

The Green Future of Cities: the importance of urban forestry for climate adaptation



Introduction

Cities today are facing increasingly complex challenges such as air pollution, climate change and biodiversity loss, in this context urban forestry emerges as a strategic and necessary solution.

The project “The true value of urban greenery”, promoted by the Forestry Consortium KilometroVerdeParma and co-financed by Cariparma Foundation, assessed the economic and environmental impact of three urban forestry interventions in Parma, Northern Italy.

Then, Vsafe, a spin-off of the Catholic University of the Sacred Heart which carried out the study, has applied its Social Cost-Benefit Analysis (SCBA) model to the three case studies in order to measure and communicate the value of urban greening investments.

Urban greening is the incorporation of green spaces and elements into urban environments and infrastructures, such as roads, cities, roofs and walls. It can mitigate the health effects of anthropogenic pollution, at the same time It can provide social, educational and recreational benefits. All those benefits are called Ecosystem Services and can be measured in economic terms by SCBA.

On the other hand, urban greening has a cost, in terms of space, economic resources, limitations on urban sprawl, etc. The SCBA makes it possible to consider these costs as well and compare them to the benefits to assess the overall value of a project.

In recent years, innovative economic methodologies have made it possible to assign a monetary value to natural goods and services, bringing out positive externalities often overlooked in traditional valuations. This study aims to improve the management of environmental resources and promote more informed decisions by stakeholders, from citizens to municipalities and local authorities.

Methods

Two out of the three urban forestation interventions evaluated are located in public parks, the third inside a roundabout. Fig. 1 and 2 show the characteristics of each site.

A Social Cost-Benefit Analysis was conducted for each site with a 30-year time horizon and a discount rate of 1%.

Planting activities, Irrigation system and three-years maintenance are the costs valued.

Benefits consist of five ecosystem services that have been physically and economically evaluated using different methods: Global climate regulation, Air pollution reduction, Run-off regulation, Noise regulation, Aesthetic and recreational services.

Fig. 1: Satellite image and site 1 characteristics



Fig. 2: Satellite image and characteristics of site 2 and 3.



Methods

Definition of evaluated ecosystem services:

Global climate regulation

Plants transform carbon dioxide into biomass, regulating the climate and preventing climate change.

Air pollution reduction

Trees and shrubs have the capacity to absorb the following air pollutants: CO, NO_x, SO_x, O₃, PM2.5 and PM10. All of which are dangerous to human and environmental health.

Run-off regulation

Trees retain part of the rainfall, facilitating soil infiltration and reducing runoff, resulting in lower wastewater management costs.

Noise regulation

Trees and shrubs absorb part of the noise produced by anthropogenic sources with a positive effect on people's health and well-being.

Aesthetic-recreational services

Those who enjoy a green area enjoy a sense of beauty that generates well-being, while the possibility of outdoor activities improves physical and mental health. Part of these aesthetic and recreational benefits can be measured through increased property values.

Because of different site features, not all ecosystem services are available for each site, as shown in tab. 1.

Tab 1: Valuated ESs, adopted methods and unit measure

Ecosystem services	Biophysical valuation	Economic valuation
Global climate regulation (ton of CO ₂ eq.) [*]	i-Tree Eco v6 Software	Prevention cost
Air pollution reduction (kg of pollutant) [°]	i-Tree Eco v6 Software	Avoided cost
Runoff regulation (m ³ of water)	i-Tree Eco v6 Software	Avoided cost
Noise regulation (Lden in Db(A)) ⁺	Noise simulation	Avoided cost
Aesthetic-recreational services	-	Hedonic price

* Annual carbon sequestration by plants.

° Considered pollutants: CO, NO₂, SO₂, O₃, PM2.5 and PM10.

+ Lden: Day-evening-night level. It is a descriptor of noise level based on energy equivalent noise level (Leq) over a whole day with a penalty of 10 dB(A) for night noise and an additional penalty of 5 dB(A) for evening noise.

** i-Tree Eco: www.itreetools.org/tools/i-tree-eco.

Results

Total Benefits represent the sum of the discounted benefits, the same for Total Costs. Net Present Value (NPV) is the difference between Total Benefits and Total Costs; when positive the investment is profitable.

The same type of forestry intervention with comparable planting densities and costs leads to different results in terms of benefits generated over thirty years and then in terms of NPV.

Tab 2: Total social Benefits, Costs and NPV (€/ha)

	Site 1	Site 2	Site 3
Total Benefits (€/ha)	416 345	5 819 614	44 225
Total Costs (€/ha)	43 252	51 780	51 862
Net Present Value (€/ha)	362 228	5 767 833	-7 638

Site 1, a public park in the countryside, generates a total benefit that is almost 10 times the total cost, and a positive high NPV. This thanks to the aesthetic-recreational services that account for 86% of the generated benefits.

Site 2, a public park located in a densely populated area of the city of Parma, generates the highest total benefit and NPV, over 112 times the costs. This thanks to noise regulation that accounts for 58% of generated benefits. Only in this site was possible to evaluate noise regulation due to the location of planting area between the source (a railway) and the receiver (apartment blocks). The aesthetic-recreational services are also very important because they account for 41% of the generated benefits.

Site 3, a roundabout in the city of Parma, is the only site that shows a negative NPV, but with three more years the NPV becomes positive. Indeed, regulation services alone cannot generate a total benefit that exceeds the total cost in only thirty years.

Tab 3: ESs present value generated in 30 years for each Site (€/ha)

Ecosystem Services (€/ha)	Site 1	Site 2	Site 3
Global climate regulation	40 386	22 684	28 697
Air pollution reduction	5 351	8 514	6 877
Runoff regulation	11 919	6 628	8 651
Noise regulation		3 401 413	
Aesthetic-recreational services	358 689	2 380 375	
Total Benefits	416 345	5 819 614	44 225

Discussion

Urban forestation projects that have a recreational function and are located near densely populated areas seem to be very profitable investments that pay back immediately through increased property values. This is the case for sites 1 and 2.

Noise reduction with vegetation barriers is an excellent investment. At site 2 this service alone is sufficient to justify the total cost.

In contrast, the other regulating services together are not sufficient to justify the total cost in both Site 2 and Site 3. This is because the plants used are only 1-3 years old, so their ability to capture CO₂, pollutants and water is limited. Another reason is that the method of economic evaluation of these services is less robust than that of aesthetic-recreational values.

Conclusions

Results suggest that the three urban forestry interventions carried out by the Forestry Consortium KilometroVerdeParma can provide important ecosystem services to citizens over time. All interventions are economically viable in a long-term perspective. Interventions with an aesthetic-recreational function produce great immediate benefits through increased property values.

Moreover, Vsafe Social Cost-Benefit Analysis model proved to be a flexible tool that can be used by municipalities and designers both for urban planning and project design. In fact, the model can assess the costs and benefits of urban greenery to evaluate alternative scenarios and their replicability across the whole territory. While, in project design, it can be used both to guide design choices and to demonstrate the economic and environmental sustainability of a project to funders and citizens.

Credits

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