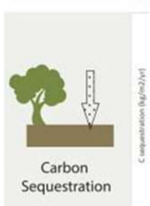
Summer School

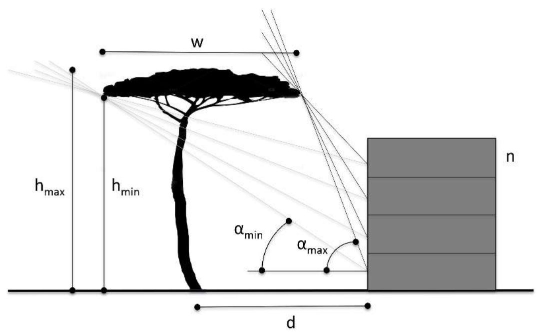
COME! - Costal and Marine Sustainability Enacted

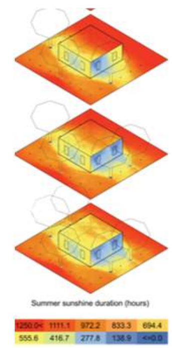
Co-funded by the Erasmus+ Programme of the European Union

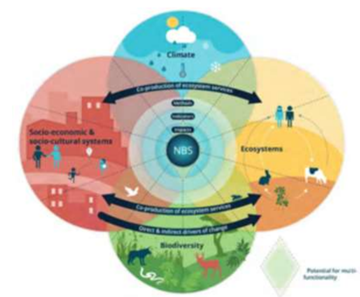
Universiti Teknologi PETRONAS & Universiti Kuala Lumpur (Malaysia)
August 15-28, 2022

Positive effects of trees on climate regulation, carbon sequestration and noise reduction









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Outline

Background and keywords:

- Nature-based solutions (NBS)

Green Infrastructure for

- **Urban climate regulation**
- Carbon storage
- Noise reduction

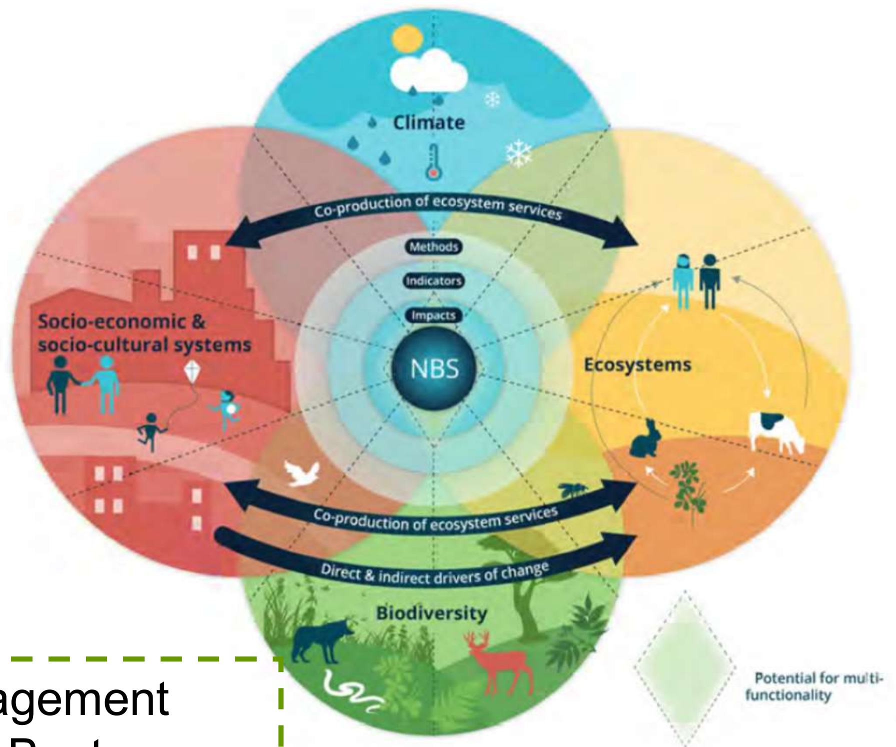
Exercise on the choice of most suitable tree

Nature-based solutions

using and deploying natural ecosystems to provide solutions to several urban issues and improve the overall sustainability of urban environments (Cohen-Shacham et al., 2016).

….nothing new but…..
…a couple of interesting specification

NBS provide sustainable, ***cost-effective, multi-purpose,*** *and flexible alternatives for various planning* objectives and can significantly enhance **resilience of cities**.



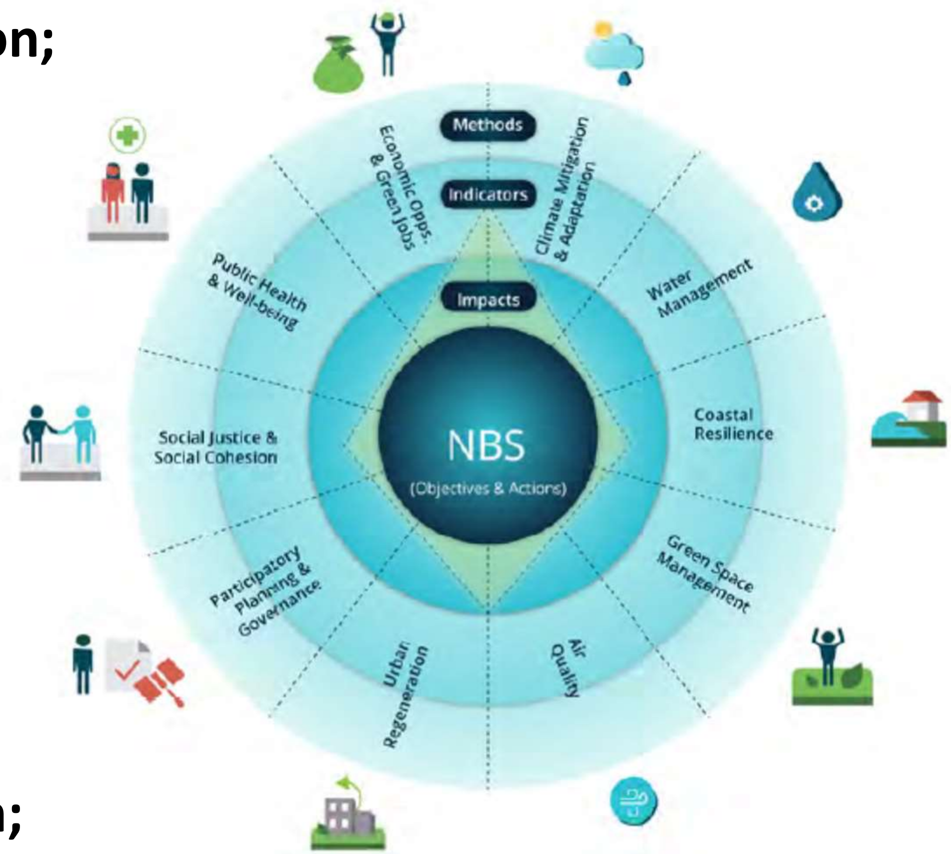
Source Raymond et al. (2017)

Green Infrastructure, use of greenery to management water (Sustainable Urban Drainage Systems, Best Management Practices, Low Impact Development) and to regenerate deprived portions of cities (i.e peri-urban areas)

NBS and the city

Possible applications in cities

1) Climate mitigation and adaptation;
2) Water management;
3) Coastal resilience;
4) Green space planning and management (including enhancing/conserving urban biodiversity);
5) Air/ambient quality;
6) Urban regeneration;
7) Participatory planning and governance;
8) Social justice and social cohesion;
9) Public health and well-being;
10) Generating potential for new economic opportunities and creating green jobs.



Source Raymond et al. 2017)

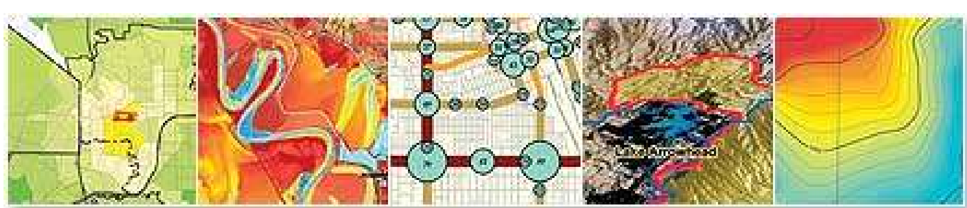
Key benefits (Xing et al., 2017)

Categories	Examples of Measured Key Benefits	Examples of Quantification and Data Collection Methods	References
Health impacts.	+Physiological and psychological benefits.	Survey, GIS mapping and models.	[34–37]
UHI effects, mitigation and energy saving.	+UHI effects mitigation. +Heating and cooling for energy saving.	Laboratory testing. Outdoor test cells. In situ measurement. Computer simulation.	[38–44]
Carbon sequestration.	+Photosynthesis for carbon sequestration.	Laboratory testing, e.g., gravimetric method	[45–49]
Biodiversity.	+Type and size of plants and insects, other species, green and brown spaces.	Site observation. GIS mapping	[50–55]
Sustainable water management.	+Stormwater retention. +Water quality.	Test rigs and modelling of runoff retention. Laboratory testing of pollutants.	[56–63]
Urban agriculture.	+ Local food supply. +Pollination services and urban honey.	Economic value. Food miles saved.	[64–72]
Air quality through bio-infiltration.	+Percentage of air pollutants reduced.	In situ monitoring. Laboratory testing. Computer modelling.	[46,59,62,73–80]
Acoustic comfort.	+Acoustic insulation (dB). +Noise pollution reduction and sound environment.	Laboratory testing. In situ measurement.	[81–83]
Job and investment opportunities.	+Positive return on investment. +Job opportunities	NPV Calculation, surveys and interviews.	[84–89]
Social cohesion and pride.	+Uses of urban parks by different groups. +Attachment to the community and increased interactions.	Survey, observation, interviews and spatial mapping.	[90–95]

Planning and planning processes

Land-use planning processes focus on the design and organization of urban and non-urban physical and socio-economic spaces and the measures/actions that can be undertaken to solve or prevent problems in land use.

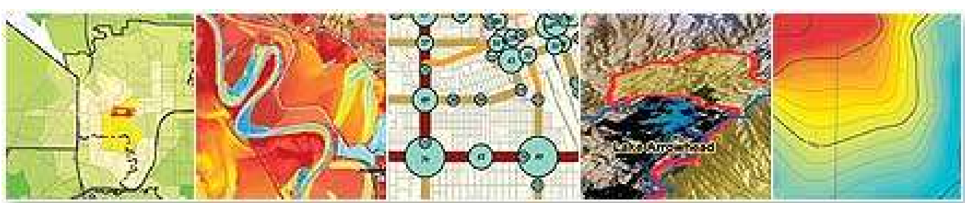
This objective is usually achieved by using knowledge and creativity to design, evaluate and implement a set of justified actions in the public domain (Friedman, 1987).



Planning and planning processes

To provide decisions about the activities in a certain space which should be better than the existing pattern without planning (Hall, 2002).

Planning is a shifting ensemble of activities (zoning of the space, allocation and design of infrastructure/services, allocation of economic resources), all of which converge in the best of circumstances to effect major improvements to urban well-being and efficiency.



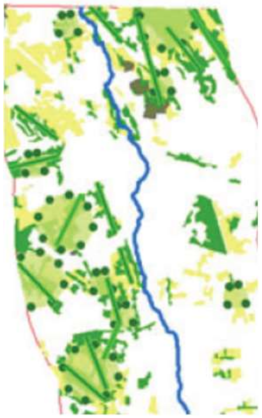
Planning for NBS

One of the objectives of sustainable planning is to promote equitable access to social and economic resources and therefore improve environmental health of people living in urban contexts (Berke and Conroy, 2000).

