Urban forests as a Nature-Based Solution to mitigate climate change and to reduce pollution: <u>What is the scientific evidence?</u>

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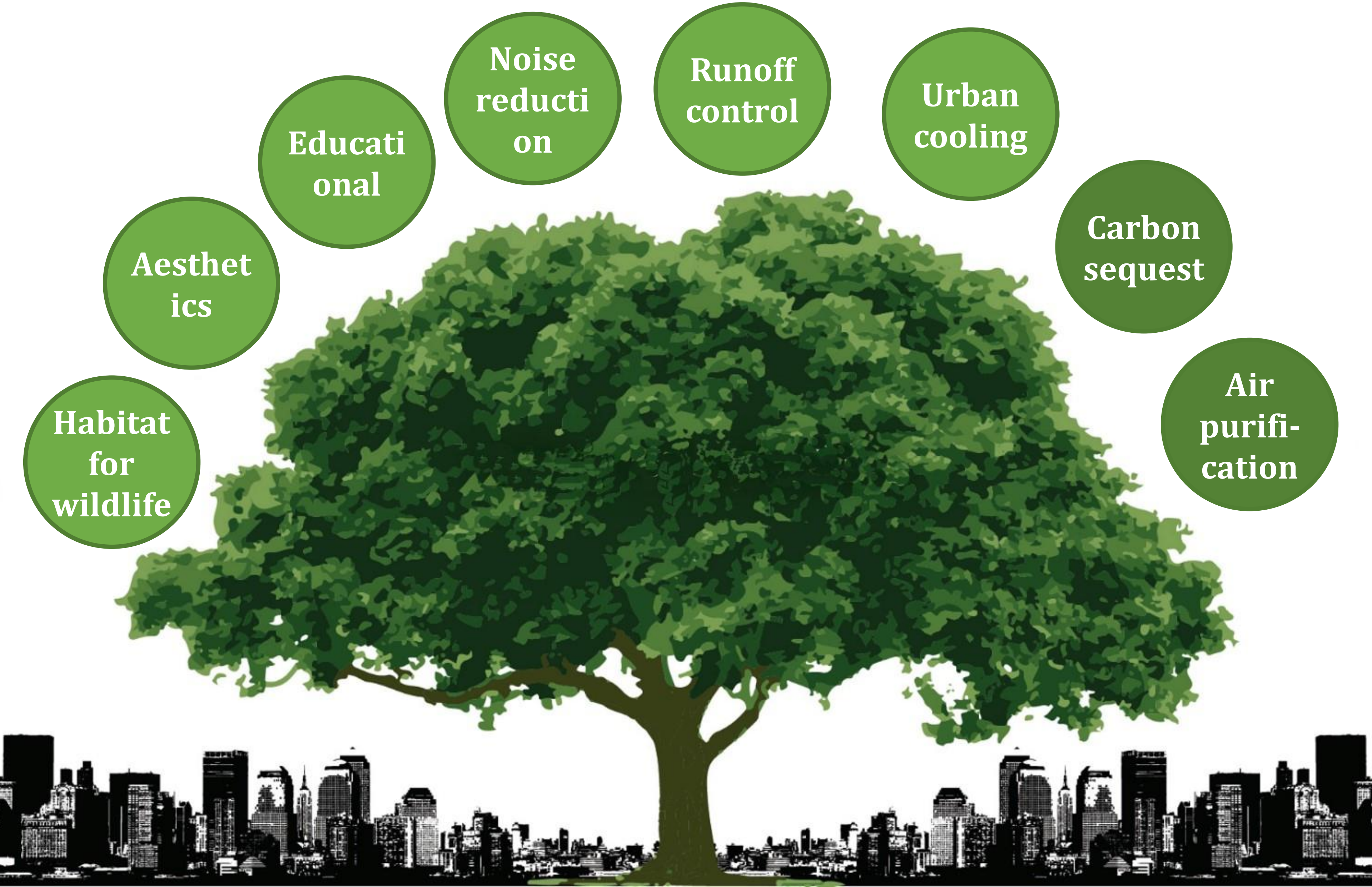
EU Green Week 2021- Urban forestry as a Nature-Based Solution to mitigate climate change and to reduce pollution – Partner event

