Designing Sponge Cities for multiple benefits: integrating nature-based solutions to create sustainable places (DeSCIPHER)

Europe lead: Mike Hutchins (UKCEH),
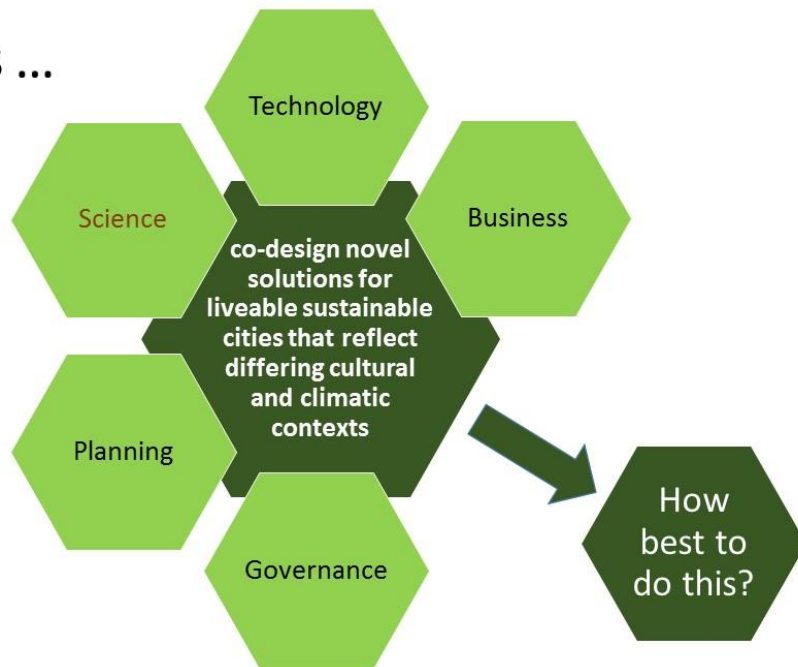China lead: Shen Yu (CAS Institute of Urban Environment (Xiamen))

May 2019 – April 2022

UK   **Norway**   **China**

Objectives

Our ethos …

Learning from each other and working together

Technology
Science
Business
Planning
Governance

co-design novel solutions for liveable sustainable cities that reflect differing cultural and climatic contexts

How best to do this?

Key questions:

- How does the size of implemented Nature Based Solutions (NBS) and the spatial extent of its influence affect the arising co-benefits and trade-offs between a range of environmental quality indicators?

- How are these co-benefits and trade-offs affected by climate and social drivers?

- How can business innovation be incentivised to provide or contribute to NBS?

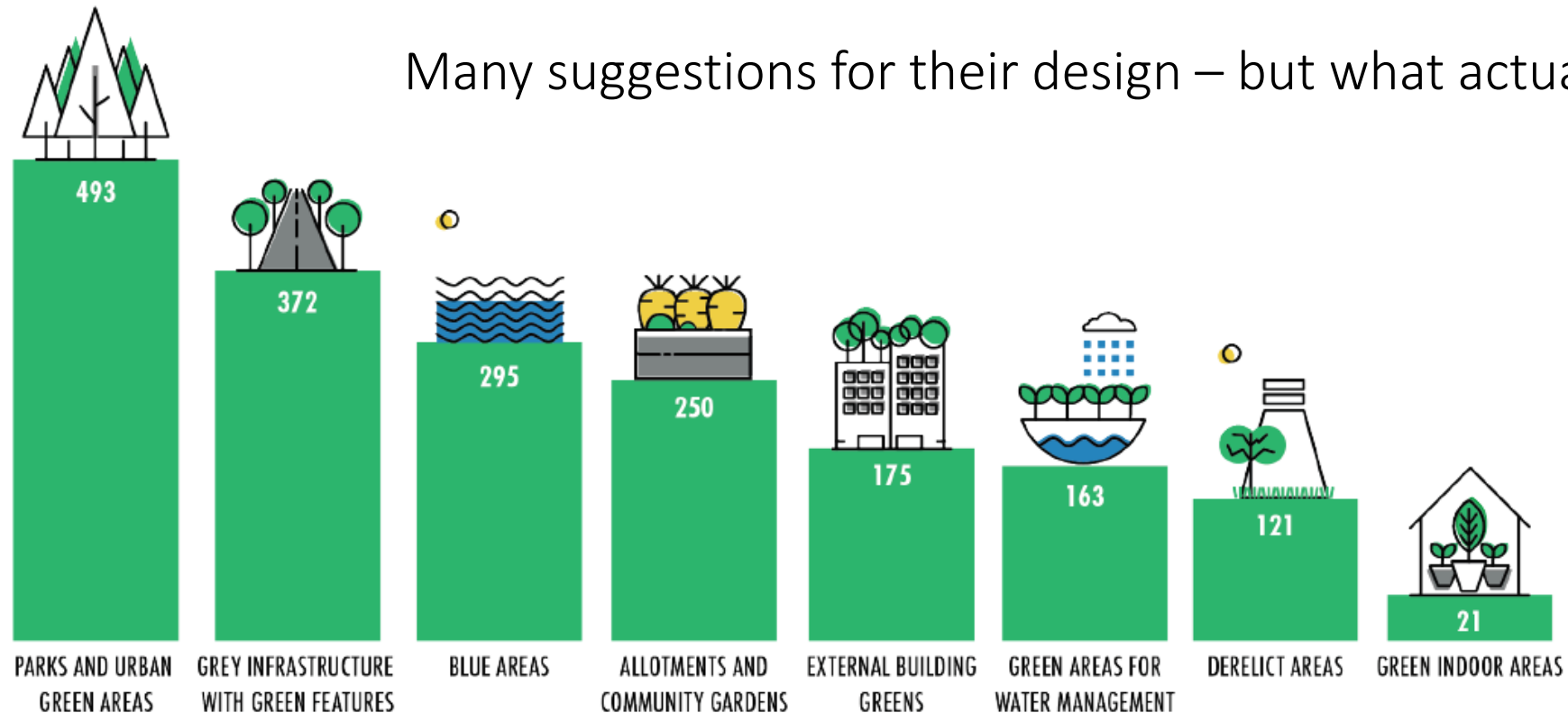**Specific focus on urban forestry and equitable access to urban green space.**

