Rooting Ecosystems Services Theory in Urban Greening Practice

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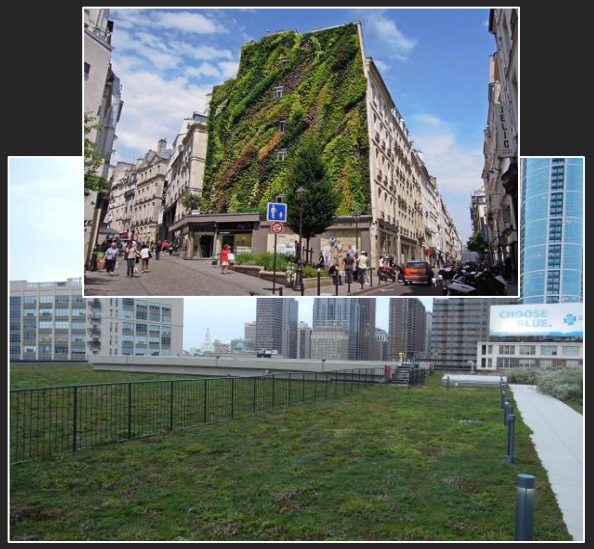
University of Pennsylvania

Context: *Cities are Greening! . . . "frantic greening process"*

(Cariñanos & Casares-Porcel 2011)

Singapore: "pervasive greenery…wherever the eye [can] see" (ULI 2013)



Green Roofs & Walls (GRHC 2014)

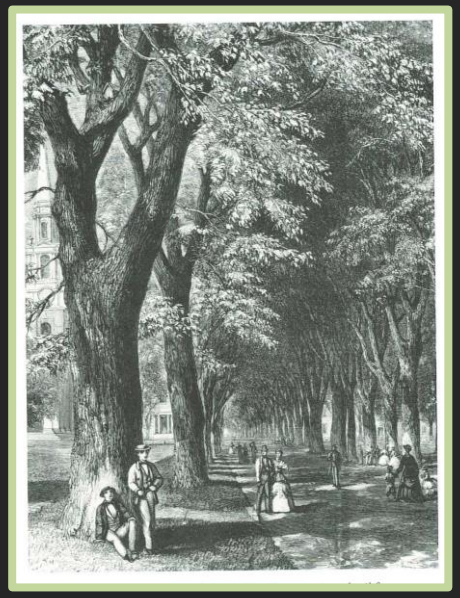
GI for Stormwater Management
(City of Philadelphia)

Green Area Factors (Keeley 2011)

Major Tree Planting (Young 2011)

Context: *Ecosystem services is the dominant rationale*

(Wolf 2008; Young 2010; Pincetl 2012; Silvera Seamans 2013)



New Haven, c. 1870, detail from Appleton's Journal (in Campanella 2003, 132).

Beauty &
Civic Improvement

"Tabernacles in the air…"

Henry Ward Beecher quoted in the City of Cambridge Report of the General Superintendent of Parks (1894, 76).

CHANGING RATIONALE

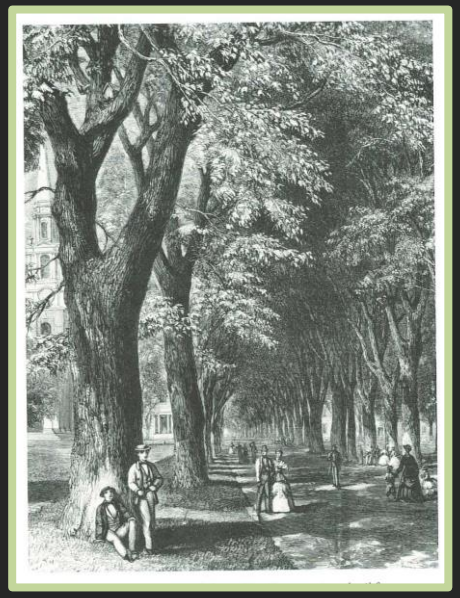
Ecosystem Services

Chicago street tree. (Photo by Tomasz Jelenski [2011], in Hubacek and Kronenberg, 2013).

"This tree gives back $1,436 worth of environmental benefits over the next 15 years."

Context: *Ecosystem services is the dominant rationale*

(Wolf 2008; Young 2010; Pincetl 2012; Silvera Seamans 2013)



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Beauty &
Civic Improvement

"Tabernacles in the air…"

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CHANGING RATIONALE

NASCENT DISCOURSE

- 1995–2012: About 8% of all ecosystem service articles addressed urban settings (Hubacek and Kronenberg 2013)
- "an open frontier in ecosystem service research" (Gómez-Baggethun and Barton 2013, 235)

"This tree gives back $1,436 worth of environmental benefits over the next 15 years."

GAP: Theory & Practice

1) Definition
2) Geographic Scale
3) Terminology
4) Disciplinary Scope

1) Definition of Urban Ecosystem Services (UES)

• Some assess the functions and services provided by vegetation and ecosystems *IN* cities and urban areas (Bolund &Hunhammar 1999; Pataki et al. 2011; Nowak et al. 2013).

→ Cities as providers of ecosystem services as well as disservices

• Others assess the functions and services provided by vegetation and ecosystems *TO* cities and urban areas . . . and sometimes those generated in cities and urban areas (Hirsch 2008; Breuste, Haase, and Elmqvist 2013; Gómez-Baggethun et al. 2013; Jansson 2013).

→ "the process of urbanization, rather than an assessment of cities per se" (Elmqvist et al. 2013, x).

→ Cities as consumers and degraders of non-urban ecosystem services

→ Blurs distinction b/w UES and non-urban ecosystem services

1) Definition of Urban Ecosystem Services (UES)

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Discrepancy muddles scholarly discourse and weakens capacity to inform urban greening practice

→ "the process of urbanization, rather than an assessment of cities per se" (Elmqvist et al. 2013, x).

