REGREEN
NATURE-BASED SOLUTIONS

Ecosystem services modelling

Policy Recommendations

- Models can give locally-relevant information on the benefits of nature-based solutions
- This information is specific to each local context in a city (not a generic value)
- Model outputs are real numbers (not just a score from high to low), and are particularly useful when combined with socio-economic data to make decisions on green and blue space planning

This brief provides information about the outcomes of REGREEN research on using ecosystem services models to calculate the many benefits from urban green and blue space.

Why modelling?

Decision-makers need accurate information on the benefits that urban Nature-based Solutions can provide, which are specific to their city. REGREEN has created new models which address this need, and help them make the right planning decisions to address urban challenges in a sustainable way.

Need

City officials need accurate assessments of the benefits that nature-based solutions (NbS) provide, to help with planning decisions on green and blue space in cities, like parks, street trees, rivers or other natural features. A challenge is that many existing sources of information fail to meet their needs for a number of reasons. Some give only relative scores for benefit (low to high), rather than actual numbers (change in pollution concentration, degrees Celsius of cooling, etc.); many are based on simple look-up tables which assume that a tree provides the same benefit regardless of where it is planted, but the reality is very different. There is a need for improved ecosystem service models which provide locally-relevant calculations of benefit which take into account local pressures, the type of NbS and the people who will benefit from it.

Approach

In REGREEN, teams of specialists worked with city representatives to develop new spatial ecosystem services models. These models incorporate key ecological and environmental processes into simpler versions which can be run relatively quickly in GIS software, but which take account of local context. New models were developed (Fig. 1) which show how NbS can help to address the following urban challenges:

- Reducing air pollution
- Reducing man-made noise
- Urban cooling
- Reducing water flow under high rainfall
- Improving water quality
- Maintaining or increasing biodiversity

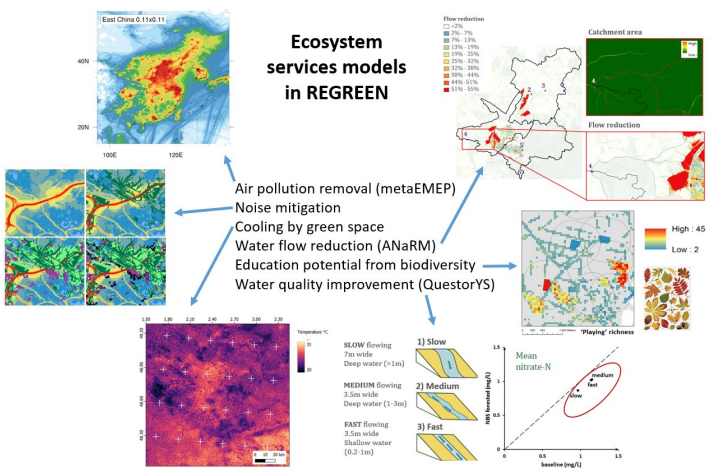

Fig. 1 New or adapted ecosystem service models created in REGREEN

Results

The models can produce maps and summary metrics, and support further analysis, which are useful for city decision makers, citizens and researchers. Models can show where urban pressures are greatest, and where NbS provide benefits to society (Fig. 2).