Case Studies...

OSLO

BIRMINGHAM

Photo: Vitality Parkrun

SUZHOU

...involve developing and applying models to evaluate NBS
What should our models represent?....

Urban NBS are resource-efficient...

....using natural processes to address many societal challenges.

Many suggestions for their design – but what actually happens?

PARKS AND URBAN GREEN AREAS	GREY INFRASTRUCTURE WITH GREEN FEATURES	BLUE AREAS	ALLOTMENTS AND COMMUNITY GARDENS	EXTERNAL BUILDING GREENS	GREEN AREAS FOR WATER MANAGEMENT	DERELICT AREAS	GREEN INDOOR AREAS
493	372	295	250	175	163	121	21

976 NBS projects have been reported. A clear prevalence of urban forestry and parkland.

(Almassy et al (2018), Urban Nature Atlas: A Database of Nature-Based Solutions across 100 European cities)

NBS (e.g. urban forestry, parkland) potentially deliver multiple ecosystem service benefits
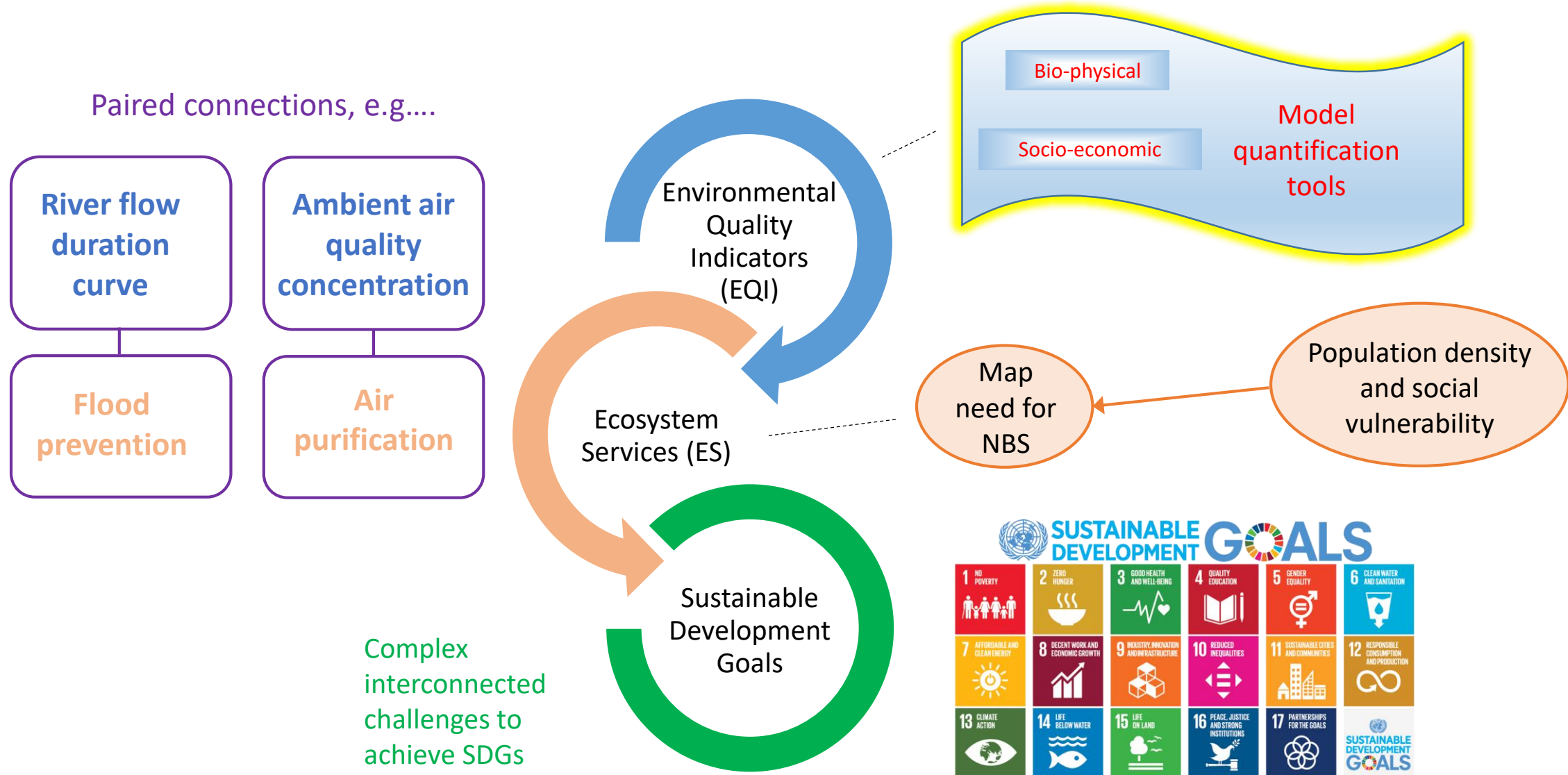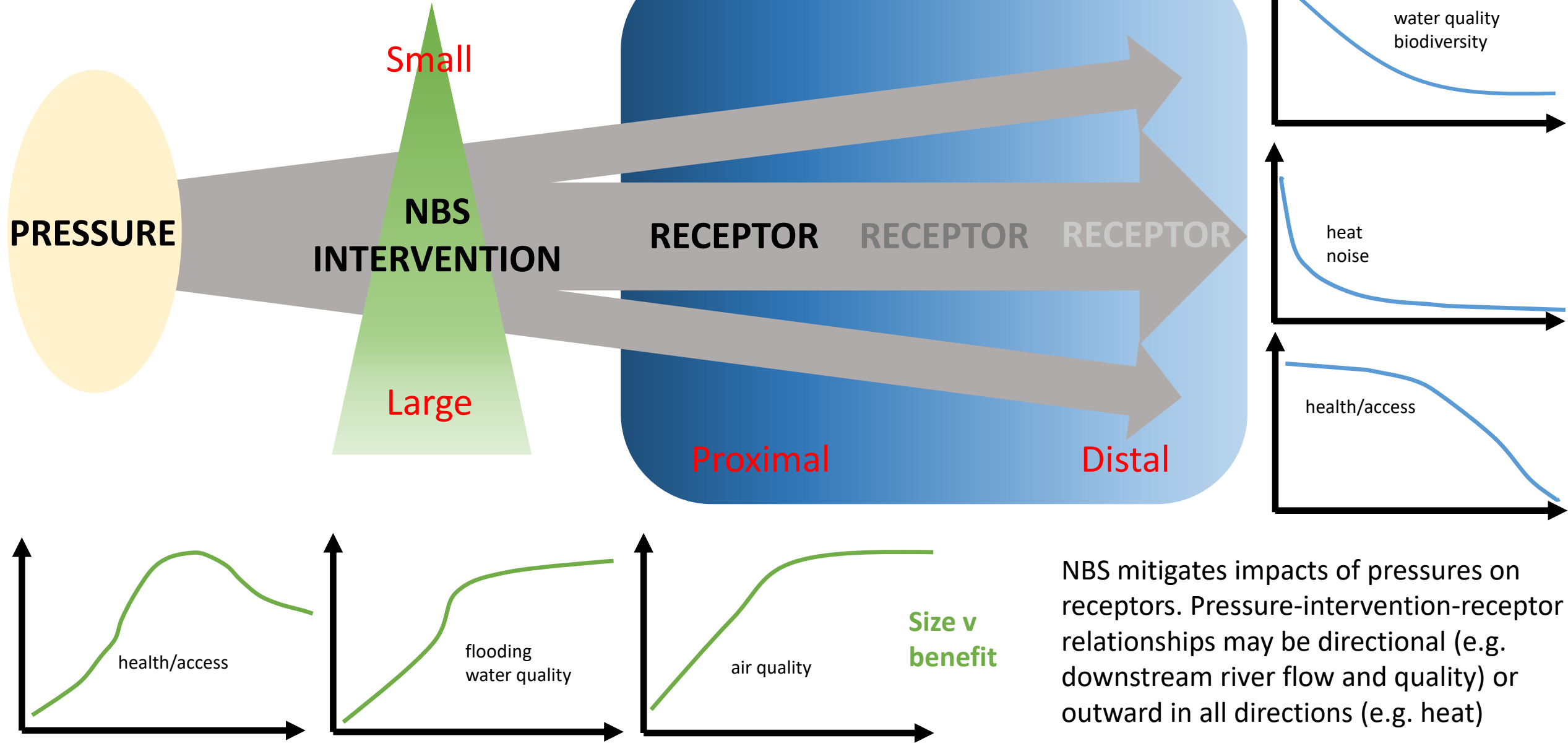
Ecosystem-enriched DPSEEA

- 'Ecological Public Health' highlights that environmental determinants of health can have direct and indirect pathways.

- eDPSEEA is a conceptual model explicitly accounting for this by presenting both direct causal chains, and those modified or moderated by NBS and ES.