→ Cities as consumers and degraders of non-urban ecosystem services

→ Blurs distinction b/w UES and non-urban ecosystem services

2) Geographic Scale

• Urban greening usually occurs at nested scales within the jurisdictional limit of cities . . .

Green Area Factors

Green Roofs & Walls

Green Infrastructure / SWM

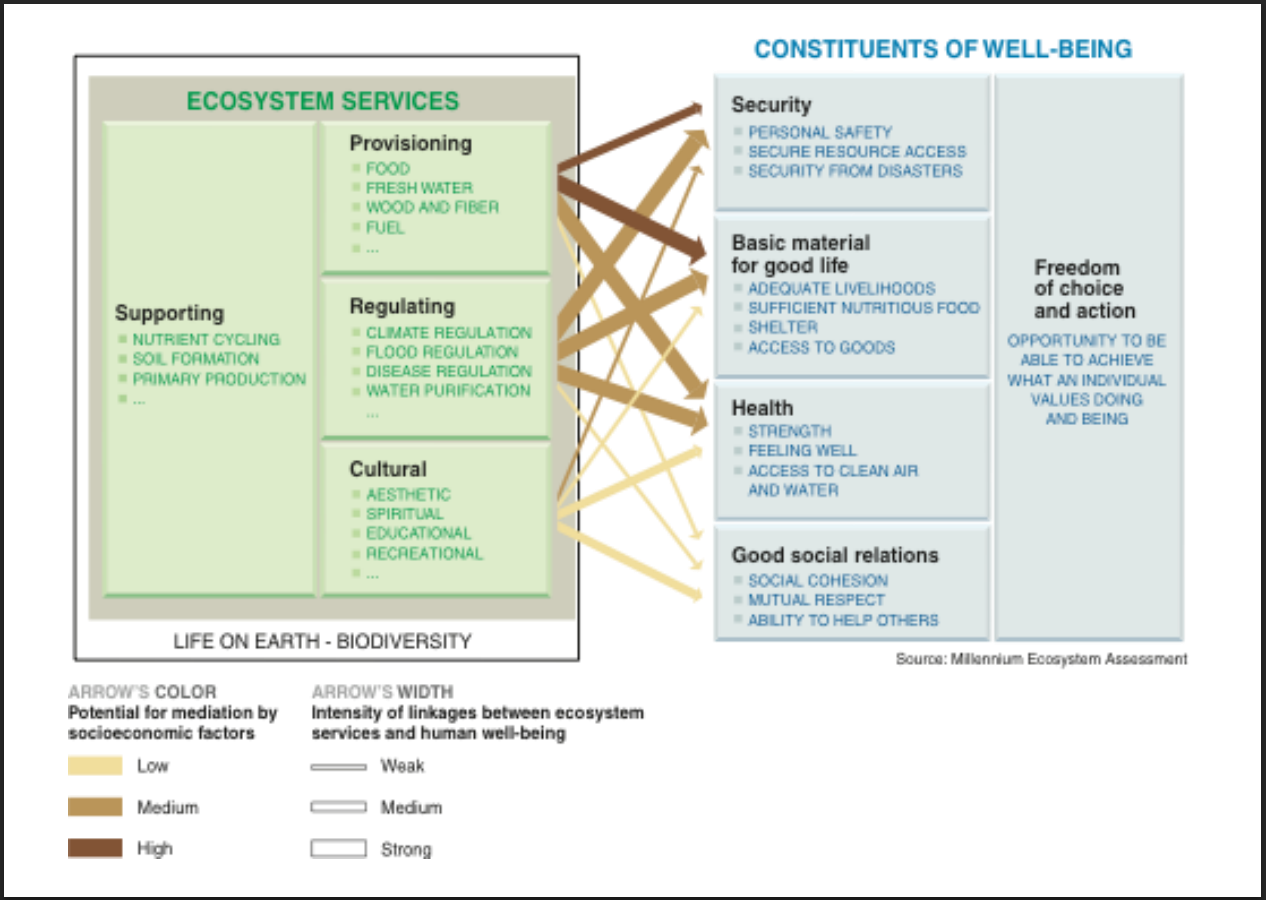
Large Scale Tree Planting

• MillionTreesNYC: “plant and care for one million new trees across the City's five boroughs”

• Tree Pittsburgh: “all of the trees within the city boundaries.”

