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Enhancing urban regeneration and spatial justice with Nature-Based Solution

Quantifying the benefits and spatial equity of Nature-based solutions in urban contexts

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LAPTA

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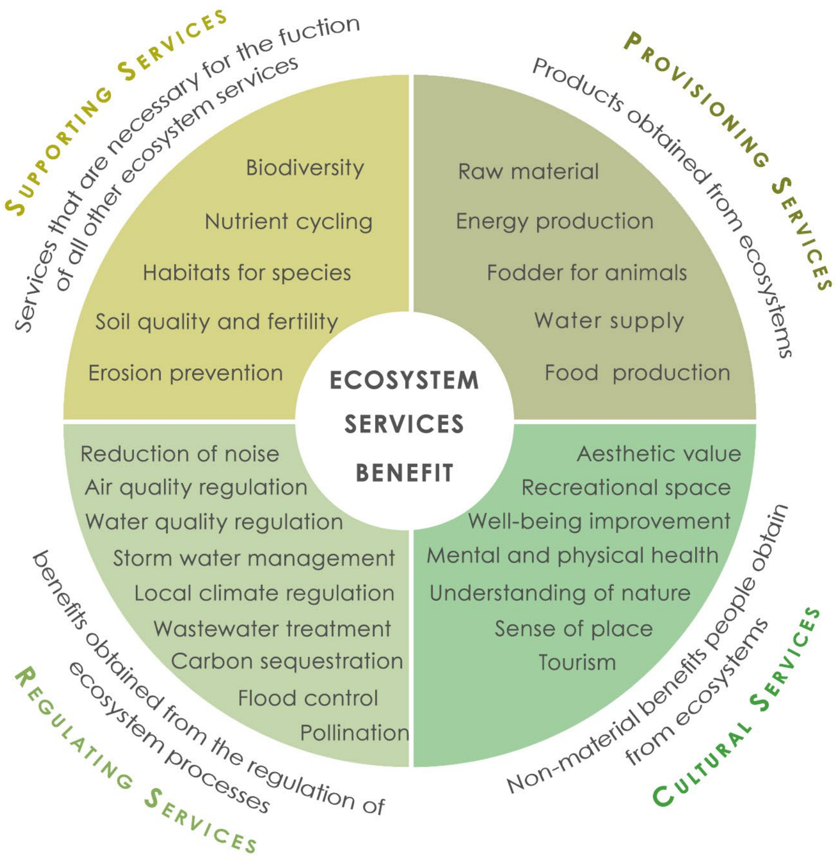
Through the set of **ecosystem services** provided, nature-based solutions (NBSs) are considered sustainable solutions inspired and supported by nature that can simultaneously deliver multiple ecological, social and economic benefits to society and the environment.



Using **NBSs** is therefore possible to reduce disaster risks and address simultaneously several requirements, related to climate change adaptation, biodiversity loss, improvement of human health and well-being.

Academic databes identified throught *Scopus*

QUERY

("nature based solutions" AND "benefit" AND ("evaluation" OR "assessment")

Initial set of papers

n=343

EVALUATION 1

Title abstract and keywords analysis

- Excluding review articles
- Documents in which NBSs and **benefit** were marginal theme or generically referred

First subset of papers

n=157

EVALUATION 2

Full text articles assessed for eligibility

CRITERIA OF SELECTION

- qualitative/quantitative evaluation
- economic evaluation
- spatially explicit evaluation
- evaluation approach with spatial equity aspects

"in working progress"

papers completely screened about 40%

During evaluation 2, a chart was built in order to collect articles that contain the most complete approaches:

Source	Title	Focus	Models and Methods	Baseline Data	Nbs evaluated	Indicators of benefit	Study scale
Liao, K.-W., Thedy, J., & Tai, C.-C. (2024)	Fluvial flood adaptation using nature-based solutions: A comprehensive and effective assessment of hydro-meteorological risks	disaster risk reduction hydro meteorological risks	HEC-RAS 2D hydraulic model (Reliability analysis and Kriging-based reliability analysis) InVEST	digital elevation model (DEM), Manning's n values, and discharge hydrographs land use land cover	converting land use in the off-line flood retention area from urban or agricultural to mixed forest	carbon sequestration, water yield, and soil erosion	watershed area
Qiu, Y., Schertzer, D., & Tchiguirinskaia , I. (2024)	Assessing spatial scales in hydrological effectiveness and economic costs of nature-based solutions within a scale-invariance framework	quantify runoff reduction	Multi-Hydro, Universal Multifractal (UM) framework, life cycle costs (LCC)	grid-based land cover, rainfall data obtained from the X-band radar of ENPC	permeable pavement, rain garden, extensive green roof	scale-invariance indicator, is 'technical' indicator to quantify the hydrological effectiveness of the NBS scenarios (overland flow maps)	peri-urban catchment
Liu L., Dobson B., Mijic A. (2023)	Optimization of urban-rural nature-based solutions for integrated catchment water management	improving water availability, water quality, and flood management	CatchWat-SD, NSGAII algorithm, trade-off analysis	Water quality monitoring data	ponds/wetlands, dams/barriers, regenerative farming, floodplains, SUDs (green roofs, rain gardens and swales, expands urban green space)	Indicator water quality Dissolved inorganic nitrogen (DIN), Soluble reactive phosphorus (SRP). Suspend solids (SS), Nash-Sutcliffe efficiency (NSE) Runoff coefficient	catchment scale
MacKinnon M., Pedersen Zari M., Brown D.K., Benavidez R., Jackson B. (2022)	Urban Biomimicry for Flood Mitigation Using an Ecosystem Service Assessment Tool in Central Wellington, New Zealand	improving stormwater management	Nature Braid flood mitigation tool	Digital elevation model, land cover, soil and climate data	green roof network	increasing of area covered by flood-mitigating land, increasing of areas benefiting from the mitigation measures	costal city
Martínez-García V., Martínez-Paz J.M., Alcon F. (2022)	The economic value of flood risk regulation by agroecosystems at semiarid areas	eccosystem Service for Flood Regulation (ESFR)	CN Assignment, Hydrological models HEC-HMS 4.6., The avoided cost method (ACM)	Precipitation data, Digital Elevation Model (DEM), a slope map, cadastral Cartography	Agroecosystems (citrus trees)	economic losses, Δ ha flood Δ peak flow Δ economic losses respect to the current scenario	watershed area