- Social, economic and environmental context can further modify the exposure or experience, as well as the effects encountered.
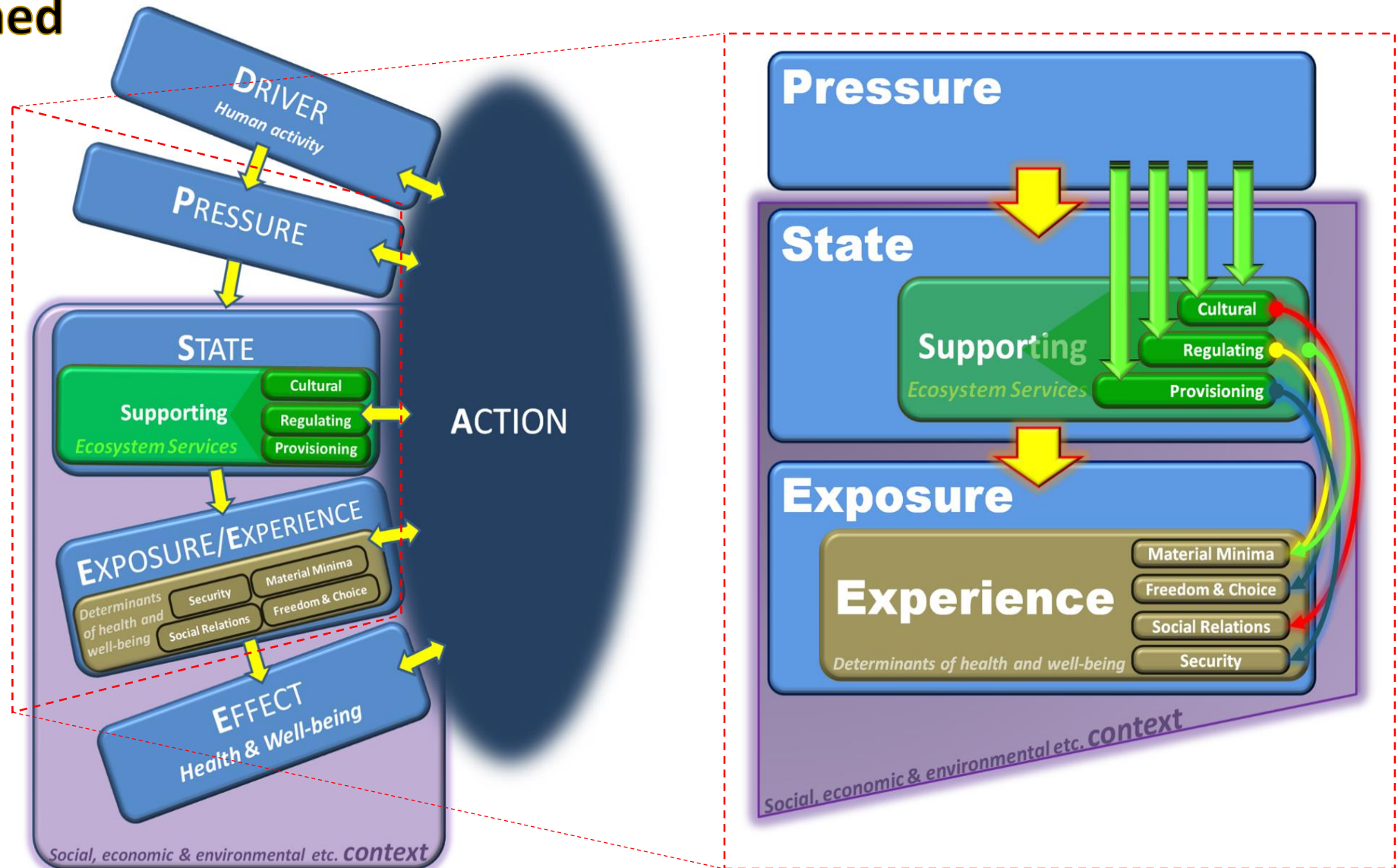
Morris GP, Reis S, et al. (2017) Scoping the Proximal and Distal Dimensions of Climate Change on Health and Wellbeing. Environ Health 16(1): 116, https://doi.org/10.1186/s12940-017-0329-y.

Reis S, Morris G, et al. (2015) Integrating Health & Environmental Impact Analysis. Public Health 129(10), 1383–1389. https://doi:10.1016/j.puhe.2013.07.006.

Scale dependencies (conceptual examples)

Distance v benefit

PRESSURE

Small

NBS INTERVENTION

Large

RECEPTOR   RECEPTOR   RECEPTOR

Proximal   Distal

water quality biodiversity

heat noise

health/access

health/access

flooding water quality

air quality

Size v benefit

NBS mitigates impacts of pressures on receptors. Pressure-intervention-receptor relationships may be directional (e.g. downstream river flow and quality) or outward in all directions (e.g. heat)