2) Geographic Scale

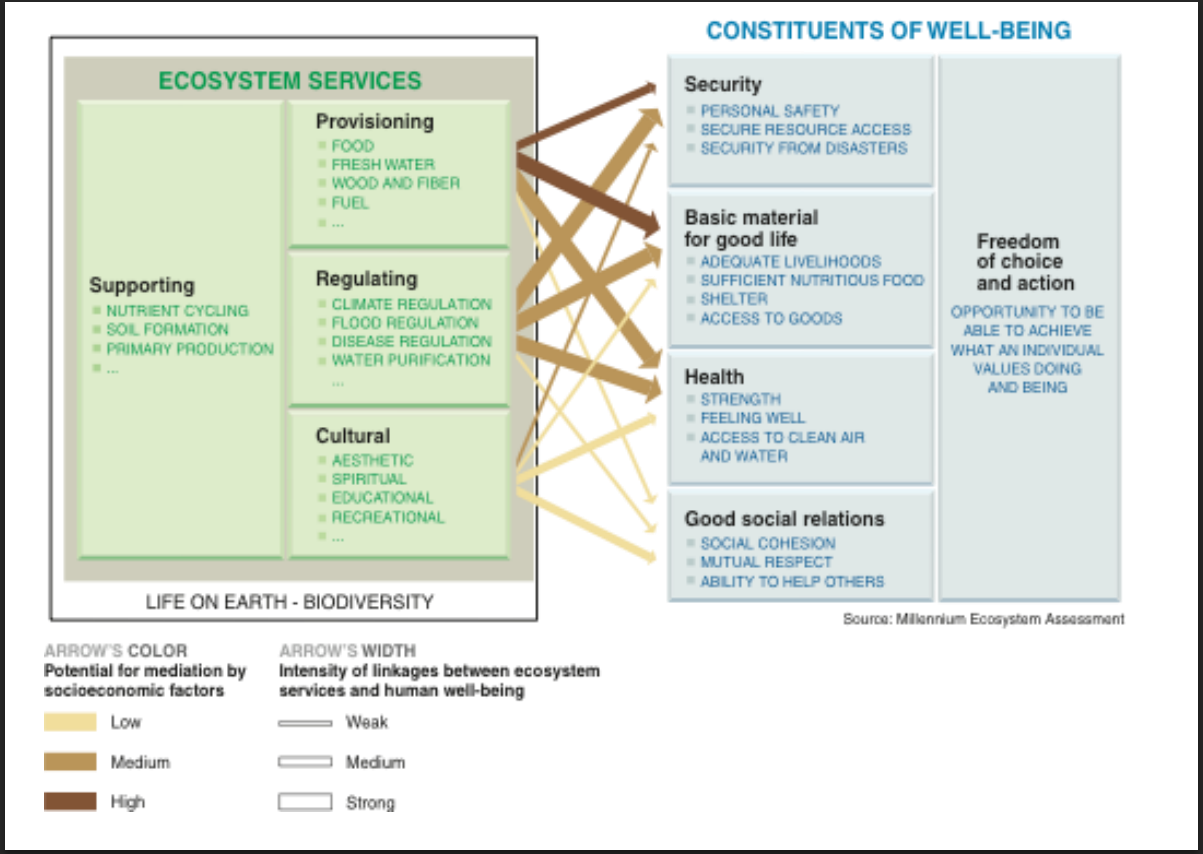
• YET . . . the dominant conceptual framework informing UES discourse is global / sub-global.



(MA 2005)

2) Geographic Scale

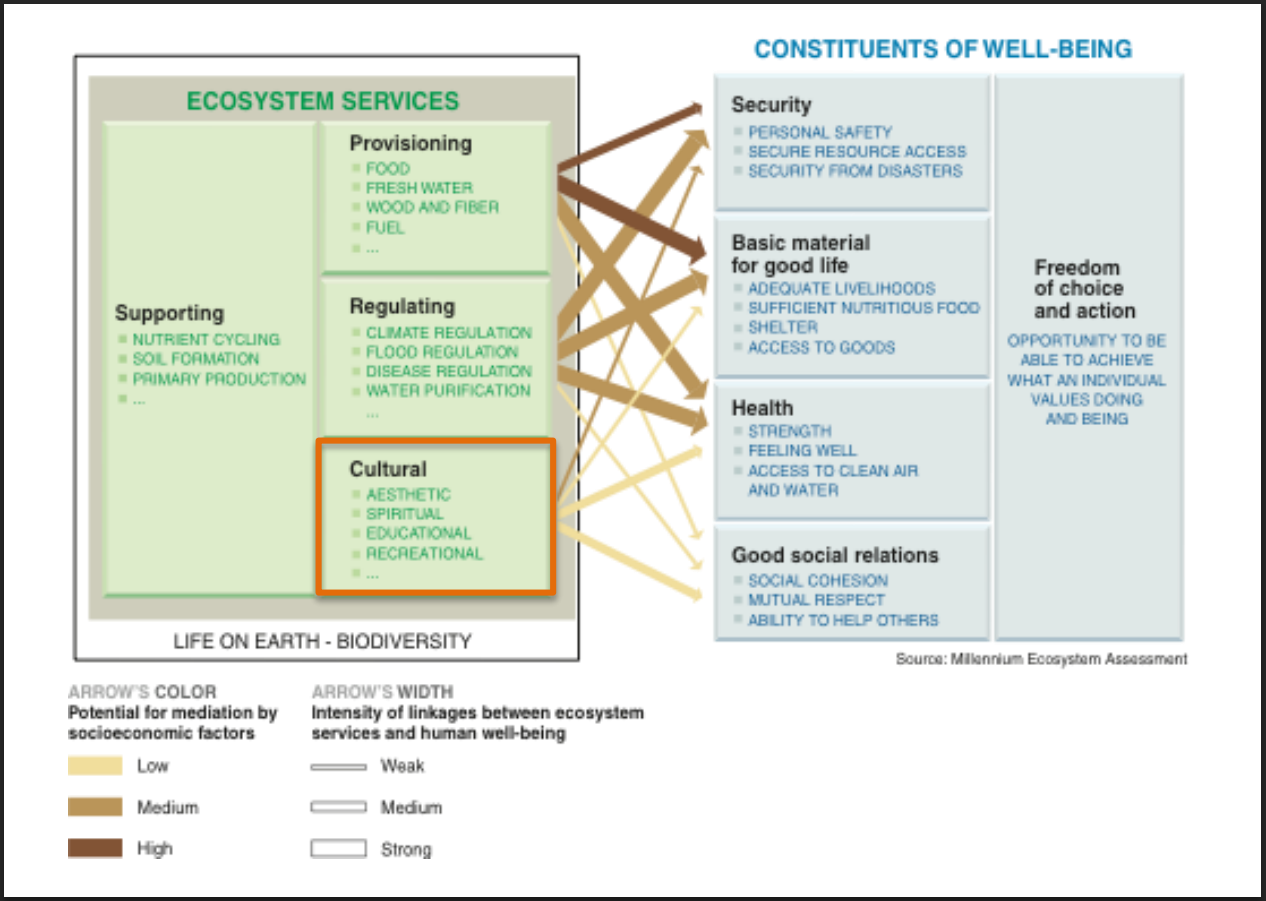
• The relationship, direction, and strength of services provided by highly altered ecosystems in urban areas – less than 3% of the Earth's terrestrial surface – is likely to be dramatically different from global / sub-global ecosystem services.