Socially inclusive planning of NBS in urban contexts should maximize its benefits based on convergence of human interests (accessibility and qualities of goods and services, culturally appropriate development and fulfilment, self-reliance, etc.), considering equity and disparity within the current population and between present and future generations (van Herzele et al., 2005)

Planning and/for NBS

One of the objectives **of sustainable planning** is to promote equitable access to social and economic resources and therefore improve environmental health of people living in urban contexts (Berke and Conroy, 2000).



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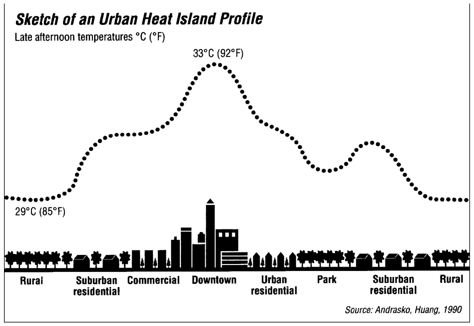
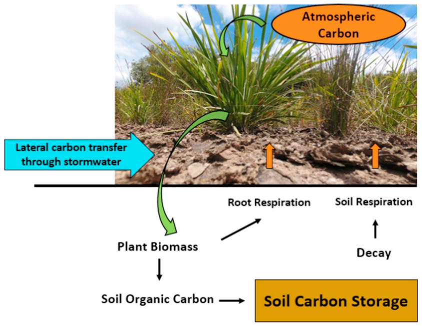
Set of Ecosystem Services provided by urban Green Infrastructure

Growing attention recognized today to health and well-being benefits from open and green spaces in urban contexts



- regulation of urban (micro)climate
- preservation of biodiversity
- sequestration of CO^2
- reduction of noise
- provision of cultural and recreational value



Green Infrastructure for urban cooling

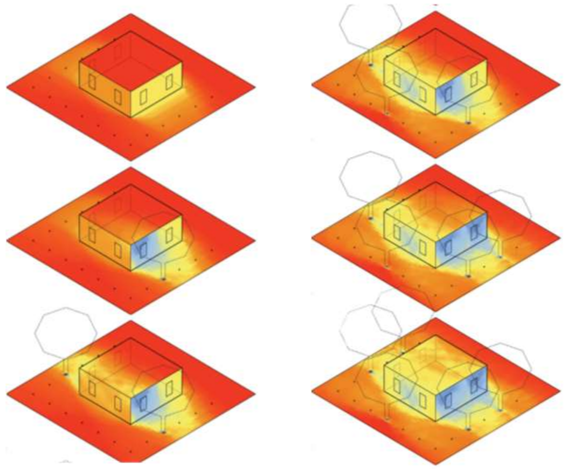
Green Infrastructure provides beneficial microclimatic effects, including air temperature reduction, which eases the UHI effect and therefore the buildings' energy consumptions.

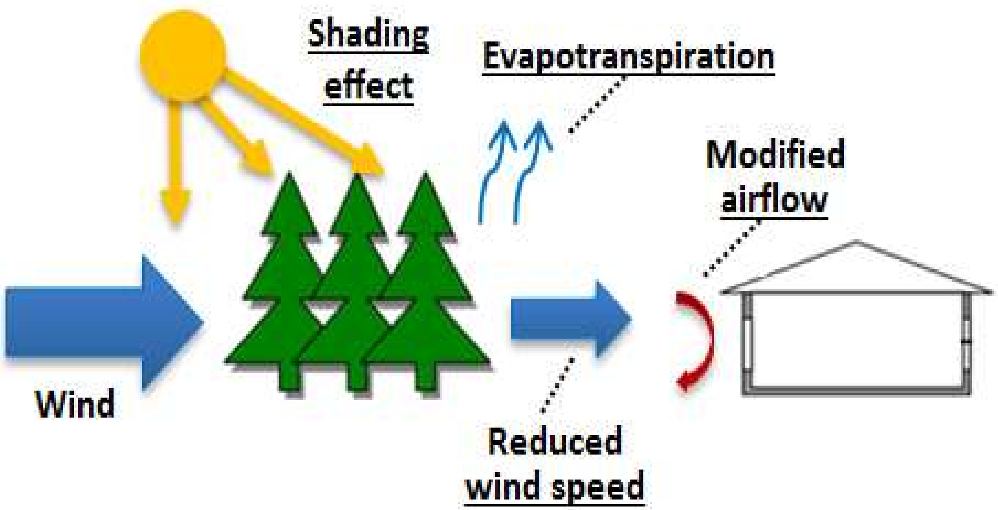
Processes generating microclimatic beneficial effects

1. Shading of solar heat gains on windows, walls, roofs, and other surfaces

2. Wind-breaking effect of trees

3. Evapotranspiration processes

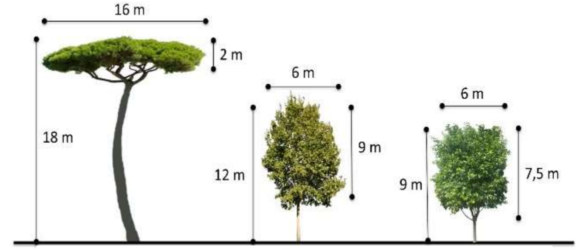




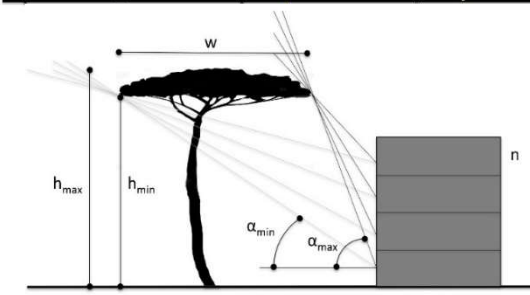
Shading effect

Most important effect, depending on the following variables

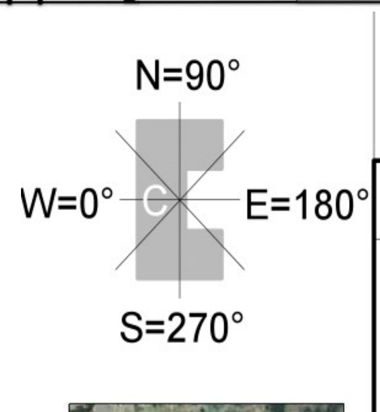
trees species and related parameter (height, canopy width, age, …)



Distance of trees from buildings



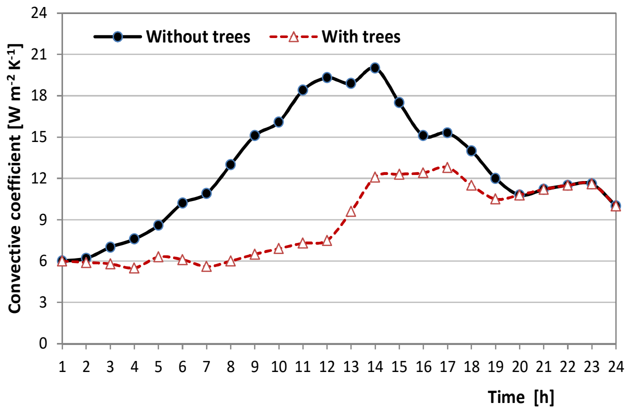
Shape and orientation of orientations of buildings



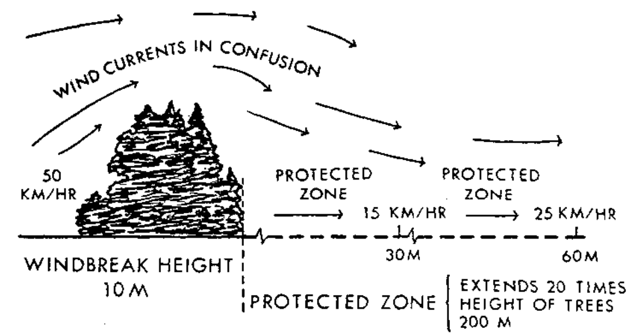
Climate conditions

Wind-breaking effect of trees

- slow down the wind close to the buildings and reduce the convective heat losses and the infiltration rates
- particularly relevant in windy, cold and frequently overcast sites.



Reduction of the convective heat losses with reduction of heating energy need



Modified after Liu & Harris (2008)

Best-practice management/design rules:

- the ideal arrangement of shelterbelt trees is perpendicular to the prevailing wind;
- shelterbelt trees should have a medium porosity (about 40%) so as to provide satisfactory wind speed reduction over a long distance;
- shrubs should be planted at the basis of the trees, to avoid any vertical gaps occurring in the shelterbelt;
- Trees to planted along the entire length of the building.

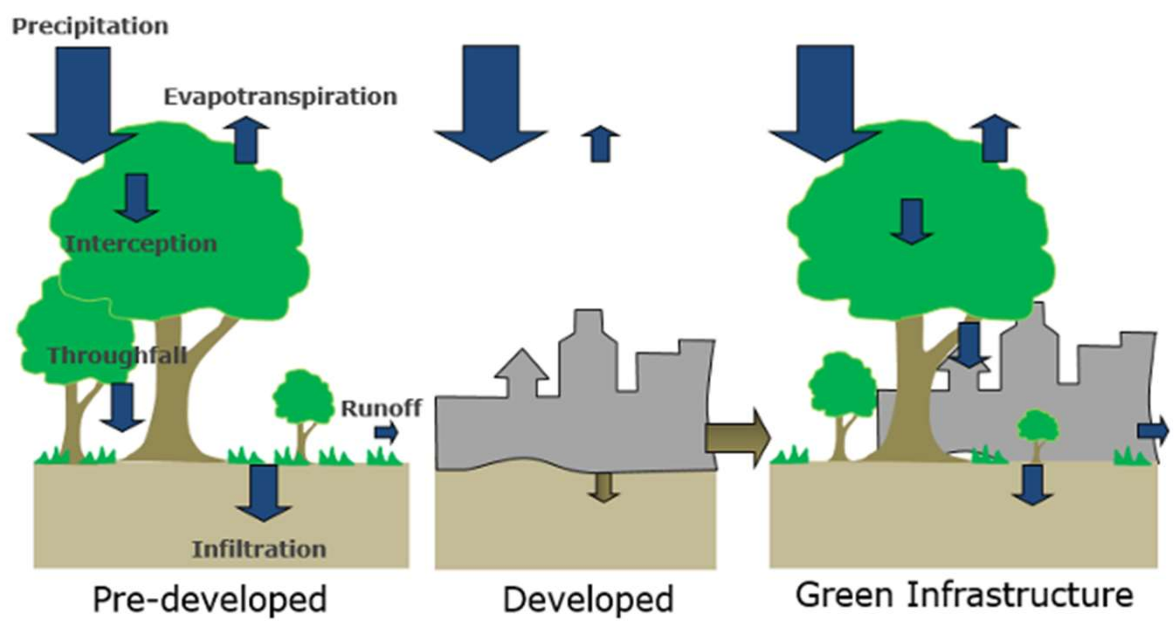
Evapotranspiration processes

Reduction in the dry-bulb temperature due to evapotranspiration, as the loss of water from a plant as a vapour into the atmosphere (Givoni, 1991).