4 June 2021 – 11 am CEST – ONLINE

THE BENEFITS OF URBAN TREES

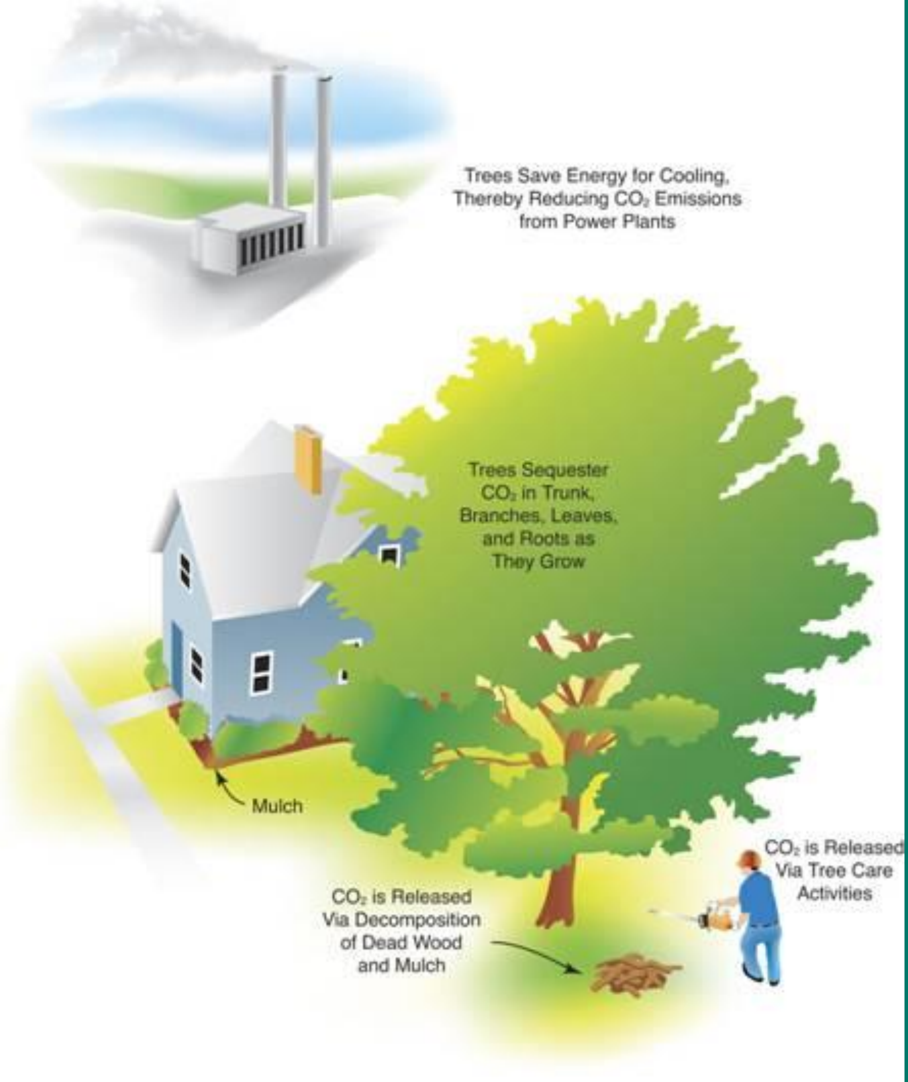


THE BENEFITS OF URBAN TREES: CARBON OFFSETTING

Urban forests can directly offset GHG emissions by sequestering carbon dioxide (CO_2) through photosynthesis and biomass storage