(MA 2005)

2) Geographic Scale

• As one moves from wildland and rural areas to urban landscapes, cultural ecosystem services become more important (Haines-Young and Potschin 2008; Wolf 2012).



(MA 2005)

3) Terminology

- Lack of clarity between ecosystem functions & ecosystem services (Boyd & Banzhaf 2007; Fisher & Turner 2008)

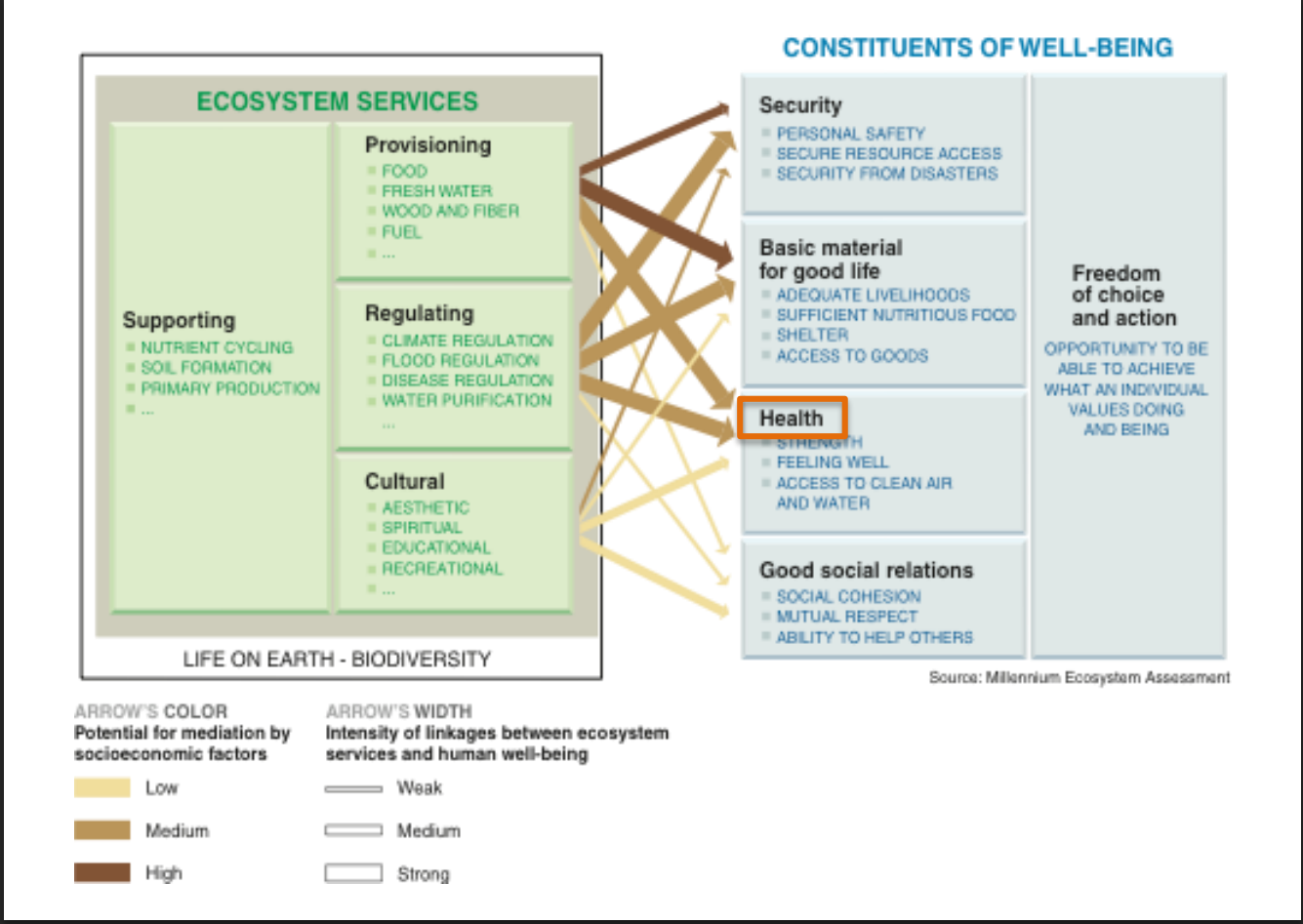
→ General Agreement on FUNCTIONS: "intermediate effects of forests on pollutants and other environmental processes . . . resulting benefits for human well-being." (Escobedo, Kroeger & Wagner 2011, 2078).

→ Less Agreement on SERVICES:

- "the benefits people derive from ecosystems" (MEA 2005)
- "Final Ecosystem Service Units" (Boyd & Banzhaf 2007)
- "Ecosystem Service Values" (Gómez-Baggethun et al. 2013)
- "Costs, Benefits, and Services" (Roy et al. 2012)
- "Disservices" (Lyytimäkki et al 2008; Pataki et al. 2011)