Less relevant than previous processes in terms of generated energy reduction

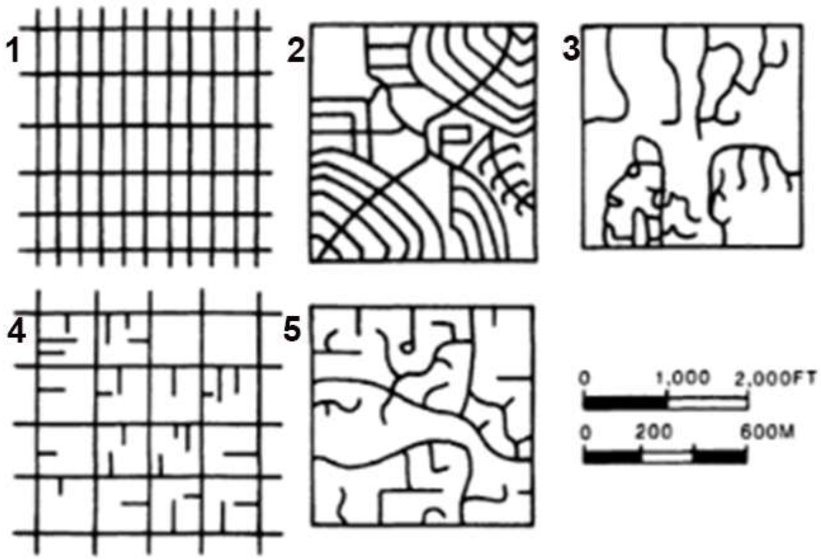
A reduction in the cooling needs and an increase in the latent cooling needs of buildings can be observed

Spatial extent of this reduction can be limited to some meters from the trees



Source: https://www.itreetools.org/tools/hydro

Role of urban morphology



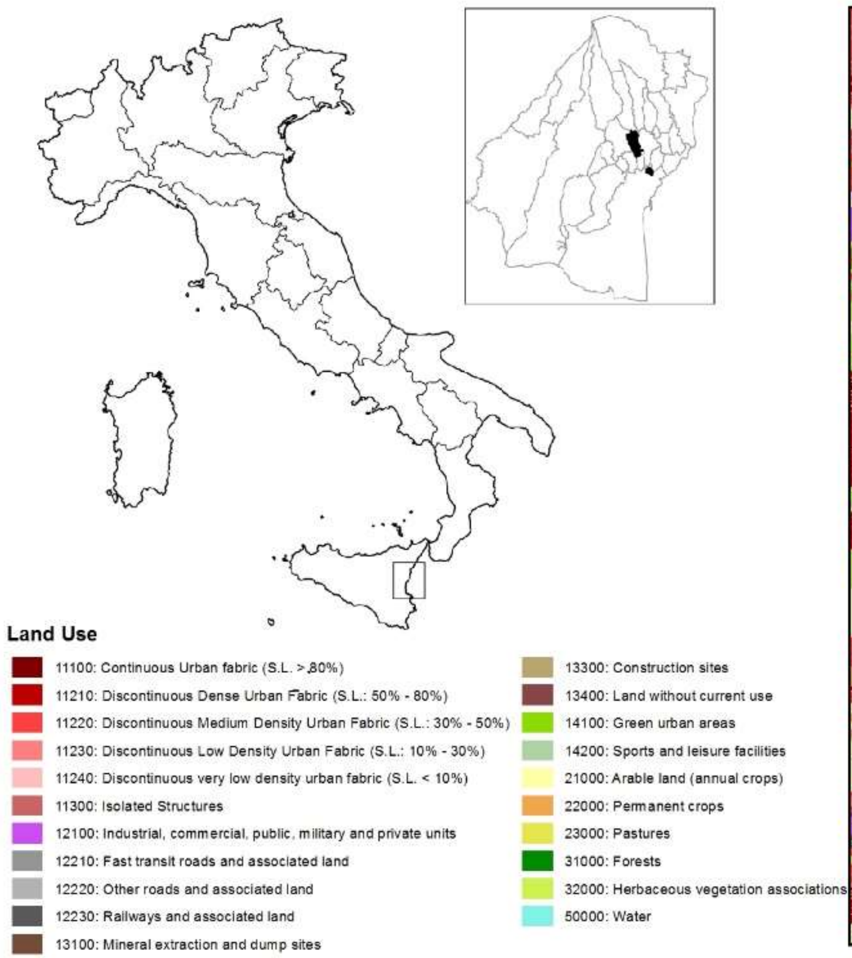
Urban morphology involves relationship among the primary elements of urban fabric such as plot, street, constructed space and open space (Levy, 1999)

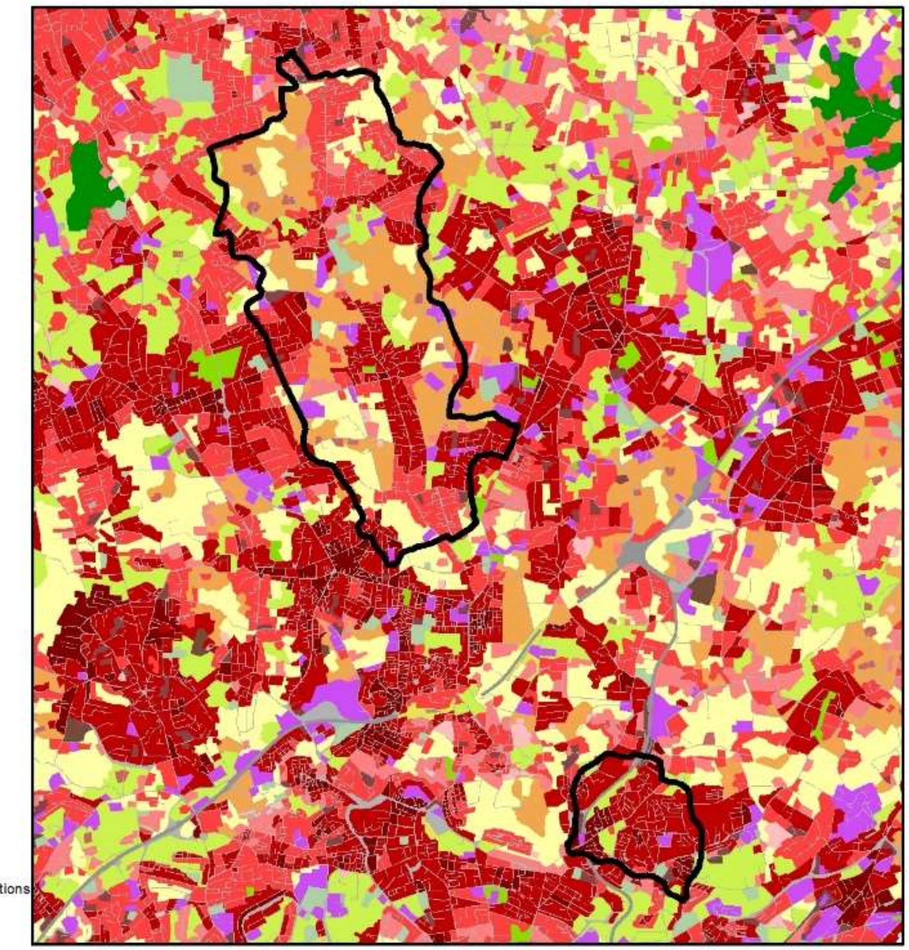
All these features and their spatial configurations strongly influence the urban climate, heat island (Palme et al., 2021)

Example from Italy

A portion of the Metropolitan area of Catania

- **Lack of greenspaces**
- **High seismic vulnerability of existing urban fabric**
- **Low energy efficient building stock**

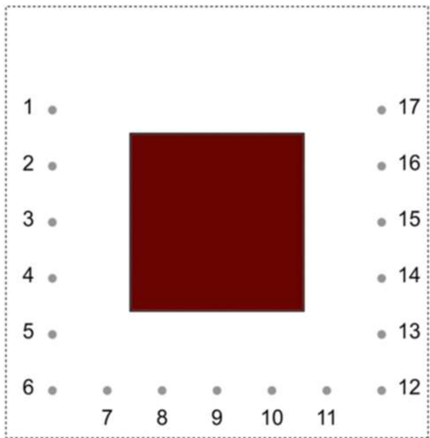


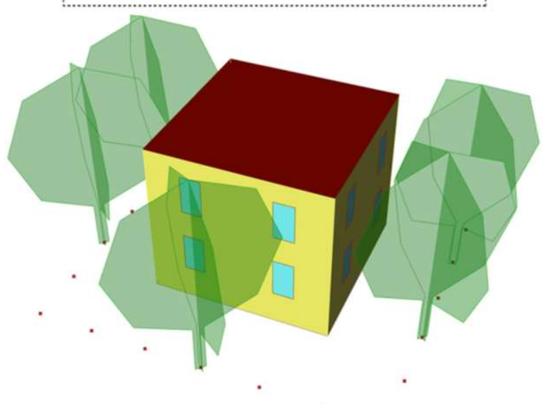


Results - Potential local cooling effect of vegetation

and relative building energy demand reduction

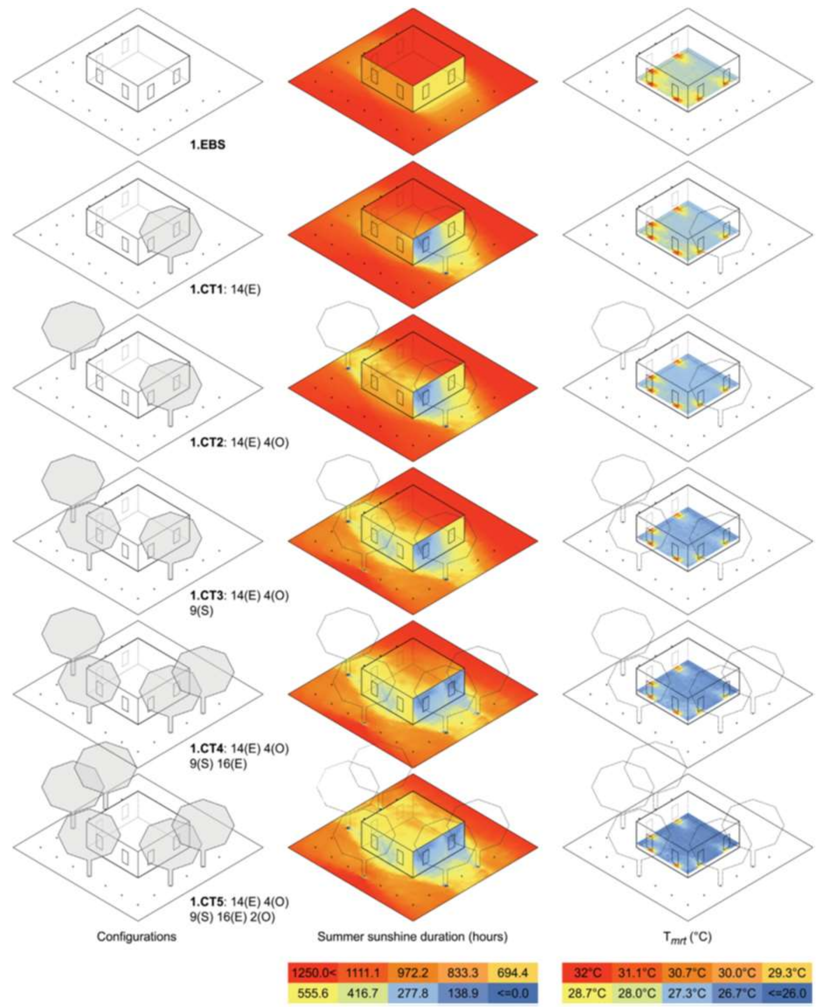
Dynamic simulation of the position of trees around a stand-alone building to reduce cooling energy consumption.





