URBAN BIODIVERSITY AND CLIMATE CHANGE: CO-BENÉFITS, CASE STUDIES AND NOVEL APPROACHES

Dr. Christopher Ling
Dr. Leslie King

Royal Roads University
School of Environment and Sustainability

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PLANETARY BOUNDARIES

Four transgressed boundaries (Rockstrom et al, 2009; Steffen et al, 2015)

- Climate Change
- Biogeochemical flows
- Land Use System Change
- BIODIVERSITY

- All inter-connected – makes sense to address holistically
# Biodiversity

Loss of biodiversity arguably the most extreme

<table>
<thead>
<tr>
<th>Indicator</th>
<th>boundary</th>
<th>Current value</th>
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<tbody>
<tr>
<td><strong>Climate Change</strong></td>
<td></td>
<td></td>
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<tr>
<td>CO² ppm</td>
<td>350</td>
<td>396.5</td>
</tr>
<tr>
<td>Energy imbalance</td>
<td>+1.0 W m⁻²</td>
<td>2.3 W m⁻²</td>
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<td><strong>Biogeochemical Flows</strong></td>
<td></td>
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<tr>
<td>P freshwater into oceans</td>
<td>11 Tg p yr⁻¹</td>
<td>22 Tg p yr⁻¹</td>
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<tr>
<td>P fertiliser to erodible soil</td>
<td>6.2 22 Tg p yr⁻¹</td>
<td>14 22 Tg p yr⁻¹</td>
</tr>
<tr>
<td>N industrial and intentional fixation</td>
<td>62 Tg p yr⁻¹</td>
<td>150 Tg p yr⁻¹</td>
</tr>
<tr>
<td><strong>Land Use System Change</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forest % of original cover</td>
<td>75%</td>
<td>62%</td>
</tr>
<tr>
<td><strong>Biosphere Integrity</strong></td>
<td></td>
<td></td>
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<tr>
<td>Extinction Rate</td>
<td>10 E/MSY</td>
<td>100-100 E/MSY</td>
</tr>
<tr>
<td>Functional diversity</td>
<td>90% BII</td>
<td>84% (S. Africa)</td>
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HYPOTHESES: CO-BENEFITS OF ACTIONS TO ADDRESS URBAN BIODIVERSITY

**Climate Actions**
- Actions to address climate change do not necessarily contribute to addressing biodiversity loss

**Biodiversity actions**
- Actions to address biodiversity loss contribute to both mitigation and adaptation to the impacts of climate change.
CAUSES OF LOSS

3rd Global Biodiversity Outlook

- Habitat loss and degradation; Climate change; Excessive nutrient load and other forms of pollution; Over-exploitation and unsustainable use; Invasive alien species
- Most intense in urban and peri-urban environment (Nilsson et al, 2013)
  - Expanding cities (McKinney, 2002)
  - Intensive agriculture (Vanderplank, Ezcurra, Delgadillo, 2014)
  - Watercourse pollution
COST

Global cost of climate change – 2030:
$2.4 trillion / year
(DARA group 2016)

Potential global cost of biodiversity loss:
$14 trillion / year
(European Commission, 2008)
INVESTMENT

Global Climate Spending - 2014:
$392 Billion (Climate Policy Initiative 2016)

Global Biodiversity Spending – 2010:
$7 - $10 Billion (IUCN 2010)
BIODIVERSITY POLICY FOCUS

Main global solution - more and bigger protected areas

- Excludes people from biodiversity
- Reinforces notion that biodiversity is elsewhere rather than everywhere
- Limits opportunities for biodiversity enhancement
- Can create negative feelings towards biodiversity protection

PROTECTED AREAS ARE NOT SUFFICIENT...

• “no statistically significant differences in forest conditions between legally protected forests and forests governed by users who establish and recognize forest rules” Hayes, 2006

• “Despite local successes of ... protected areas proving effective in stemming biodiversity loss ... the usual process of implementation of protected areas that preclude relying on them as a global solution to this problem” (Mora and Sale, 2011)

• “protection does not consistently benefit species with small ranges or increase the variety of ecological niches.” (Gray et al 2015)
URBAN RESPONSES

Moving away from protecting existing biodiversity to creating new biodiversity: e.g.

