https://climate-adapt.eea.europa.eu/metadata/case-studies/urban-storm-water-management-in-augustenborg-malmo

Putting the blue in urban blue-green infrastructure: How can urban waters and landscapes support ecosystem services?

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Landscape Architecture, Planning and Management

SLU Alnarp

February 2021 – SLU Vatten Seminar

https://climate-adapt.eea.europa.eu/metadata/case-studies/urban-storm-water-management-in-augustenborg-malmo

We need more research on

~~Putting~~ the blue in urban blue-green infrastructure: How can urban waters and landscapes support ecosystem services?

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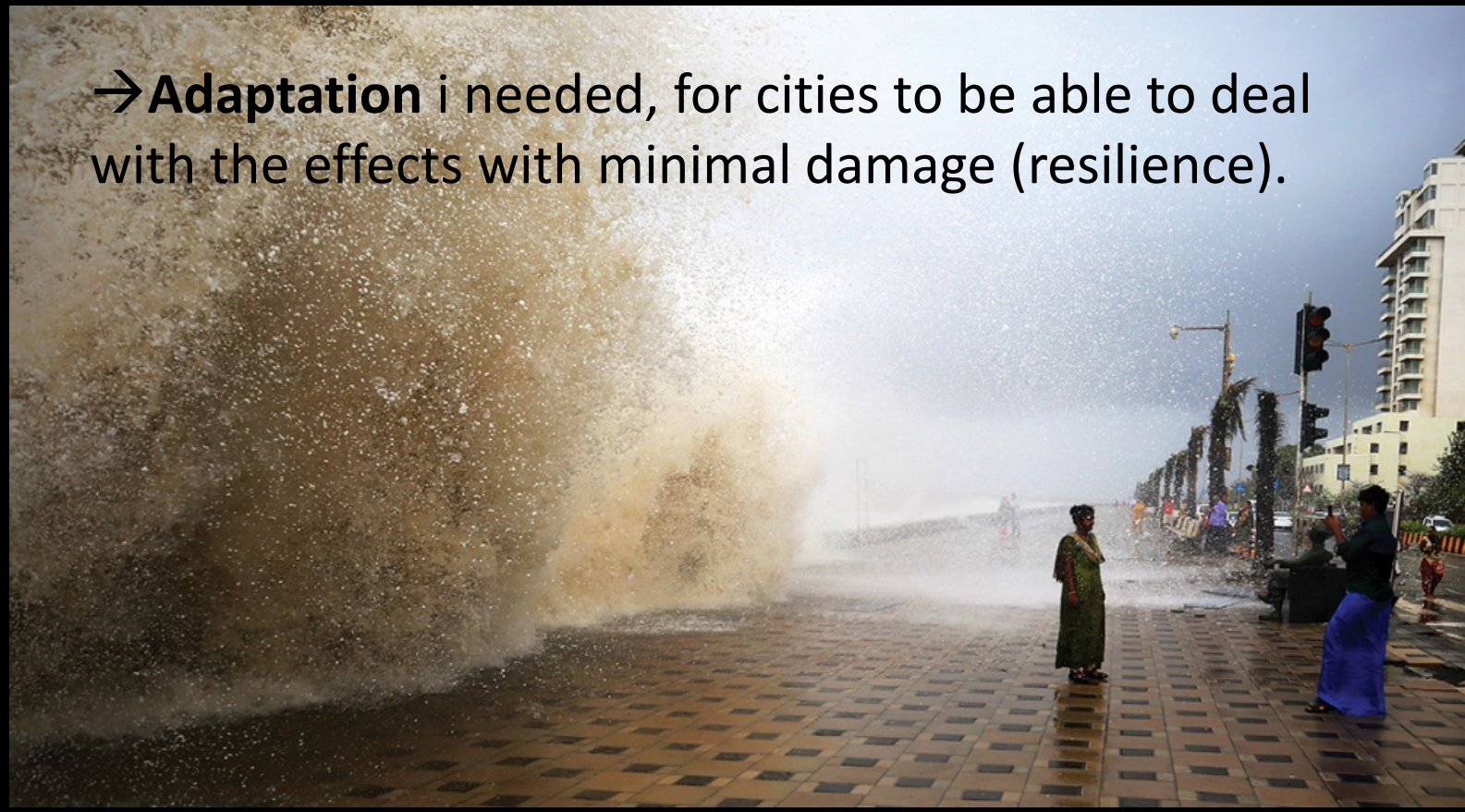
Climate change is an existential threat to many cities, and this threat is intertwined with the water cycle

Major CC threats

1. Sea Level Rise
2. Flooding
3. Drought, loss of crops
4. Heat waves
5. Storm water runoff causing pollution



https://www.sciencenews.org/article/waters-rise-coastal-megacities-mumbai-face-catastrophe

Grey infrastructure – stormwater capture tunnel, Milwaukee, WI

Urban (blue)-green infrastructure provides multifunctional benefits

- **Multiple ecosystem services from the same structure in the same space**
- Stormwater runoff mitigation
- Flood reduction
- Improved water quality – nutrient and metals removal
- Reduced Urban Heat Island Effect
- Reduced greenhouse gas emissions
- Wildlife Habitat Creation
- Noise and Air Pollution Reduction
- Psychological Effects
- Creation of social/community/recreation spaces

SLU's LAPF department is attacking the challenge of urban water resilience from different angles, in teaching and research

- Climate change – landscape in transition (Kristina Blennow)
- Challenges of the city (Ann-Mari Fransson)
- Green-blue infrastructure (Scott Wahl)
- Green roofs – basic concepts and application (Tobias Emilsson)
- Dynamic Vegetation Design (Björn Wiström)
- Design research on urban water landscapes (Lisa Diedrich)
- Etc.