Calcerano and Martinelli (2016)

Shading effect



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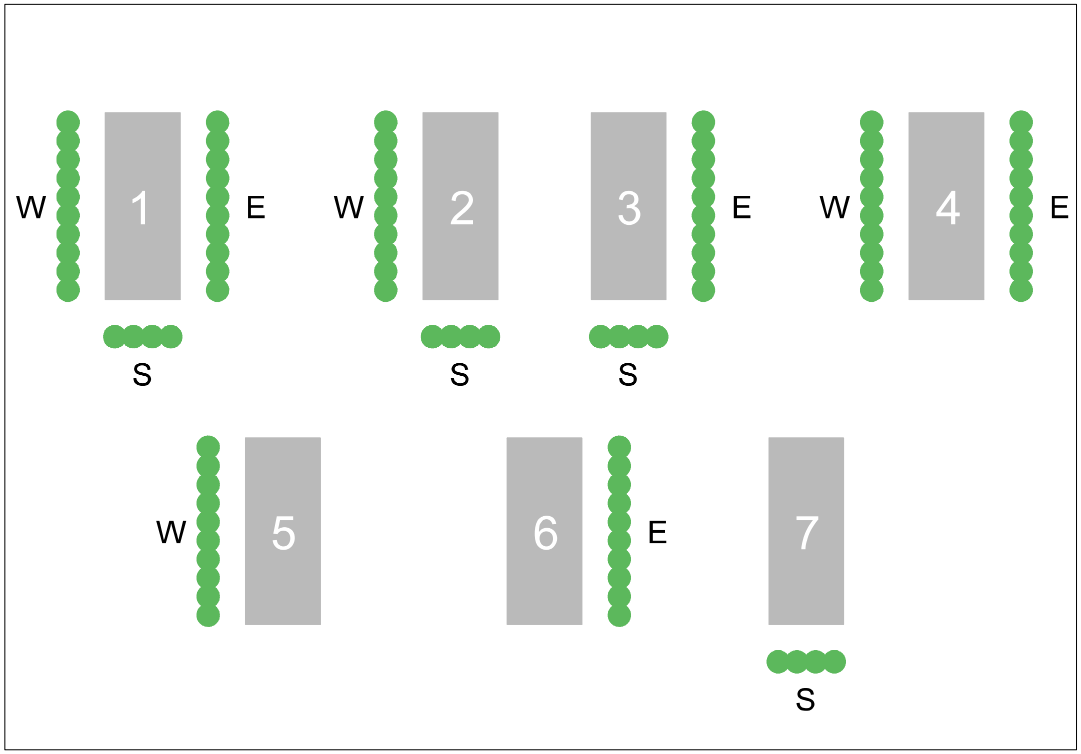


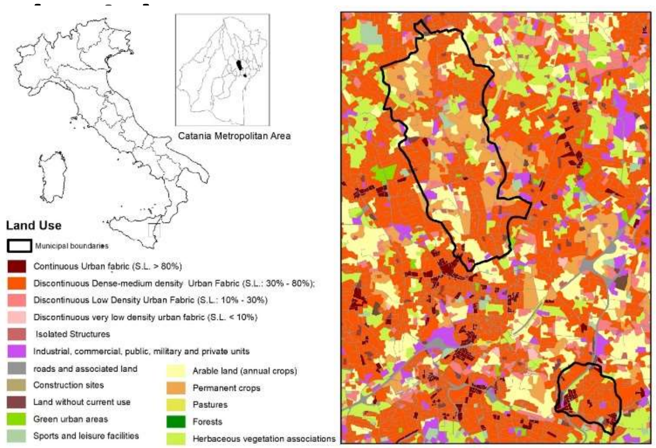
Configuration #	Range of energy reduction (%)
1 (E+S+O)	44.4 – 48.5
4 (E+O)	37.3 – 41.8
5 (O)	10.4 – 13.6
6 (E)	19.2 – 21.2

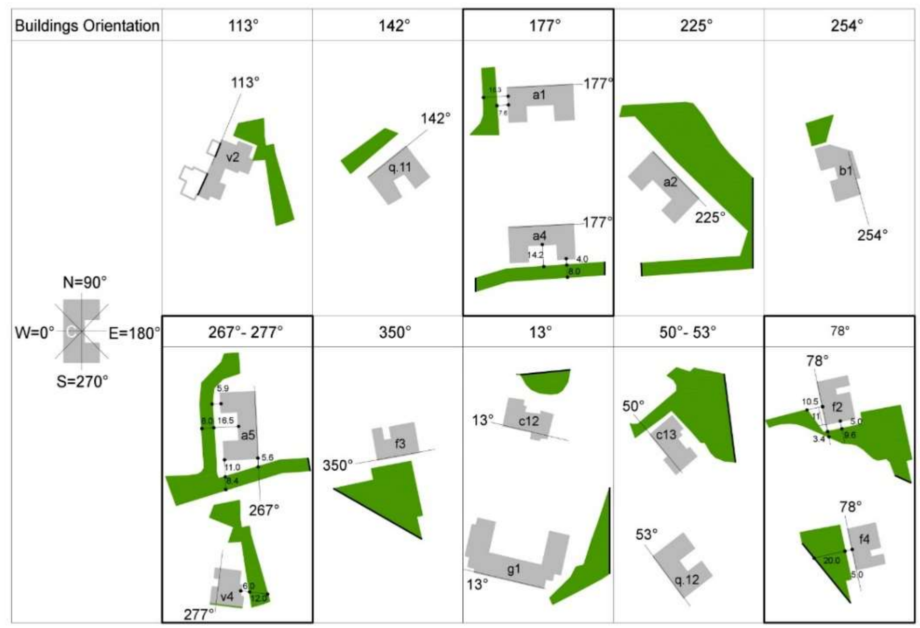
Energy saving ranging from a minimum of 11% when locating 1 only tree to a maximum of 44% when locating 5 trees around buildings: a limited amount of greenery is able to achieve relevant energy savings

Building simulations (shading effects)

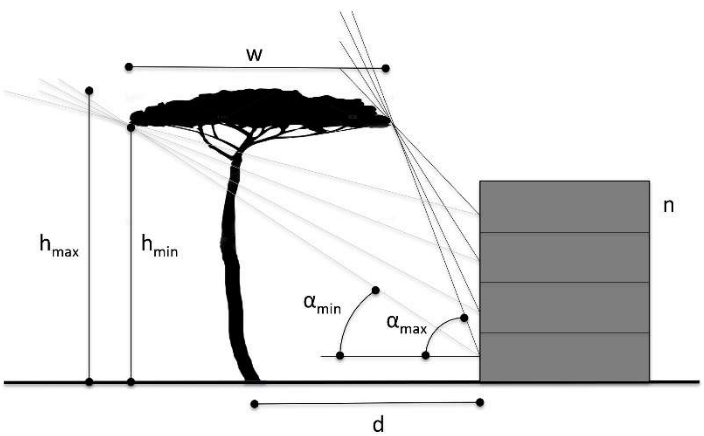
With TRNSYS v.17 we simulated the shading effect of trees that can be located in the shared open spaces close to the buildings and following **different spatial configurations identified in a morphological analysis of the urban environment**.

A portion of the Metropolitan area of Catania





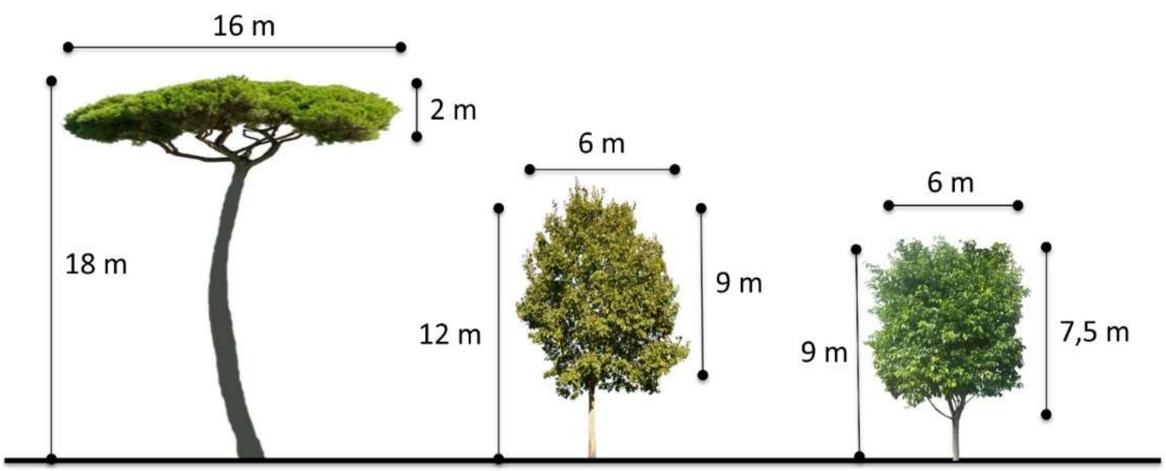
patches of multi-storey apartment buildings with available open spaces



Evaluating impact of height of trees and distance from the buildings

Building simulations (shading effect)

Building simulations to evaluate the effect of shading on energy demands of building, considering the influence of different variables involved

