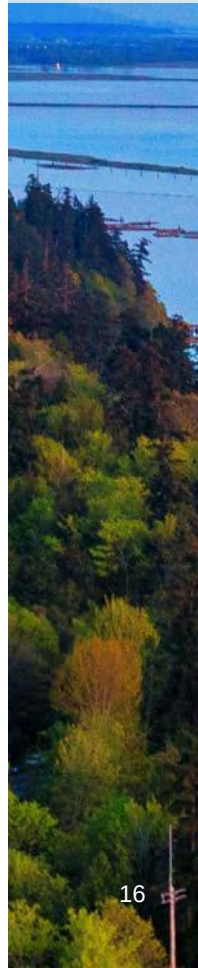
2. DIFFERENT LANGUAGES

- What policy and practice **need** is not always what is studied

- **Different terms** for the same things

- The **cautiousness** of a researcher: “There might potentially be an effect. Perhaps”. “More studies are needed”…

- Academia may have “**low status**” in urban planning practice

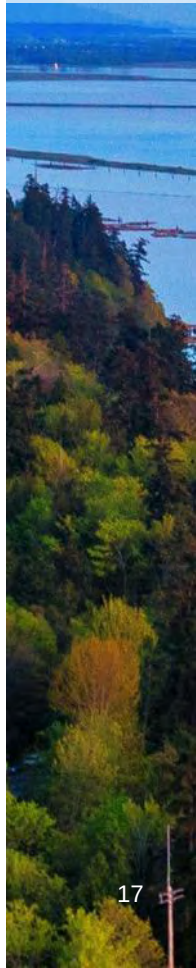


3. UNBALANCED MESSAGES

a) Risks. Unfamiliarity, fear (parents, carers, schools, stakeholders)

In UK the outdoor area in which children may roam without supervision has decreased by almost **90%** since the 1970s (Moss, 2016).

> *"Kids are no longer allowed to **climb trees, throw rocks** into the creek, or **collect pine cones**, all very natural, normal kid behavior. When the outdoors become a **museum** where nothing can be touched, you are going to see people become **detached from nature**." (Bekoff, 2014)*



UNBALANCED MESSAGES

b) "Ecosystem disservices"

- Allergenic pollen
- Vector-borne diseases
- Falling branches

<u>Other solutions than reducing nature exposure, e.g.:</u>

Use non-allergenic species and genotype

Use proper clothing

Invest in maintaining and managing trees.

Services and disservices – for whom…?

4. COMPETING/VESTED INTERESTS

- **Governmental budgets** for green space management have decreased significantly because of **land use competition** (Buizer et al. 2015)

- **Economic crisis**

- **Densification**

- **Commercial investments**

- **Industry**

WHY WE NEED TO BE CLEAR IN OUR COMMUNICATION

Parks hit again in council budget cuts

13 April 2012, by Jez Abbott and news staff, Be the first to comment

Maintenance teams, plant spending and street trees all face cutbacks as local authorities battle to meet savings targets.

Parks: negotiations are continuing on how budget reductions will bite on communities' green spaces - image: Morguefile

The latest local authority spending round for 2012-13 is seeing more parks services facin cuts of up to 20 per cent, while a number have won a respite from the axe thanks in part to "front loading" of their budget reductions in 2011-12.

HorticultureWeek, 2012

Sheffield: **17% cuts** for parks, woodlands and open spaces; merging and reducing parks and open-space

Liverpool: **22% cut** in budget for green space management

Newcastle: reduced maintenance of green spaces and tree-inspection services (loss of **~ 20 jobs**)

London, Leeds, Brighton, etc.

www.nature.com/scientificreports

OPEN

Neighborhood greenspace and health in a large urban center

Omid Kardan[1], Peter Gozdyra[2], Bratislav Misic[3], Faisal Moola[4], Lyle J. Palmer[5], Tomáš Paus[6] & Marc G. Berman[1,7]

Received: 08 February 2015
Accepted: 01 June 2015
Published: 09 July 2015

Studies have shown that natural environments can enhance health and here we build upon that work by examining the associations between comprehensive greenspace metrics and health. We focused

- **10 more trees** per city block: increased health perception equivalent to the effect of a **$10,200** increase in annual household income and being **seven years younger.**

- **10 more trees**: **~ 4%** increase in street tree density

- **10 more trees**: cost between **$300 and $5,000.**

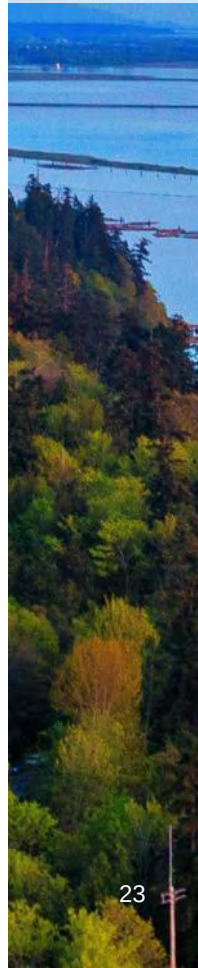
WHAT CAN WE DO TO IMPROVE IMPACT?

Tools for

- Monitoring
- Quantification
- Monetizing

Indicators

BETTER **COMMUNICATION** AND **UNDERSTANDING** AND **ARGUMENTATION**



COMMON ASPECTS IN GREEN SPACE INDICATORS

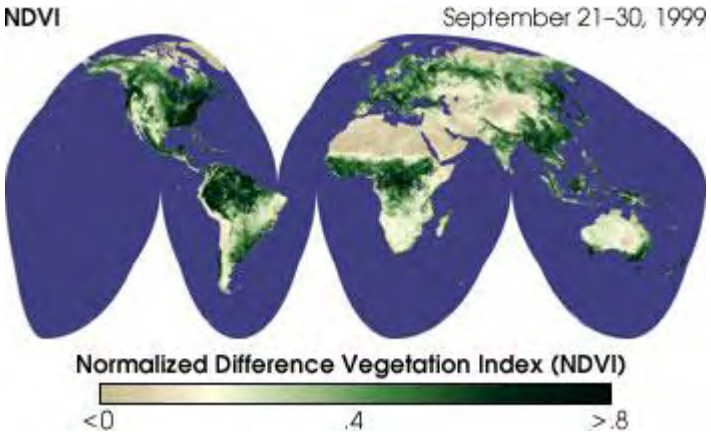
- AVAILABILITY
- ACCESSIBILITY
- CHARACTERISTICS
- USAGE

DATA FOR INDICATORS OF AVAILABILITY

1. NDVI (Normalized Difference Vegetation Index).

- Satellite images (often from NASA).
- Indicates e.g. “greenness”

➢ Linked to several health outcomes, e.g. physical activity, respiratory diseases, stress and anxiety.



AVAILABILITY

2. LAND USE/COVER DATABASES

- Urban Atlas
- USGS Land Cover
- Global Land Cover Dataset
- National, local databases

➢ Linked to e.g. mental health, childhood obesity

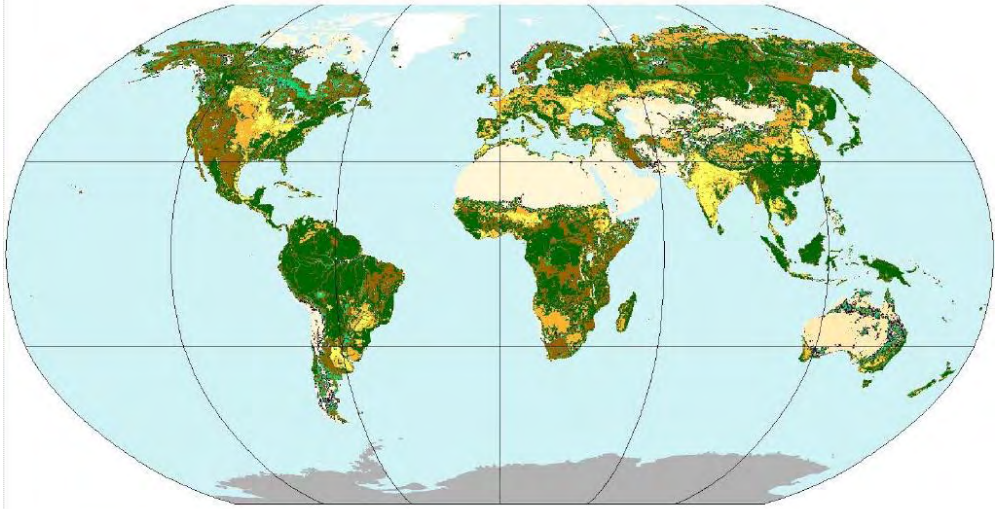


Figure 3 – Distribution of dominant GLC-SHARE Land Cover Database.