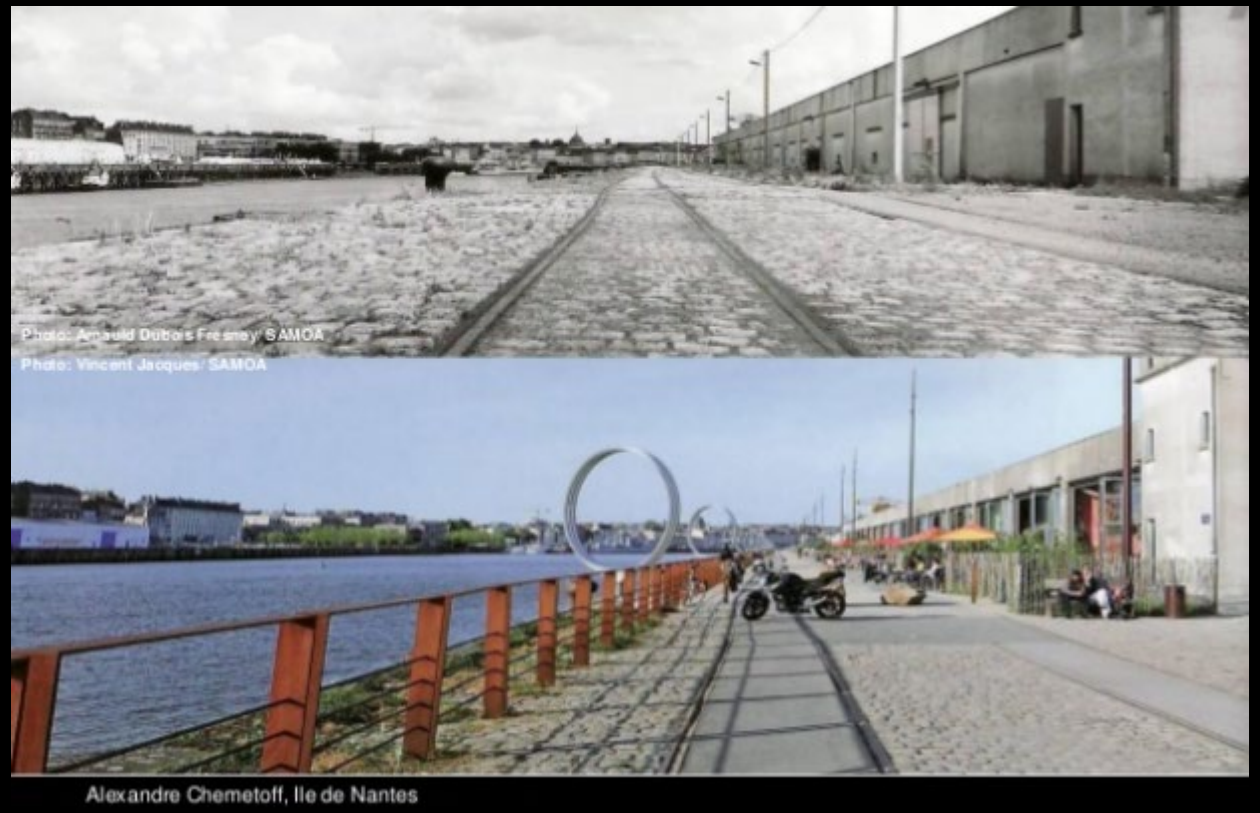


Photo courtesy Lisa Diedrich

Example #1: Street trees in a changing climate (Tobias Emilsson & Colleagues, Formas project)

Karlavägen, Stockholm

Example #2: Development of Blue-green-grey systems (Ann-Mari Fransson & colleagues)

- Collaboration between EDGE and SLU
- Raingardens, open reinforcement layer and subsurface irrigation modules
- https://bluegreengrey.edges.se/

Rest till bäst project: **Biokol.org**

Example #3: Research on hydrological and biogeochemical function in Green Roofs – novel engineered ecosystems, simple catchments

Coupling biogeochemical cycles in urban environments: ecosystem services, green solutions, and misconceptions

Diane E Pataki[1,2*], Margaret M Carreiro[3], Jennifer Cherrier[4], Nancy E Grulke[5], Viniece Jennings[6], Stephanie Pincetl[7], Richard V Pouyat[8], Thomas H Whitlow[9], and Wayne C Zipperer[6]

Table 1. Commonly discussed urban ecosystem services/ disservices associated with biogeochemical cycles, with their potential magnitudes (relative to the scope of the associated environmental problem) and uncertainty levels

Ecosystem service	*Potential magnitude*	*Current level of uncertainty*
C sequestration	Low	Low
Net GHG emissions	Moderate	High
Local cooling	High	Moderate
Stormwater mitigation	High	Moderate
Water-quality mitigation	High	High
Air-quality mitigation	Low	High
General human health	Moderate	Moderate

Ecosystem disservice	*Potential magnitude*	*Current level of uncertainty*
Water use	High	Moderate
Net GHG emissions	Moderate	High
Source of allergens	High	Low
VOC emissions	Moderate	Moderate

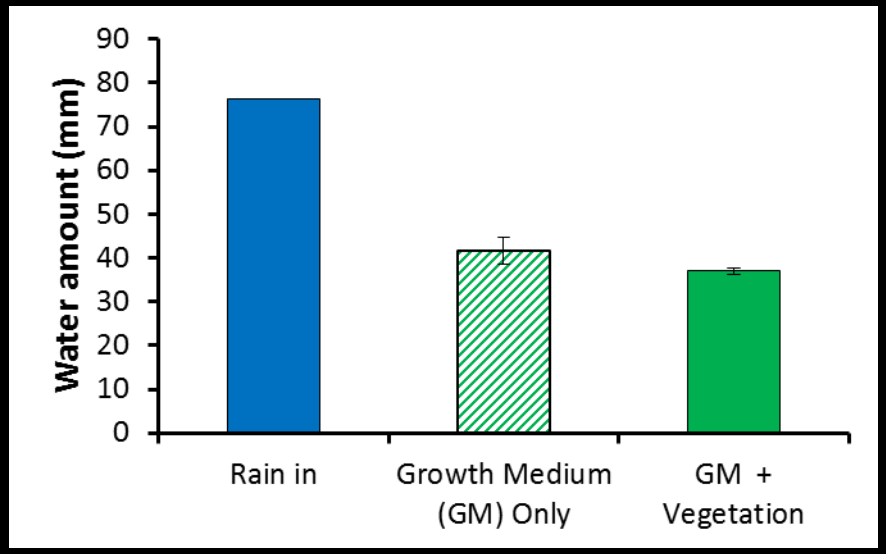
Notes: GHG emissions are listed as both a service and disservice because the impacts of plants or soils may be either positive (net cooling) or negative (net warming) in hot climates. VOC = volatile organic compounds, which are precursors to the formation of ozone pollution.

?

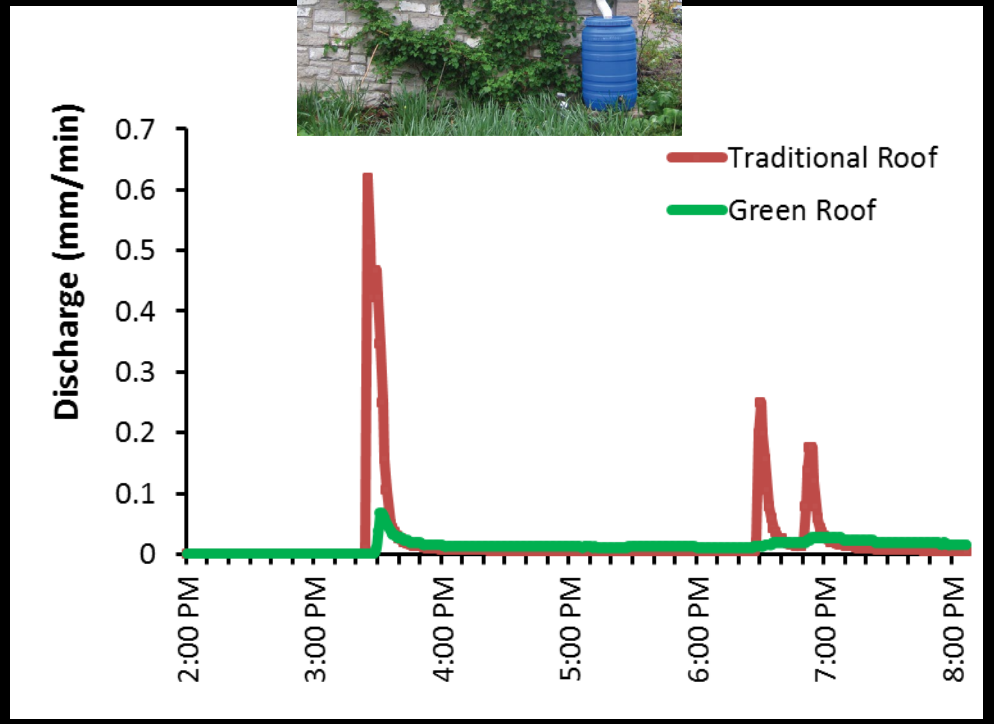
Pataki et al., 2011 (Frontiers in Ecology and the Environment)