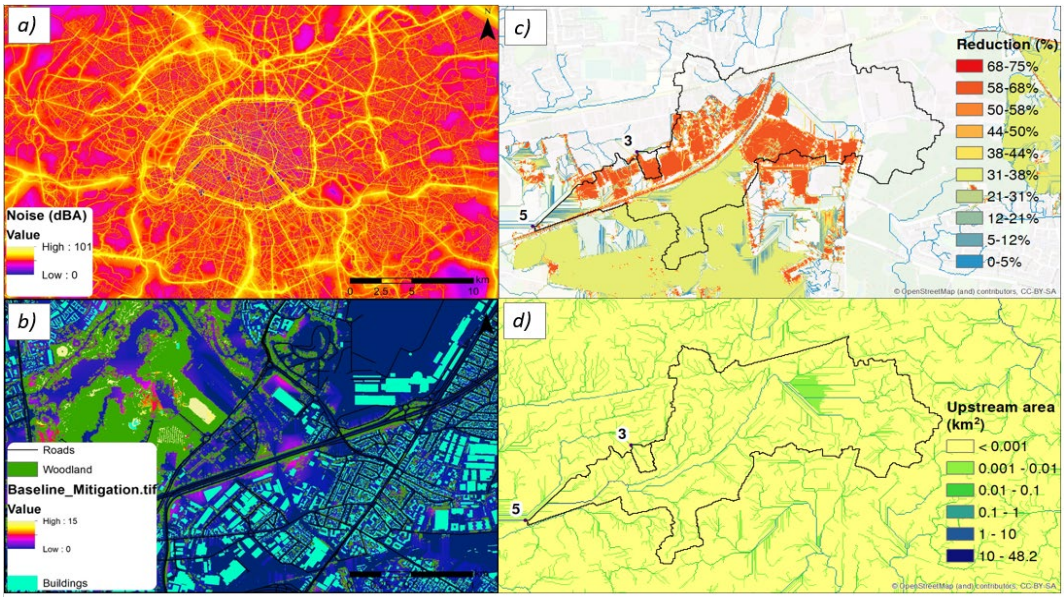

Fig. 2 Examples of ES models showing a) noise levels in Paris, b) mitigation of noise by urban trees, c) water flow models showing % runoff reduction and d) stream flows benefitting from new tree planting.

Looking at models together with social data can identify areas where NbS can help reduce social and health inequalities. For example, poorer neighbourhoods in Paris experience higher air pollution levels, but urban trees benefit these neighbourhoods more than they do in wealthier communities (Fig. 3).

		Background PM2.5	Effect of Urban Trees
Households in Deprivation (%)	Total Population	Baseline (µg/m³)	Δ Concentration (µg/m³)
0	558,400	10.7	-0.21
> 0 & ≤ 10	4,411,169	12.0	-0.26
>10 & ≤20	4,287,820	12.9	-0.23
≥20	2,740,053	12.5	-0.22

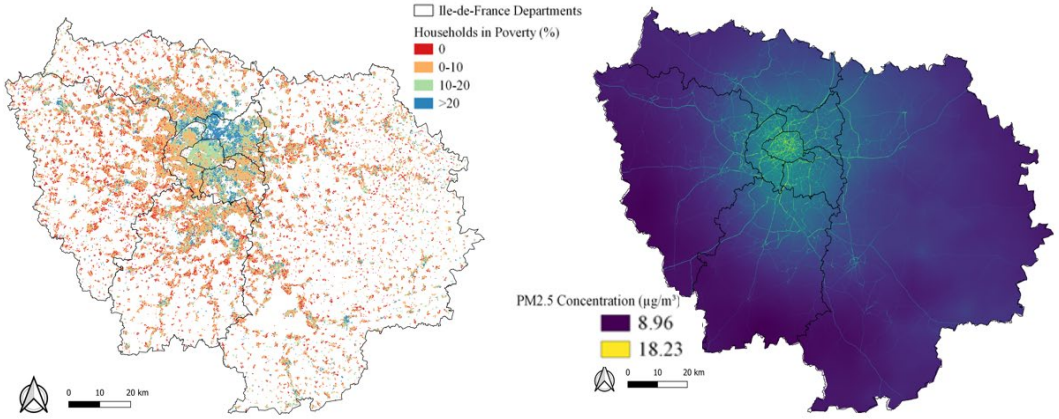

Fig. 3 Trees help address social inequalities in Paris, by removing more air pollution in poor areas compared with more wealthy neighbourhoods.

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Integrated analysis

Developing scenarios which explore city plans, or future policy guidelines such as the 3-30-300 rule, is a powerful tool for decision-makers. These can be used in new model runs to see the multi-functional benefits for many different challenges (Fig. 4)

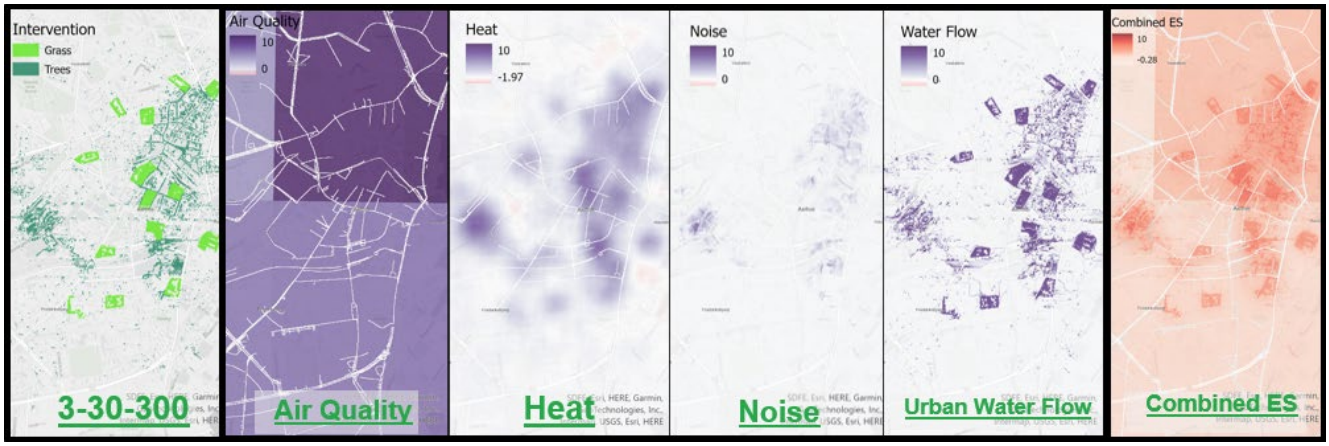

Fig. 4 Evaluating the 3-30-300 rules using four models (air quality, heat, noise and water flow), showing central part of Aarhus. Last panel shows combined results of all models.