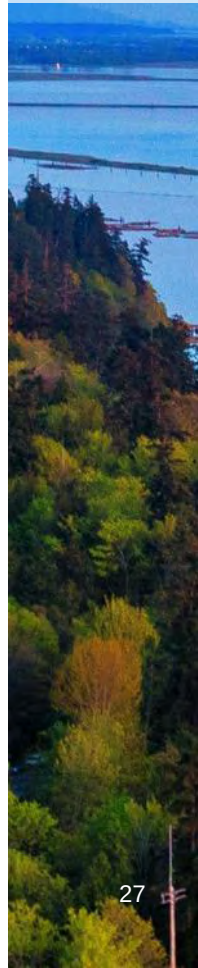
01 Artificial Surfaces
02 Cropland
03 Grassland
04 Tree Covered Area
05 Shrubs Covered Area
06 Herbaceous Vegetation
07 Mangroves
08 Sparse Vegetation
09 Baresoil
10 Snow and Glaciers + Antarctica
11 Water bodies
Antartica

AVAILABILITY

3. STREET TREES

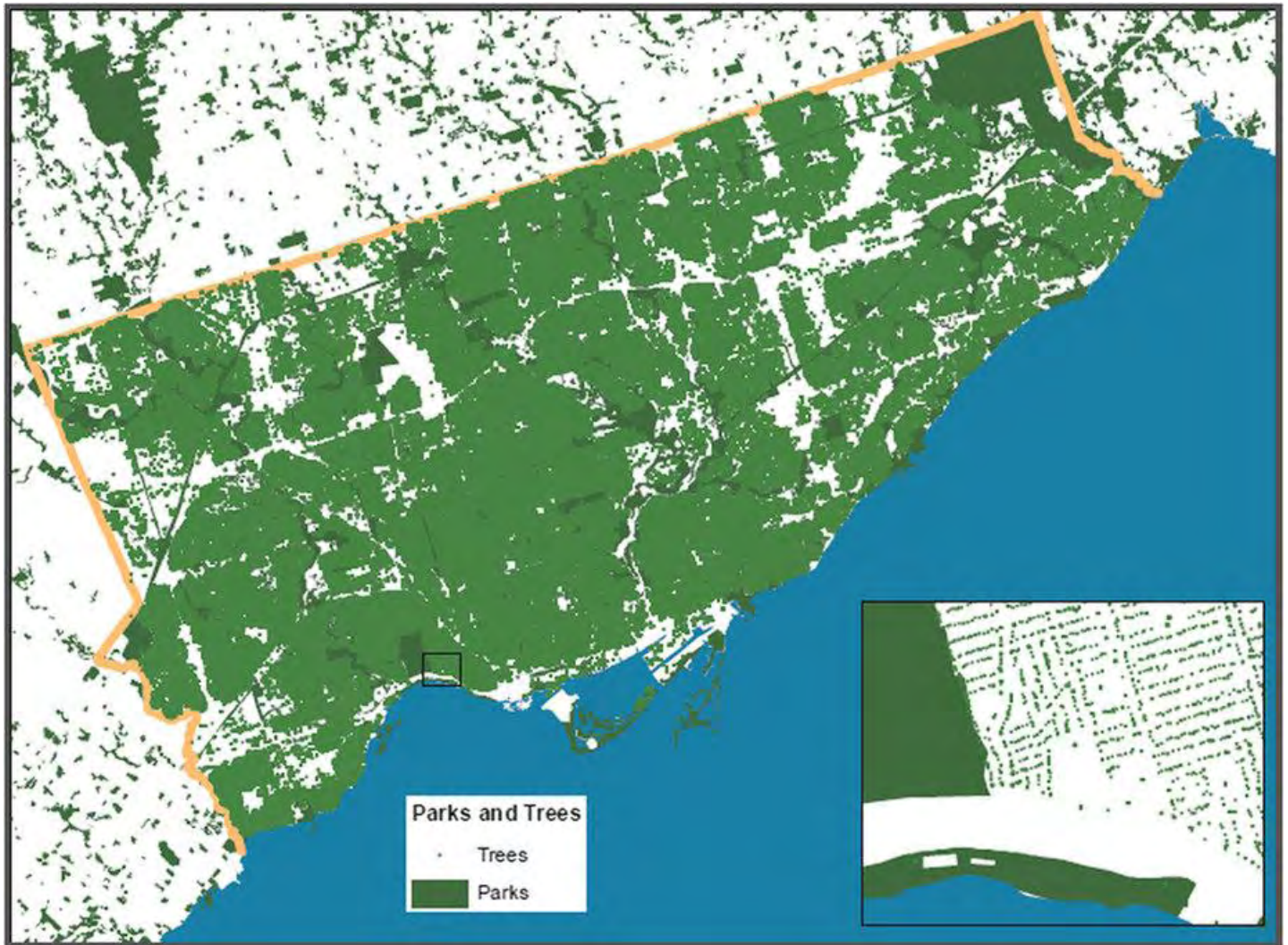
- USGS Global Tree Canopy Cover
- Local databases

➢ Linked to cardiometabolic health and perceived health



KARDAN ET AL. 2015. STREET TREES VS PARK TREES

Individual tree data from the “Street Tree General Data” and tree-canopy data from the “Forest and Land Cover” dataset (city of Toronto).



ACCESSIBILITY CONSIDERATIONS

- linear or walking distance, walking time?
- proximity to **what**? (home or work/school, residences)
- Proximity to **whom**? (children, disabled, elderly, disadvantaged)
- **publicly** accessible (with or without entry fee)
- specific **points of access** (e.g. gateways, paths, car parks)

- *Data sources:* land cover/use + **population distribution**, geocoded, road network, local data

CONSIDERATIONS OF CHARACTERISTICS

- size
- shape
- land cover type e.g. grass or woodland
- presence of water (blue space)
- recreational types e.g. children's play areas, 'natural', formal gardens
- environmental qualities e.g. biodiversity, 'serenity', 'wilderness'
- amenities (e.g. benches, lavatories)

USAGE: DATA SOURCES

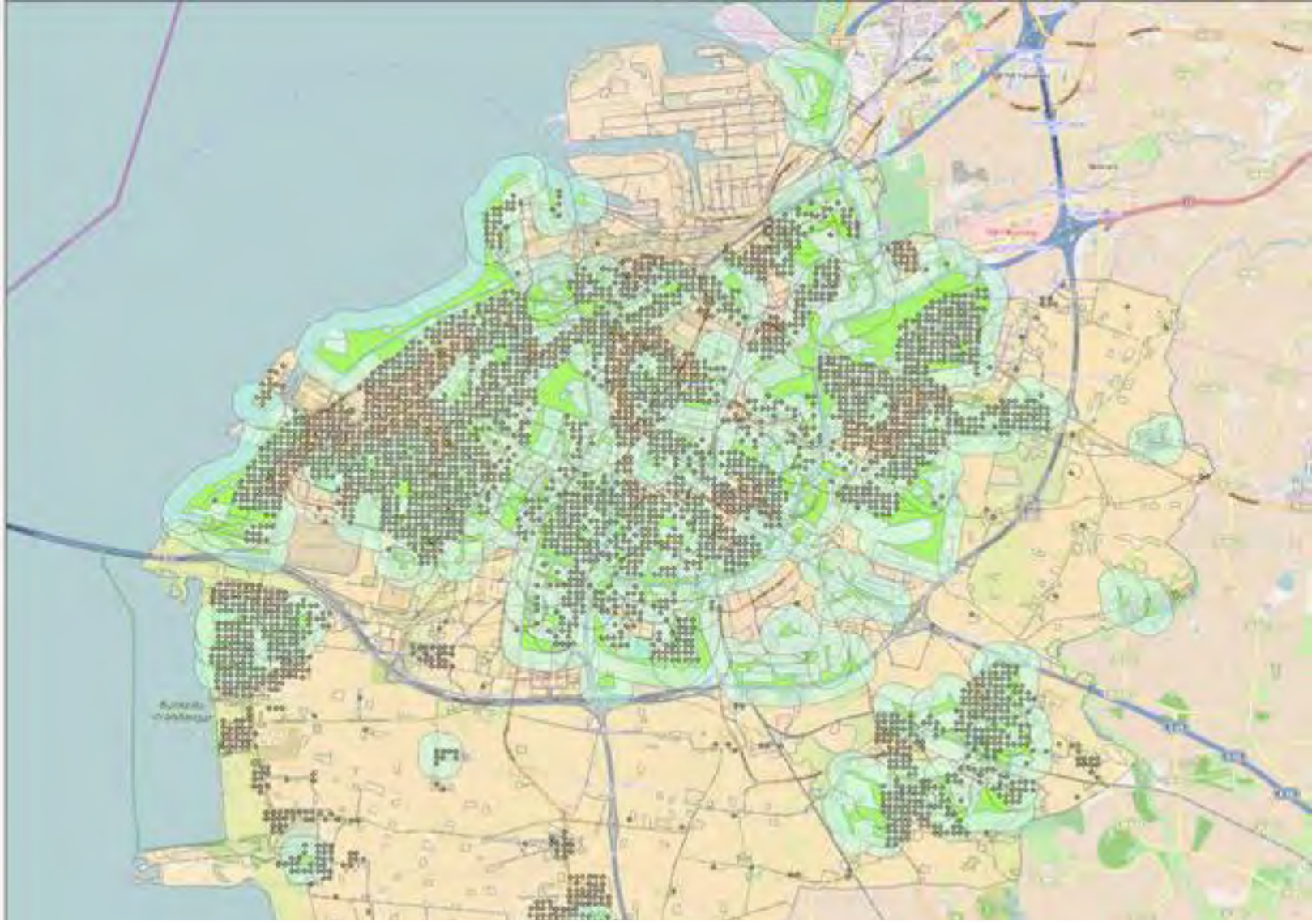
- GPS
- Accelerometers
- Smart phone apps
- Standardized scales, e.g. System for Observing Play and Recreation in Communities, SOPARC
- Surveys
- Big data