Green roofs delay and reduce stormwater runoff

Plot-scale experiments

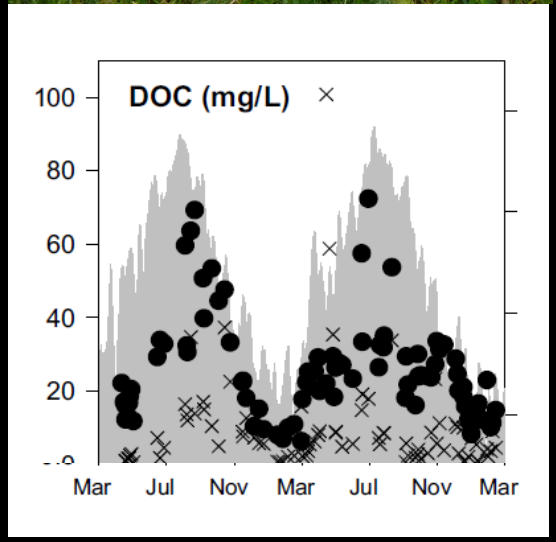


Civic Garden Center Roof, Cincinnati, USA
Example rain event (12mm)

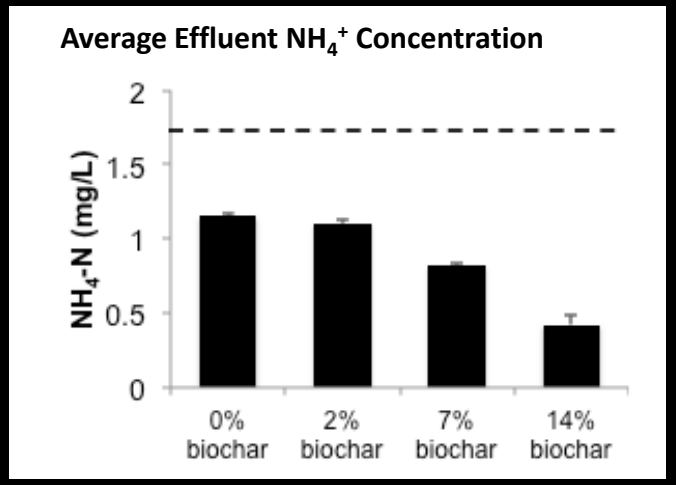


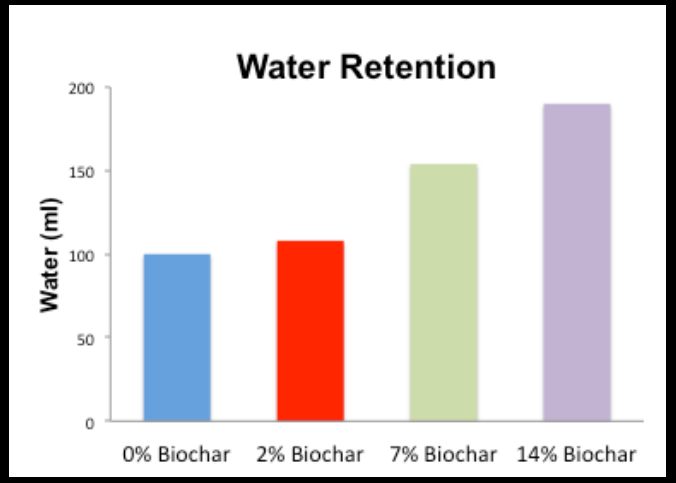
Clear runoff reduction, 50-70% on annual basis: Our group and many others.

Green roof design and climate play a strong role in the impact on runoff water quality



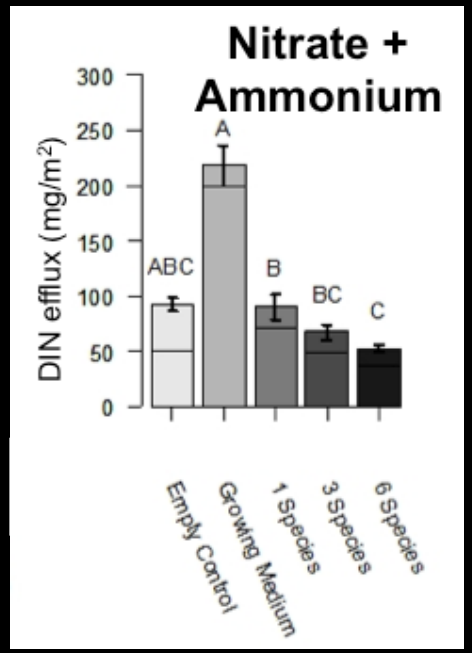
Seasonal variation *in runoff nutrients (Buffam et al. 2016, Buffam and Mitchell 2015)*