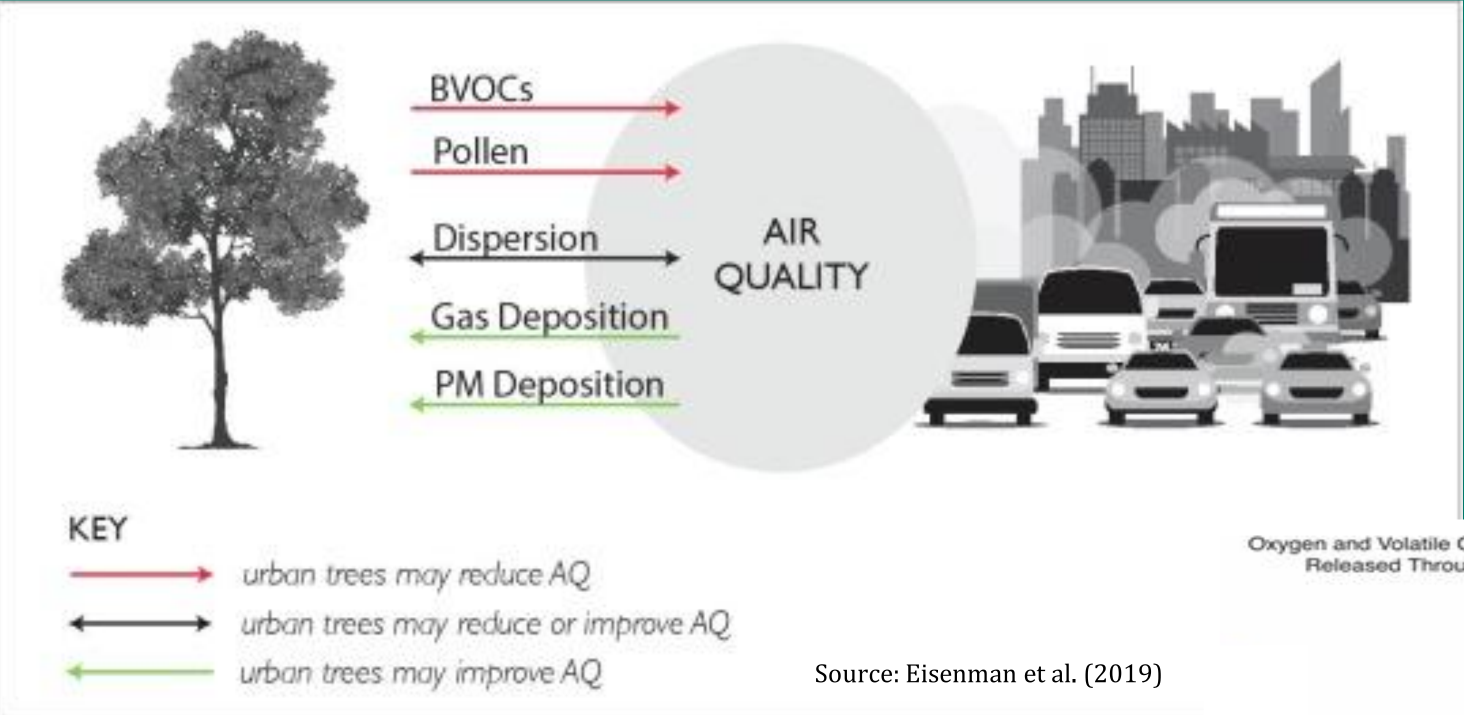
Urban trees can avoid GHG emissions associated to energy use in buildings due to their micro-climate regulation effects related to shading and evapotranspiration

Urban trees' respiration, maintenance (e.g., pruning), mortality can lead to negative carbon balances



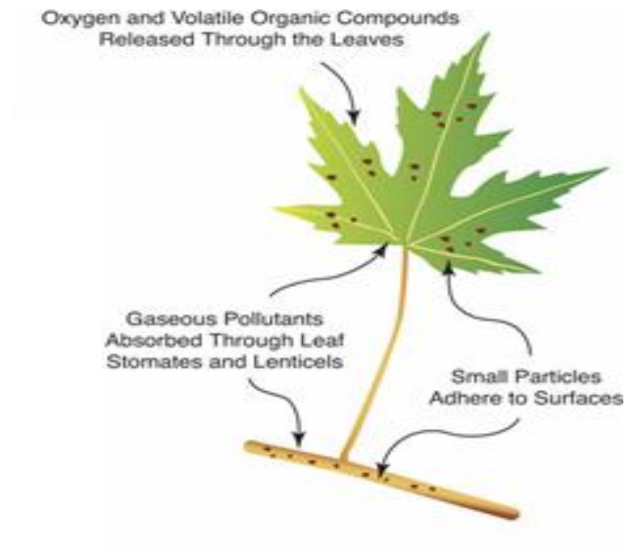
Source: i-Tree Tools

THE BENEFITS OF URBAN TREES: AIR POLLUTION REDUCTION



Source: Eisenman et al. (2019)

Urban forests/trees may improve air quality mainly via airborne particle interception and gas absorption through leaf stomata