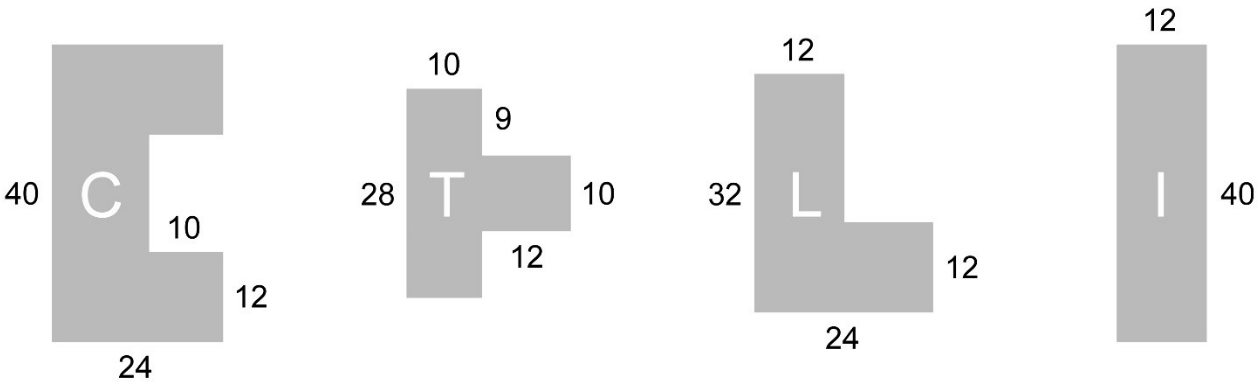


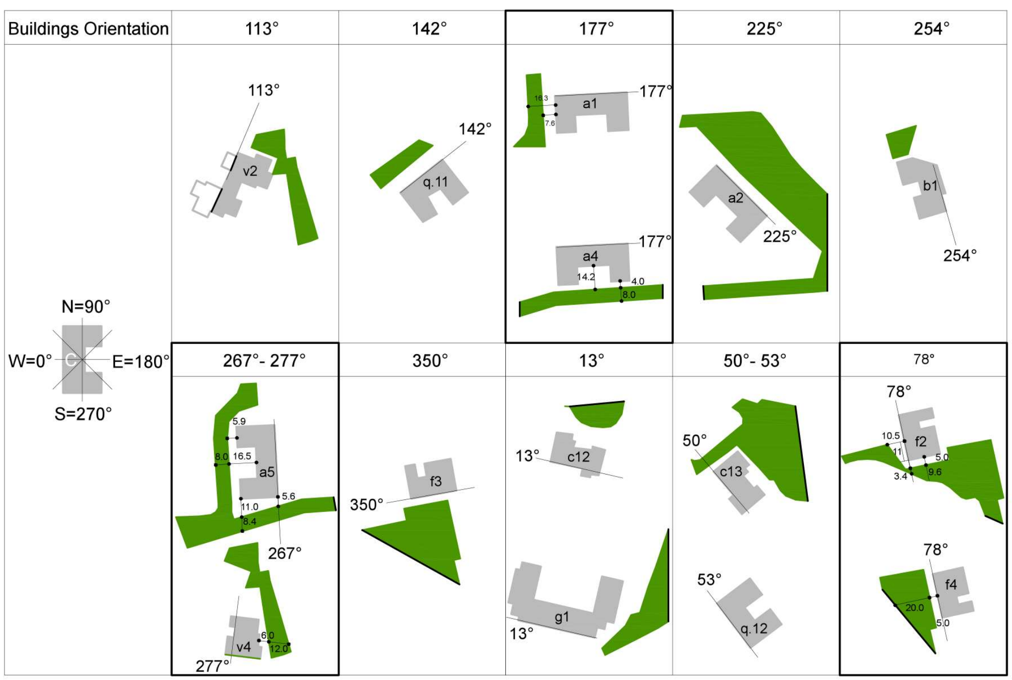
Investigated types of buildings

***Investigated tree species**:*
Pinus Pinaster,
Platanus Occidentalis
Ficus Benjamina.

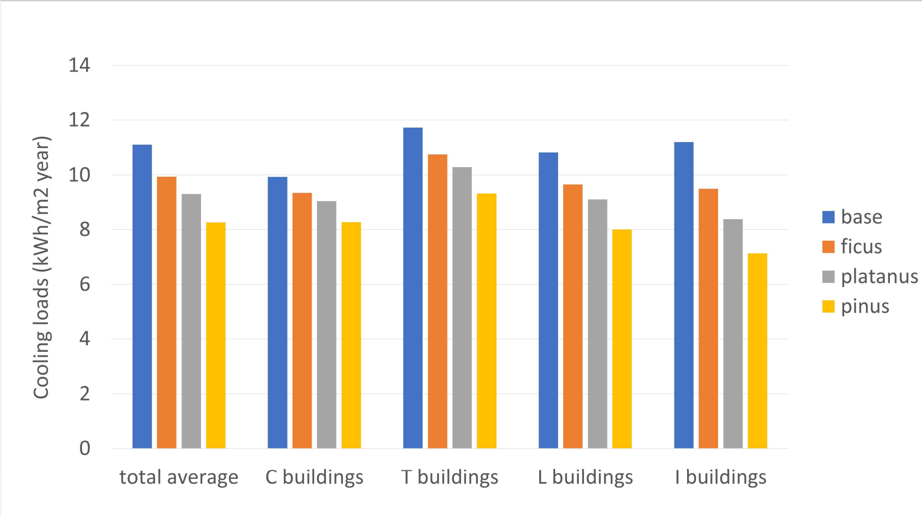
Building simulations (shading effect)

Investigated types of buildings



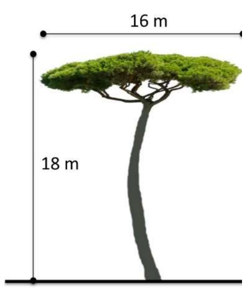


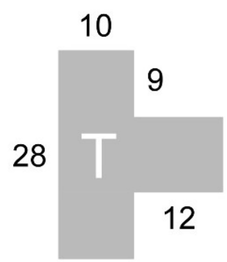
Building simulations - results

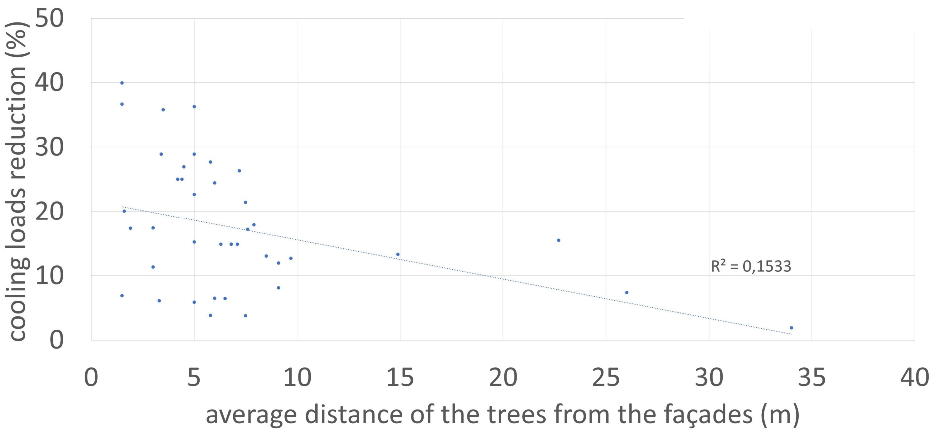


Cooling loads grouped by building type and trees species

- *cooling loads of buildings were reduced from 11.1 kWh/m2year to 9.2 kWh/m2year (17.3% reduction)*
- *Overall Pinus Pinaster performs better results than Platanus Occidentalis or Ficus Benjamina*
- *T-buildings have better behaviors*







Results by distance between trees and buildings

- *Higher distances reduce the positive contribute of shadows*
- *Overall, 5-8 meters as optimal distance*

Simulating the effects of GI – other approaches

ELSEVIER

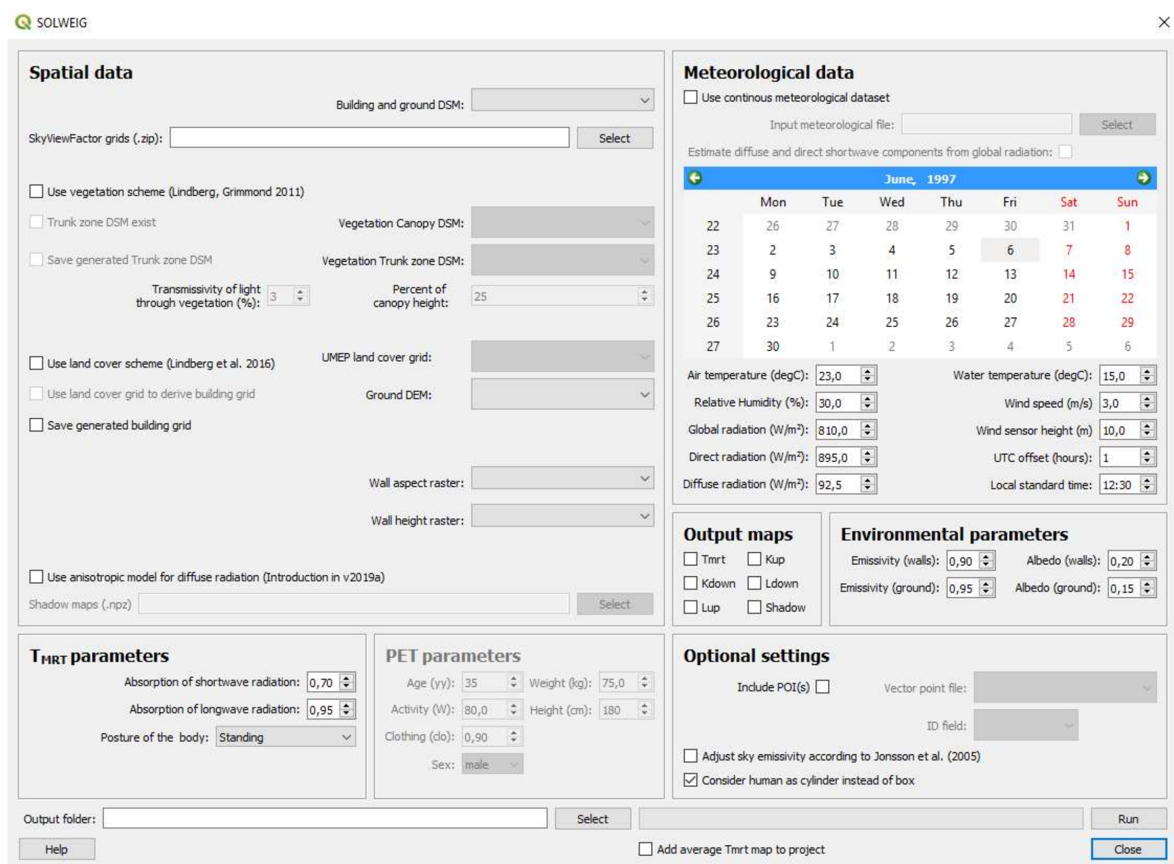
Environmental Modelling & Software
Volume 99, January 2018, Pages 70-87

Urban Multi-scale Environmental Predictor (UMEP): An integrated tool for city-based climate services

Fredrik Lindberg [a], C.S.B. Grimmond [b], Andrew Gabey [b], Bei Huang [b, c], Christoph W. Kent [b], Ting Sun [b], Natalie E. Theeuwes [b], Leena Järvi [d], Helen C. Ward [b, e], I. Capel-Timms [b], Yuanyong Chang [f], Per Jonsson [g], Niklas Krave [a, b], Dongwei Liu [f], D. Meyer [b], K. Frans G. Olofson [a], Jianguo Tan [h], Dag Wästberg [g] ... Zhe Zhang [b, j]

Integrated in QGIS

[UMEP Manual — UMEP Manual documentation (umep-docs.readthedocs.io)]

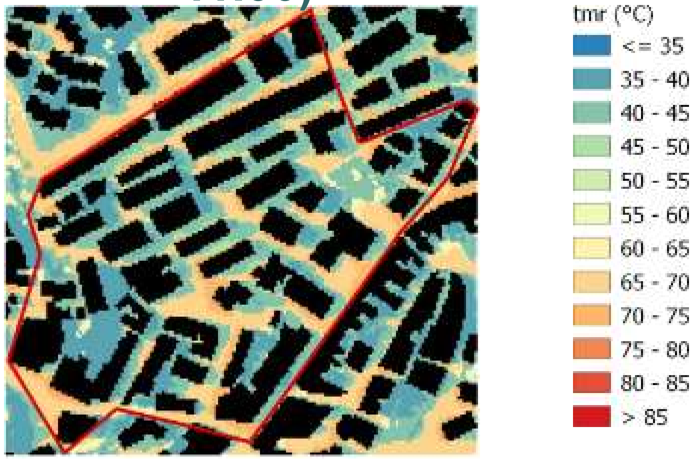


Simulating the effects of GI – other approaches

Ficarazzi (satellite)