Permeable pavements, Lingang.
Photo: Helen Roxburgh

Some examples of initial assessments and model applications...
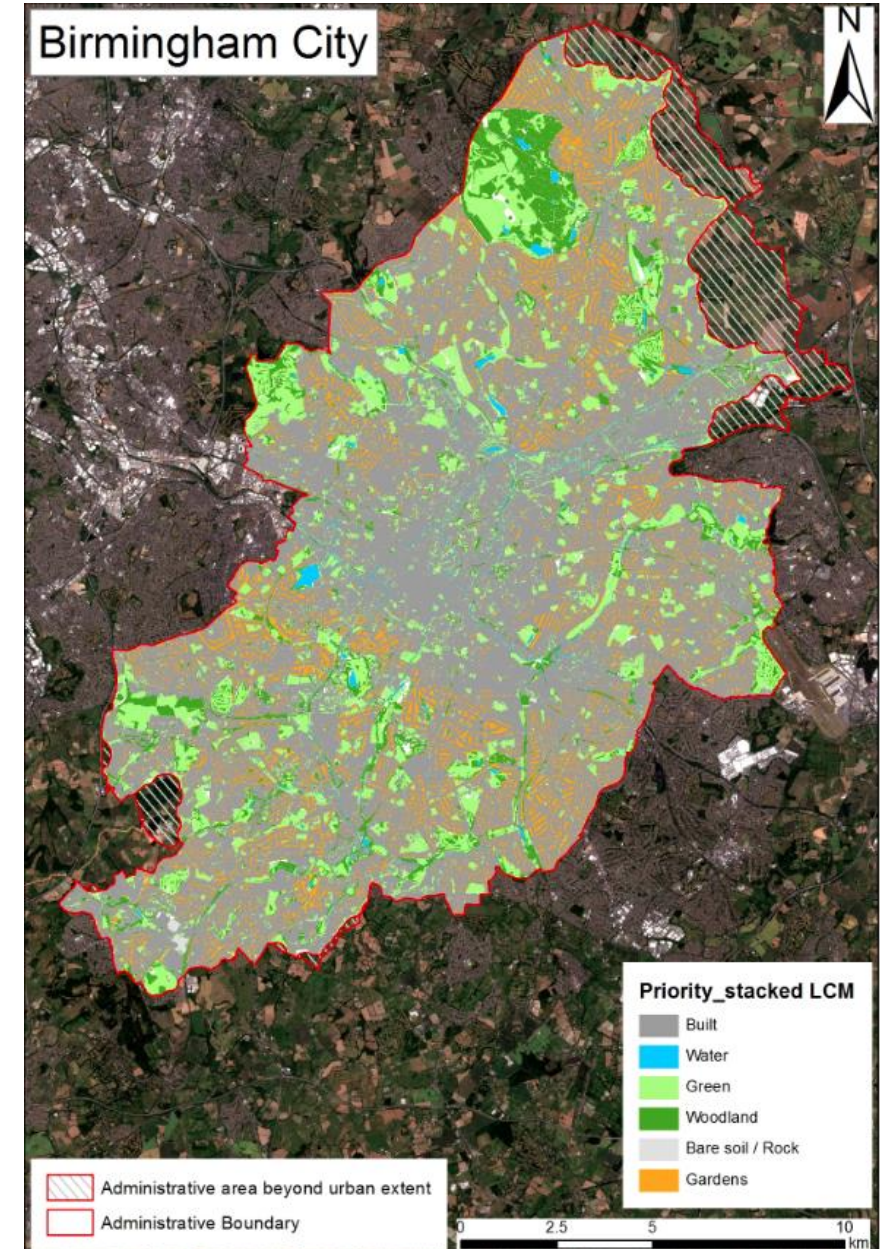
Mapping greenspace in Birmingham

Urban extent (within administrative boundary)

urban footprint created for:

UK Urban Natural Capital Accounts (eftec et al. 2017; ONS 2020)
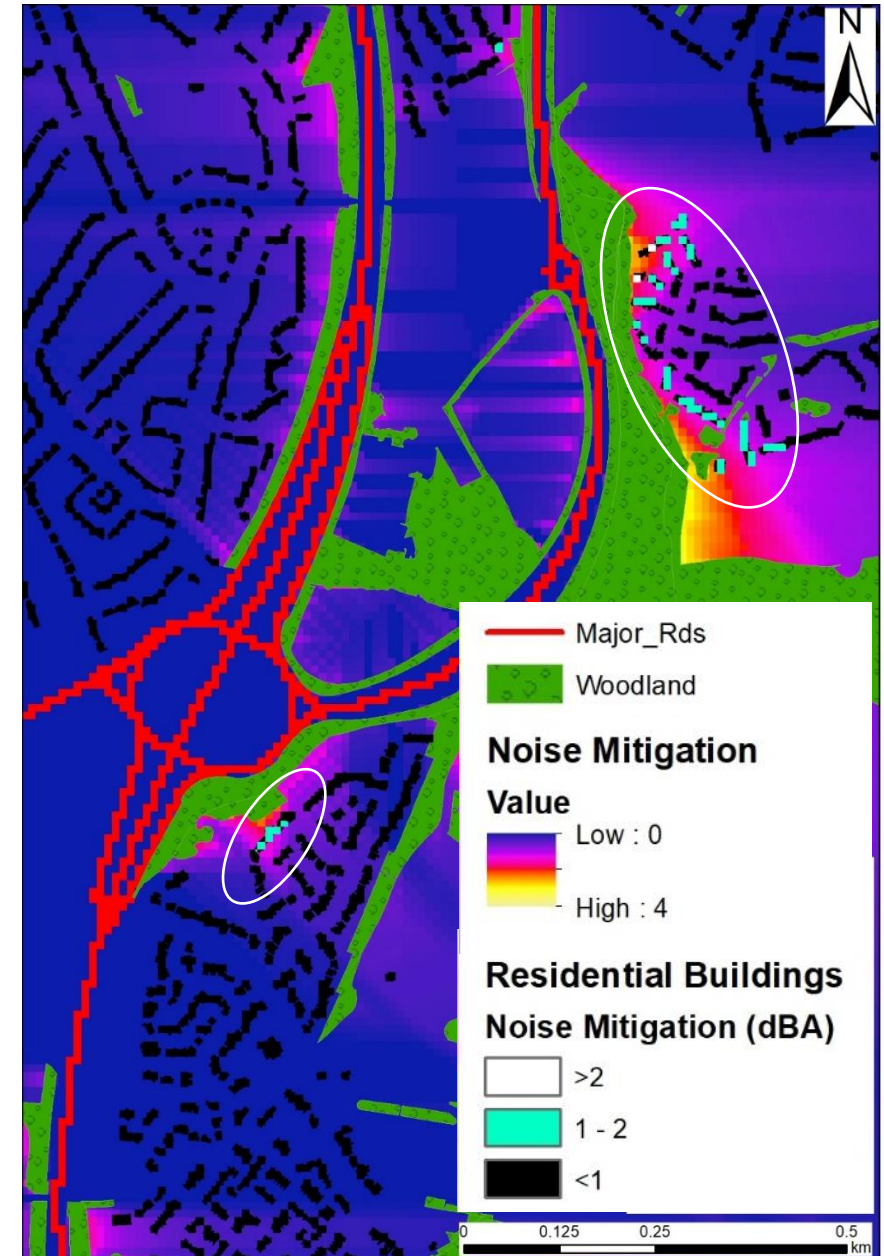
Urban natural capital:

- Woodland

- Grassland

- Gardens

- Blue-space

- (OS Greenspace layer)

Modelling ecosystem service benefits

e.g. Local scale example of noise mitigation benefits provided by trees.