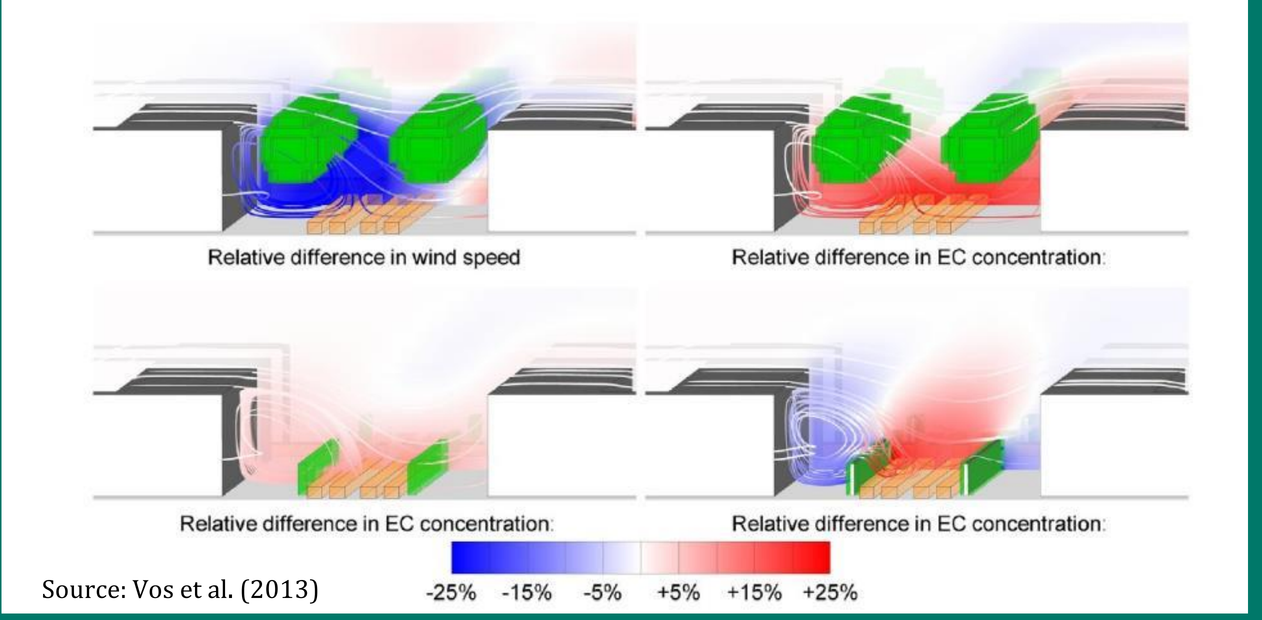
Source: i-Tree Tools

THE BENEFITS OF URBAN TREES: AIR POLLUTION REDUCTION

Urban forests/trees may reduce air quality via the emission of allergenic pollen and biogenic volatile compounds (BVOCs). BVOCs may contribute to the formation of ground-level ozone.

Modification of air circulation – also known as dispersion – by tree surfaces may reduce or improve air quality, depending on a series of factors such as urban form, wind direction & speed, tree size, etc.

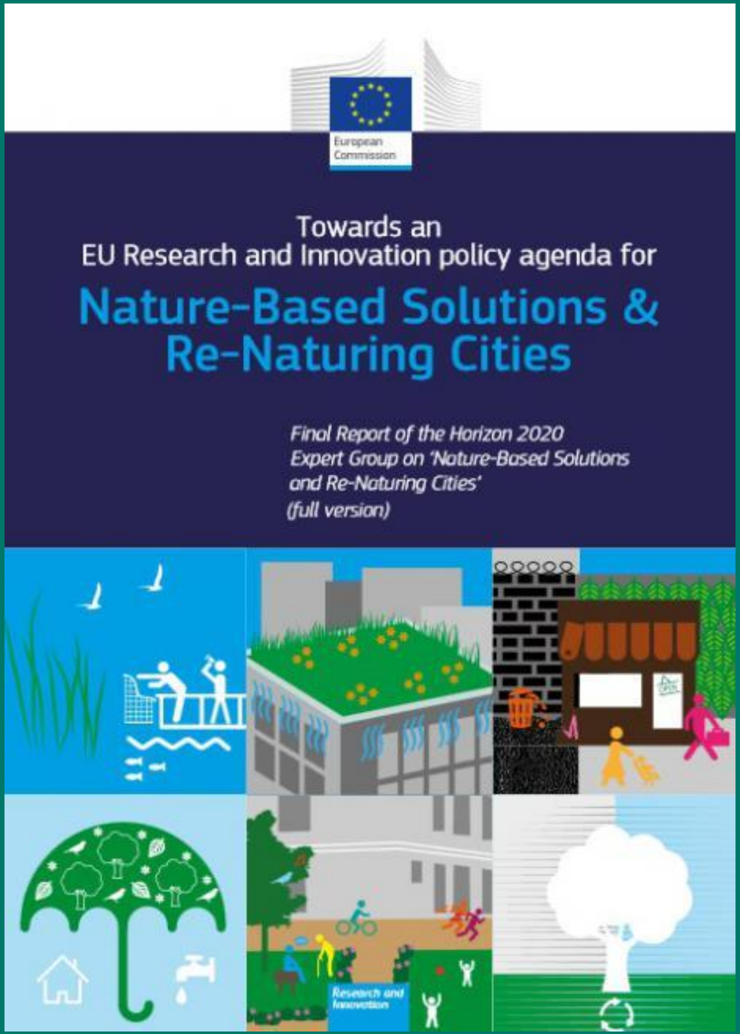
Scientific consensus that trees in narrow street canyons increase air pollution concentrations by reducing air pollution dispersion



Source: Vos et al. (2013)

NATURE-BASED SOLUTIONS: EUROPEAN COMMISSION DEFINITION

"Solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions."