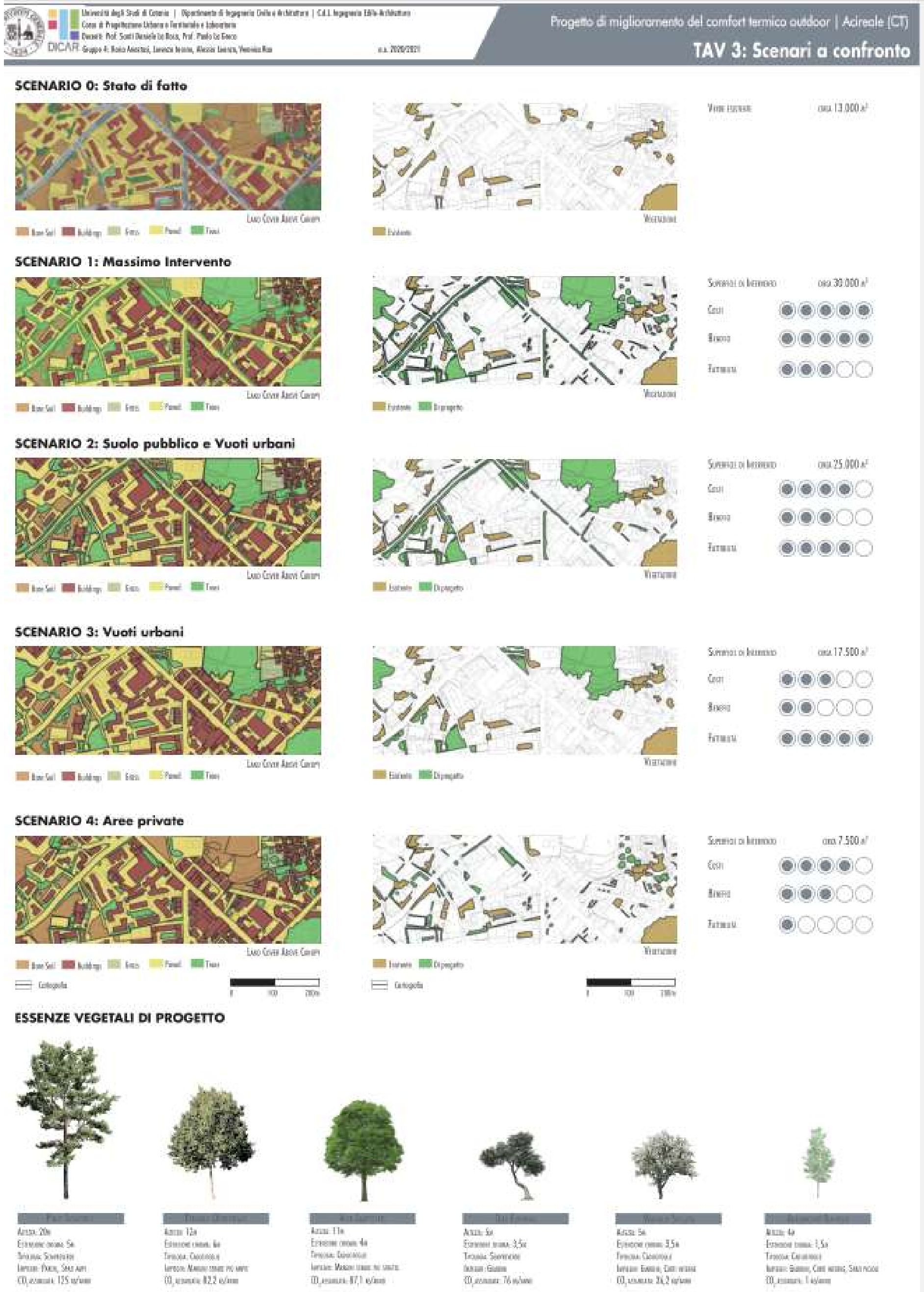
Mappa TMR (ore 11.00)

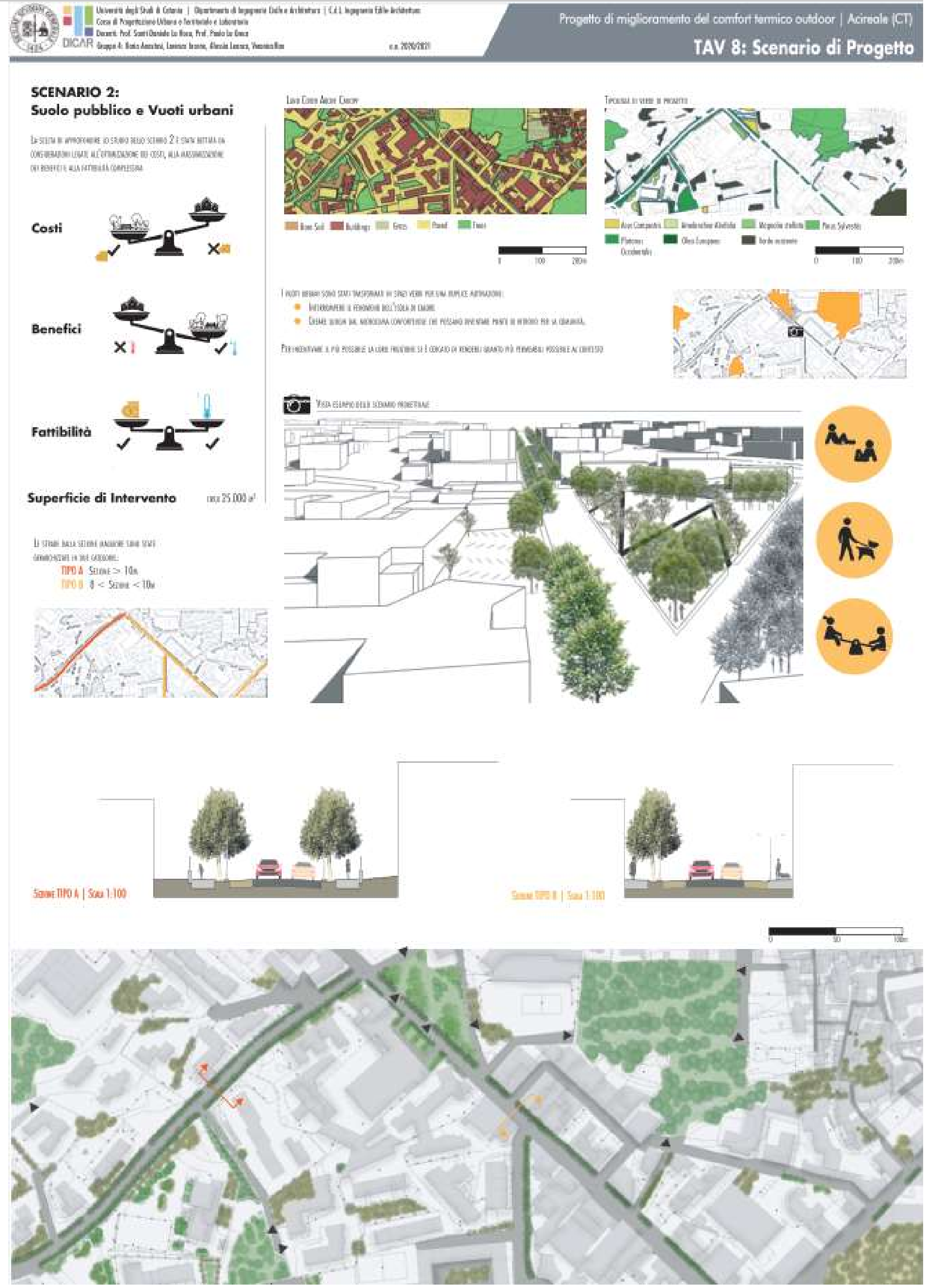
Mappa TMR (ore 14.00)



Mappa TMR (ore 17.00)

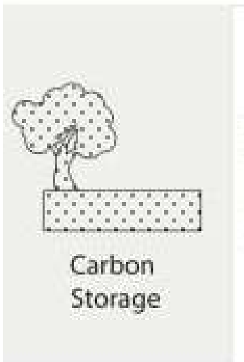
Simulating the effects of GI – other approaches



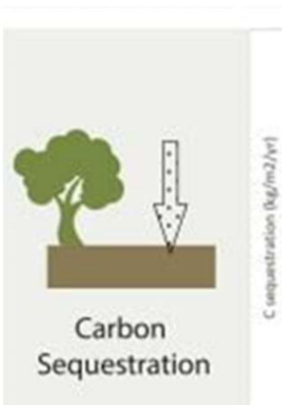


Carbon storage/sequestration by GI

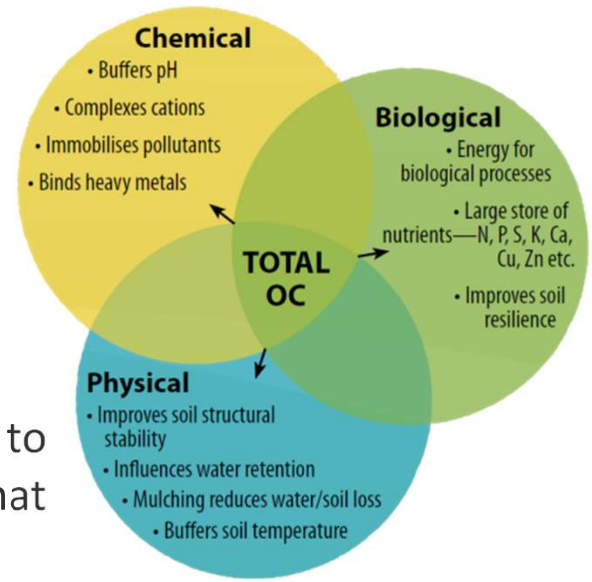
Mechanism to sequester and store carbon in vegetation and soil



The amount of organic carbon stored in soil is the sum of inputs to soil (plant and animal residues) and losses from soil (decomposition, erosion and offtake in plant and animal production). It depends on the soil type (% clay).



The process of capturing, securing and storing carbon dioxide from the atmosphere. The idea is to stabilize carbon in solid and dissolved forms so that it doesn't cause the atmosphere to warm.



Management practices that maximise plant growth and minimise losses of organic carbon from soil will result in greatest organic carbon storage in soil

Carbon storage/sequestration by GI

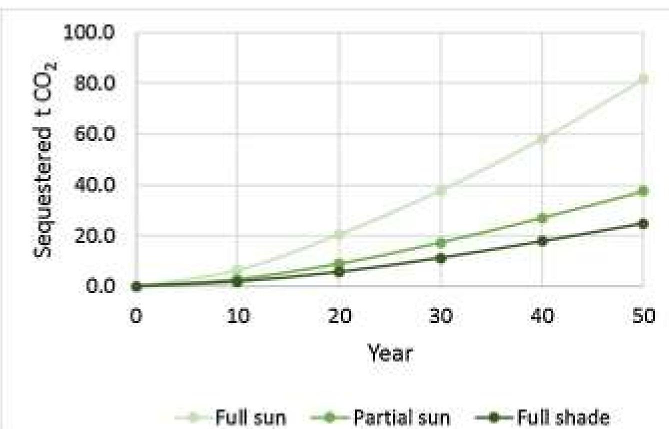
Species scientific name	Species	South, full sun	East or West, partial sun	North, full shade	Average
Acer tataricum subsp. *ginnala*	Amur maple	1.6	0.9	0.5	1.0
Malus domestica	Apple tree	2.7	0.9	0.5	**1.2**
Sorbus aucuparia	European mountain ash	1.3	**1.1**	**0.8**	**1.1**
Prunus pensylvanica	Pin cherry	0.5	0.4	0.3	0.4
Pinus sylvestris	Scots pine	2.5	0.9	0.5	**1.2**
Betula pendula	Silver birch	1.2	0.7	0.5	0.8
Tilia spp.	Lime	1.4	0.5	0.3	0.7

ELSEVIER
Urban Forestry & Urban Greening
Volume 57, January 2021, 126939

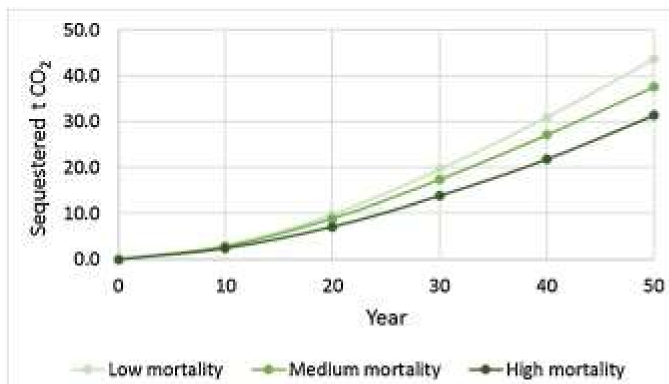
Carbon sequestration and storage potential of urban green in residential yards: A case study from Helsinki

Mari Ariluoma [a,1], Juudit Ottelin [b], Ranja Hautamäki [a], Eeva-Maria Tuhkanen [c], Miia Mänttäri [d]

The carbon sequestration ability of different urban tree species (tCO_2 sequestered by one tree in good condition during 50 years, i-Tree planting). The compass points refer to the direction of the tree in relation to the nearest building.