➢ Linked to physical activity, obesity, overweight, mental health

A GREEN PUBLIC HEALTH INDICATOR

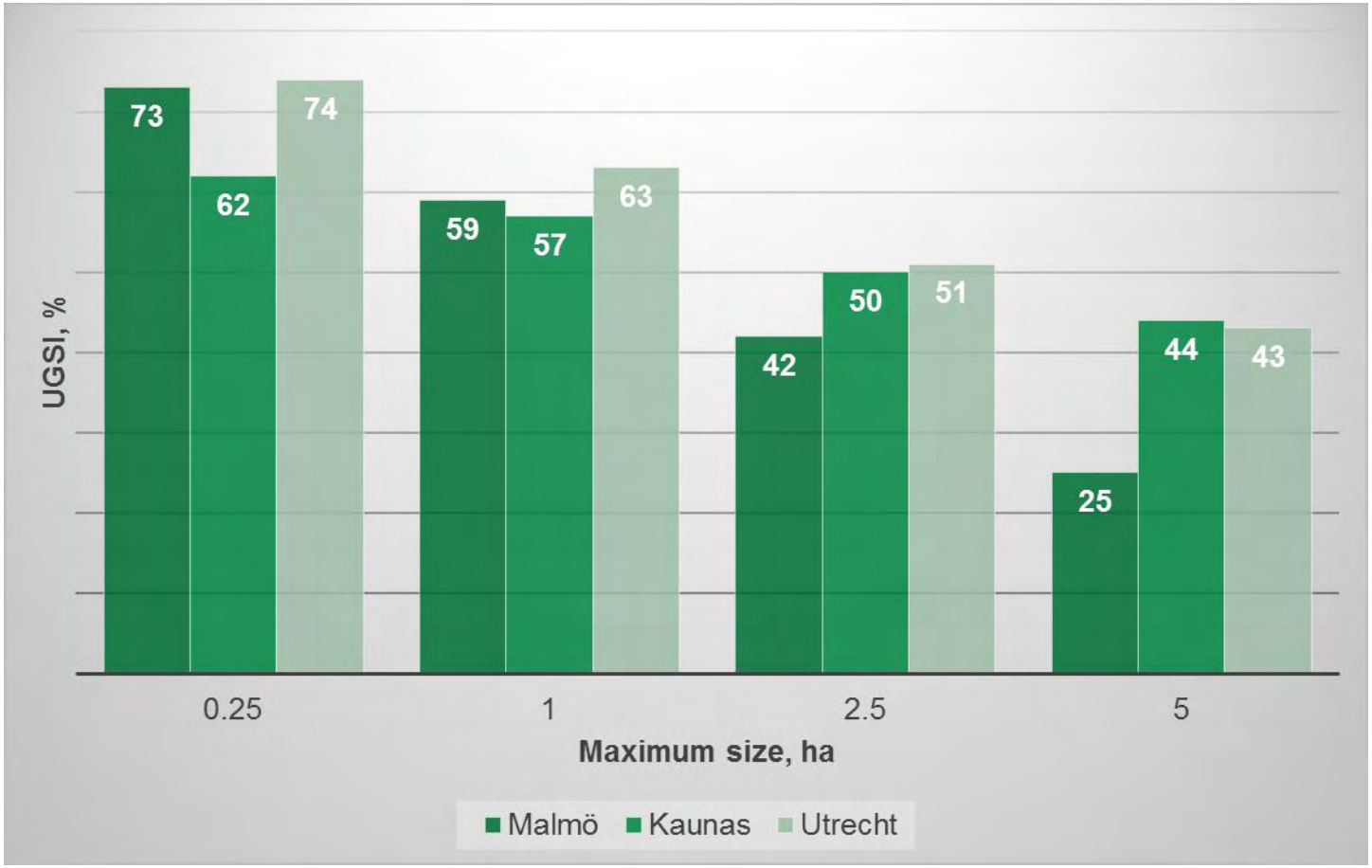
The Parma Commitments (WHO, 2010)

*"We aim to provide each child by 2020 with access to healthy and safe environments …, and to **green spaces** in which to play and undertake physical activity."*



$$\frac{\textit{population living within 300 m buffer (1 ha)}}{\textit{total population}} = \frac{237936}{297616} * 100 = 79.9\%$$

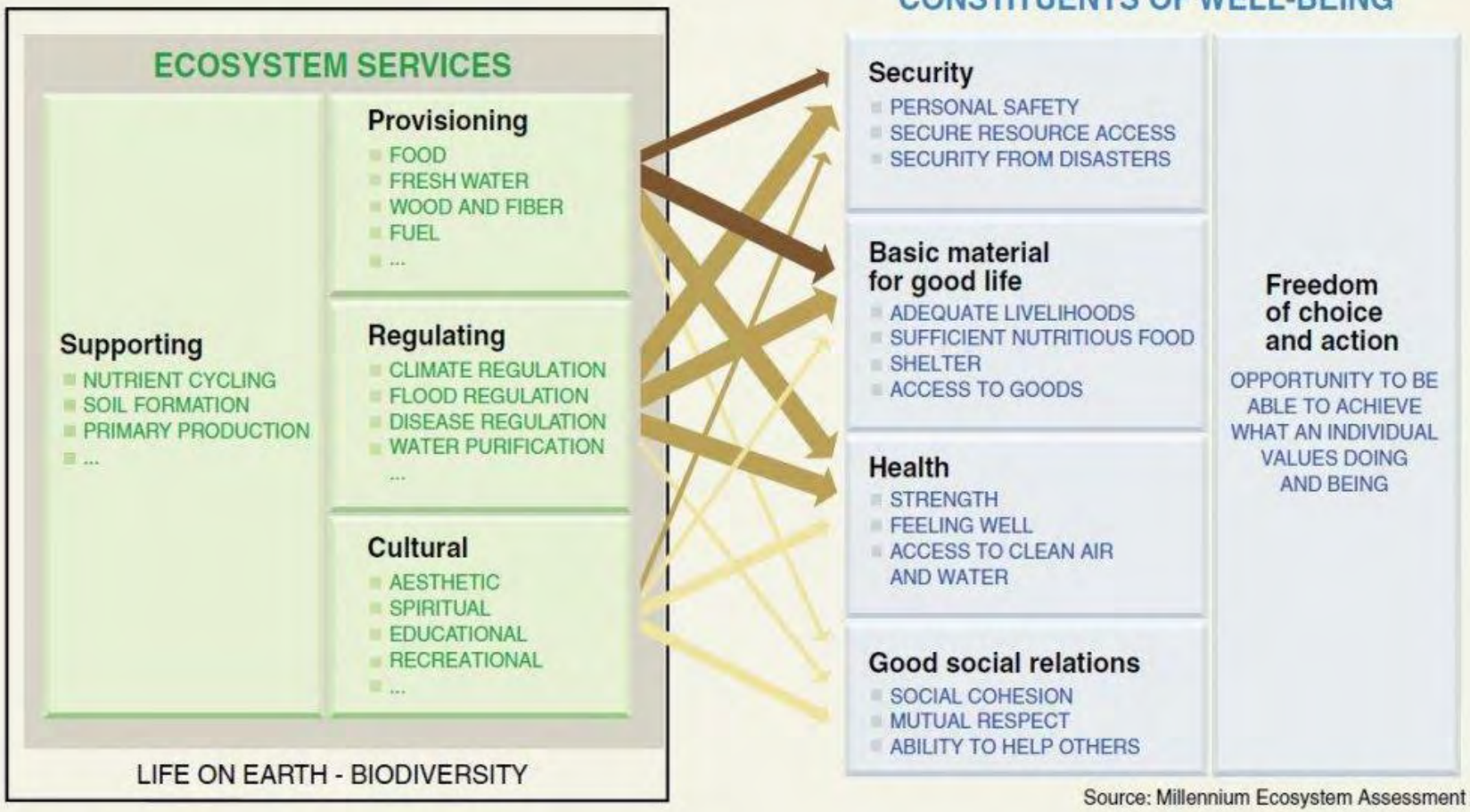
UGSI, 200M, MALMÖ, KAUNAS, UTRECHT



Annerstedt van den Bosch M, Mudu P, Uscila V, Barrdahl M, Kulinkina A, Staatsen B, Swart W, Kruize H, Zurlyte I, Egorov AI: **Development of an urban green space indicator and the public health rationale**. *Scandinavian Journal of Public Health* 2016, **44**:159-167

Includes a **tool-kit** for the assessment with step-by-step procedure for use by **urban planners**

