Trees serve as nature's engineers in cities

A house sparrow perches in a young budding tree in downtown Cedar Rapids on Friday, March 31, 2017. (Liz)
Trees, Water and Wellness ::
Green Infrastructure & Human Health Co-Benefits

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University of Washington (Seattle)
School of Environmental and Forest Sciences

Trees Forever
Our Woodland Legacy Symposium
Cedar Rapids :: 7 December 2017
Outline

stormwater mitigation
the evolution (trees as example)
green infrastructure spaces & places
human health - performance
co-design examples
economic value
credit: EPA: Stormwater to Street Trees
measure the canopy of a city
Grey Infrastructure

Drain, direct, dispatch

Green Infrastructure

Slow, spread, soak

Source: Low Impact Development: A Design Manual for Urban Areas, 2010
Stormwater Trees
Technical Memorandum

September 2016

Typical street tree challenges (image from EPA 2013)
How can we transform the roof?

- Infiltration
- Retention
- Biodiversity
- Evapotranspiration

How can we transform the walls?

- Filtration

How can we transform the ground?

- Storage
Gray to Green

Decision support tool for transitioning to vegetation-based stormwater management

Rob Northrop
Andrew Koeser, PhD.
green infrastructure tools & strategies = mini parks?

credit: Seattle Public Utilities
SEASONS OF SEATTLE

credit: Cliff Mass
Green Stormwater Infrastructure :: Hermosillo, Mexico (6 inch rainfall)
credit: American Planning Association
Harding Middle School
stormwater management
Winslow, Bainbridge Island, Washington
retail district green stormwater infrastructure
management for co-benefits - retail
Stormwater Management

Thornton Creek Water Quality Channel (Seattle, SvR Design)
1 hectare, treats runoff from 275 hectares (1 hectare = 2.47 acres)
Clear Creek Basin, 2 acre stormwater detention lake, 17 acres of greenspace & parks amenities
Outline

trees & stormwater attenuation
the evolution

precipitation patterns
single trees
green stormwater infrastructure
novel ecosystems
place and identity
Outline

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human health - performance
co-design examples
economic value
WHO Health Definition

A state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity (1946)
Determinants of Health
Green Cities: Good Health
www.greenhealth.washington.edu

Sponsors:
USDA Forest Service, U&CF Program
University of Washington
NGO partners

Thanks!
to U of WA students:
Katrina Flora
Mary Ann Rozance
Sarah Krueger

Research Reviews & Summaries
Local Economics

Trees in cities are not grown and managed for products that can be bought and sold on markets, but they do provide many intangible services and functions! This article serves two purposes. First, it introduces valuation methods that are used to convert intangible benefits to dollar sums. Then, it shows how nonmarket valuations can support local decision-making.

Fast Facts

- The presence of larger trees in yards and as street trees can add from 3% to 15% to home values throughout neighborhoods.
- Averaging the market effect of street trees on all house values across Portland, Oregon yields a total value of $1.35 billion, potentially increasing annual property tax revenues $15.3 million.
- A study found 7% higher rental rates for commercial offices having high quality landscapes.
- Shoppers claim that they will spend 9% to 12% more for goods and services in central business districts having high quality tree canopy.
- Shoppers indicate that they will travel greater distance and a longer time to visit a district having high quality trees, and spend more time there once they arrive.
design: milepost
co-author
co-author & printing: The Nature Conservancy
strength of evidence; causal mechanisms?

Outline

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economic value
Stormwater Report, online April 2014 (search health)
place making: vertical + horizontal surfaces
design concept

bring people in!
design concept

orient seating to nature!
design concept

enable biodiversity & soft fascination
spatial linkages: the city becomes a park

TKF Foundation :: Nature Sacred initiative
Outline

trees & stormwater attenuation
the evolution
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co-design examples
economic value
What are the economic values of nature and human health benefits?
Elements of Economic Valuation

- What are the benefits?
- Who are the beneficiaries?
- What is the green condition or situation that provides benefits?
- Scale of value question (i.e., community, province/state, nation)
- What are the costs/income gained/lost associated with these benefits?
Analysis Process

- Scale of individual to community
- Screen for benefits
- Green condition
  - Urban forestry, parks, gardens, etc.
- Market & non-market valuation strategy
process #1: screen for benefits
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Urban Forests and Newborns

the natural environment may affect pregnancy outcomes . . .

10% increase in tree-canopy cover within 50m of a house
= lower number of low weight births (1.42 per 1000 births)

*Donovan et al., Health & Place 2011; Hystad et al., Env Health Perspectives 2014*
Hygiene Hypothesis

- presence of soil bacteria in body, *Mycobacterium vaccae* = increased serotonin
- boost immune function
- may alleviate depression (dirt or Prozac?)

Lowry et al. 2007. Neuroscience
ADHD and nature contact

- 17 children aged 7-12 with diagnosed ADHD
- 20-minute guided walks
  - Park
  - Neighborhood
  - Downtown
- Pre-walk puzzles
- Post-walk cognitive test

Faber Taylor & Kuo. 2009. *Journal of Attention Disorders*
% of Americans Ages 20-44 on ADHD Meds
2001 - 2010

America’s State of Mind, Medco Health Solutions, Inc
CDC moderate activity recommendations

parks, active living, active transit
Parks Prescription

Rx for Health

Date: _________________________

Dr: _________________________

Name: _______________________

I recommend: _________________________

[ ] Walking [ ] Other: _________________________

__________________________ minutes a day

__________________________ days per week

* Health Canada suggests moderate activity of 30 minutes per day | 5 days a week

Benefits of daily activity

• Improve overall physical and mental health
• Maintain a healthy weight
• Reduce the risk of diabetes and other chronic conditions
• Lower cholesterol levels
• Manage stress and anxiety

Signature: _________________________

Source: Doctors of BC
Parks Prescription

1. Get a prescription for ParksRx from your healthcare provider.
2. Visit www.REACHforbetterhealth.com
   - Enter your zip code
   - Click
3. Pick your park
4. Exercise in the park and share outcomes with your healthcare provider.

