An Ecosystem Service-Disservice Ratio: Using Composite Indicators to assess the Net Benefits of Urban Trees

Andrew Speak[1], Francisco Escobedo[2], Alessio Russo[3], Stefan Zerbe[1]

World Forum on Urban Forests Mantova 2018

1 Faculty of Science and Technology, Free University of Bozen-Bolzano, Bolzano, Italy
2 Faculty of Natural Sciences and Mathematics, Universidad del Rosario, Bogota, Colombia
3 Laboratory of Urban and Landscape Design, Far Eastern Federal University, Vladivostok, Russia

unibz Freie Universität Bozen Libera Università di Bolzano Università Liedia de Bulsan

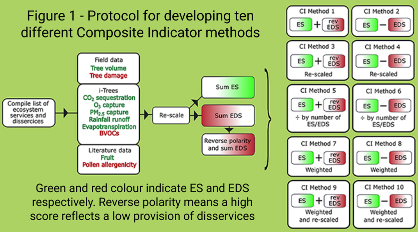
HIGHLIGHTS

- Disparate ecosystem data can be combined in simple composite indicators
- Patterns in urban ecosystem service and disservice provision are mapped
- Ranks of relative tree species performance allow for better decision-making
- A protocol is presented for transparent creation of composite indicators

INTRODUCTION

Many cities around the world are promoting and implementing tree planting schemes in order to capitalize on the ecosystem services (ES) that urban forests provide. Interactions between urban ecosystems and urban residents are not always positive, however, and these ecosystem disservices (EDS) are increasingly the subject of research. There is currently a controversy in the use of the EDS concept in that many feel it only serves to highlight the harm to humans which may be caused by ecosystems, and thus hamper conservation efforts, or justify exploitation of natural resources. The goal is to put ES and EDS under the same assessment framework, allowing decision makers to weigh the benefits of urban forests against the costs, leading to better-informed decisions. Financial approaches (net monetary benefit per tree) often fail to account for less easy to quantify aspects of trees. The main objective of this research is thus to assess whether simple, disparate measurements of the urban forest can be combined into a single assessment framework.

Figure 1 - Protocol for developing ten different Composite Indicator methods



Green and red colour indicate ES and EDS respectively. Reverse polarity means a high score reflects a low provision of disservices

METHODS

- 5,156 public trees and 1,215 private trees identified and measured
- Lists of ES and EDS from the literature were consulted and suitable metrics were chosen for each variable to be included in the Compound Indicator (CI) e.g. i-Trees for BVOC production and pollutant capture, Ogren score for pollen
- CIs are a means of providing simple comparisons between entities, which reduces the complexity of considering trends in multiple indicators by agglomerating them into one index
- Technical guidelines for constructing CIs in a transparent manner are available in Nardo et al. (2005).
- To avoid issues with mixing units and scales, indicators are first standardized before summing.
- To assess the impact of different methods for calculating the CI from the separate indicators, a total of ten methods for deriving CIs were used and sensitivity analysis undertaken.

1 ***Malus domestica***
2 ***Liriodendron tulipifera***
3 *Juglans regia*
4 *Prunus armeniaca*
5 *Larix decidua*
6 ***Celtis australis***
7 *Tsuga canadensis*
8 *Prunus domestica*
9 ***Eriobotrya japonica***
10 *Prunus persica*
11 *Diospyros virginiana*
12 *Ficus carica*
13 *Prunus cerasifera*
14 *Fagus sp.*
15 *Fagus sylvatica*
16 *Castanea sativa*
17 *Punica granatum*
18 ***Cedrus atlantica***
19 *Juglans nigra*

193 *Quercus coccinea*
194 *Acer saccharinum*
195 *Salix alba*
196 ***Salix babyonlica***
197 ***Gleditsia triacanthos***
198 *Liquidambar orientalis*
199 *Quercus palustris*
200 *Quercus sp.*
201 ***Liquidambar styraciflua***
202 *Quercus cerris*
203 *Quercus pubescens*
204 *Populus nigra*
205 *Populus canascens*
206 ***Populus alba***
207 *Populus x canescens*
208 *Acacia sp.*
209 ***Quercus ilex***

Fruit production, high carbon sequestration

Low pollen and BVOC production

High pollutant filtering capability

Fruit production, low pollen production

Low pollen production, good pollutant filtering capability

High pollen production

Low pollutant filtering capability

Low carbon sequestration, moderate pollen production

High pollen production, low pollutant filtering capability

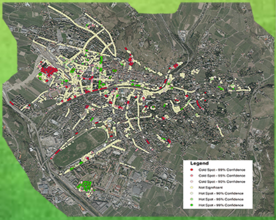
High pollen and BVOC production, low runoff retention capability

RESULTS

Figure 2 - The top and bottom ranked trees as determined using the average of all 10 CI methods, with underlying reasons.

Care must be taken with interpretation of CIs. A low CI does not identify a tree or species as "bad" or more harmful than others. Instead, it is simply drawing attention that, given certain contexts, some local-scale sites might need more attention, for example, location of high pollen producing trees next to potentially sensitive human receptors.

Figure 3 shows a hotspot analysis for the study site of Meran, Italy. Hot and cold spots indicate high and low CI values for a selected ES/EDS ratio. The map can be used to target areas where improvements in species selection may be most beneficial.



Speak, A.F., Escobedo, F.J., Russo, A. and Zerbe, S. (2018) An ecosystem service-disservice ratio: Using composite indicators to assess the net benefits of urban trees. Ecological Indicators 95: 544 - 553

Nardo, M., Saisana, M., Saltelli, A., Tarantola, S., Hoffman, A. & Giovannini, E. (2005) "Handbook on Constructing CIs: Methodology and User Guide", OECD Statistics Working Papers, No. 2005/03, OECD Publishing, Paris.

andrewfrancis.speak@unibz.it