INDICATORS OF ECOSYSTEM SERVICES



Source: Millennium Ecosystem Assessment

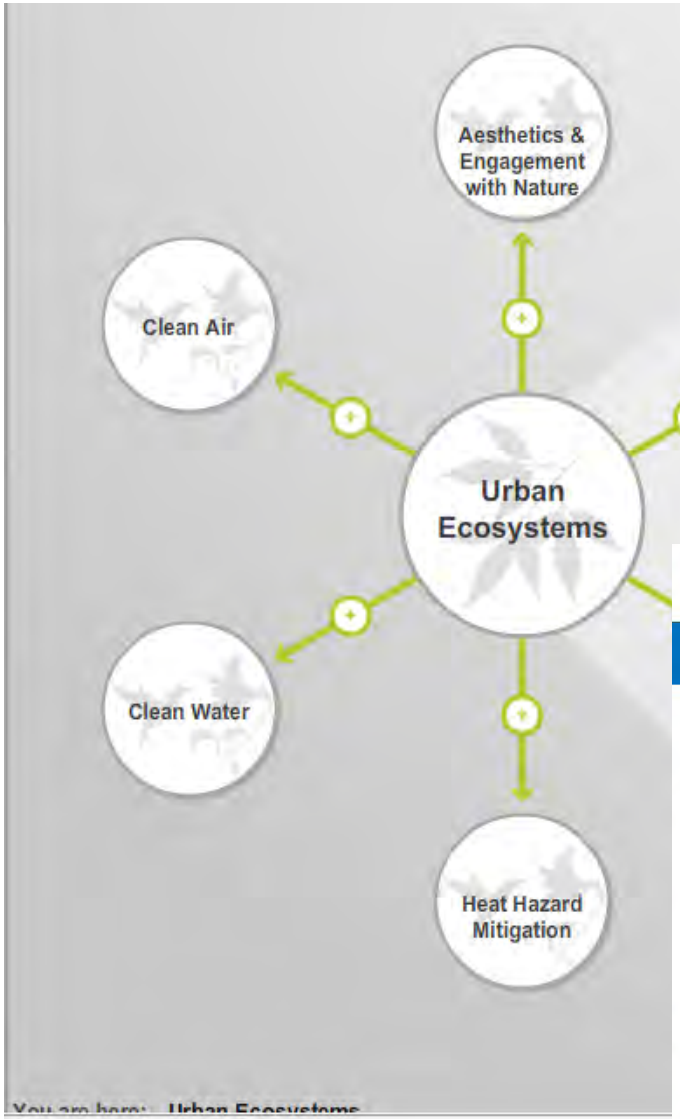
ARROW'S COLOR
Potential for mediation by socioeconomic factors

- Low
- Medium
- High

ARROW'S WIDTH
Intensity of linkages between ecosystem services and human well-being

- Weak
- Medium
- Strong

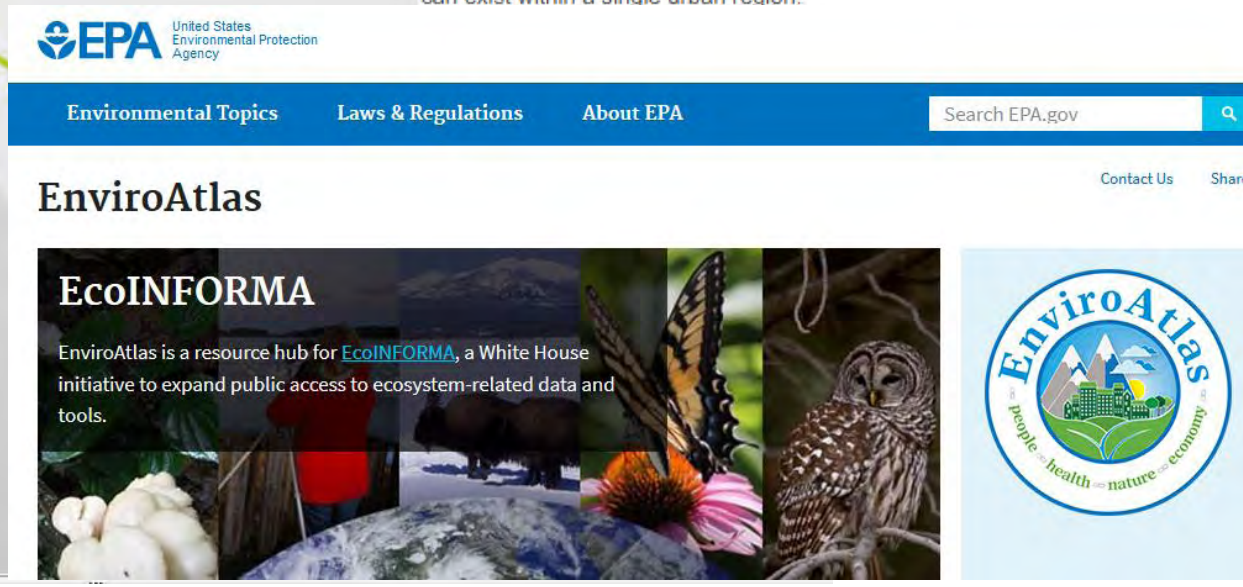
ENVIROATLAS -
AN INDICATOR OF ECOSYSTEM SERVICES



Details

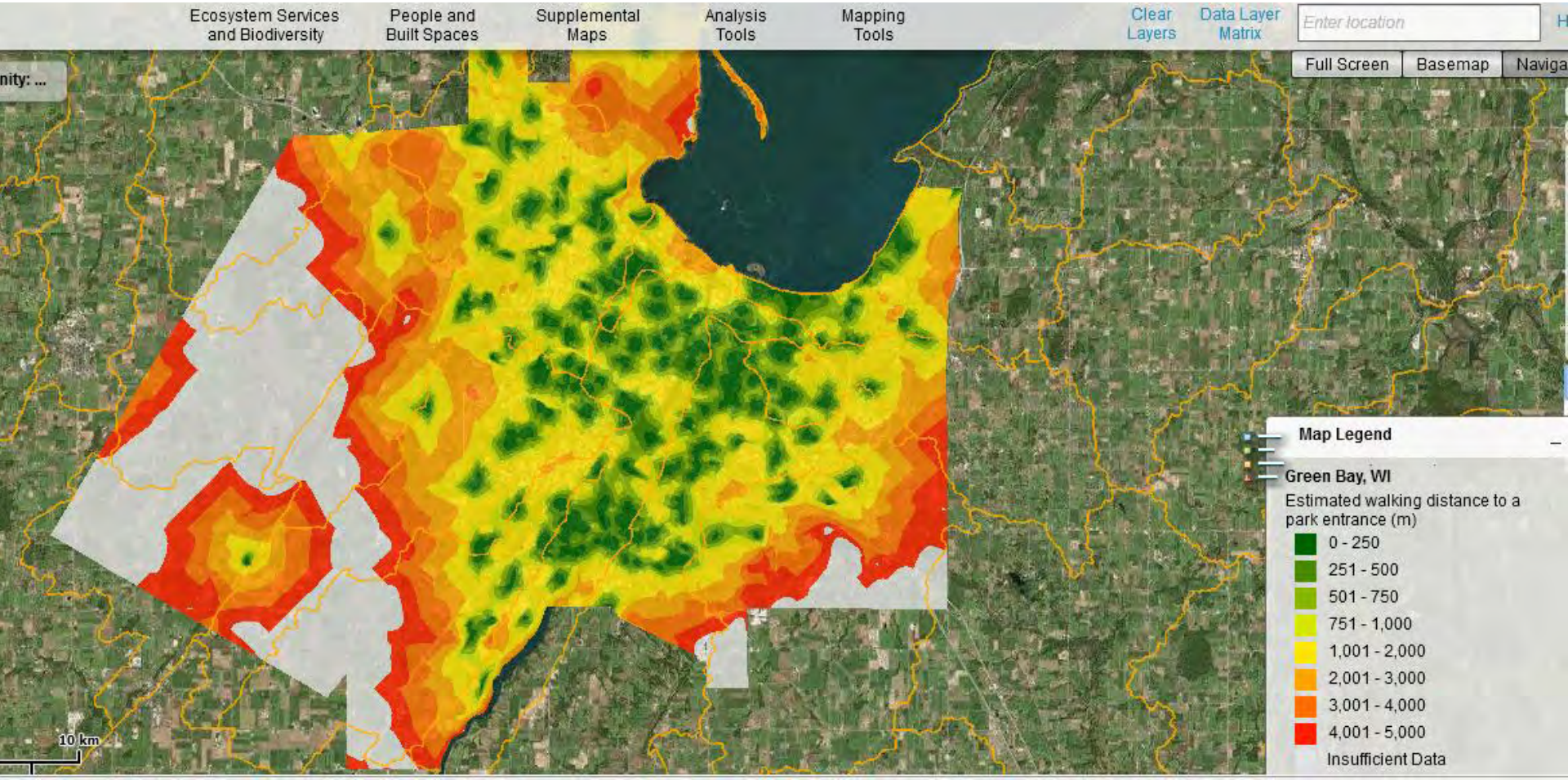
Description: Urban Ecosystems

An urban ecosystem is a dynamic system that contains both built and natural elements. In urban ecosystems, built infrastructure typically covers a large proportion of the land surface and/or people live in high densities. These systems include all green and blue spaces within the area, such as parks, cemeteries, lakes and streams, along with human components. Urban ecosystems can mimic the function of natural ecosystems and thus provide their own important ecosystem services that contribute to human well-being in those urban areas. Various green environments such as shade trees, urban green spaces and urban forests, can exist within a single urban region.