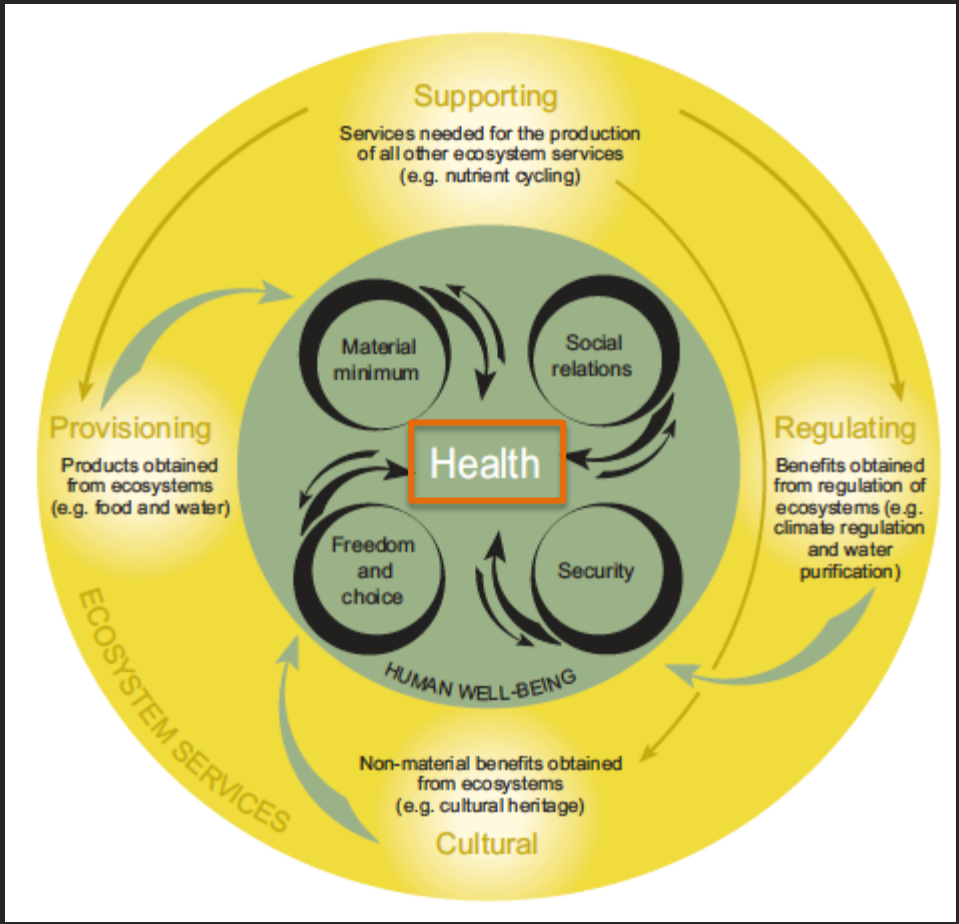
HUMAN HEALTH?

4) Disciplinary Scope



(MA 2005)

4) Disciplinary Scope



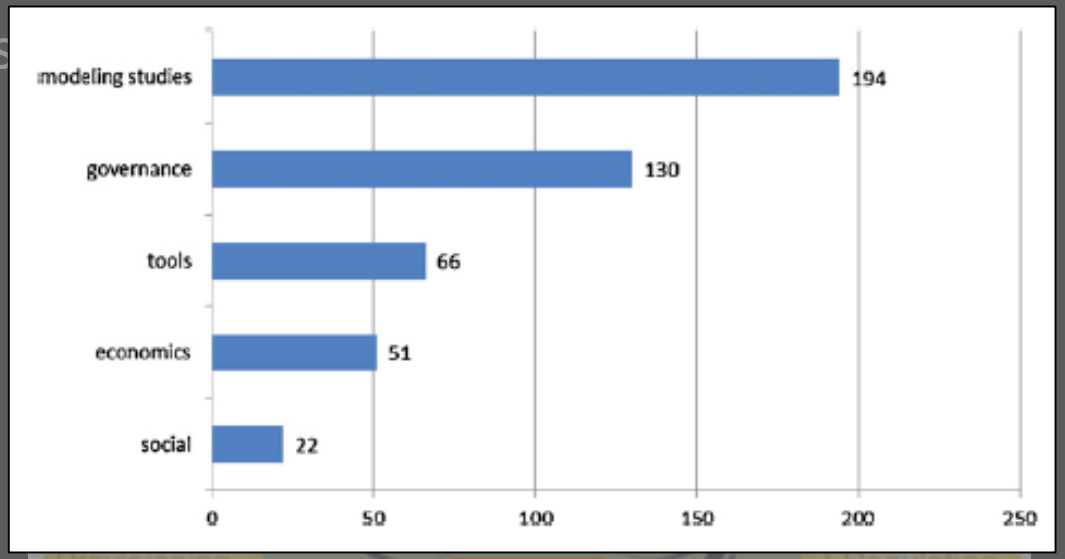
Human health . . . "the central aspect" of ecosystem services.

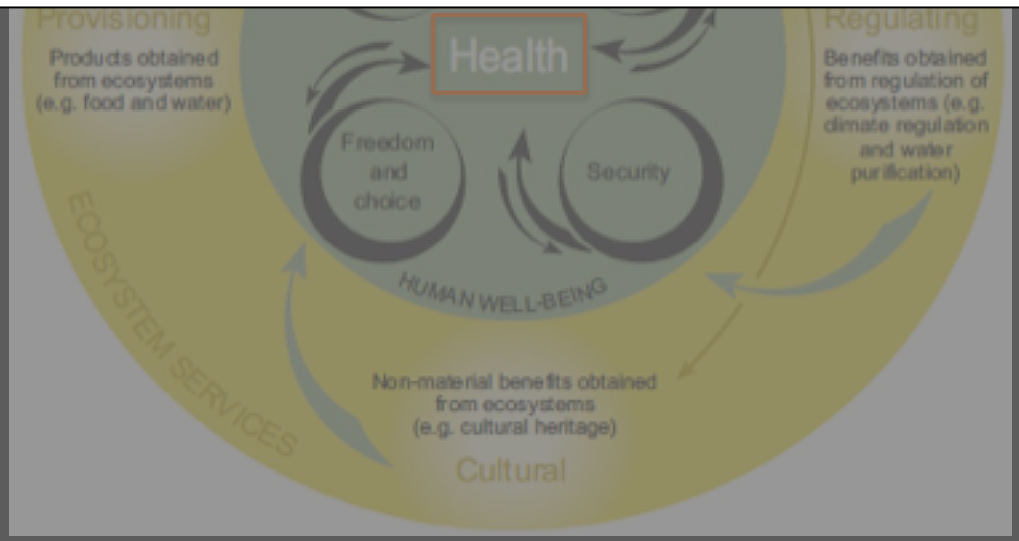
(MA 2005, 14)