- Noise mitigation, 1-2 & 2+ dB(A)

- Mitigation estimated using UKCEH Noise Mitigation Model

- Original Noise levels from Defra (Extrium) don't account for presence of trees

- Outputs include number of residents benefitting from mitigation

- Calculating health benefit & economic benefit is also possible

Traffic Noise mitigation by trees

Modelling ecosystem service benefits

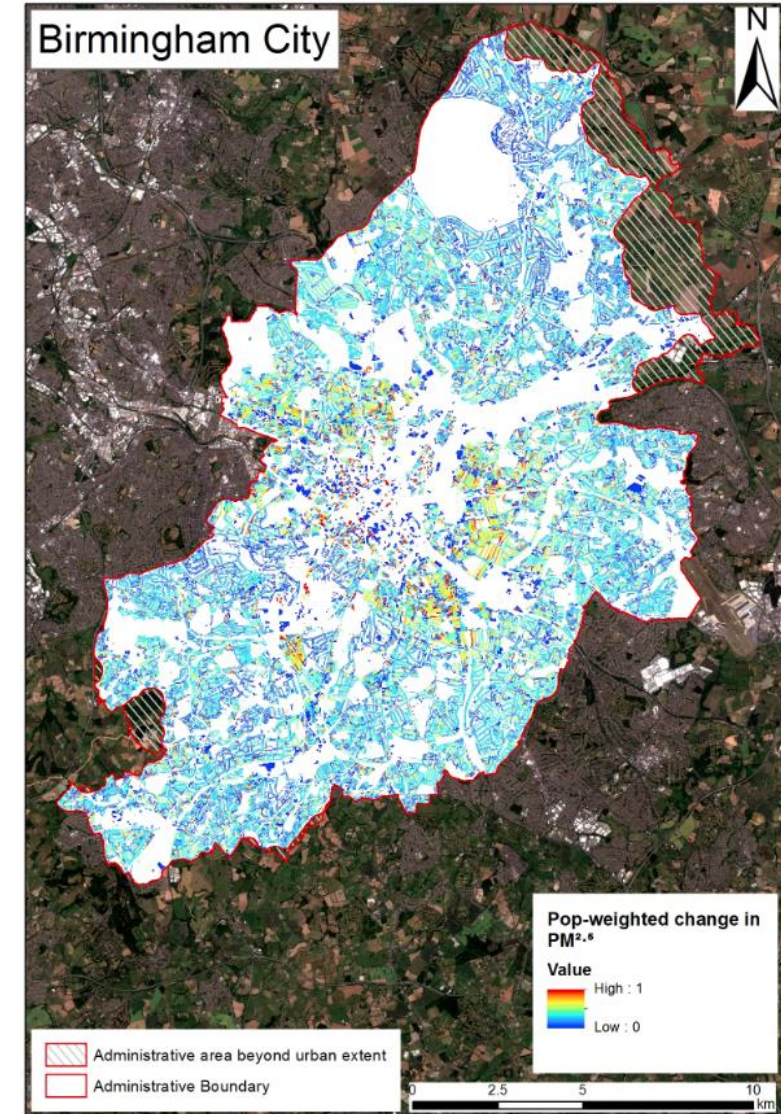## e.g. Pollution removal by vegetation

- Uses scenario modelling (Atmospheric Chemistry Transport Model – EMEP4UK)

- Health economics model ALPHA RiskPOLL
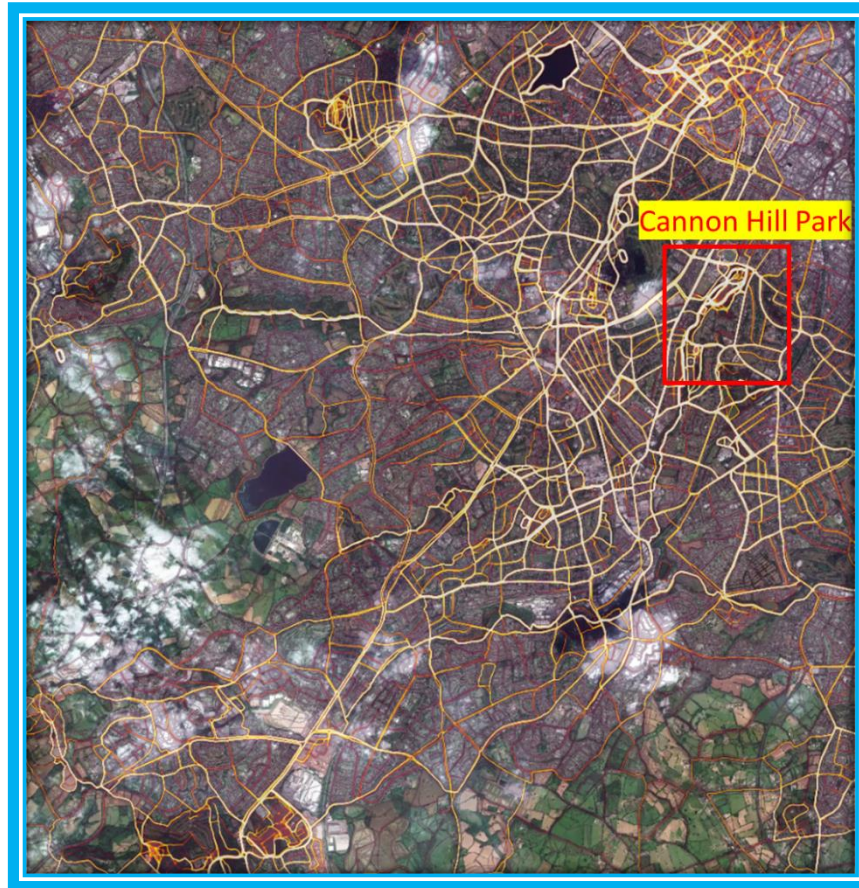
From ONS Natural Capital Account (Jones et al. 2017)