Different sunlit situations



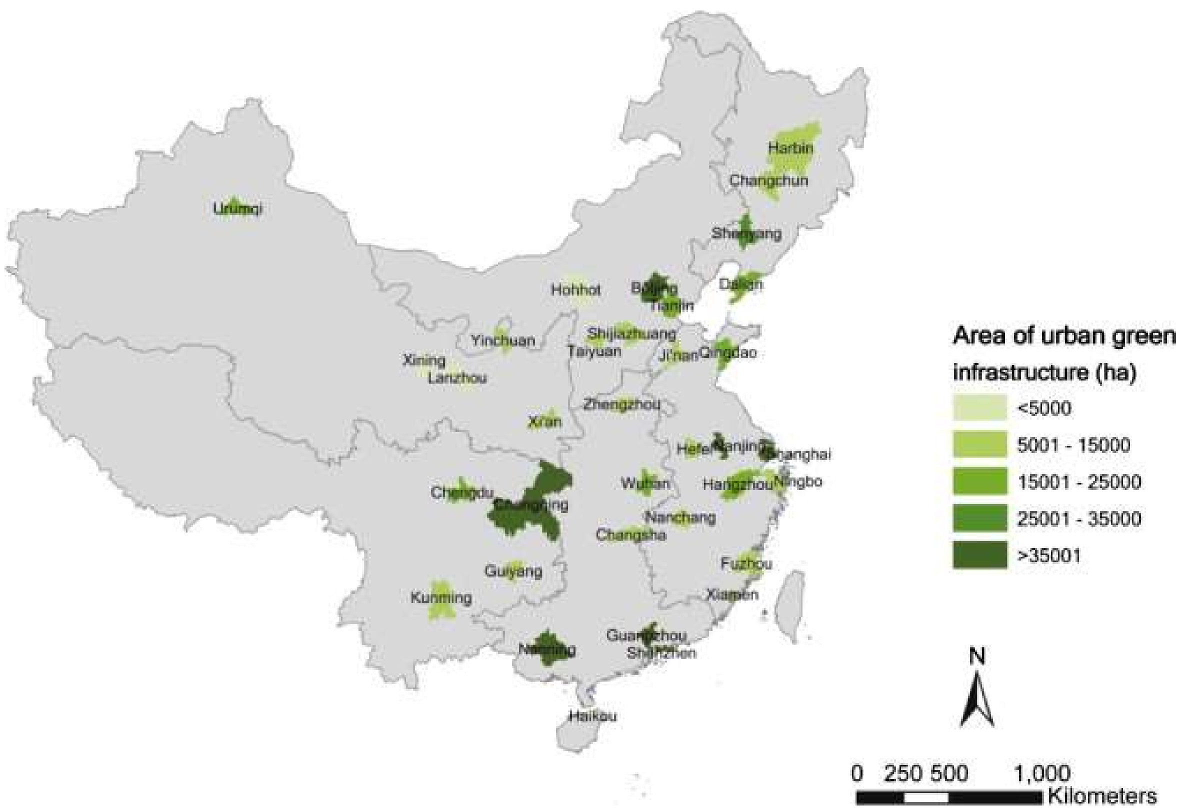
Different mortality of trees

Carbon storage/sequestration by GI

Cities
Volume 44, April 2015, Pages 112-120

The role of urban green infrastructure in offsetting carbon emissions in 35 major Chinese cities: A nationwide estimate

Wendy Y. Chen



City	Carbon storage (t/ha)	Carbon sequestration (t/ha/year)
Harbin	9.50	2.50[a]
Changchun	38.80	1.59
Shenyang	33.22	2.84
Dalian	21.81	0.66
Urumqi	16.90	0.71
Xining	15.98	2.06
Lanzhou	12.84	2.97
Yinchuan	12.84	0.89
Xi'an	19.70	1.13
Kunming	28.43	2.93
Guiyang	10.95	1.10
Chongqing	16.08	1.73
Chengdu	19.87	2.93
Shijiazhuang	23.64	1.26
Taiyuan	11.44	2.08
Hohhot	8.82	1.04
Beijing	19.27	2.22
Tianjin	8.11	1.07
Ji'nan	30.88	2.81
Zhengzhou	19.10	2.87
Qingdao	16.54[b]	1.91[b]
Nanjing	38.69	2.87
Hefei	24.97	1.19
Shanghai	17.01	1.45
Hangzhou	30.25	1.66
Ningbo	16.29[c]	1.96
Nanchang	6.99[d]	2.33[d]
Wuhan	22.83	2.01
Changsha	20.15	1.67
Fuzhou	18.84	2.91
Xiamen	19.21	0.56
Guangzhou	27.80	3.01
Nanning	14.12[e]	1.54
Haikou	35.18[f]	1.80
Shenzhen	12.37	3.01[g]

Carbon storage/sequestration by GI

% Area of Total GI	Sequestration Potential MT C/yr	Below-Ground C Storage Capacity MT C	GI subcategory	Findings and Limitations
52% Turfgrass	87.86	1718.37	Residental Lawns	Covering a significant portion of land, both these turfs have large capacities to store C but are in danger of being offset due to intensive management practices
	338.56	3463.73	Institutional	
	9.34	293.27	Golf Course	Management limits the amount of C sequestration
	NA	811.86	Athletic Field	Extensive maintenance disrupts C accumulation altogether
44% Urban Forests	439.89	11311.49		Large amounts of woody biomass from trees and being the largest area of land cover contribute to this category having the highest C storage capacity among GI
0.9% Landscaped Cover	NA	81.99	Gardens	Covering limited amounts of area, these GI, with high productivity in perennial vegetation, lead to greater C storage
	0.71	11.11	Ornamental Lawns	
	NA	92.26	Grassland	Undisturbed vegetation results in large amounts of both plant and soil C
2.8% Green Stormwater Infrastructure	1.54	29.34	Green Roofs	C sequestration is limited by species composition and substrate depth
	0.48	17.30	Bioswales	Although emissions are higher, these GSI still accumulate much C through sedimentation and vegetation growth in and around aquatic basins
	NA	11.61	Bioretention Basins	
	0.15	1.33	Stormwater Ponds	
	0.22	199.48	Wetlands	

Noise reduction by GI

European Commission

Science for Environment Policy

Urban greening reduces noise pollution

16 May 2013
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Source: Van Renterghem, T. *et al.* (2013). The potential of building envelope greening to achieve quietness. *Building and Environment*, 61, 34–44.
DOI:10.1016/j.buildenv.2012.12.001

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Read more about:
Noise, Urban environment

Green roofs have the potential to significantly reduce road traffic noise in the urban environment, according to a new study. The results suggest that greening of roofs and walls with materials suitable for growing plants softens the urban environment keeping sound levels low, whereas hard, manmade structures tend to amplify traffic noise.

The Environmental Noise Directive (2002/49/EC)[1] recognises the need to protect quiet areas in cities and towns as sites of value to the local community. Plants can play a role in this by softening the urban environment and reducing noise. Green roofs and vertical gardens also offer far greater benefits than noise reduction, and thus 'greening' is also considered under the Green Infrastructure Strategy (COM(2013)249)[2].

The researchers investigated what type of greening produced the greatest benefit in terms of reducing noise in places that were already of some value as 'quiet areas'. They considered green roofs, green facade walls on the fronts of buildings and low, vegetated screens at the edges of flat roofs.

Researchers simulated how sound made by cars travelling at different speeds would be transmitted to enclosed courtyards shielded from the road by buildings. In the simulations, each courtyard was positioned at the centre of a six-storey tower block building, with each block separated from the next by a crossroad. To show how sound would travel between the road and the courtyards, two numerical methods for simulating sound propagation were used. One method modelled how sound travels in three dimensions, whereas the other modelled it in only two dimensions, but was able to account for the complex characteristics of the materials involved. The study only considers the noise from the adjacent street – the authors add that distant noise may also be important depending on the wind direction.

The substrate materials modelled (i.e. those used to provide a surface for plant growth) accounted for most of the noise reduction seen in the simulations. According to the results, green roofs have the greatest potential for attenuating noise, and on certain roof shapes, may be able to reduce noise by up to 7.5 decibels. The noise reduction was smaller for green facade walls, and depended on the materials used in the adjacent street – the harder the bricks in buildings on the street, the greater the reduction in noise in the roadside courtyard.

The model also predicted that green facade walls would be best positioned high up on the walls surrounding the courtyard, unless the materials used for buildings in the nearby street are softer, in which case the facades would be better positioned around the courtyard itself. Vegetated screens on roof edges were only effective when the screens themselves were made from absorbent materials as opposed to rigid materials, which even had the potential to increase noise levels.

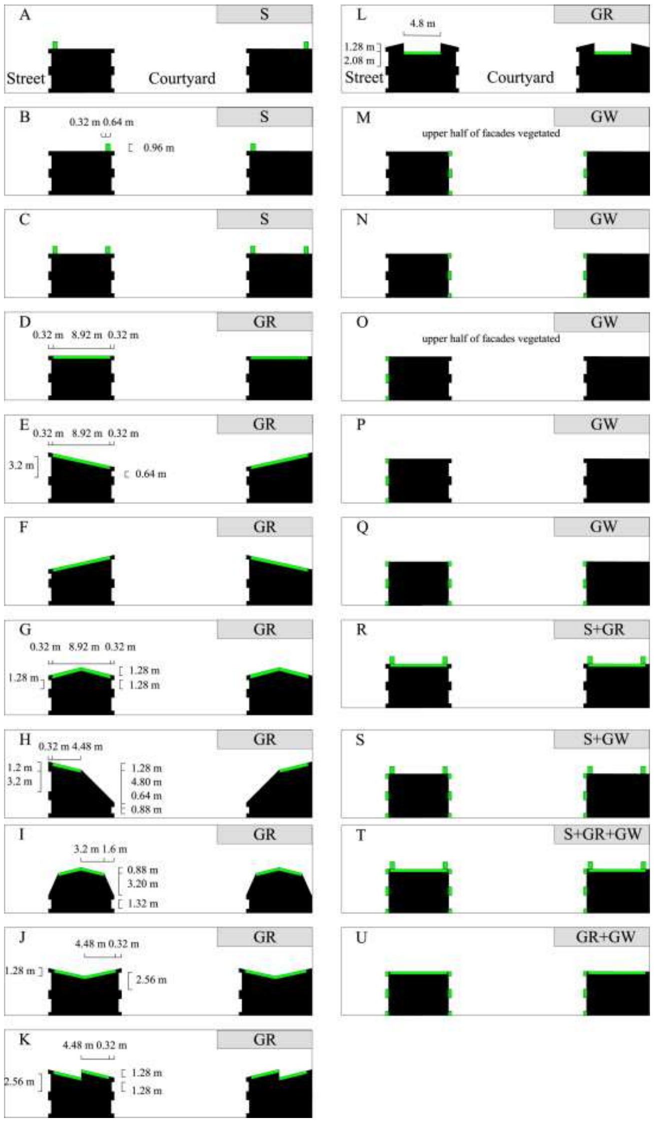
The researchers also used their models to test combinations of different types of building greening. Soft roof edge screens in combination with either green roofs or walls were the most effective at reducing noise.