4) Disciplinary Scope

1. Ecos

Hubacek and Kronenberg (2013)





- 463 articles addressing ecosystems services in urban settings

* Human health absent

4) Disciplinary Scope

1. Eco

Hubacek and Kronenberg (2013)

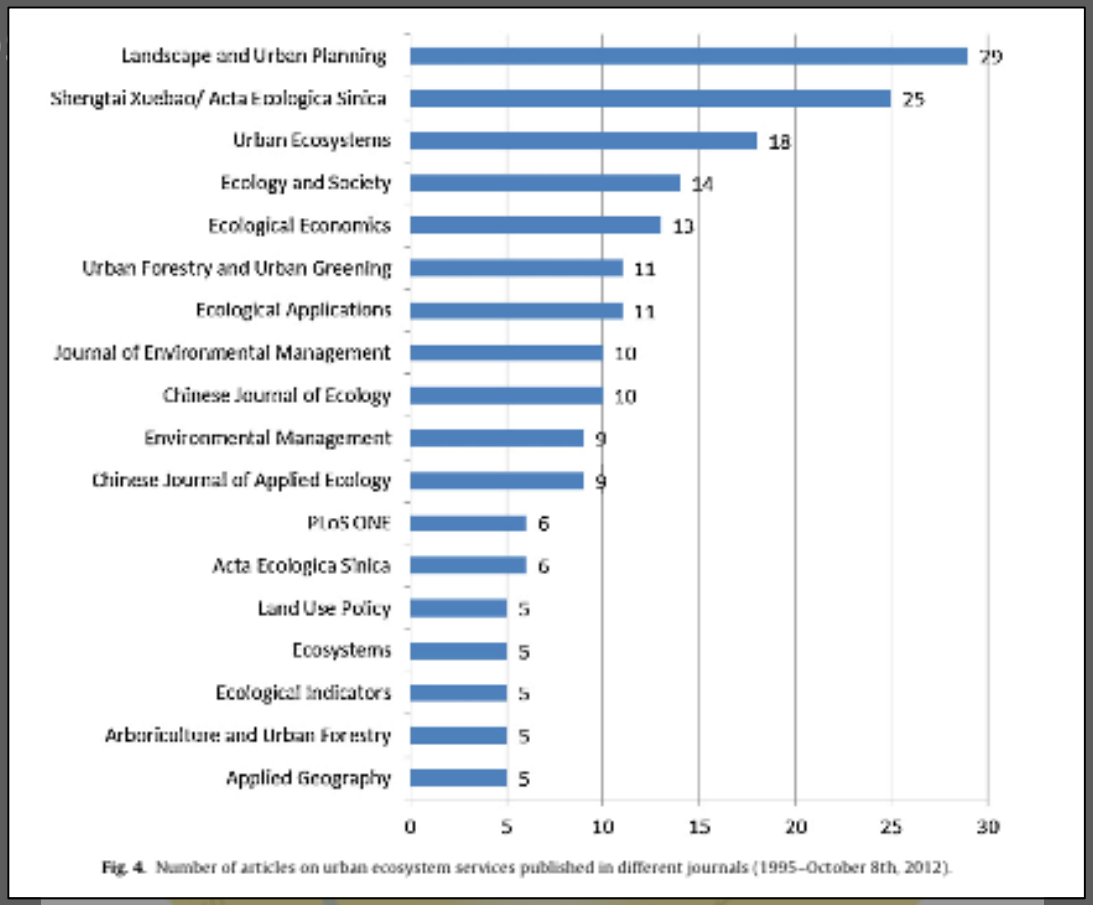
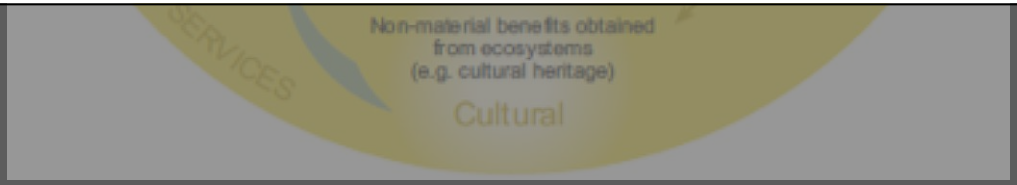


Fig. 4. Number of articles on urban ecosystem services published in different journals (1995–October 8th, 2012).

- 463 articles addressing ecosystems services in urban settings

* Public health journals absent



4) Disciplinary Scope

Example: Air Quality

Environmental Pollution 191 (2014) 256

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Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol

Letter to the Editor

Comments on "Modeled PM2.5 removal by trees in ten U.S. cities and associated health effects" by Nowak et al. (2013)

Dear Bill,

As active researchers in urban ecology and scientific communication, we read with great interest a paper co-authored by Dave Nowak and colleagues, *Modeled PM2.5 removal by trees in ten U.S. cities and associated health effects* published earlier this year in the journal, *Environmental Pollution*. This report is the latest of many using output of the i-Tree model and its predecessors to monetize the value of urban trees. The abstract states that air quality improvement attributable to trees in 10 cities ranges from 0.05% to 0.24%. In the conclusions, however, the authors state that " the broad-scale effects of pollution removal by trees on PM2.5 concentrations and human health reveal that trees can produce substantial health improvements and values in cities." The contradiction between the model results and the conclusion raises concerns over the critical role of the scientists in providing clear information and communicating this to decision makers.