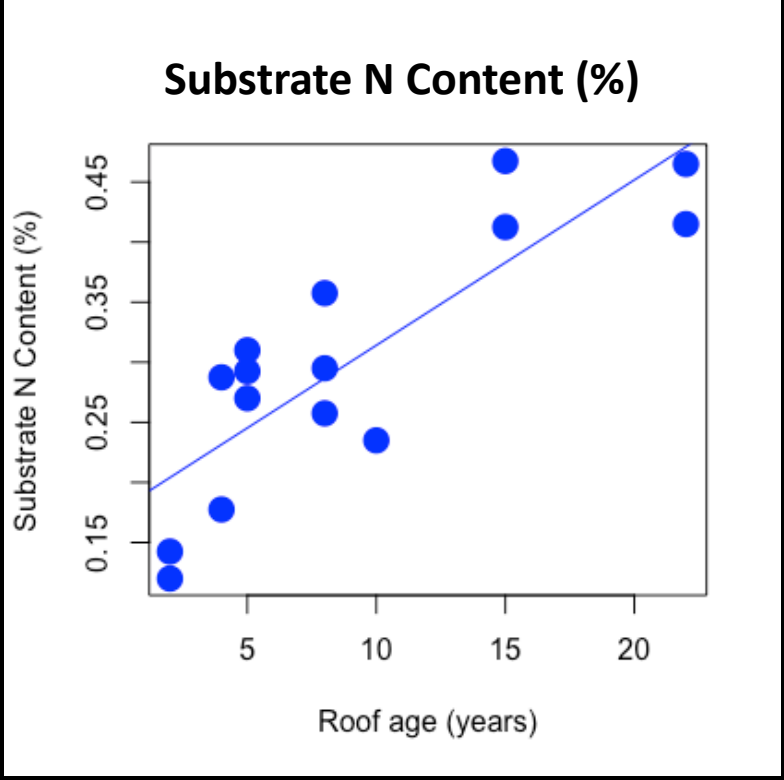


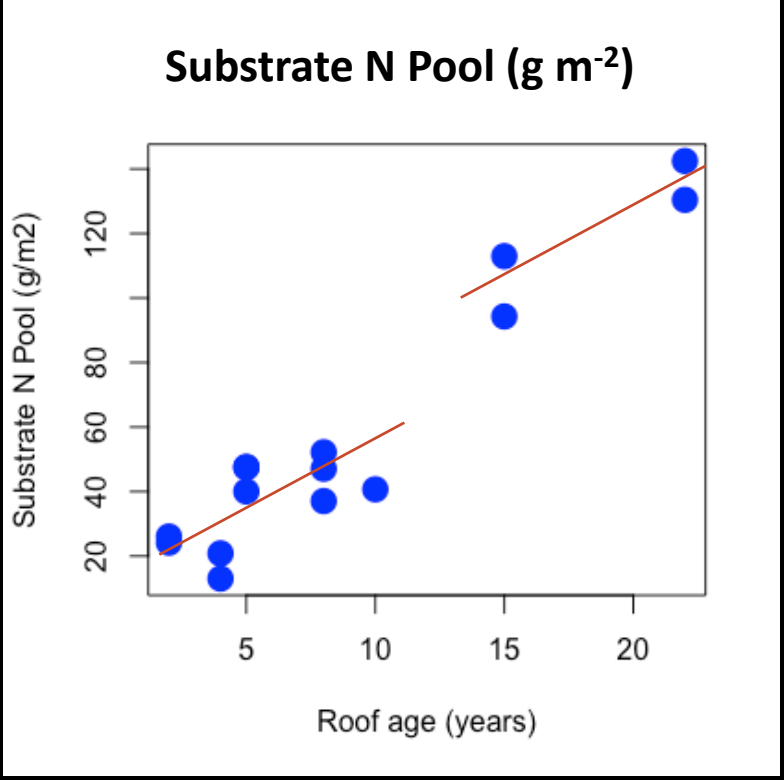
Biochar *in green roof substrate increases water retention and* ***reduces NH_4^+ and PO_4^{3-} leaching*** *loss (Goldschmidt et al. 2018)*

Biodiverse ***plots*** *MUCH better at holding N (Johnson et al., 2016)*



Current Project: How do ecosystem services provided by green roofs develop over the long term as a function of changes in soil and plant communities? (Formas 2020-2022)



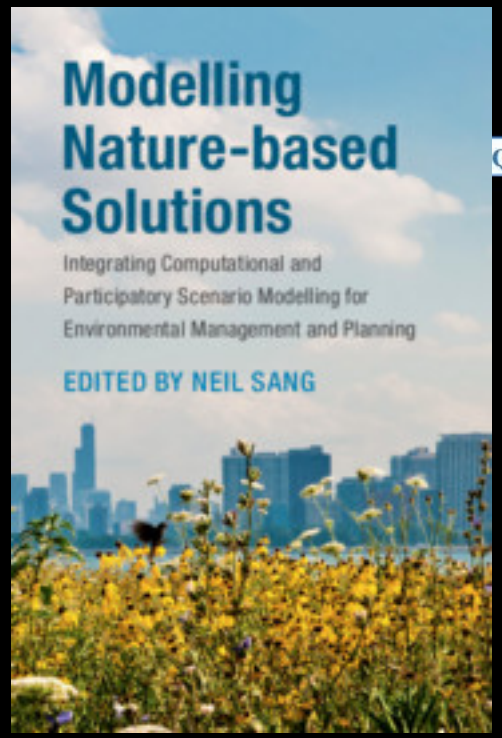


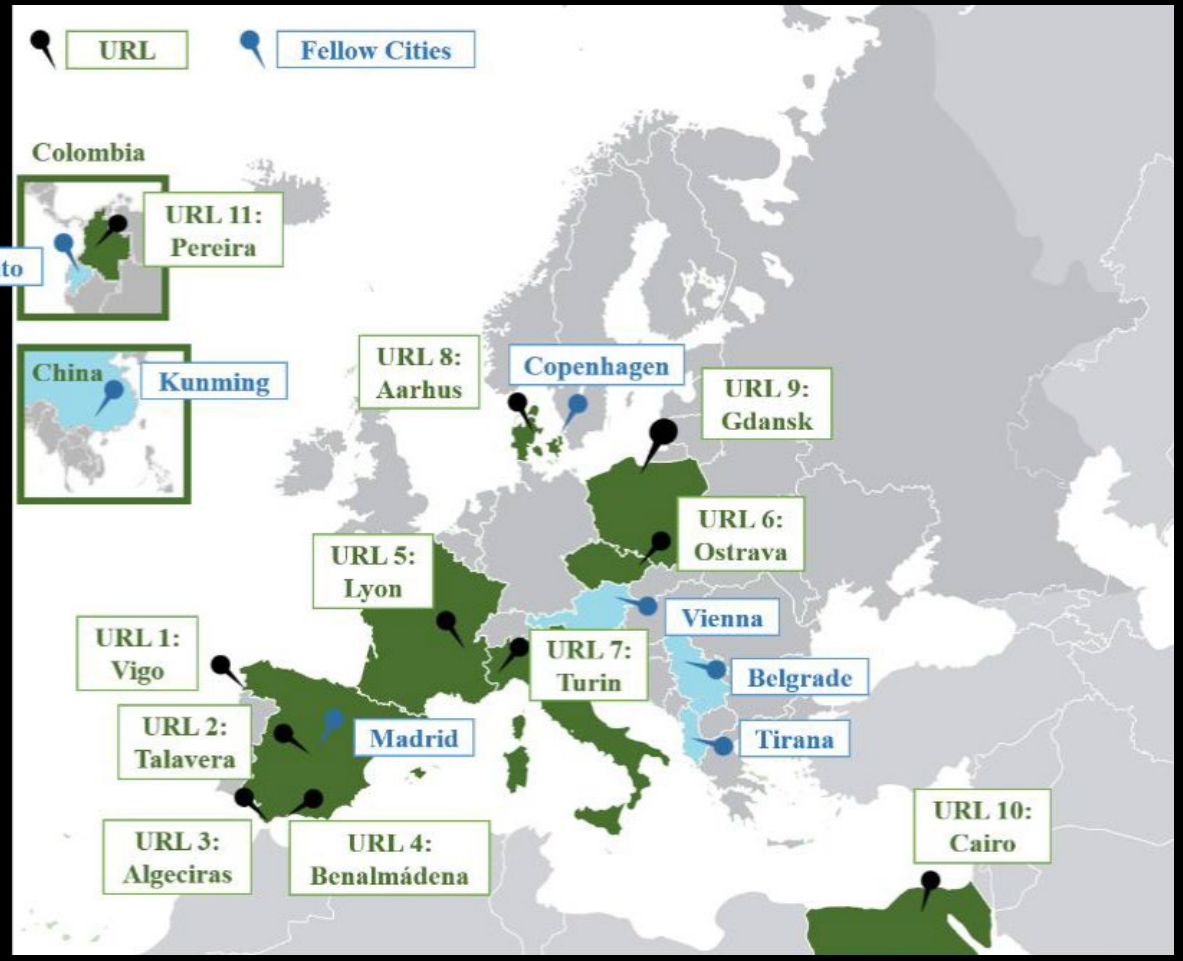
Experimental Design: Chronosequence Isolating Long Term Changes in Nutrient Pools and Export (N=15 roofs, Malmö, Sweden) **(Soon in Stockholm, Helsinki)**