Dr. Robert Zarr
‘walk with a doc’
Shinrin yoku (forest bathing)

- extensive research
- restorative experiences
- workers retirees
- networked system, 52 bases in Japan
Improving Depression

20 adults with major depression walk in a park setting and an urban setting

- 50-minute walks one week apart
- before-after testing:
  - Mood: Positive and Negative Affect (PANAS)
  - Cognition: Backward Digit Span (BDS)

Berman et al. 2012. *Journal of Affective Disorders*

cognitive and affective improvements after walking in a nature setting
% of U.S. Population Using Mental Health Medications

2001 vs 2010

America’s State of Mind, Medco Health Solutions, Inc
Alzheimer’s Disease & Dementia
Provide wander gardens & horticulture therapy

- 10.5% reduction in amount of medications used in dementia facility
- 30% fewer falls, accompanied by a reduction in fall severity

Detweiler et al. 2009. American Journal of Alzheimer’s Disease and Other Dementias

www.rph.org/eden.html
process #2: understand green condition
Diversity in Metro Nature

Nearby Nature Includes a Variety of Spaces and Places

Urban Forest Canopy

Biophilic Design

Parks and Gardens

Green Stormwater Infrastructure
Prison Inmates :: nature videos

solitary confinement, video room/exercise option

- felt significantly calmer, less irritable, more empathetic
- committed 26% fewer violent infractions

process #3: apply valuation strategy
Valuation Strategies

Benefits Transfer approaches

- factor income
- avoided or replacement cost
- burden of illness
- hedonic pricing
- stated preference/contingent valuation
- revealed preference (e.g., travel cost)
- quality adjusted life years
- benefit/cost
What is the Value?
Analysis Process

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### Summary Table

<table>
<thead>
<tr>
<th>Benefit (geographic scope)</th>
<th>Minimum ($)</th>
<th>Maximum ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newborn Health (U.S.)</td>
<td>5.3</td>
<td>5.3</td>
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<tr>
<td>Attention Deficit Hyperactivity Disorder (U.S.)</td>
<td>383.5</td>
<td>1,917.7</td>
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<tr>
<td>Schools (U.S.)</td>
<td>20.4</td>
<td>1,262.9</td>
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<tr>
<td>Crime (U.S.)</td>
<td>340.6</td>
<td>899.4</td>
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<tr>
<td>Cardiovascular Disease (U.K., U.S.)</td>
<td>1,220.0</td>
<td>1,220.0</td>
</tr>
<tr>
<td>Alzheimer’s Disease (U.S.)</td>
<td>724.6</td>
<td>1,449.2</td>
</tr>
<tr>
<td>Totals</td>
<td>2,694.4</td>
<td>6,754.5</td>
</tr>
</tbody>
</table>

Nearby nature experiences are important across the entire life cycle, from cradle to grave.

**INFANTS**

**BIRTH WEIGHT**

**ECONOMIC IMPACT:**

Increased physical activity, reduced asthma or other causes of emergency department visits, hospitalizations and missed school days, and reduced risk of adult skin conditions.

**IMMUNE FUNCTION**

Enhanced immune response.

**FAMILY DYNAMICS**

Improved family dynamics, perhaps reducing mental health treatment and counseling services.

**FUTURE FINANCIAL SUCCESS**

$1.26 increase in high school graduates’ lifetime annual income.

**Note:** All analyses assume age in 2001 U.S. dollar and are relevant annual averages across the entire U.S.

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**CHILDREN & TEENS**

**OVERALL HEALTH AND WELL-BEING**

**ECONOMIC IMPACT:**

Increased physical activity, reduced autism or other causes of emergency department visits, hospitalizations and missed school days, and reduced risk of adult skin conditions.

**NEED TO NURTURE**

Nurturing children helps them develop learning, social, and emotional skills that are important for their development.

**ADHD**

**ECONOMIC IMPACT:**

$9.30 savings on medication savings per year.

**CARDIOVASCULAR DISEASE**

**ECONOMIC IMPACT:**

$1.30-$3.90 annual savings, based on a 1-2% reduction in medication expenditures.

**CANCER**

**ECONOMIC IMPACT:**

$1.60 savings on cancer treatment costs annually.

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**ADULTS**

**DEPRESSION & STRESS**

**ECONOMIC IMPACT:**

Reduces frustration, mental distress, and depression disorders, and improves body image and self-esteem.

**MOBILITY & QUALITY OF LIFE**

**ECONOMIC IMPACT:**

$3.60-$4.80 savings on health care costs from falls per year.

**HYPERTENSION**

**ECONOMIC IMPACT:**

Reduced hypertension, or high blood pressure, is one of the five most expensive conditions impacting older adults. Exercise and nature exposure can reduce blood pressure.

**COGNITIVE DISORDERS**

**ECONOMIC IMPACT:**

$1.60-$3.20 annual savings on medical services, not counting the value of home care services.

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**OLDER ADULTS**

**MOBILITY & QUALITY OF LIFE**

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**Contributing Analysts:**

Dr. Stephen Grado & Marcus Measells, MSU; Dr. Alicia Robbins, Weyerhaueser
Summary

- trees as a green infrastructure element
- co-design for co-benefits
- eco + human health performance
- health outcomes evidence
- economic consequences, return on investment
Urban Forests for Human Health: A Focused Economic Valuation

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