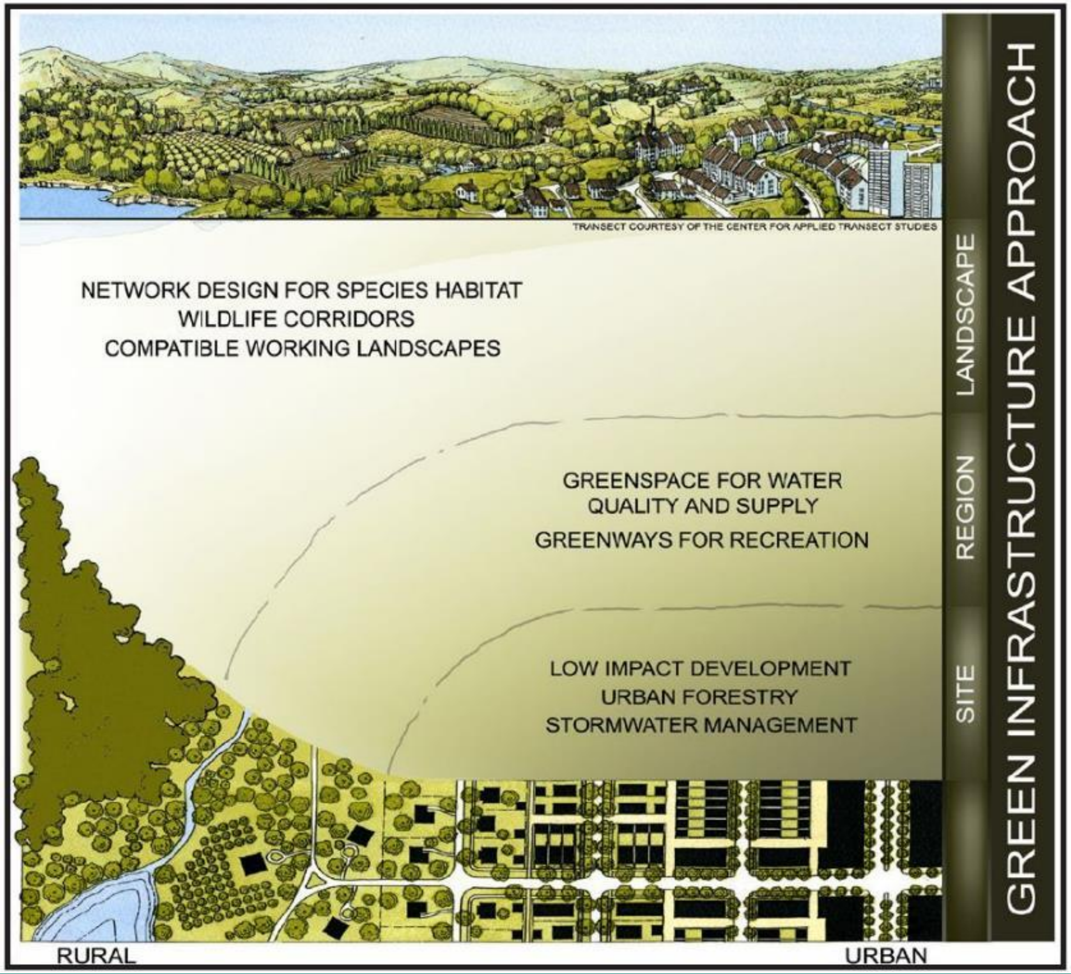


Source: European Commission (2015)

URBAN FORESTS AS NATURE-BASED SOLUTIONS

Urban forest/tree planting can be considered a nature-based solution for the mitigation of climate change and air pollution in cities?

DEPENDING. It's fundamentally an issue of SCALE



Source: Allen (2014)

MODELLING AND EMPIRICAL STUDIES ON CARBON OFFSETTING

Study sites	Scale and green infrastructure considered	Methods and data	Indirect energy effects considered?	Annual % offset of total CO_2 emissions	References
35 Chinese cities	City (green space in general)	Meta-analysis of various empirical studies	No	From 0.01 (Hohhot) to 22.45 (Haikou).	Chen (2015)
				0.33 (overall)	
Shenyang (China)	Metropolitan (urban trees)	Biomass equations, field survey data and satellite images	No	0.26	Liu and Li (2012)
Beijing (China)	City (street trees)	Field surveys, tree growth measurements and statistical data	No	0.2	Tang et al. (2016)
Urbanized portion of Miami-Dade County and city of Gainesville (USA)	Metropolitan and city (Urban trees and palms)	UFORE model (allometric equations), field data	Yes	3.4 (Gainesville)	Escobedo et al. (2010)
				1.8 (Miami-Dade)	
Municipality of Florence (Italy)	City (urban green space in general)	Eddy covariance technique, GIS data	No	6.2 (total)	Vaccari et al. (2013)
				1,1 (urban green)	
				5.1 (periurban green)	