Mitchell et al. (*In Revision, Ecological Engineering*)

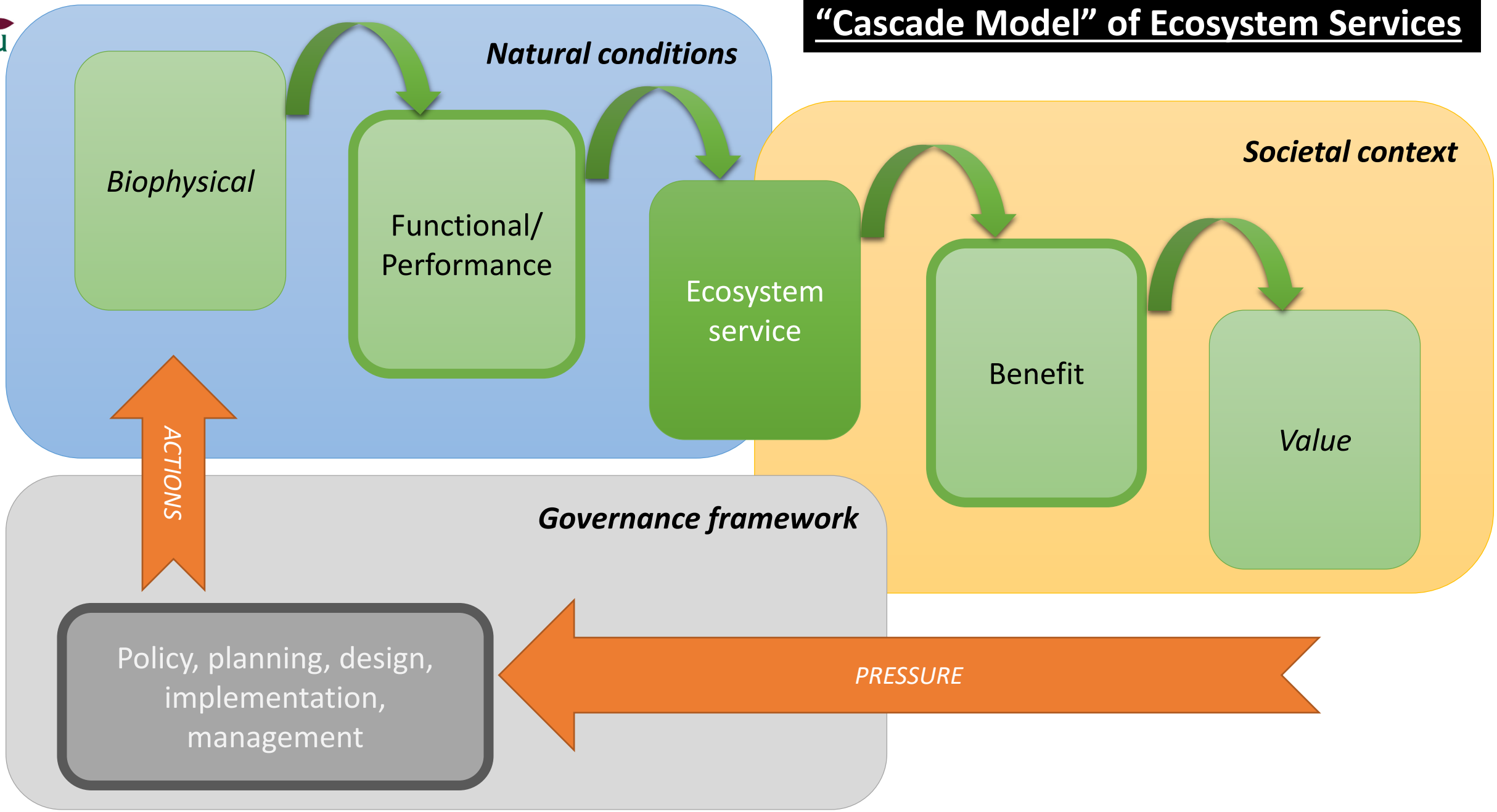
Scaling up: NICE - Innovate and Enhanced Nature-based Solutions for Sustainable Urban Water Cycle (EU H2020, Neil Sang & colleagues)

- Lead : Fundación Centro Tecnológico de Investigación Multisectorial (CETIM, Spain)
- SLU Lead WP 6 Modelling of NBS
- Budget: Approx 5 Million Euros.





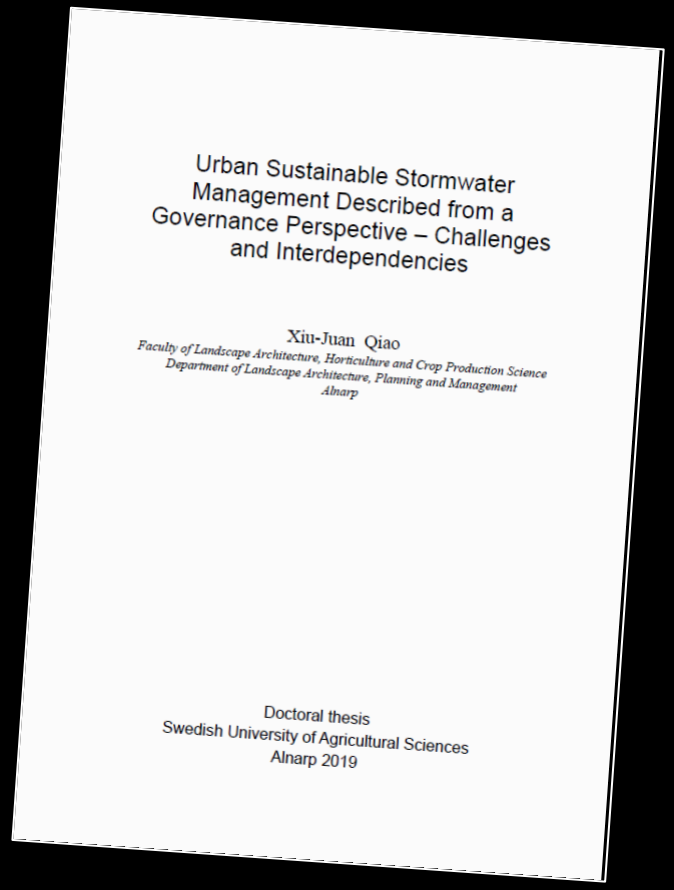
"Cascade Model" of Ecosystem Services



Developed based on Andersson-Sköld et al. 2017

Addressing Governance of Urban Sustainable Stormwater Management – Challenges and Interdependencies (Thomas Randrup & colleagues)