Metrics

Detailed model results can be summarised into key metrics for each city. These city-tailored results allow Municipal officials to make future decisions using the efficiency metrics for very rapid estimates of benefit without re-running the models (Tab. 1). Note that these may be very different for each city.

Theme	Metric	Aarhus	Paris	Velika Gorica
Pressure	Average PM2.5 concentration (ug/m3 - modelled)	8.520	9.410	18.380
Area of NBS (trees)	Tree cover (ha) - current urban trees	1,688	54,216	20
	Tree cover (%) - current urban trees	10.36	18.79	1.74
Total service provided	Total quantity of PM2.5 pollution removed (kg)	5,986	295,410	31
	Average PM2.5 concentration change (ug/m3)	-0.035	-0.182	-0.004
	Average percentage change in PM2.5 concentration (%)	-0.41	-1.93	-0.02
Efficiency	*Pollutant removed per ha (kg/ha)*	*3.5*	*5.4*	*1.5*
	Concentration change per 10% urban trees	*-0.034*	*-0.097*	*-0.020*
	% concentration change per 10% urban trees	*-0.401*	*-1.029*	*-0.110*
Population affected	Urban population	130,172	6,599,815	4,259
	Peri-urban population	23,982	614,995	29,339

Tab. 1 Summary metrics with example shown for air pollution removal, giving metrics for each city.

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Impact

The models produce maps and summary metrics which are useful for city decision makers and citizens as well as researchers. They can be used to show what existing street green and blue space like street trees, grassland or ponds do to improve quality of life of city residents. They help city officials plan the best locations for new NbS, and which type of NbS to choose when solving particular problems.

Findings from the modelling in REGREEN have been used to change planning policies on new construction in Velika Gorica, inspired by the hot-day temperature mapping. The proportion of green space required in new construction has been increased from 25% to 33%. The models are being used to evaluate the benefits of NbS plans in Aarhus, and to make the economic case for new schemes.

Do you know that...

… descriptions of some of the models can be found in the following papers:

Noise: Fletcher et al. (2022)
https://doi.org/10.3390/su14127079
Water flow: Miller et al. (2023)
https://doi.org/10.1016/j.landurbplan.2023.104737
Water quality: Hutchins et al. (2019)
https://doi.org/10.1016/j.jenvman.2023.119950
Air quality: Harrison et al. (2023)
https://doi.org/10.1016/j.envsoft.2023.105821
Heat: Bird et al. (2022)
https://doi.org/10.3390/atmos13071152

… some of these models are being incorporated into the City Explorer Toolkit
https://www.ceh.ac.uk/city-explorer

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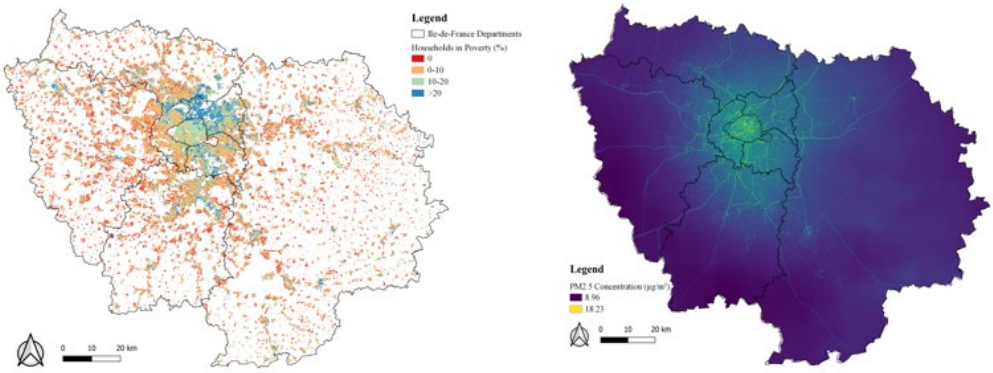

Fig. 5 Urban trees can help reduce inequality. Poorer neighbourhoods in Paris experience worse air pollution (middle column of table) BUT trees in these areas remove more pollution than they do in more wealthy neighbourhoods (right hand column).

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You want to know more?

REGREEN webpage
www.regreen-project.eu

REGREEN repository zenodo
https://zenodo.org/communities/regreen

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