To put this in context, the 3-year mean concentration (2009–2011) for PM2.5 in New York City was ca. 10 μg per cubic meter, which presumably would include the effect of the existing tree canopy (http://www.dec.ny.gov/chemical/29310.html accessed 8/21/13). Using this as a baseline and assuming the maximum improvement of 0.24% reported by Nowak et al., doubling the number of trees would decrease the concentration to 9.76 μg m^{-3}. Given that mortality metrics dominate the monetized value of the urban forest on health (Table 6), we will focus on the value of decreased mortality. Pope et al. (2009) analyzed the relationship between PM2.5 concentration and life expectancy for 51 US cities and found that life expectancy increased by 0.64 years for every 10 μg m^{-3} decrease in PM2.5. Doing the arithmetic, doubling the number of trees in NYC would increase the average lifespan of a resident by only 5.34 days, even using the maximum calculated air quality improvement of 0.24% reported by Nowak and co-authors. Given the error associated with the model and variance accompanying any of the average values used in its subcalculations, it is very likely that predicted mortality might actually be negative when the typical reduction in mortality is 1 person per year. Multiplying the small extension in lifespan by the value of a statistical life and the population of a large city yields an impressively large monetary value, distracting attention from the marginal impact that urban tree canopy may have on air quality.

There is no question that trees are necessary for a functional biosphere as we know it. Indeed, we believe that trees are vital components of urban ecosystems. But because urban development has replaced vegetation with buildings and pavement, the system has been pushed far beyond its biological capacity to compensate for human disturbances like air pollution.

Challenging the apparent consensus that trees are effective at reducing air pollution is like criticizing Johnnie Appleseed! This awkwardness must not distract attention from the reality that trees are not making a substantial difference as claimed by the authors. Prioritizing tree planting with the rationale that they alleviate air pollution can mean that other alternatives are not given due attention. At the very least, the cost effectiveness of urban trees must be compared with more direct interventions like reducing pollution loading. We affirm the conclusion by Maxim and van der Sluijs (2011) and many others that clear communication of scientific findings is crucial to inform effective policy.

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0269-7491/

STALEMATE

"substantial health improvement" . . . ?

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Reply to letter to the Editor

Author's response to letter by Whitlow et al.

This letter is in response to the letter written by Whitlow et al. expressing a possible contradiction in our article: *Modeled $PM_{2.5}$ removal by trees in ten U.S. cities and associated health effects* (Environmental Pollution 178 (2013) 395–402). While we respect Whitlow et al.'s work and opinions, we feel their concerns are unfounded. Their concern is with a sentence in the conclusion that states: "the broad-scale effects of pollution removal by trees on $PM_{2.5}$ concentrations and human health reveal that trees can produce substantial health improvements and values in cities." They state: "The contradiction between the model results and the conclusion raises concerns over the critical role of the scientists in providing clear information and communicating this to decision makers."

as high as 7.6 incidences per year with a value of $60 million per year (New York City). To us, this is a substantial value and impact for one city and one pollutant ($PM_{2.5}$).

Using Whitlow et al.'s calculation of an increased life span of 5.34 days for doubling tree canopy in New York City, this calculates out to an increase of about 122,000 years of additional life span for New York City's population of 8.34 million people. Again, to us, this is a substantial impact.

Our paper never suggested anything about "prioritizing tree planting" and clearly discusses various positive and negative aspects about trees in relation to air quality. As discussed in the paper: "Managers need to understand the magnitude of tree effects on air pollution to better manage urban vegetation to improve air quality." The intent of this paper was to reveal the magnitude of the impact of urban trees on $PM_{2.5}$ and associated health impacts so urban managers can make better informed decisions in relation to the role of trees and forests within cities. We believe we have communicated our scientific findings clearly. Although substantial is a relative term, we believe that the data show that "trees can produce substantial health improvements and values in cities".

Sincerely,

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4) Disciplinary Scope

Example → Air Quality

Epidemiology and Public Health?

4) Disciplinary Scope

Example → Air Quality

Epidemiology and Public Health? → Urban flora as HEALTH PROBLEM

- Pollen allergy: "one of the most widespread diseases in urban populations" (Cariñanos and Casares-Porcel 2011, 205).

- Prevalence of allergic respiratory diseases in industrialized nations is being called "the epidemic of the 21st century . . . mainly due to vehicle traffic, and plant-derived respiratory disorders" (D'amato 2000, 634).

- Significant association between tree pollen concentration and asthma-related emergency department visits and hospitalization (Dales 2008; Jariwala et al. 2011, 2014).

Rooting UES in urban greening practice . . .

1) Definition

   "The services and disservices provided by vegetation and ecosystems *IN* cities and urban areas."

Rooting UES in urban greening practice . . .