Xiu-Juan Qiao PhD Thesis



Urban Sustainable Stormwater Management Described from a Governance Perspective – Challenges and Interdependencies

Xiu-Juan Qiao

Faculty of Landscape Architecture, Horticulture and Crop Production Science
Department of Landscape Architecture, Planning and Management
Alnarp

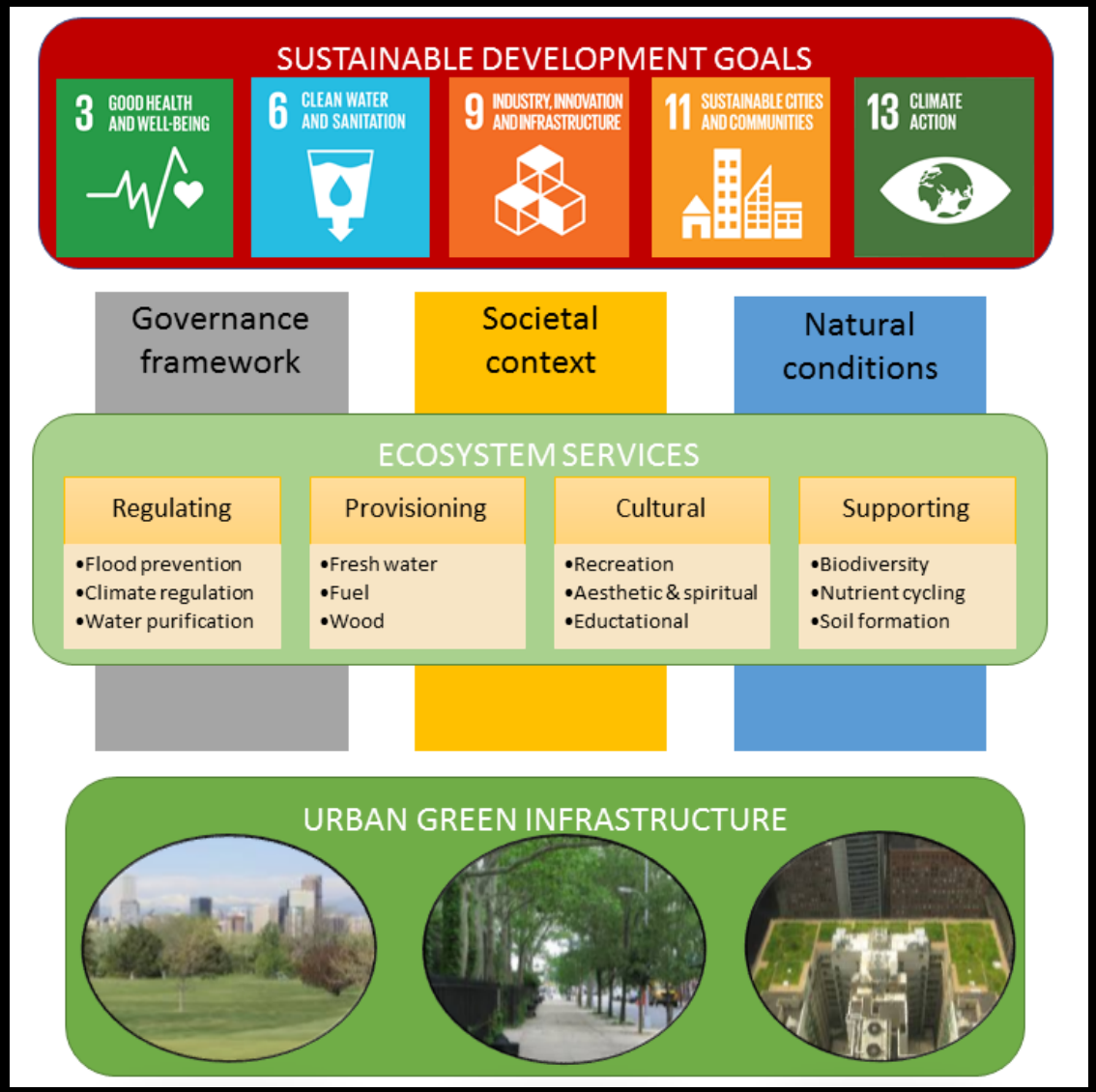
Doctoral thesis
Swedish University of Agricultural Sciences
Alnarp 2019