Source: Baró & Gómez-Baggethun (2017)

MODELLING AND EMPIRICAL STUDIES ON CARBON OFFSETTING

Study sites	Scale and green infrastructure considered	Methods and data	Indirect energy effects considered?	Annual % offset of total CO_2 emissions	References
Urbanized areas of Dakota and Ramsey County (USA)	Metropolitan (urban trees)	Allometric models and LiDAR data	No	1.08	Zhao and Sander (2015)
5 EU cities (Barcelona, Berlin, Rotterdam, Stockholm, Salzburg)	City (urban trees)	i-Tree Eco model, tree cover data	No	From 0.12 (Rotterdam) to 2.75 (Salzburg)	Baró et al. (2015)
Residential neighbour-hoods in Singapore and Mexico City	District (Trees and other vegetation, soils)	Eddy covariance technique, biomass and growth equations, tree survey	No	1.4 (Mexico City)-4.4 (Singapore)	Velasco et al. (2016)
Salt Lake Valley (USA)	Metropolitan (urban trees)	Forest growth model and satellite imagery	No	0.2 (relative to a scenario of doubling the tree-planting density after 50 years)	Pataki et al. (2009)

Source: Baró & Gómez-Baggethun (2017)

MODELLING AND EMPIRICAL STUDIES ON AIR PURIFICATION

Study site(s)	Scale and green infrastructure considered	Air pollutants assessed	Method	Estimated % air quality improvement	References
55 USA cities	City (urban trees and shrubs)	CO, NO_2, O_3, PM_{10}, SO_2	Dry deposition model (i-Tree Eco)	0.2–1.0 (PM_{10}) 0.1–0.6 (NO_2)	Nowak et al. (2006)
Santiago Metropolitan Region (Chile)	Metropolitan (urban trees)	CO, NO_2, O_3, PM_{10}, SO_2	Dry deposition model (i-Tree Eco)	0.6–1.6 (PM_{10}) 0.2–0.4 (NO_2)	Escobedo and Nowak (2009)
10 USA cities	City (urban trees)	$PM_{2.5}$	Dry deposition model (i-Tree Eco)	0.05–0.24	Nowak et al. (2013a)
5 EU cities (Barcelona, Berlin, Rotterdam, Stockholm, Salzburg)	City (urban trees and shrubs)	PM_{10}, NO_2, O_3	Dry deposition model (i-Tree Eco)	0.20–2.42 (PM_{10}) 0.07–0.81 (NO_2) 0.10–1.16 (O_3)	Baró et al. (2015)
Central London (UK)	Site - Street Canyon (Green roofs and walls scenarios)	PM_{10}, NO_2	Street-canyon chemistry and deposition model (CiTTy-Street)	6.4–42.9 (NO_2) 10.8–61.9 (PM_{10})	Pugh et al. (2012)

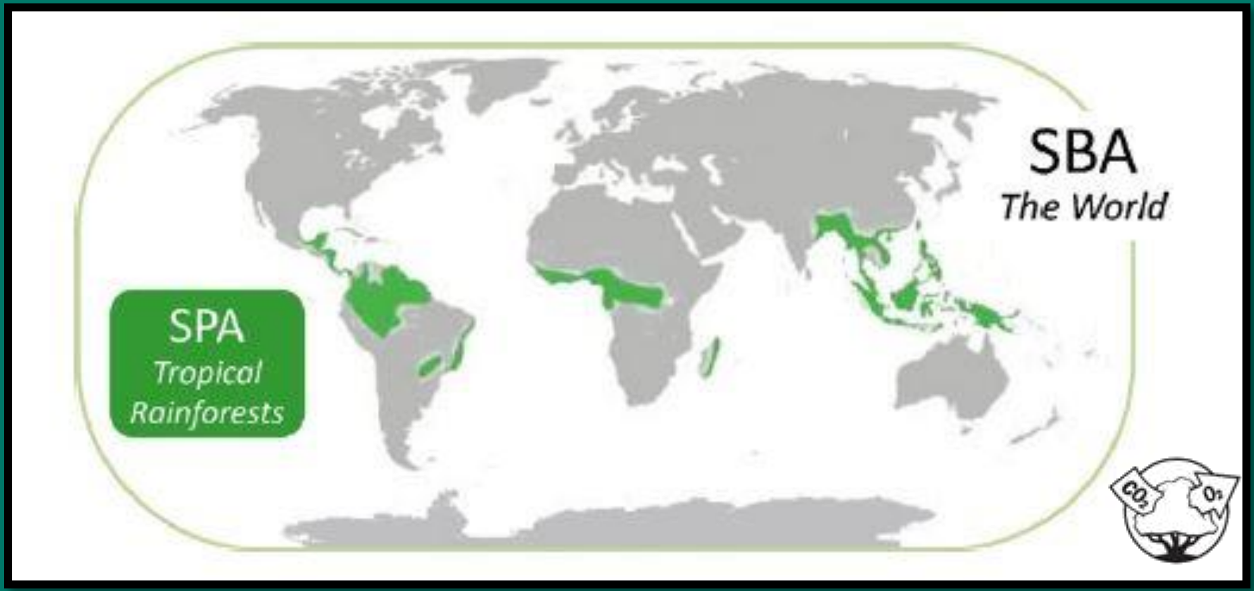
Source: Baró & Gómez-Baggethun (2017)