According to the researchers, greening could be used to limit noise from other sources, such as air conditioning units, although the current study focuses solely on traffic noise. Vegetation (as part of 'Green Infrastructure') also has other important environmental benefits, such as absorbing carbon dioxide, improving air quality, reducing the urban heat island effect, increasing urban biodiversity and making streets and roofs look more attractive.

1. http://ec.europa.eu/environment/noise/directive.htm
2. http://ec.europa.eu/environment/nature/ecosystems/index_en.htm

Environment

https://linkinghub.elsevier.com/retrieve/pii/S036013231200323X



Noise reduction by GI

European Commission

Science for Environment Policy

Green walls show promise as sound barriers for buildings

Green walls, designed so they are covered in vegetation, could help cut the amount of noise that enters buildings, a new study has found. In lab. tests, researchers found that a modular green wall system reduced sound levels by 15 decibels (dB). This leads them to believe that it is a promising sound reduction device that could improve quality-of-life for city residents.

Green walls and green roofs can provide ecosystem services in urban areas. Their benefits include: lower energy use in buildings, support for biodiversity and storm-water control. Studies have also shown that they reduce noise levels. However, most studies have focused on green roofs' ability to insulate buildings from external sound, and very little research has looked specifically at green walls.

This Spanish study, carried out under the EU-funded SILENTVEG project[1], conducted laboratory tests on green walls' acoustic properties. Its aim was to help predict their sound insulation performance in the real world.

The design of green walls can affect their sound insulation properties. The type of plant grown can also have a big effect. In this case, the study focused on a modular green wall system, which is composed of compartments or boxes attached to a vertical frame and is the most widely used system.

The boxes in this study were made of recycled plastic and filled with coconut fibre, acting as 'soil'. They were all planted with *Helichrysum thianschanicum*, a popular shrub for gardening in the Mediterranean region, with an average height of 40 cm.

The researchers placed 10 of the boxes, totalling 2.4 m^2 in area, onto a wall which separated two rooms. They emitted noise in one room at frequencies ranging between 100 hertz (Hz) and 5 000 Hz, and then measured the reduction in noise levels in the neighbouring room caused by the green wall.

The green wall reduced noise levels in the neighbouring room by an average of 15 dB. The researchers note that this reduction is quite low compared with other solutions; thermal double-glazing can reduce noise by 30 dB, for example. A sound barrier made from two layers of plasterboard, separated by a wool-filled cavity, can reduce noise by 70 dB.

Nonetheless, they believe it still has good potential to help cut noise levels in urban buildings and could be used effectively in public places, such as hotels and restaurants. Furthermore, if its design was improved by sealing the joints between the boxes, then it could reduce noise by an extra 3 dB. The other benefits of green walls, such as increased biodiversity, visual attractiveness, air purification or climate regulation, also make them an attractive option.

This experiment considered noise that is transmitted directly through a wall, but in a realistic situation noise bounces off different surfaces and can be transmitted indirectly through a number of routes. Therefore the logical next step in this research would be to test the green wall on actual building façades, the study's authors say.

To further improve their understanding of the wall's basic acoustic properties, the researchers also investigated how much sound a green wall can absorb. In this experiment, they placed the green wall (this time 10 m^2 in area) on the floor of a room in which sound was emitted, again at frequencies of 100–5 000 Hz. The wall was calculated to have a 'sound absorption coefficient' of 0.40, i.e. it absorbed 40% of the sound.

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Source: Azkorra, Z., Pérez, G., Coma, J. *et al.* (2015). Evaluation of green walls as a passive acoustic insulation system for buildings. *Applied Acoustics* 89: 46–56. DOI:10.1016/j.apacoust.2014.09.010. This study is free to view at: www.sciencedirect.com/science/article/pii/S0003682X14002333

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Read more about:

Green infrastructure, Noise, Urban environment

1. SILENTVEG: Barreras vegetales autónomas y sostenibles para la mitigación acústica y compensación del CO2 en vías de transporte, con seguimiento telemático, was supported by the European Union's Regional Development Fund. See: www.agenandalucia.es/innovacion/principal.asp?alias=al_barreras&zona=proyectos&t=0 (in Spanish)

Environment

https://www.sciencedirect.com/science/article/pii/S0003682X14002333

Noise reduction by GI

How to Reduce Noise by urban greenery

Noise reduction is achieved by either deflection or absorption of the noise or by a combination of the previous two:

Design factors to be considered before deciding to create a tree barrier against noise:

•Noise is more effectively reduced by completely screening the source from view.

•A noise barrier should be planted as close to the noise source as possible.

•Wide belts of high density trees and shrubs are required to achieve significant noise reductions.

•noise reduction tends to increase with tree height up to 10-12m

•Effectiveness of noise reduction is closely related to the density of stems, branches and leaves.

•For year-round noise reduction use broadleaved evergreens or a combination of coniferous and broadleaved evergreen species.

•Soft ground is an efficient noise absorber. Cultivating ground before planting and the addition of well-rotted organic matter to the soil surface may also help to reduce noise whilst vegetation becomes established.

Knowledge gap for tropical cities

Cities in the tropics differ from those in temperate regions for climate, ecology, demography, economic development, and lifestyle.

Many people in the tropics, especially the poorest, spend most of their time outdoors; for them, the shade and shelter provided by trees are especially important.
Tropical cities are generally warmer and experience heavier rainfall, which exacerbates the challenges of the urban heat island and flood risk. Mitigating these effects is therefore likelyt o be a priority in tropical cities.

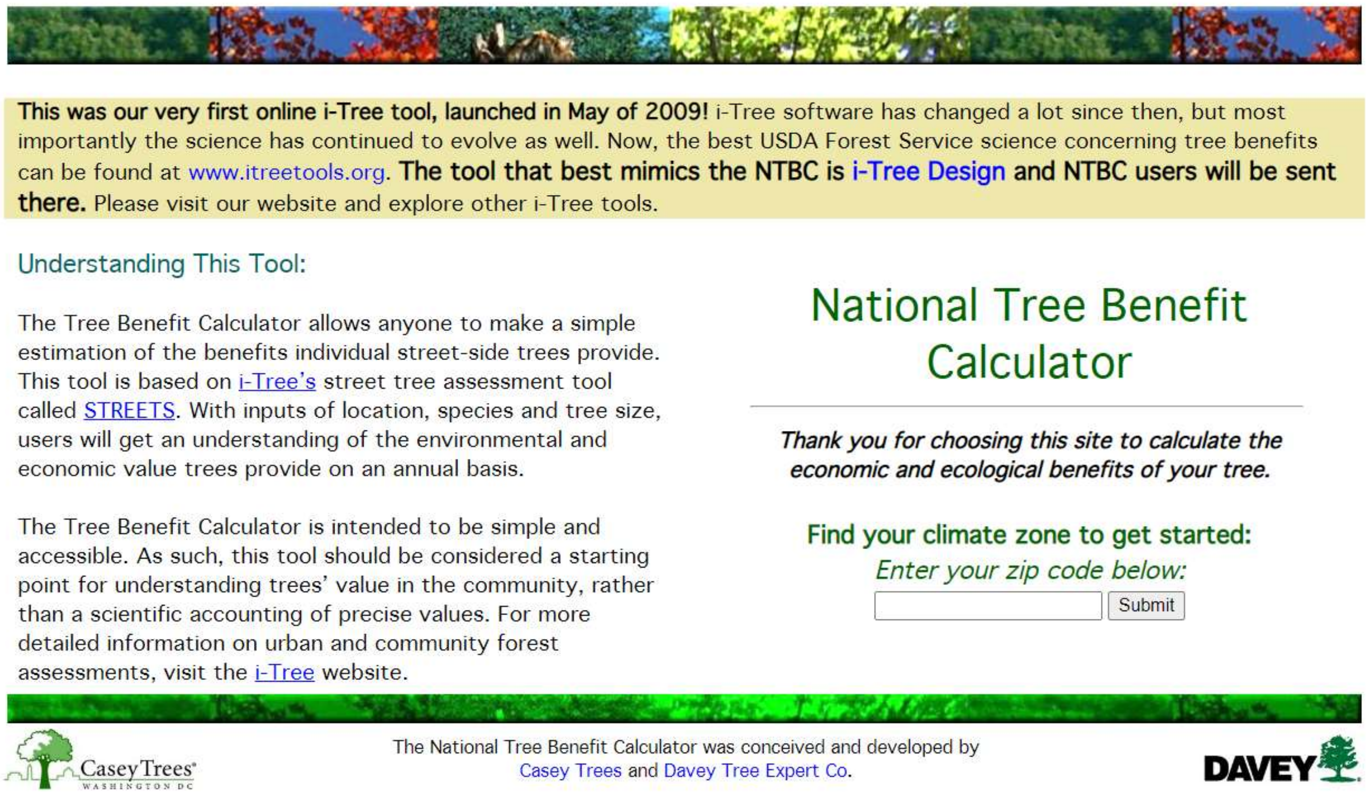
Tropical regions have long growing seasons and are among the most biodiverse in the world (3). High tree diversity offers the potential for selecting species that provide multiple benefits and best fulfil local needs.

Yet, there remains a substantial knowledge gap concerning the benefits provided by tropical tree species. For example: the software i-Tree includes tools that allow users to quantify the structure and environmental services of trees, but i-Tree has only been adapted for the US, UK, Australia, and Canada

Given that some of the world's fastest growing cities, such as those in Southeast Asia, are in the tropics, future research should explore the full benefits of urban ecosystem services of trees

Database/Resources for urban trees

[National Tree Benefit Calculator (treebenefits.com)]



[Are you looking for trees for narrow streets? vdberk.co.uk]

[Urban tree database | Ag Data Commons (usda.gov)]

[Coastal Plain Community Tree Guide: Benefits, Costs, and Strategic Planting] (chapter 5)

Exercise/research

Positive effects of trees on climate regulation, carbon sequestration and noise reduction

- Choose an urban area that you know or where you've been
- Take a screenshoot from google map and paste it on a power point (the scale should be enough detailed to allow you to correctly identify sidewalks, streets, yards or other place where trees can be planted)
- Paste the screenshot on a power point slide
- Draw lines or polygons with power point forms on the google map to locate different type of trees in different parts of the cities
- Use different colors for the lines of trees, indicating a specific function that trees are expected to do (reduce heat island, maximise carbon sequestration and noise reduction, multifunctional)

Ipoh, Malaysia

Street trees, heat island reduction

Street trees, noise reduction

Park trees, carbon sequestrantion