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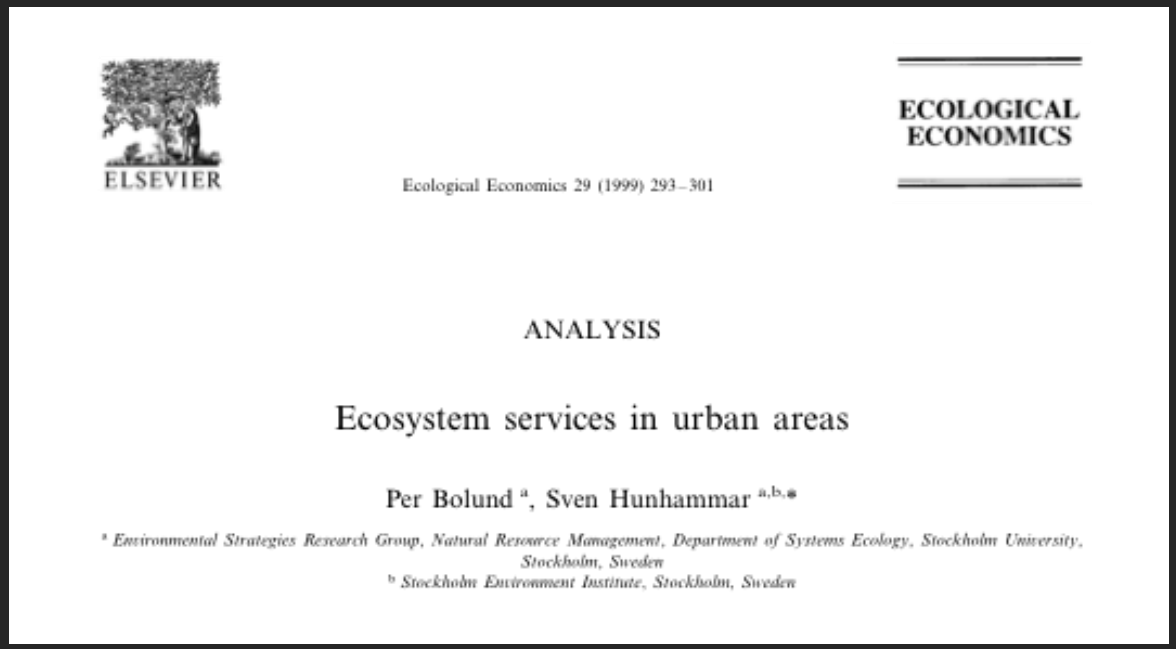
"The services and disservices provided by vegetation and ecosystems *IN* cities and urban areas."



ELSEVIER

Ecological Economics 29 (1999) 293–301

ECOLOGICAL ECONOMICS

ANALYSIS

Ecosystem services in urban areas

Per Bolund [a], Sven Hunhammar [a,b,*]

[a] *Environmental Strategies Research Group, Natural Resource Management, Department of Systems Ecology, Stockholm University, Stockholm, Sweden*

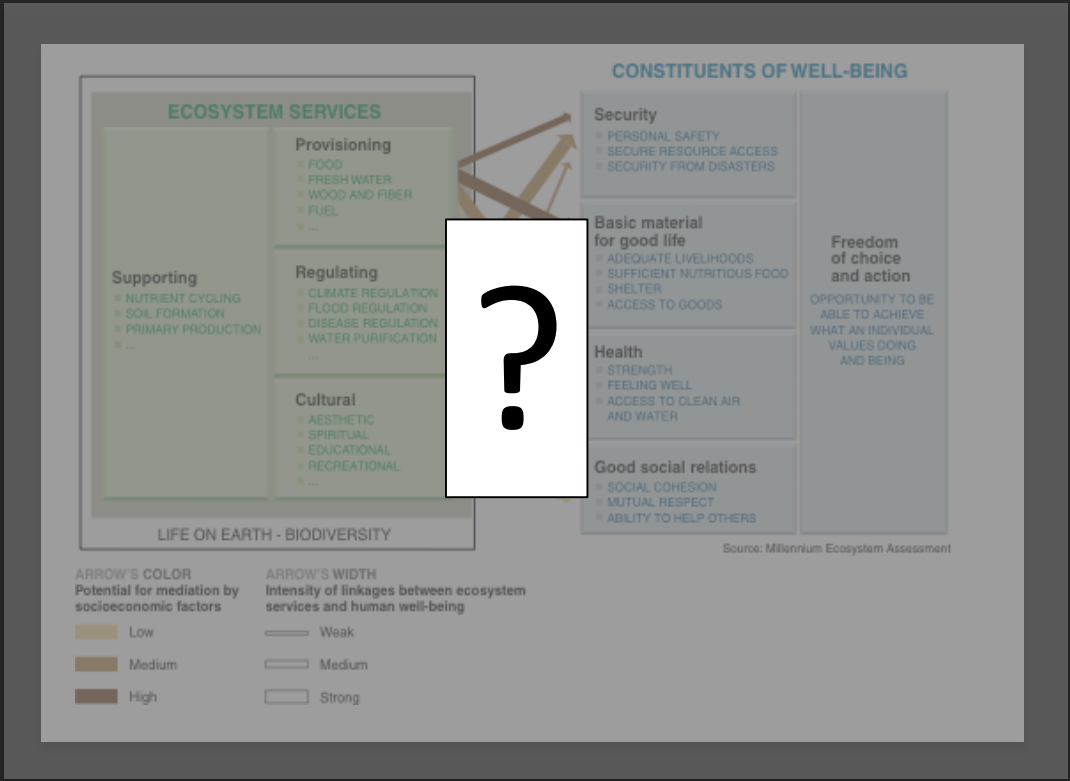
[b] *Stockholm Environment Institute, Stockholm, Sweden*

- "internal urban ecosystems" (p. 293).
- "the aim of [the] paper is to analyze the ecosystem services generated by ecosystems within the urban area" (p. 293).
- "presence of natural ecosystems within the city limits." (p. 294)

Rooting UES in urban greening practice . . .

2) Geographic Scale

- Updated conceptual framework that speaks to the socio-political and biophysical reality of urban greening practice.



PRACTICE

Rooting UES in urban greening practice . . .

3) Terminology

- Distinguish between intermediate functions & actual services
- Services should directly address human health outcomes

  -“the satisfaction of human needs and wants specified in the medical/psychological/social domain” (Daniel et al. 2012, 8813).

Rooting UES in urban greening practice . . .

4) Disciplinary Scope

- Greater interdisciplinary engagement

  - Public Health

  - Urban Planning & Landscape Architecture

  - Cultural Services (Social Science, Psychology, Humanities, etc.)

Rooting UES in urban greening practice . . .

“Century of the city”

(Rockefeller Foundation 2008)

Urban greening for livability & sustainability