MODELLING AND EMPIRICAL STUDIES ON AIR PURIFICATION

Study site(s)	Scale and green infrastructure considered	Air pollutants assessed	Method	Estimated % air quality improvement	References
19 different real-life urban vegetation designs (Belgium and Netherlands)	Site- Street Canyon (Trees and other green barriers)	PM_{10}, NO_2 and EC	Computational fluid dynamics (CFD) model (ENVI-met)	Most part of roadside urban vegetation designs have a negative effect on air quality	Vos et al. (2013)
Pudong District, Shanghai (China)	Site (six urban parks)	TSP, NO_2 and SO_2	Empirical data (mid-flux air and passive samplers)	2–35 (TSP) 2–27 (SO_2) 1–21 (NO_2)	Yin et al. (2011)
Khulna City, Bangladesh	Site (two greenbelts)	TSP	Empirical data (active monitors)	Approx. 50–65	Islam et al. (2012)
Two Finnish cities (Helsinki and Lahti)	Site (tree-covered park areas and treeless open areas, twenty sites in total)	NO_2, VOC and TSP	Empirical data (passive samplers)	2.0–7.1 (NO_2) 36.1–40.1 (TSP)	Setälä et al. (2013)
Sydney (Australia)	Site (eleven sites in central Sydney with various green space conditions)	CO_2, CO, VOC, NO, NO_2, SO_2, TSP, PM_{10}, $PM_{2.5}$	Empirical data (active monitors)	Green space is quantifiable associated with reduced PM levels	Irga et al. (2015)

Source: Baró & Gómez-Baggethun (2017)