Change in pollution ($PM_{2.5}$) concentrations attributable to vegetation
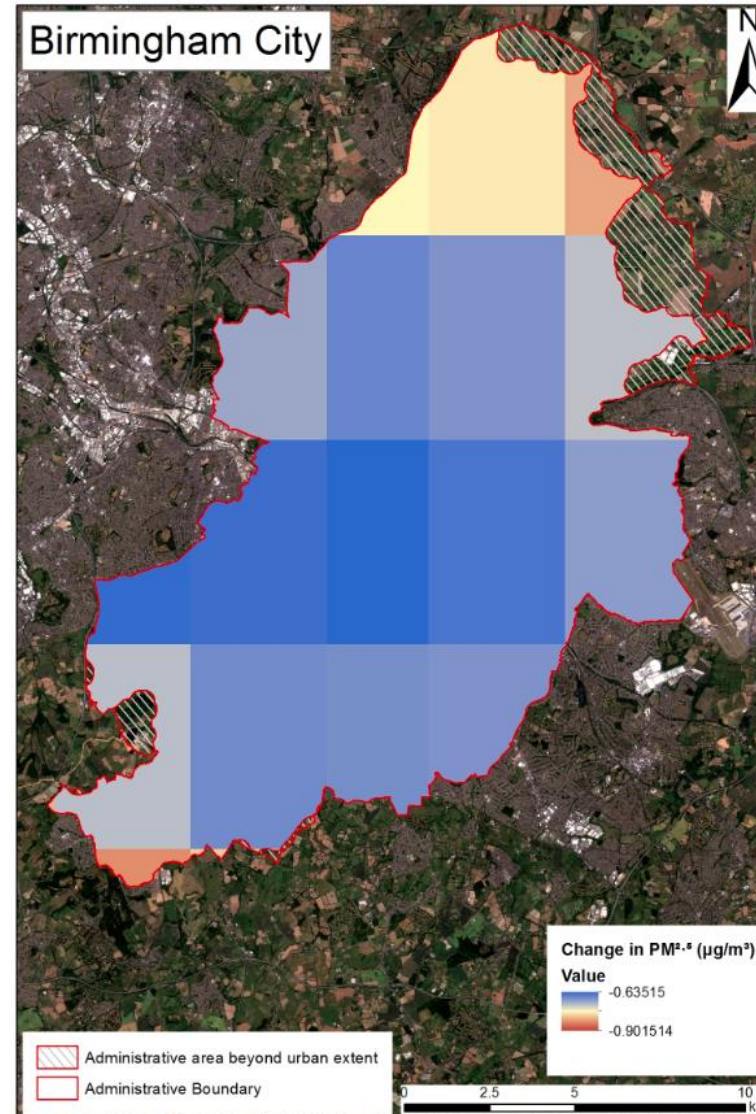
Reduced exposure for benefitting population (weighted)

Urban Green Space usage in Birmingham
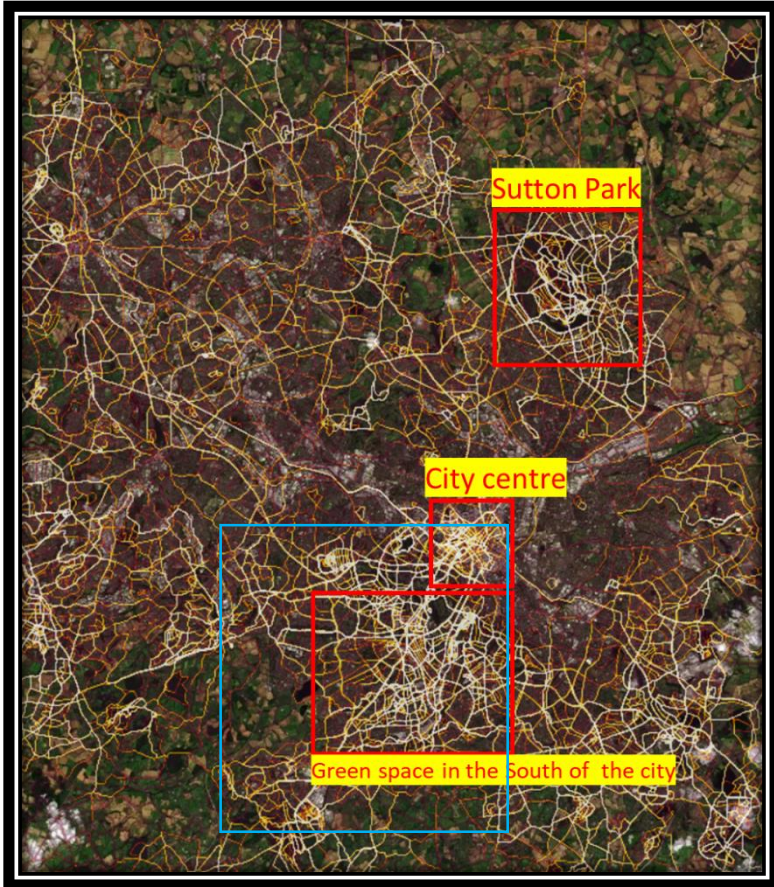
Running activity intensity based on Strava data