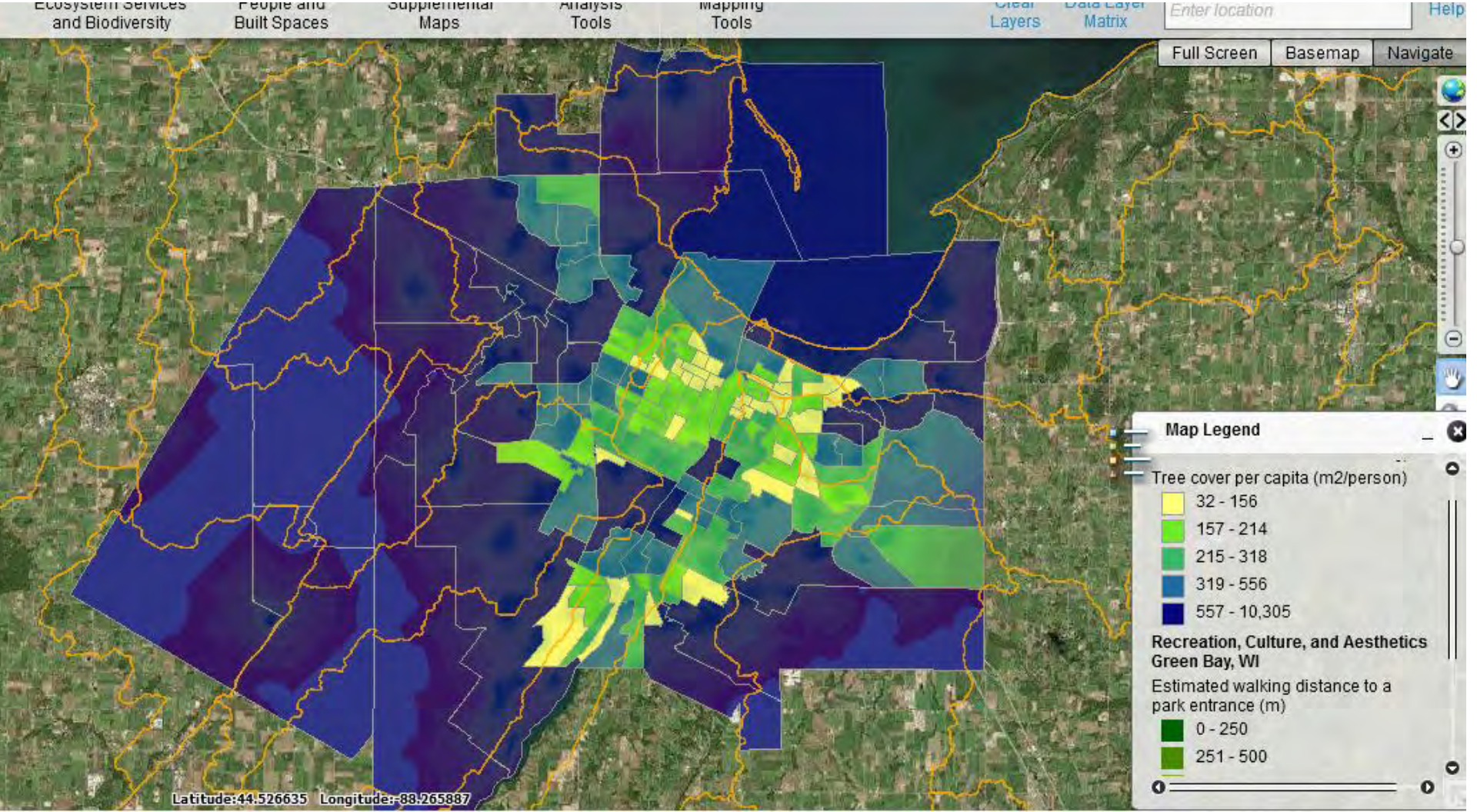
ESTIMATED WALKING DISTANCE TO A PARK ENTRANCE IN GREEN BAY

ENVIROATLAS



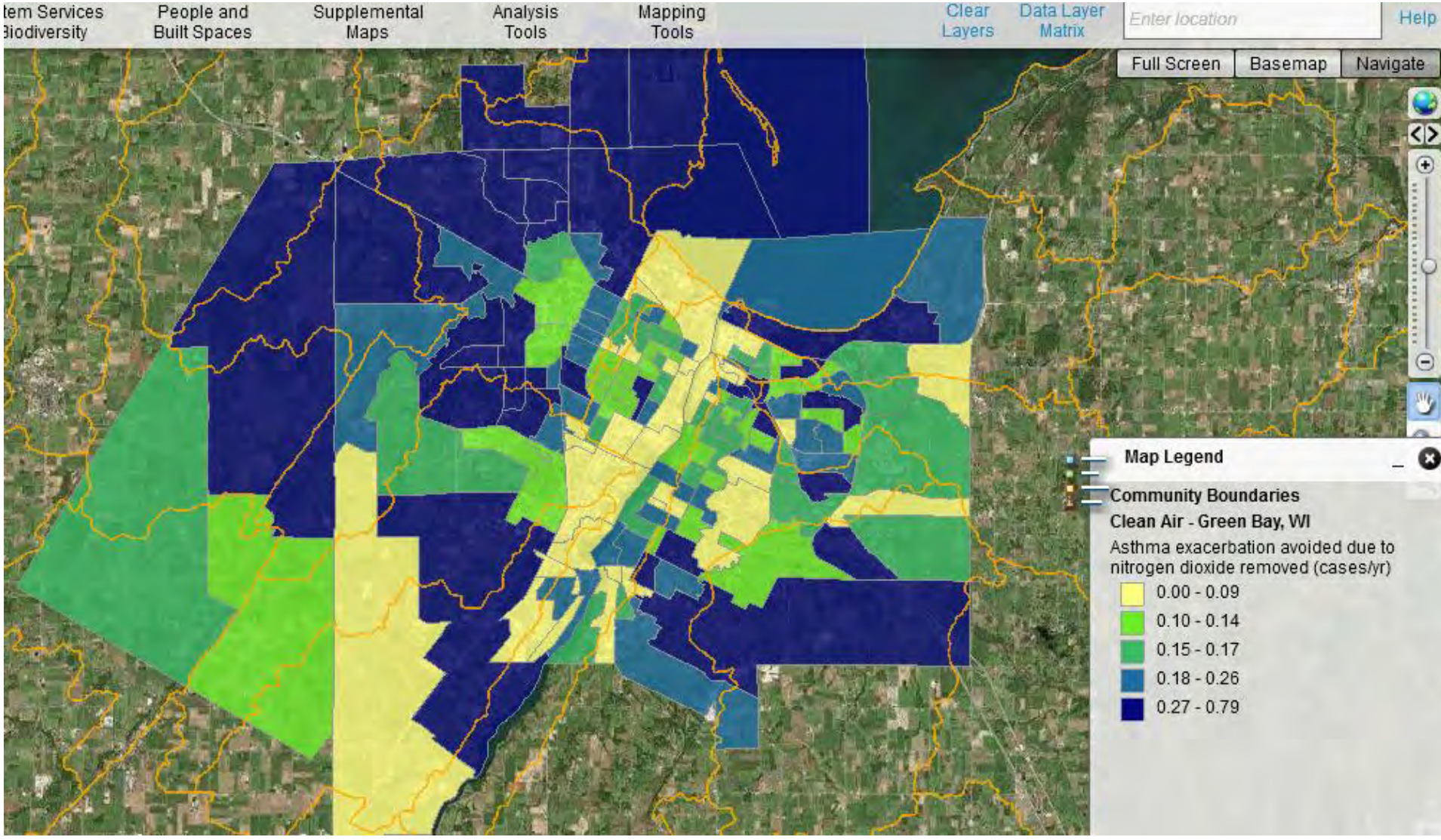
TREE COVER PER CAPITA (m2/person)