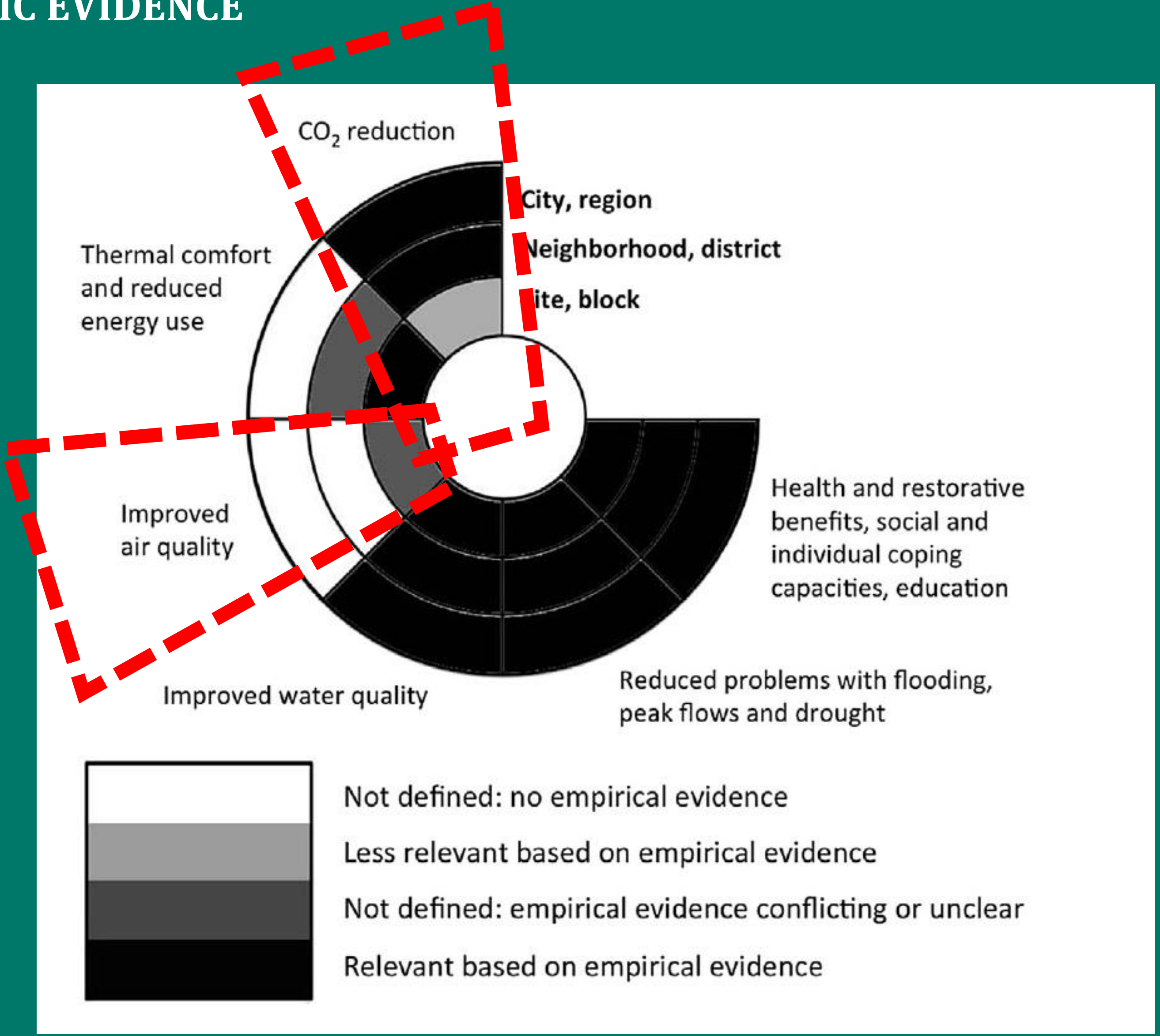
SCALE (MIS)MATCH BETWEEN SERVICE PROVISION AND DEMAND



Source Syrbe and Waltz(2013)

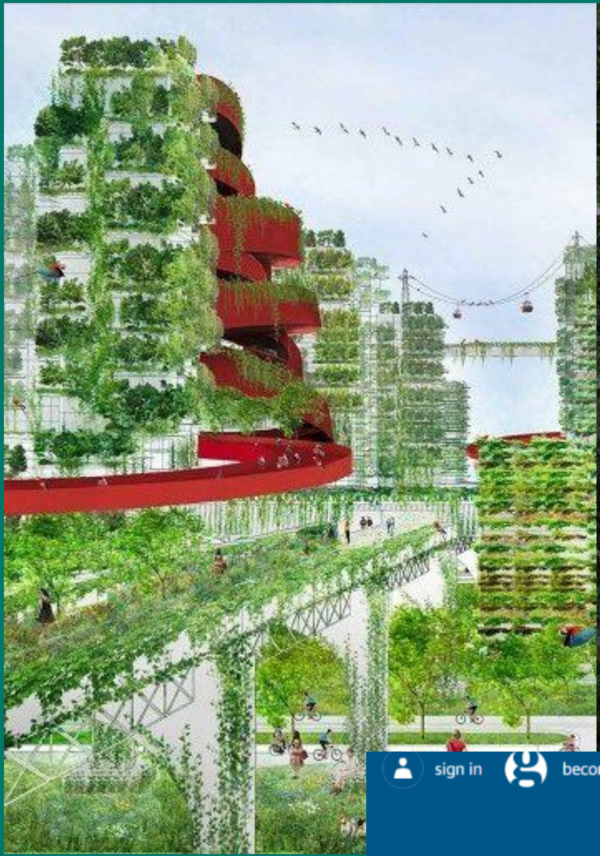
Source: i-Tree Tools

SUMMARY OF THE RELEVANCE OF THE BENEFITS FROM UGI BASED ON SCIENTIFIC EVIDENCE



Source: Demuzere et al. 2014

URBAN FORESTS NBS TO KEEP POLLUTING?



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Cities
The air we breathe

'Forest cities': the radical plan to save China from air pollution

Stefano Boeri, the architect famous for his plant-covered skyscrapers, has designs to create entire new green settlements in a nation plagued by dirty air

Source: The Guardian

TAKE HOME MESSAGES

Urban forest/trees for climate and pollution *adaptation* policies rather than mitigation. Focus on pollution sources rather than sinks.

Always consider the (WIDE) range of urban forest benefits at the local/site scale (runoff control, thermal comfort, health and socio-cultural benefits, habitat for biodiversity). Also consider trade-offs/disservices and ways to minimize them (e.g., plant low-emission BVOC/allergenic pollen species).

Cities can act as stewards for forest conservation/enhancement beyond urban boundaries and hence contribute to climate change mitigation at the global level.

TAKE HOME MESSAGES

MORE URBAN TREES/FORESTS IN MOBILITY INFRASTRUCTRUE= LESS CARS = LESS POLLUTION

Source: Barcelona City Council

THANKS FOR THE ATTENTION

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