Almost only methodologies related to **water regulation** come up.

Is possible that there is an inaccuracy in the use of the terminology "NBSs," which turns out to be in common use in hydrology studies so it makes us understand that nature-based solution terminology is not widespread in other fields of study where other terms are used to refer to NBSs.

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In order to have a quick recap of the progress research we have categorized the most common methodologies encountered for each types of evaluation methods:

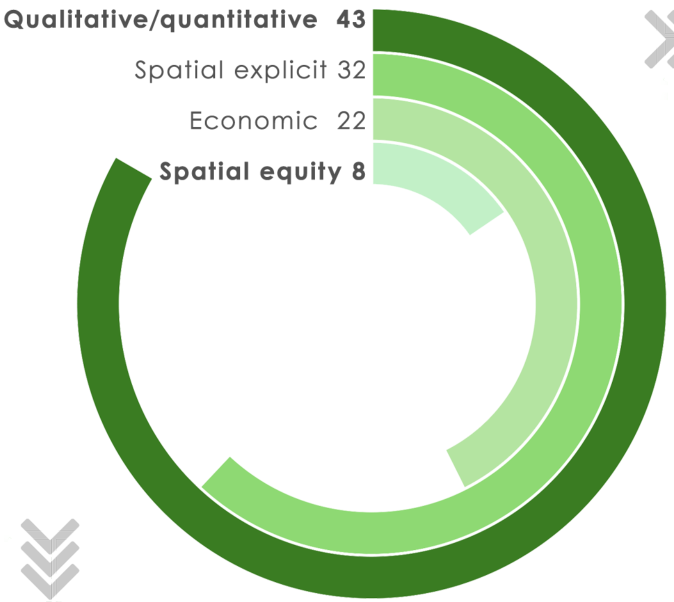
Coherently with the result of the preceding chart, the evaluation methodologies mainly refer to themes related to **water regulation**

Approaches	Common Methodologies
Qualitative/quantitative	Indicators of ecosystem service benefits in order to quantify the effectiveness of the NBS Monitoring and evaluation programs, using surveys
Economic	Cost-benefit analysis, replacement cost estimate, quantification of the costs of avoided damages , economic losses, life cycle costs (LCC)
Spatially explicit	Base scenario simulation, modelling scenario of distribution for NBSs, flood risk map, extreme event distribution maps
Spatial equity	Map of exposure and vulnerability to identifies prior areas suitable for mitigation scenarios Quantification of socio-economic vulnerability

Benefits can be generated only in a portion of city, the planning of benefits without taking into account spatial equity issues limits the potential numbers of beneficiaries and this produce or increase **spatial injustice**

The diagram sums up the data about the dissemination of different evaluation approaches used in the papers examined

QUANTIFICATION OF EVALUATION APPROACHES



Qualitative/quantitative approaches are the most common (encountered in 76% of the articles examined)

- Indicators to measure effectiveness are widely used tools
- In comparison to state of real conditions are used to quantify the results produced by the NBS interventions
- Indicators used to estimate NBSs effectiveness mostly widespread are related to ecological and environment aspects

carbon sequestration rates | decrease in runoff volume

variation of temperatures | water quality indicator | contamination reduction | Increase in stormwater retention capacity

- Indicator used to quantify the results produced by the NBS interventions are universal and not context-dependent, therefore, their application is quick and intuitive, even for non-experts

Aspects of spatial equity are less experimented (encountered in 14% of the articles examined)

- Spatial distributions of NBSs cross with datasets on socio-economic vulnerability can optimize scenarios of distribution without causing negative impacts like 'green gentrification' or displacement of low-income.
  To avoid potential disparities, understanding current inequities is the key step in reducing these inequities through future planning and policies
- Inequities in the distribution of benefits are not universal but context-dependent
- Existing methodologies are based on census tracks whom contain public datasets on population easily available, but are not always sufficient
- The implementation of datasets about social-economic vulnerability could help creating a detailed baseline knowledge for later decision-making about the priorization on NBSs intervention and location

Thank you for your attention

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SPECIAL WORKSHOP TITLE: Enhancing urban regeneration and spatial justice with Nature-Based Solution

TITLE OF THE PRESENTATION Quantifying the benefits and spatial equity of Nature-based solutions in urban contexts

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