ENVIROATLAS



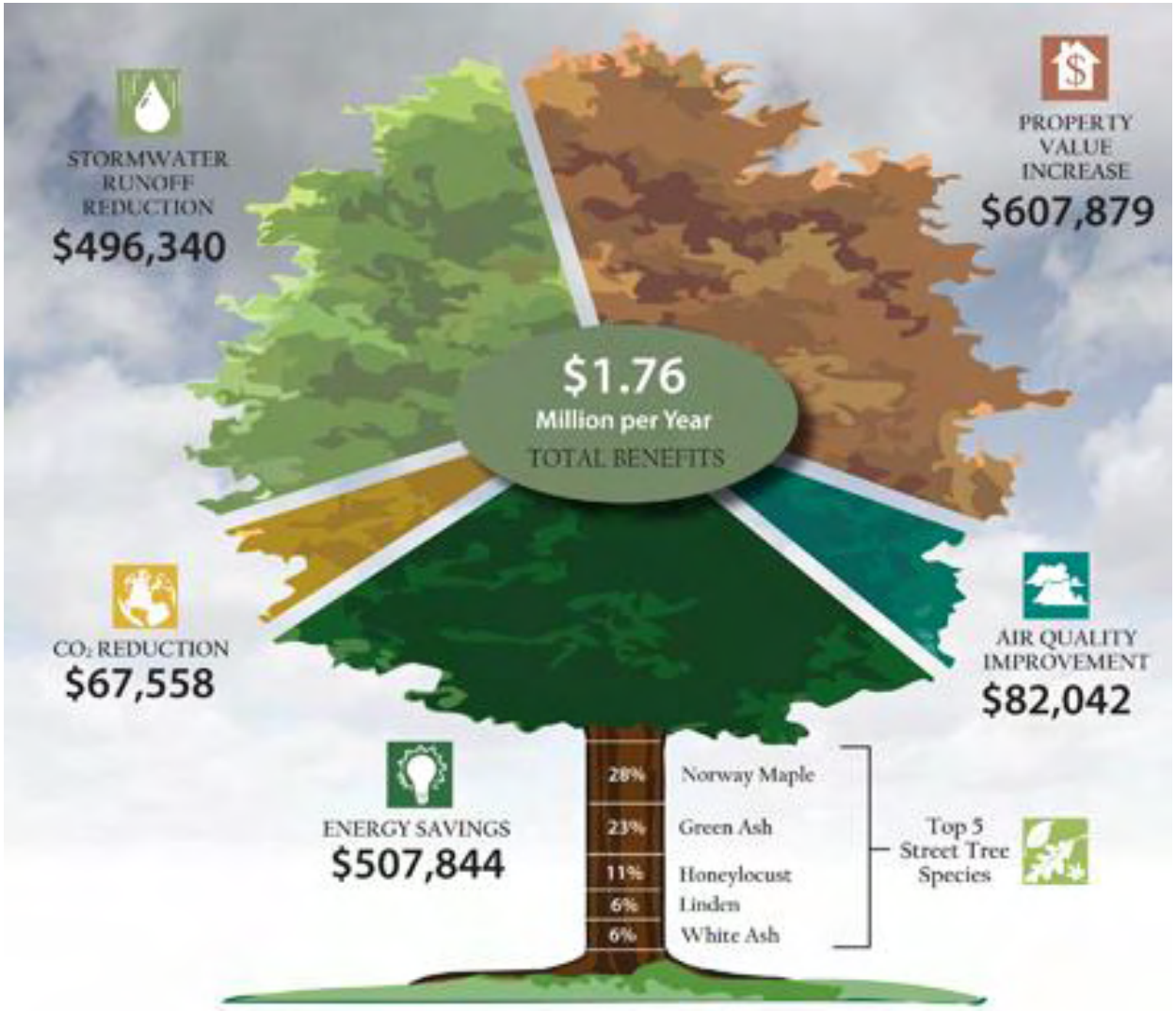
ASTHMA EXACERBATION AVOIDED DUE TO NO2 REMOVED BY TREES

ENVIROATLAS

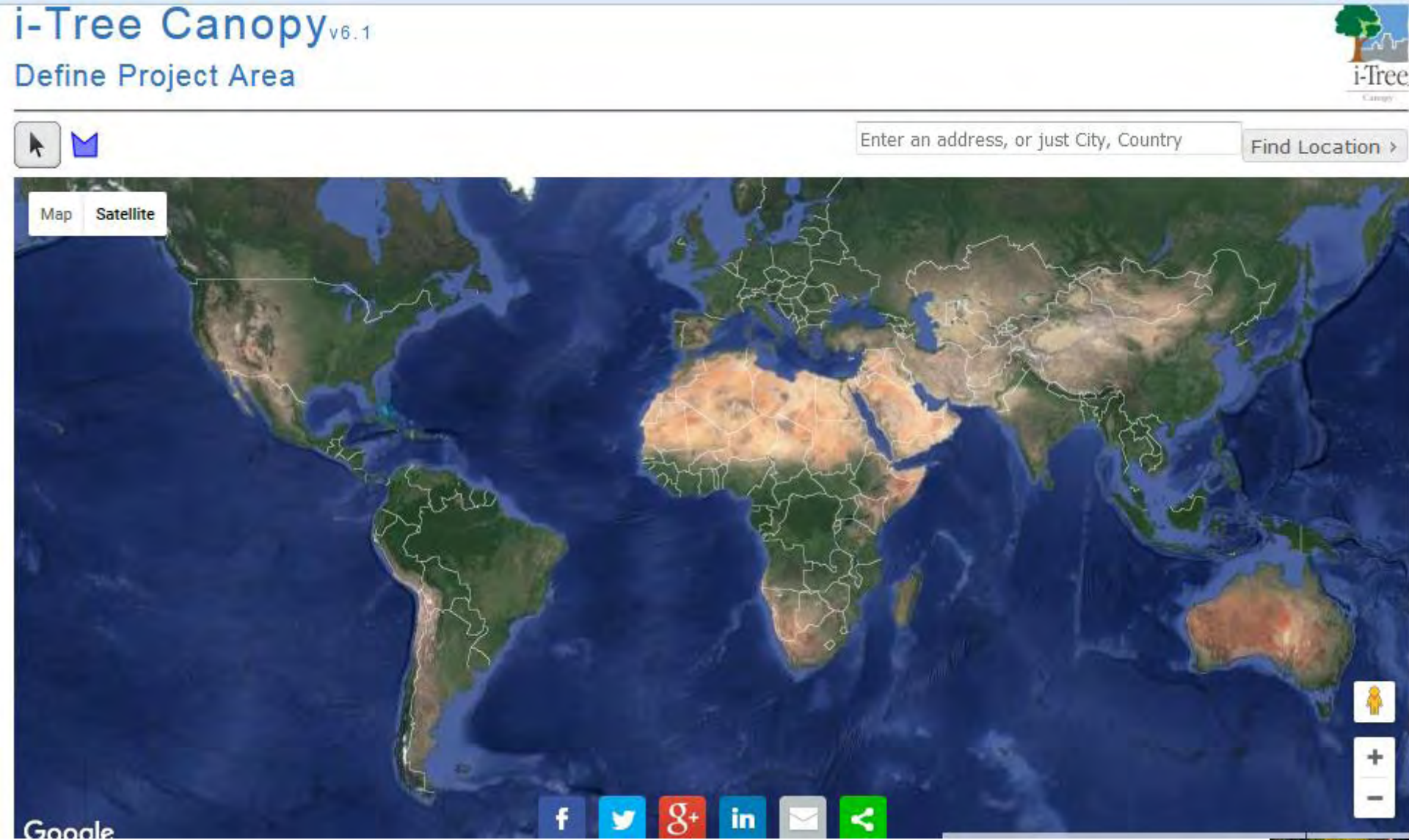


BIOPHYSICAL AND ECONOMIC INDICATORS

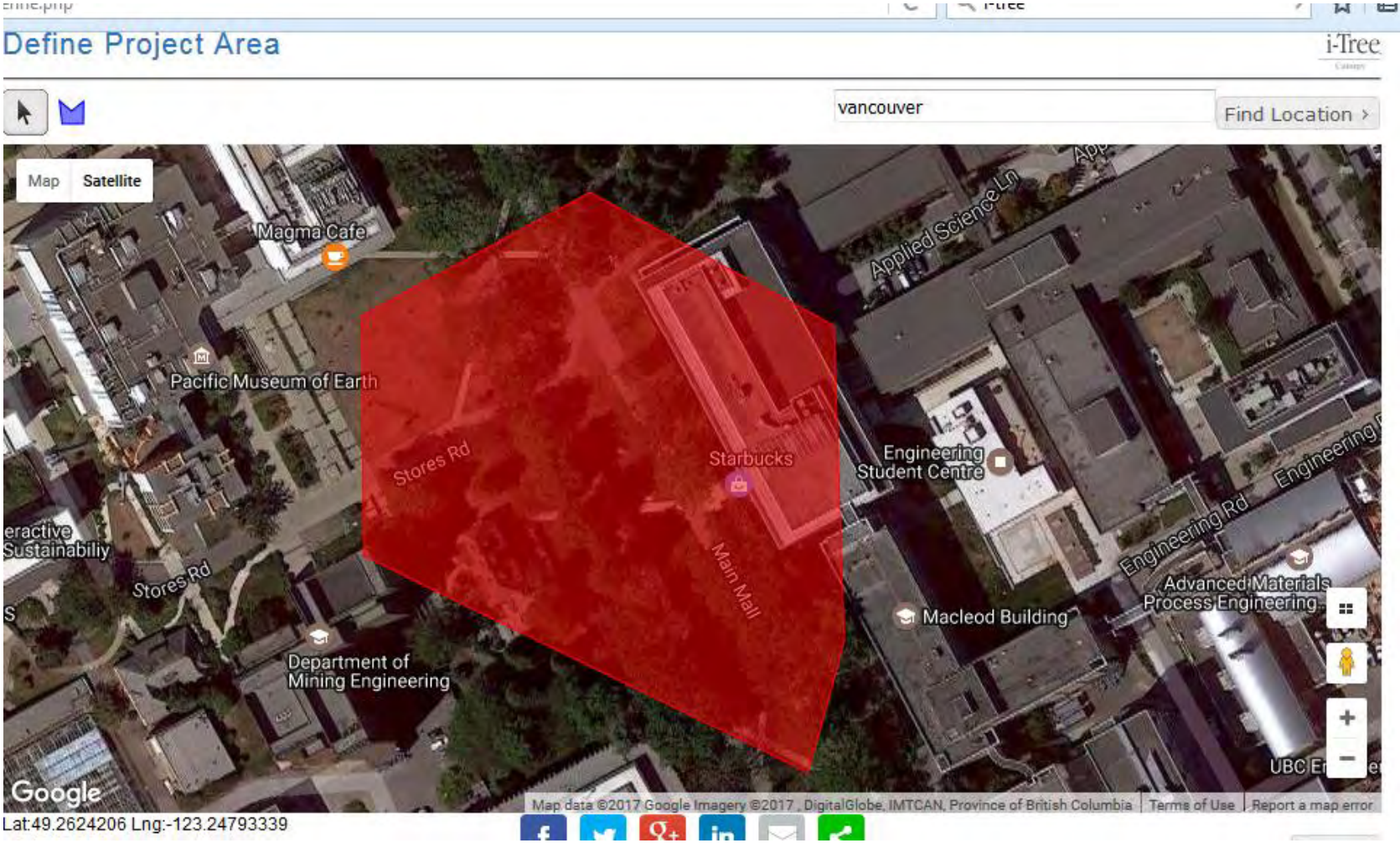
i-Tree and InVEST



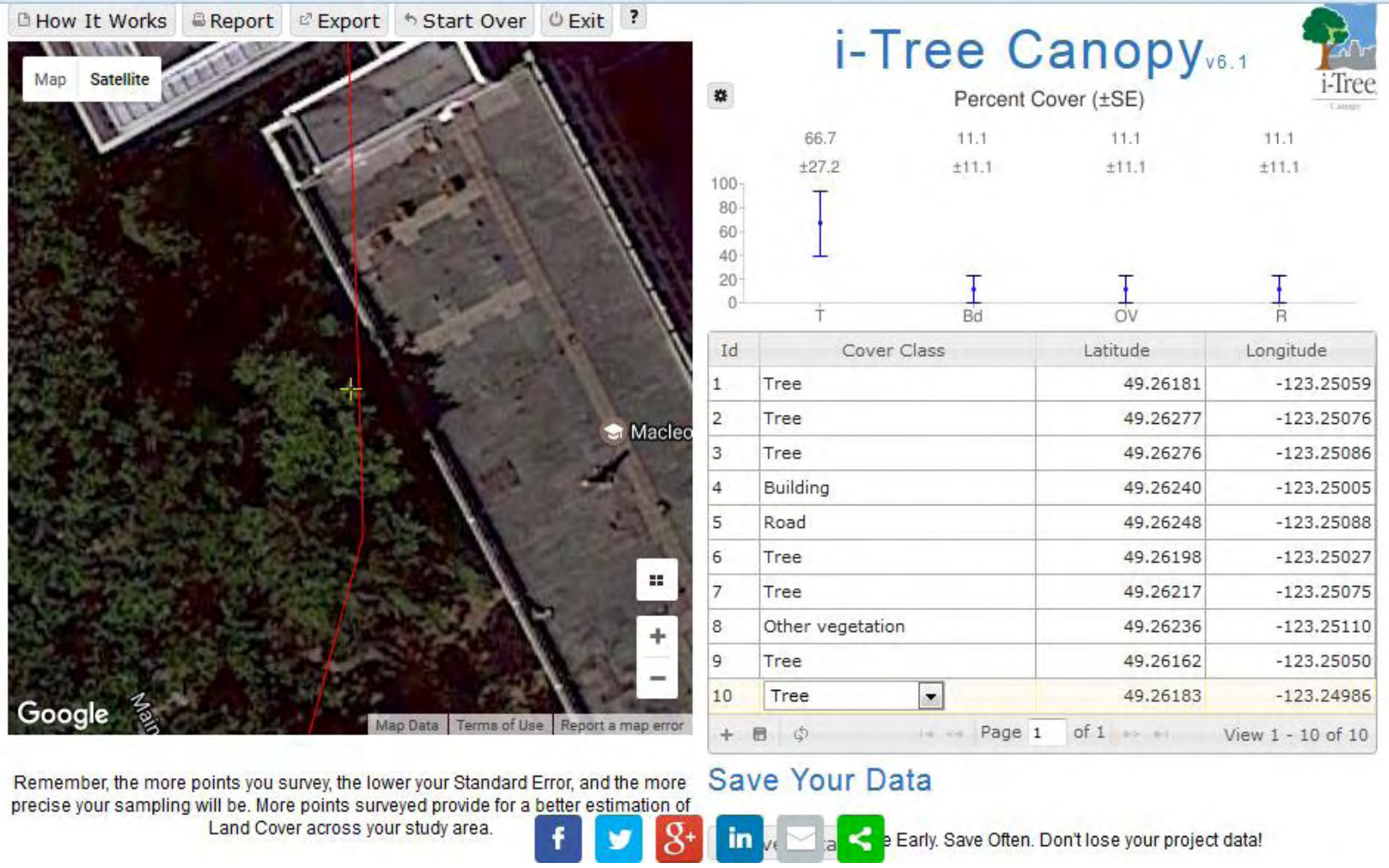
DEFINE REGION OF INTEREST

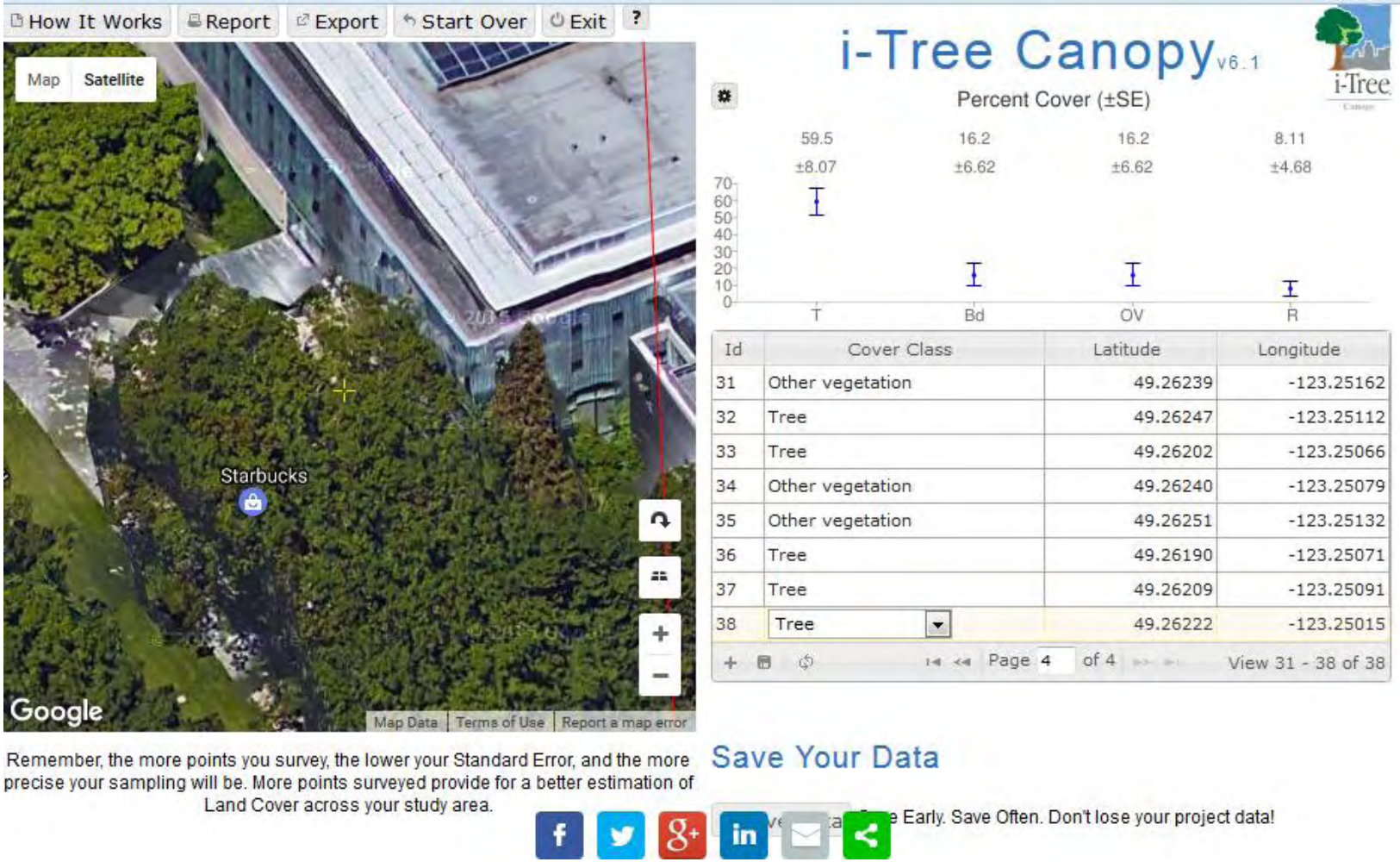


i-TREE CANOPY AT CAMPUS



SAMPLING


How It Works
Report
Export
Start Over
Exit
Map
Satellite
Google
Map Data
Terms of Use
Report a map error
i-Tree Canopy v6.1
Percent Cover (±SE)
66.7
±27.2
11.1
±11.1
11.1
±11.1
11.1
±11.1
100
80
60
40
20
0
T
Bd
OV
R
Id | Cover Class | Latitude | Longitude
1 | Tree | 49.26181 | -123.25059
2 | Tree | 49.26277 | -123.25076
3 | Tree | 49.26276 | -123.25086
4 | Building | 49.26240 | -123.25005
5 | Road | 49.26248 | -123.25088
6 | Tree | 49.26198 | -123.25027
7 | Tree | 49.26217 | -123.25075
8 | Other vegetation | 49.26236 | -123.25110
9 | Tree | 49.26162 | -123.25050
10 | Tree | 49.26183 | -123.24986
Page 1 of 1
View 1 - 10 of 10
Remember, the more points you survey, the lower your Standard Error, and the more precise your sampling will be. More points surveyed provide for a better estimation of Land Cover across your study area.
Save Your Data
e Early. Save Often. Don't lose your project data!


How It Works
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Terms of Use
Report a map error
i-Tree Canopy v6.1
i-Tree
Percent Cover (±SE)
59.5
±8.07
16.2
±6.62
16.2
±6.62
8.11
±4.68
70
60
50
40
30
20
10
0
T
Bd
OV
R
Id
Cover Class
Latitude
Longitude
31 Other vegetation 49.26239 -123.25162
32 Tree 49.26247 -123.25112
33 Tree 49.26202 -123.25066
34 Other vegetation 49.26240 -123.25079
35 Other vegetation 49.26251 -123.25132
36 Tree 49.26190 -123.25071
37 Tree 49.26209 -123.25091
38 Tree 49.26222 -123.25015
Page 4 of 4
View 31 - 38 of 38
Remember, the more points you survey, the lower your Standard Error, and the more precise your sampling will be. More points surveyed provide for a better estimation of Land Cover across your study area.
Save Your Data
Early. Save Often. Don't lose your project data!