- Green infrastructure (Rouse & Bunster-Ossa, 2013; Andersson et al, 2014; etc),
- Ecologically informed brownfield restoration (Bagaeen, 2006; Foster & Sandberg, 2014; etc),
- Stream daylighting (Botelho, 1999; Broadhead & Lerner, 2013; etc)
- Green roofs/buildings (Williams et al, 2014; Schrader and Böning, 2006; etc)
GREENWAYS

City of Surrey, BC:
Connectivity along and between:
- Riparian habitat
- Terrestrial ecosystems
- Steep slopes
- Flood plains

Includes:
- bike path
- Hiking trails
- multi-use trails

Cecelia ravine / Galloping Goose Trail/Victoria, BC
- Stream restoration, old rail corridor, recreation, cultural and historical features
SURREY, BC

Biodiversity Conservation Strategy: Urban and Rural

- Surrey’s biodiversity as a key foundation of a healthy, livable and sustainable City. The goal of the Strategy is to preserve, protect, and enhance Surrey’s biodiversity.
  - Preserving large core habitat areas.
  - Ensuring connectivity between habitat areas.
  - Providing a diversity of habitat features throughout the City.
COLLIERS MOSS COMMON, LANCASHIRE, UK

- From coal mine waste to nature reserve
- 130ha alongside socio-economically impacted community
- Has encouraged new investment and enhanced social capital
EVERGREEN BRICK WORKS, TORONTO

- A former brick making factory in Toronto,
- Community environmental
- Farmers' Market
- Nature trails for hiking and cycling, site tours, cooking and gardening workshops, exhibits, conferences, festivals, nature-based camps for youth and a sustainable garden market and eco-store. (Toronto)
GREEN ROOFS AND WALLS

Sloane Square – London, designed for butterflies and bees
“The high abundance of invertebrates [on green roofs in London] is, in and of itself, of great interest...at least 10% of our collected species ... are in fact considered nationally rare and scarce” (Kadas, 2006)

Vancouver Convention Centre – British Columbia
“the green roof is landscaped with more than 400,000 indigenous plants and grasses from the Gulf Islands, providing natural habitat to birds, insects and small mammals” (Velaquez, 2012)
COMMUNITY GARDENS

Community Gardens, Baltimore “gardens provide benefits at multiple levels, creating an “urban oasis” that provides refuge from urban decay while revitalizing city neighborhoods. At the individual level, gardeners underscored psychological benefits, including pride and a connection with nature.” Poulsen et al (2014)

Los Angeles “community gardens contribute to a biologically diverse urban ecosystem and provide valued ecosystem services in food insecure regions.” (Clarke and Jenerette, 2014)
PRIVATE GARDENS

Back Yards in the UK
“Populations of common frog in Britain have experienced declines in rural areas but increases in urban gardens. Density of bumblebee nests recorded in UK suburban gardens (36 nests/ha) was comparable to that found in linear countryside habitats (20–37 nests/ha)” (Goddard et al, 2009)

Rain Gardens (also as public space)
City of Victoria – tax incentives to homes with increased permeability
Danforth, York – Rain Gardens United, Toronto Foundation and Crowd Funding, community project
Increases in native vegetation, and biodiversity. Storm water management. Water conservation
CLIMATE CHANGE BENEFITS – CURRENT RESEARCH

**Urban Green Cover/Green Roofs**

Manchester, UK
- Roof Greening – largest contribution to reducing surface temperature in urban areas (Obendorfer *et al*, 2007)

**Tree planting**

Manchester, UK
- Urban green cover -reduce maximum surface temperature in 2080s by ~2.5 C (Gill *et al* 2007)

Munich, Germany
- Pedestrian level tree plantings achieve Physiological Equivalent Temperature (Heat stress) reductions of 10-13% (Zolch *et al*. 2016)
EMERGING RESEARCH

Shading and Green Infrastructure

Australia

- Tree canopies reduce temp of surfaces they shade by as much as 25°C (Livesey, 2010)

Pheonix, Arizona

- Land surface reduced by 1 – 2°C locally and 0.5°C regionally by green space (Zhang et al. 2017)

Carbon Storage and Energy Savings

USA

- Rates of net annual sequestration have been estimated to range from $0.26 \times 10^{-9}$ Mt C m$^{-2}$ average forest cover in Atlanta to $0.12 \times 10^{-9}$ Mt C m$^{-2}$ cover in New York (Nowak & Crane, 2002)

- CO$_2$ [reduction] due to carbon sequestration from growth 52 – 63% of net CO2 emissions reductions [in study cities] (Pataki et al. 2006)
CO-BENEFITS AND MULTI-FUNCTIONALITY

**Climate change adaptation and mitigation**
- Carbon storage
- Energy efficiency
- Flood control/storm-water management.
- Local cooling
- Water management
- Walking/cycling rights of way

**Other co-benefits**
- Recreation
- Aesthetic enhancement
- Human-nature interaction
- Food production
URBAN BIODIVERSITY INITIATIVES

• Provide broader multi-functional and quality of life benefits than climate change action alone
• Create new biodiversity as opposed to simply protecting existing biodiversity
• Provide a wide range of co-benefits including climate change adaptation and mitigation