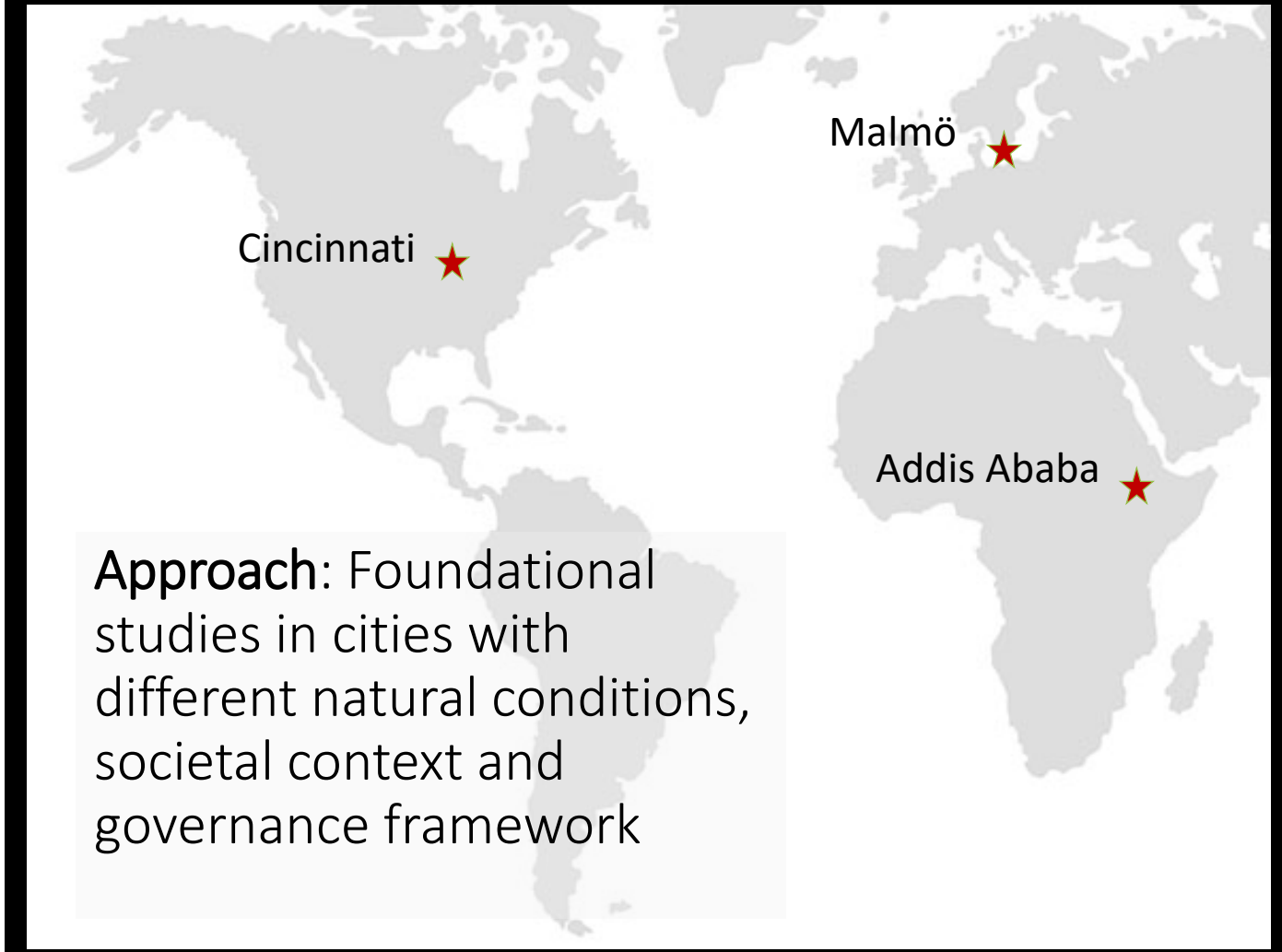
Qiao et al. 2018, 2019, 2020

Governance challenges

- Lack of funding
- Lack of knowledge
- Lack of space
- Lack of private stakeholder involvement
- Unclear leadership and responsibility
- Lack of evidence on SSM efficiency
- Lack of legislative support
- Lack of SSM standards

Transdisciplinary Project: How can we design blue-green urban landscapes for a balanced array of ecosystem services supporting the UN SDGs? (Formas, 2019-2020)

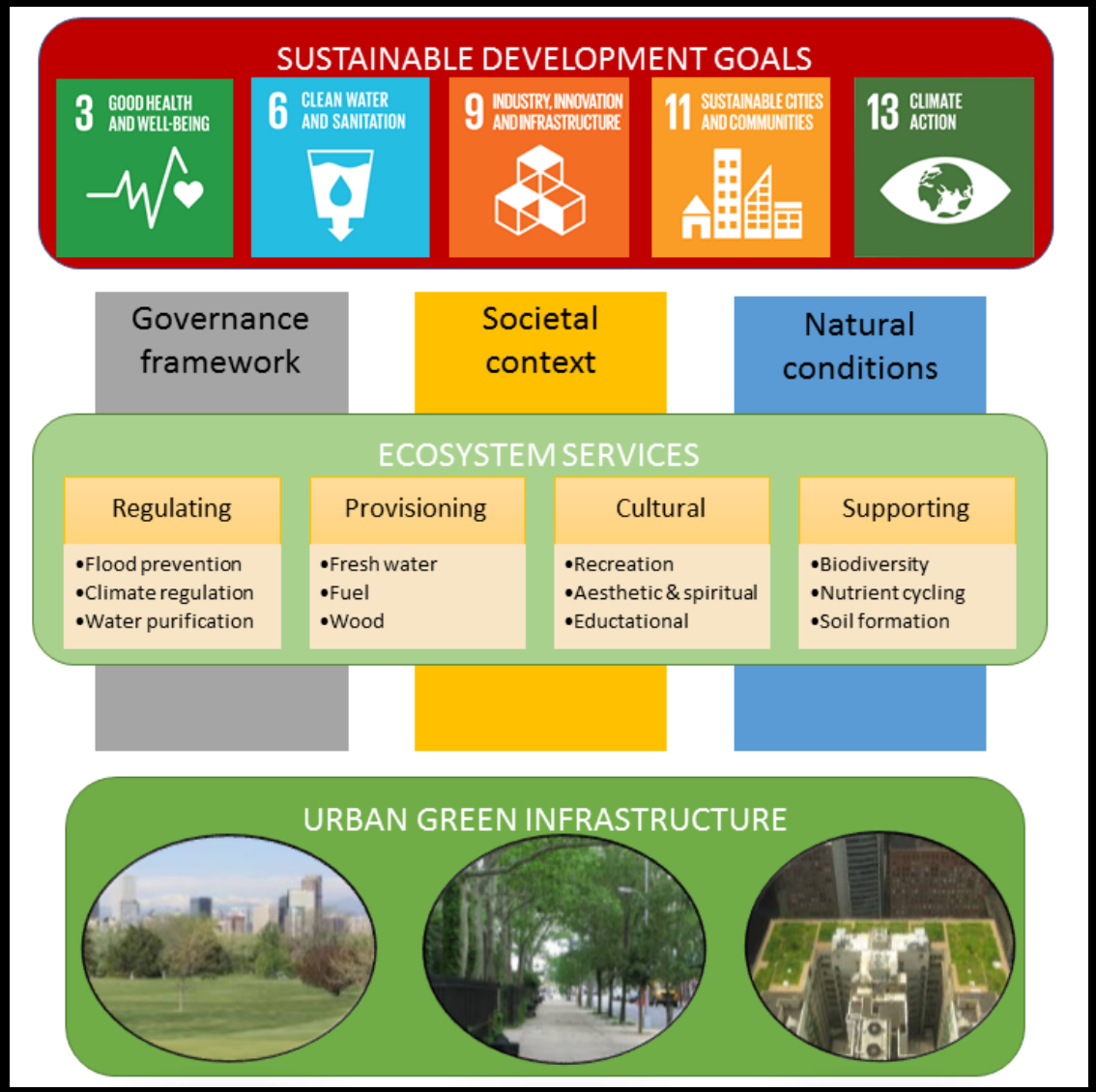




Approach: Foundational studies in cities with different natural conditions, societal context and governance framework

Ode Sang et al. in review, Gamstetter et al. 2020

Transdisciplinary Project: How can we design blue-green urban landscapes for a balanced array of ecosystem services supporting the UN SDGs? (Formas, 2019-2020)