THE REPORT

Cover Class	Description	Abbr.	Points	% Cover
Tree	Tree, non-shrub	T	22	59.5 ±8.07
Building	Built	Bd	6	16.2 ±6.62
Other vegetation	grass etc	OV	6	16.2 ±6.62
Road		R	3	8.11 ±4.68

Tree Benefit Estimates

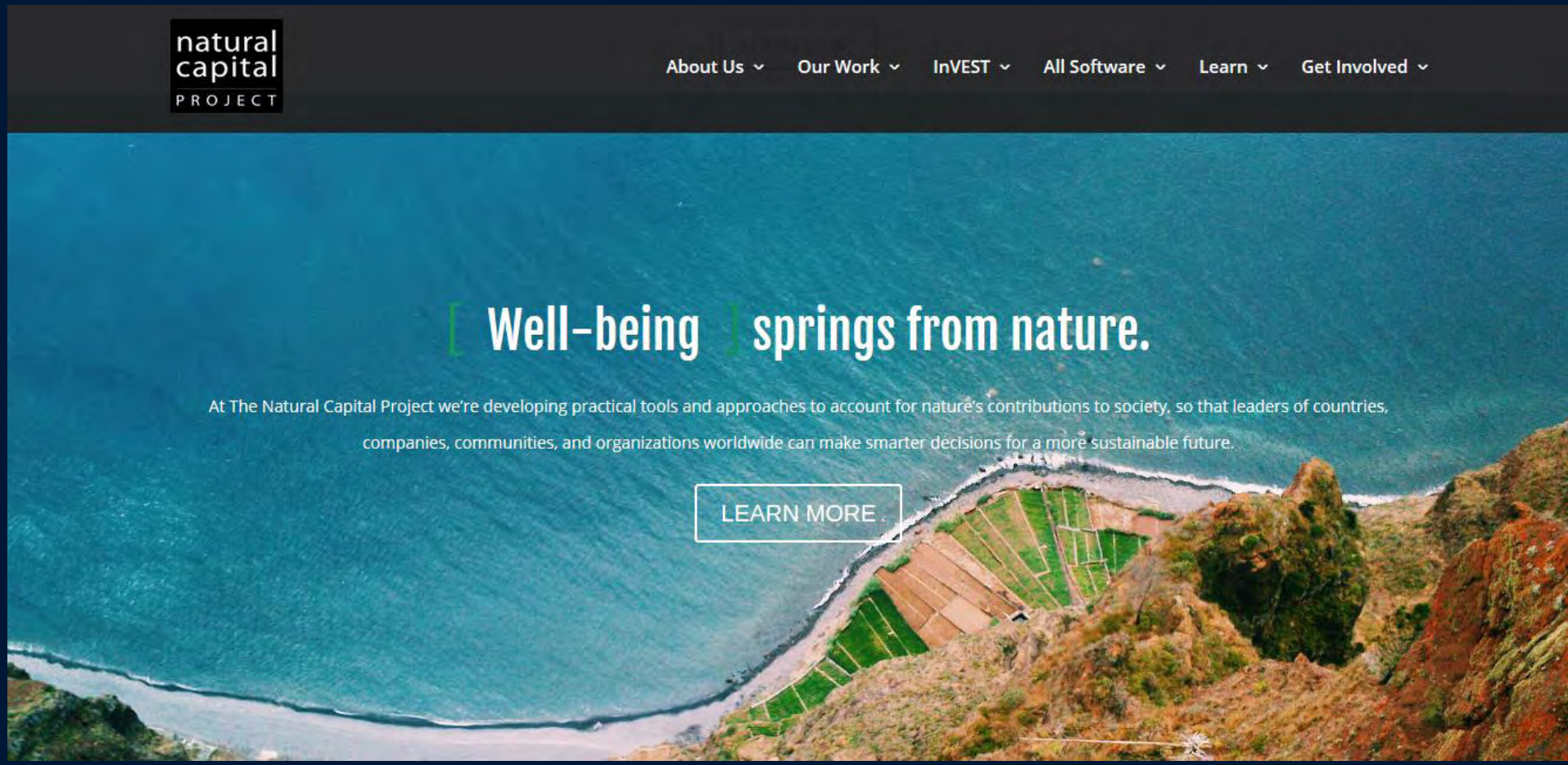
Abbr.	Benefit Description	Value	±SE	Amount	±SE
CO	Carbon Monoxide removed annually	$0.10	±0.01	0.00 t	±0.00
NO2	Nitrogen Dioxide removed annually	$0.18	±0.02	4.60 kg	±0.62
O3	Ozone removed annually	$9.36	±1.27	45.85 kg	±6.22
PM2.5	Particulate Matter less than 2.5 microns removed annually	$19.35	±2.63	2.23 kg	±0.30
SO2	Sulfur Dioxide removed annually	$0.03	±0.00	2.90 kg	±0.39
PM10*	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually	$6.80	±0.92	15.36 kg	±2.08
CO2seq	Carbon Dioxide sequestered annually in trees	$480.17	±65.18	9.34 t	±1.27
CO2stor	Carbon Dioxide stored in trees (Note: this benefit is not an annual rate)	$12,106.48	±1,643.43	235.39 t	±31.95

i-Tree Canopy Annual Tree Benefit Estimates based on these values in g/m²/yr and $/t/yr: CO 0.101 @ $123.68 | NO2 0.551 @ $39.05 | O3 5.489 @ $204.19 | PM2.5 0.267 @ $8,686.54 | SO2 0.347 @ $10.83 | PM10 1.838 @ $442.54 | CO2seq 1,117.578 @ $51.43 | CO2stor is a total biomass amount of 28,177.630 @ $51.43*

Note: Standard errors of removal amounts and ben[illegible] ampled and classified points.

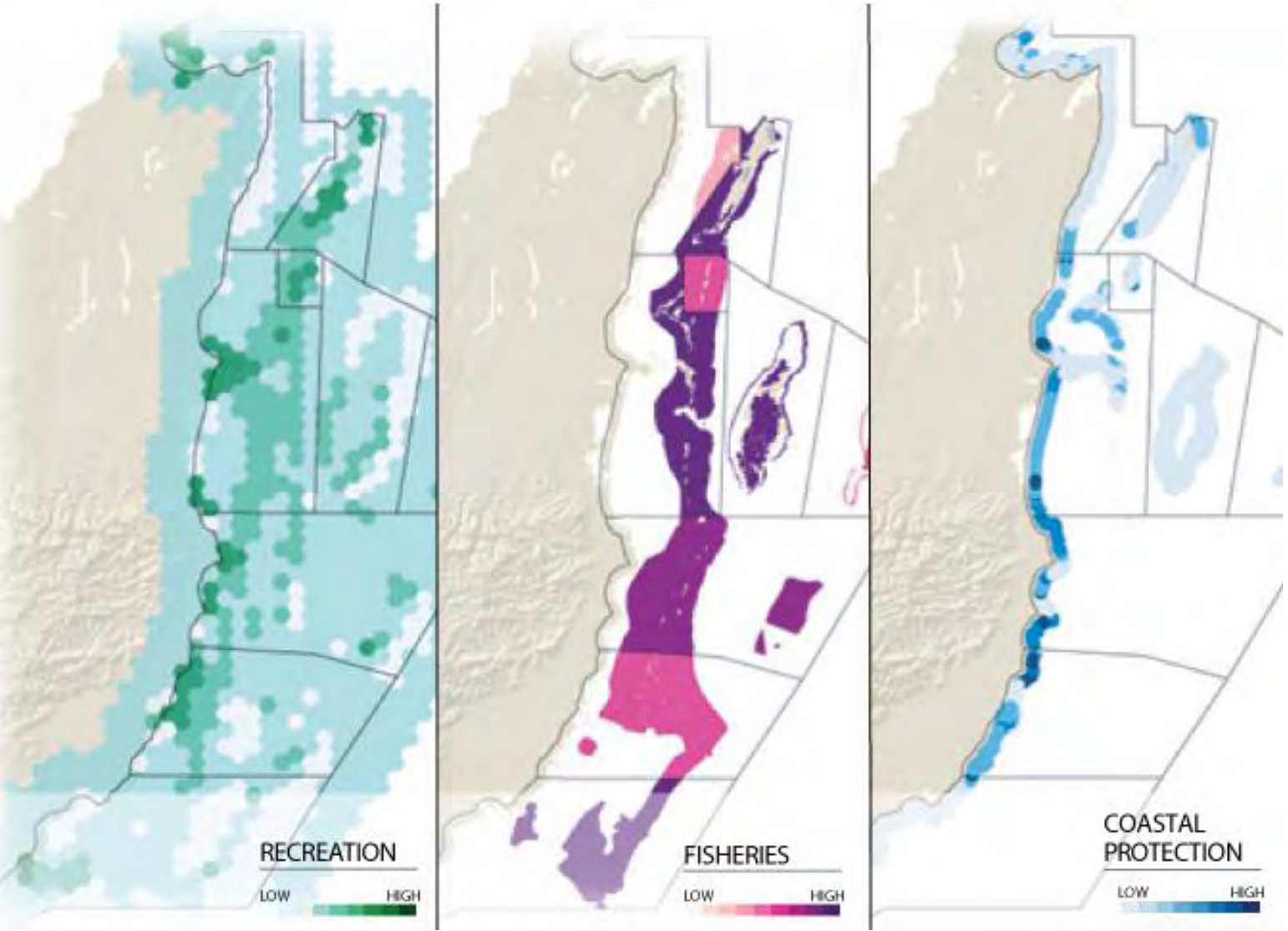
Click to add notes

NATURAL CAPITAL PROJECT



INVEST

Integrated valuation of ecosystem services and tradeoffs

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