enlarged inset map

- Use discrete choice modelling to understand urban green space attraction through individual usage choices, especially modelling recreational round-trips for leisure;

- Based on social media data, e.g. Strava;

- Quantify the recreational value of parkland and its area of influence which helps define the scale (size and proximity) dependencies.

Financing NBS

Currently: High share of public funding

Challenges to attract more private funding:

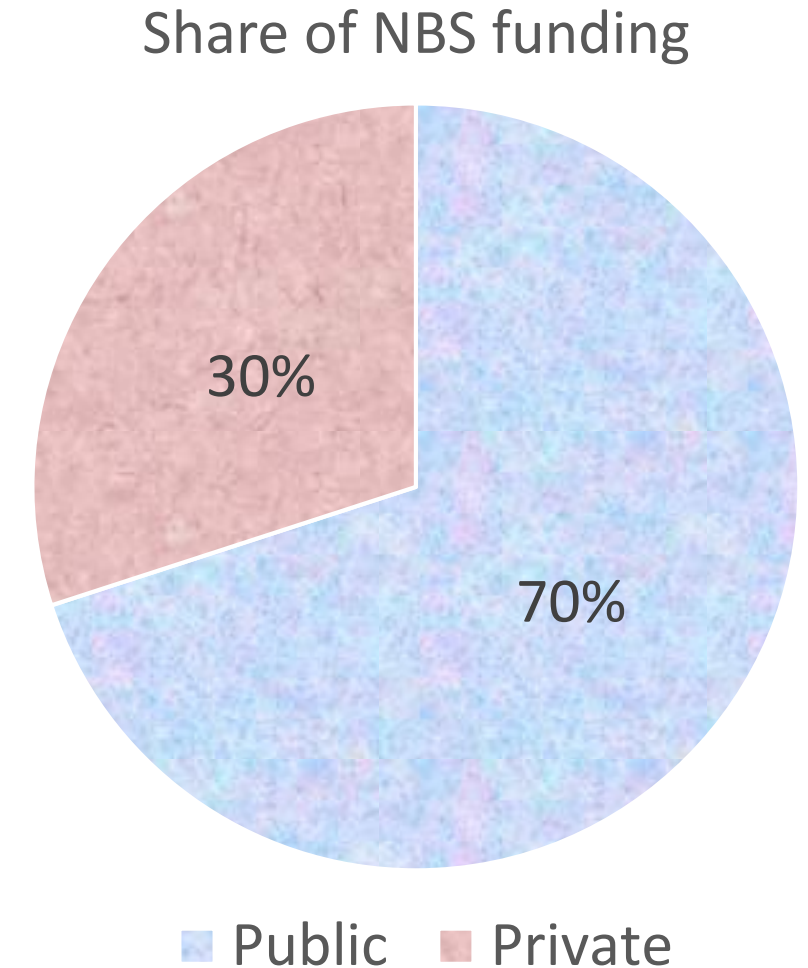- Uncertainty in **value creation**

- **Time-gap** between NBS implementation and expected revenues

- **Scale** dependency of benefits

- **Value capture** is difficult → Many benefits have the character of **public** (non-excludable, non-rival) **and common** (non-excludable, rival) **goods**

Share of NBS funding

30%

70%

■ Public ■ Private

Average values for EU and US based on Almassy et al. (2018) and Zimmermann et al. (2019)

Encourage "testing" of new financing mechanisms

- Community asset transfers

- NBS - 'Business Improvement Districts'

- Volunteer work

- Crowdfunding

e.g. UK community initiative for sponsoring or hosting **"Tiny Forests"** - fast-growing, sustainable, dense, tennis-court-sized plots

Adopt-a-Park Program
Thanks to this year's Volunteers!

Site Maintained By The Delphian School

Wikimedia: Dhoustonjackson

Powered by earthwatch EUROPE
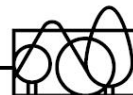
A multi-domain framework

Hypothetical example of assessing placement options for urban forestry NBS establishment

Inner city OPTIMAL

Extensive belt between urban area and polluting sources

Clumps near headwater urban rivers

Along headwater urban rivers

Along major roads and rail

Within urban area, towards side of prevailing wind

Throughout urban area

Along roads, in former industrial areas

Evaluate multi-EQI outcomes for each of 8 alternative EQI-specific primary objectives

Each radar plot shows the 8 EQI benefits (low [centre] to high [edge]) with bearings as in the central diagram

Air quality

Green space access

Flood risk

Soil quality

Water quality

Bio-diversity

Noise

Temperature

local

neighbourhood

whole city

wider hinterland, airshed, downstream

Evaluating NBS at a range of scales

Environmental quality indicators (EQI)

...for assessing co-benefits and trade-offs