Ecosystem services evaluation for a more resilient urban environment

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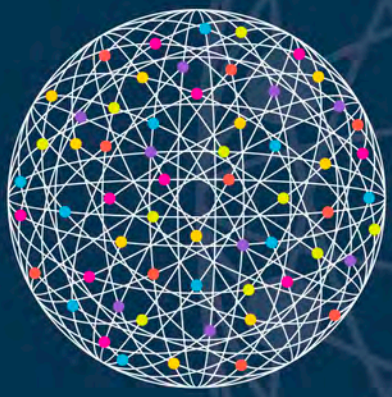

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Ecosystem services evaluation for a more resilient urban environment

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ABSTRACT

Among the Sustainable Development Goals defined in Agenda 2030 by United Nations, Number 11 aims to achieve more resilient urban environments facing the ongoing climate change. “Ecosystem Restoration” is one of the solutions to help achieving this goal, by restoring habitats and functions of the terrestrial and marine ecosystems on which flora and fauna depend. At urban scale, a method for the evaluation of the Ecosystem Services (ES) offered by a given green area is reported: among the quantifiable benefits, in this work the attention is paid to the quantity of surface water runoff that vegetation is able to reduce, through processes of infiltration, evapotranspiration and storage. The results of a case study on a Turin green space are shown as an example, deepening the species efficiency in providing the total amount of 735 cubic meters of water saved.

Keywords: resilience; ecosystem services; urban; green area.

1 INTRODUCTION

ES, defined by the Millennium Ecosystem Assessment (MA) in 2005, represent the components of natural capital that provide products, services and intangible benefits to mankind (MA, 2005). Different types could be identified: in this work the regulatory category is considered, i.e. those ES with a regulation role on some ecosystem processes and, in particular, on the urban water cycle: the avoided surface runoff, i.e. the flow of rainwater on the soil surface. At this regard, green areas within urban context have a positive effect, as they modify land cover distribution by increasing the percentage of permeable soil. This has a beneficial role in countering the soil overbuilding, typical of urban environments, and consequently leads to a reduction in the water volume of surface flow, reducing the hydrogeological risk of the city (Busca & Revelli, 2022).
In this work, the potential of *Colonnetti Park*, an urban green space within the metropolitan area of Turin, to increase urban resilience is analyzed through a ES evaluation software suite specific for vegetation, focusing on the ability to minimize the surface water flow directed to sewer systems.

2 METHODS

For the analysis carried out, i-Tree Eco has been used, a program belonging to the i-Tree suite, a collection of forest analysis tools aimed at quantifying the ES provided by trees and shrubs: specifically, Eco provides information about the environmental effects on the study area, estimating different ES, as the surface water runoff avoided (i-Tree Eco). It is obtained as the difference between annual overland flow of two different scenarios: (i) actual scenario, i.e. the study area *A* considering vegetation; (ii) hypothetical scenario, the same study area without vegetation and it can be calculated as in Eq. [1] (Hirabayashi, 2013).

$$S = Rh_{total} - Ra_{total} = 0.255 \cdot [\sum Rg_t \cdot A - (\sum Rv_t \cdot VA + \sum Rg_t \cdot GA)] \quad [1]$$

Rh_{total} and Ra_{total}, in cubic meters, represent respectively the runoff from impervious cover of the hypothetical scenario and the runoff from impervious cover of the actual scenario, where *A*, *VA* and *GA* are respectively the total area, the area covered by vegetation and the area not covered by vegetation in square meters while Rv_t and Rg_t are respectively the overland runoff in *VA* and in *GA* at time *t*, in meters. The coefficient 0.255 has been assumed from Nowak and Greenfield (2012) considering a 25.5% impervious cover of the soil in urban areas.

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3 APPLICATION TO A REAL CASE

3.1 Study Area

The study area is *Colonnetti Park*, a 385,000 square meters green area in the suburb of Mirafiori Sud of the Metropolitan City of Turin. The data required by i-Tree Eco have been: (i) Meteorological data: precipitation, temperature and concentration of the main pollutants; (ii) Data collected *in situ*: land use and cover, characteristics of trees and shrubs population; (iii) Unit price of avoided surface runoff, i.e. cost per cubic meter of water saved. The reference weather station has been Torino-Bric della Croce (45°02'N 07°44'E) while the (ii) data have been obtained with a "Plot-based sample inventory" in a 5-day inspection (September 2021).

3.2 Results

The estimated avoided surface runoff thanks to the park is more than 735 cubic meters per year, associated with a monetary value of 1,400 euros, based on the total annual precipitation of 2015 (reference year). In Figure 1 an exported graph from i-Tree Eco outputs is reported, showing the ES breakdown by specie, considering the main specie types of the area; indeed, the software represents a useful tool for territorial planning aims, investigating aspects related to the effectiveness of the species spread within the park.

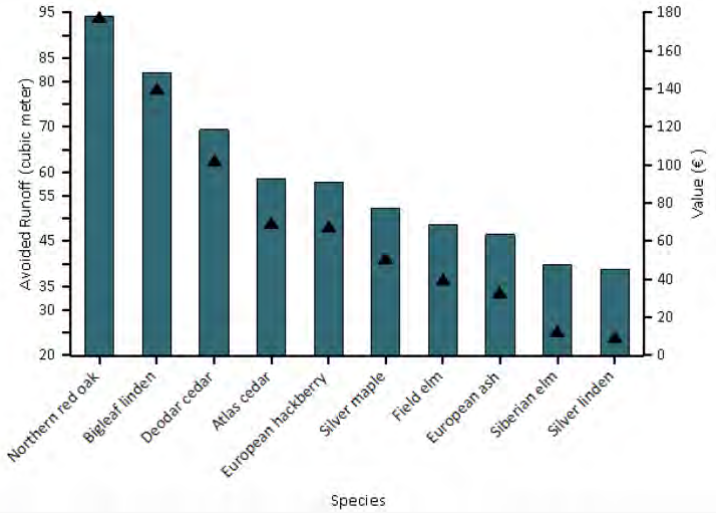

Figure 1. Avoided runoff (points) and monetary value (bars) for species with greatest impact, from Eco report.

4 CONCLUSIONS

The avoided surface runoff volume, despite being economically modest, appears to have a role in reducing the hydrogeological risk, as part of the annual flow generated by precipitation is retained through infiltration and evapotranspiration processes of the soil, storage and evaporation from the arboreal population. Therefore, this fundamental function strongly depends on the percentage of permeable coverage of the area of interest and, in particular, on the number of trees (and shrubs) present. In conclusion, it follows that green areas represent a valid solution for the retention of rainwater in urban areas, intensifying the resilience of cities to climate change.

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REFERENCES

Busca, F. and Revelli, R. (2022). Green Areas and Climate Change Adaptation in a Urban Environment: The Case Study of "Le Vallere" Park (Turin, Italy). Sustainability, 14, 8091.

Hirabayashi, S. (2013). i-Tree Eco Precipitation Interception Model Descriptions.

I-Tree Eco. Available online: https://www.itreetools.org/tools/i-tree-eco (accessed on 21 September 2022).

Millennium Ecosystem Assessment (2005). Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC.

Nowak, D.J. and Greenfield, E.J. (2012). Tree and impervious cover in the United States. Landscape and Urban Planning, 107, 21-30.

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