Governance

Environmental Psychology

Ecology

Planning

Human ecology

Landscape architecture

Management

Ode Sang et al. in review, Gamstetter et al. 2020

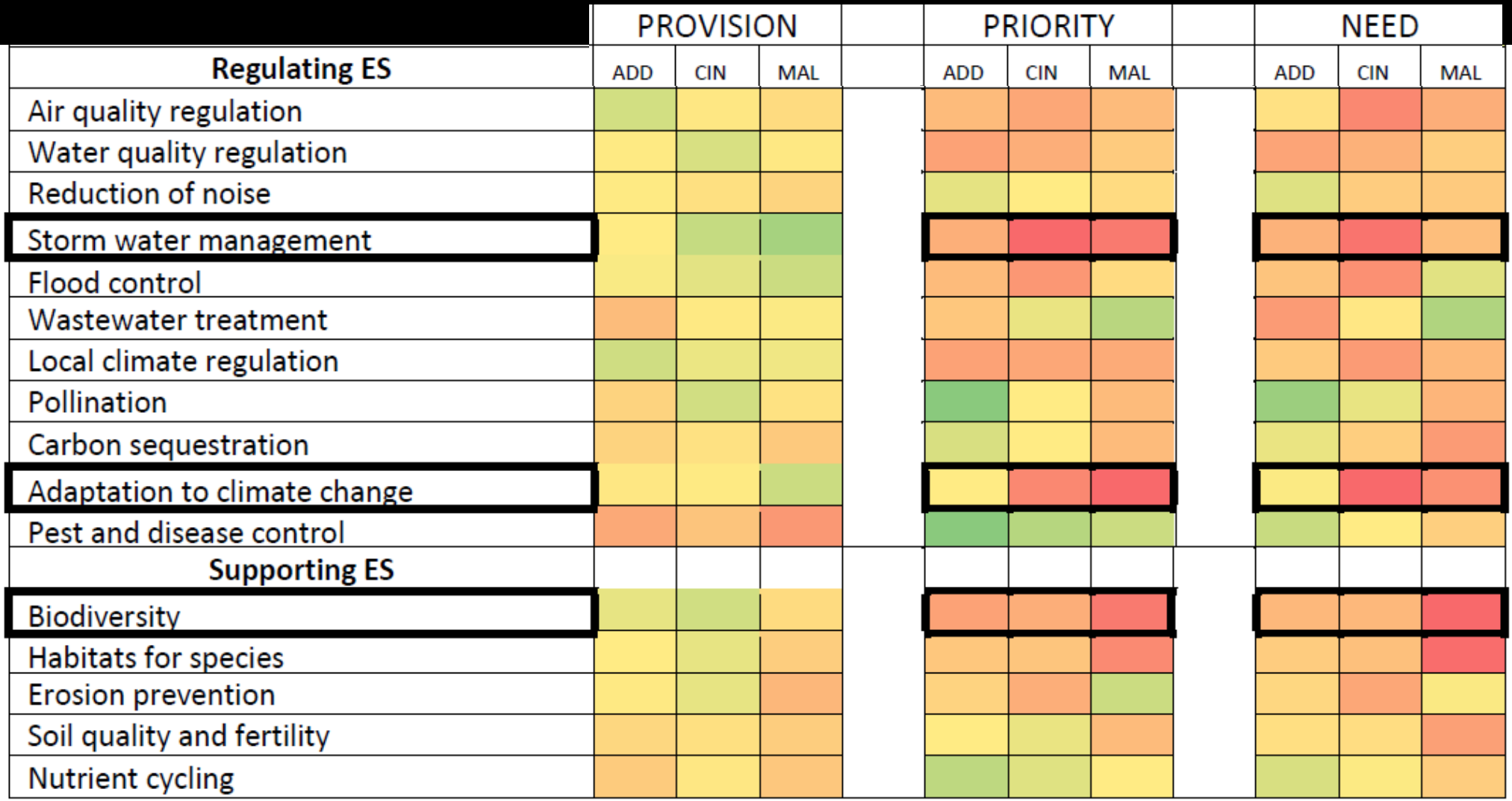


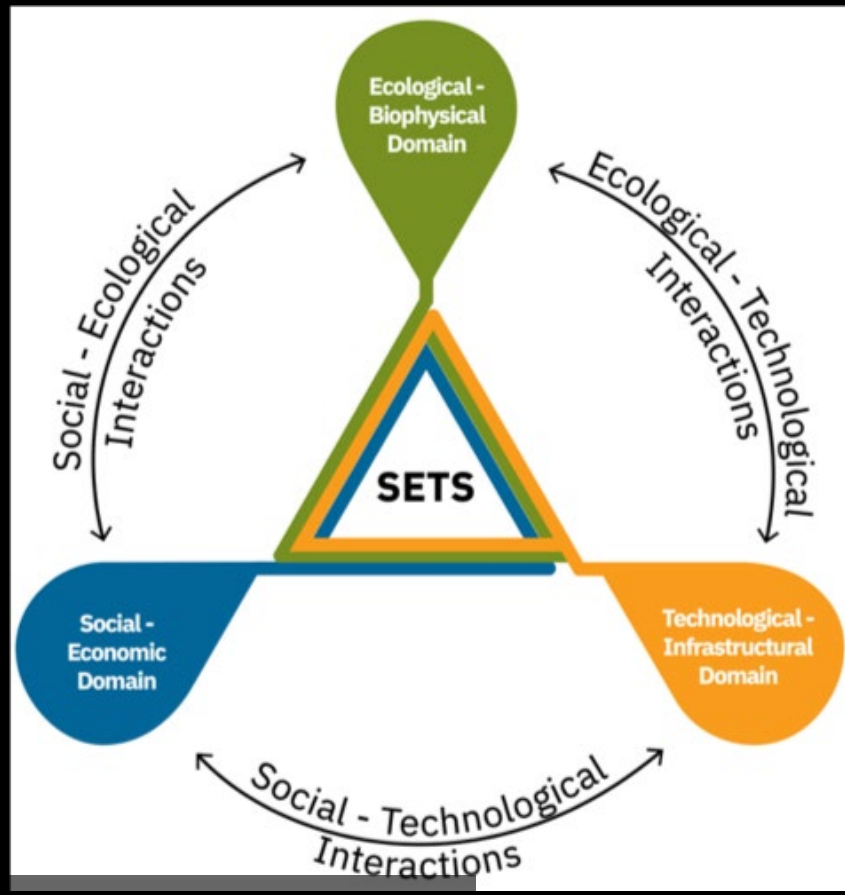
Fig. 6. Results from pilot study workshops with expert stakeholders in Addis Ababa, Ethiopia (ADD), Cincinnati, USA (CIN) and Malmö Sweden (MAL). The table presents stakeholder assessments of current

Legend	
	PRESENT or SUFFICIENT
	INTERMEDIATE
	LACKING or URGENT

Challenges and potential ways forward

- Urbanization and climate change lead to complex interrelated challenges in cities that can’t be solved by single disciplines
- Ecosystem Services = useful framework
- Research is needed:
  - of whole systems
  - at multiple spatial scales
  - long-term
  - across disciplines and domains (technical, social, ecological)
  - at different locales/regions in different climates for comparison
  - Involving policy-makers and other stakeholders

What about: Transdisciplinary Urban LTER with water focus



Thank you!

ishi.buffam@slu.se