Urban Forestry & Urban Greening 21 (2017) 48–59

Contents lists available at ScienceDirect

Urban Forestry & Urban Greening

journal homepage: www.elsevier.com/locate/ufug

Review

Linking demand and supply factors in identifying cultural ecosystem services of urban green infrastructures: A review of European studies☆

K. Tessa Hegetschweiler[a,*], Sjerp de Vries[b], Arne Arnberger[c], Simon Bell[d], Michael Brennan[e], Nathan Siter[f], Anton Stahl Olafsson[g], Annette Voigt[h], Marcel Hunziker[a]

[a] Swiss Federal Research Institute for Forest, Snow and Landscape Research WSL, Zürcherstrasse 111, 8903 Birmensdorf, Switzerland
[b] Alterra/Cultural Geography, Wageningen University and Research Centre, P.O. Box 47, 6700 AA Wageningen, The Netherlands
[c] Institute of Landscape Development, Recreation and Conservation Planning, BOKU – University of Natural Resources and Life Sciences, Peter-Jordan-Straße 56, 1180 Vienna, Austria
[d] Department of Landscape Architecture, Estonian University of Life Sciences, Kreutzwaldi 56/3, 51014 Tartu, Estonia
[e] UCD School of Geography, E004 Newman Building, Belfield, Dublin 4, Ireland
[f] School of Architecture, Tampere University of Technology, PO Box 527, 33101 Tampere, Finland
[g] Department of Geosciences and Natural Resource Management, University of Copenhagen, Rolighedsvej 23, 1958 Frederiksberg C, Denmark
[h] Department of Geography and Regional Studies, Alpen Adria University of Klagenfurt, Universitätsstrasse 65-67, 9020 Klagenfurt, Austria

ARTICLE INFO

Article history:
Received 4 July 2016
Received in revised form 12 October 2016
Accepted 9 November 2016
Available online 13 November 2016

Keywords:
Factors influencing well-being benefits
Linkage of social and physical data
Spatially explicit
Urban forestry
Urban green space

ABSTRACT

Urban green infrastructure provides a number of cultural ecosystem services that are greatly appreciated by the public. In order to benefit from these services, actual contact with the respective ecosystem is often required. Furthermore, the type of services offered depend on the physical characteristics of the ecosystem. We conducted a review of publications dealing with demand or social factors such as user needs, preferences and values as well as spatially explicit supply or physical factors such as amount of green space, (bio)diversity, recreational infrastructure, etc. and linking demand and supply factors together. The aim was to provide an overview of this highly interdisciplinary research, to describe how these linkages are being made and to identify which factors significantly influence dependent variables such as levels of use, activities or health and well-being benefits. Commonly used methods were the combination of questionnaires with either on-site visual recording of elements or GIS data. Links between social and physical data were usually established either by using statistical tools or by overlaying different thematic maps. Compared to the large number of variables assessed in most studies, the significant effects in the end were relatively few, not consistent across the studies and largely dependent on the context they were seen in. Studies focused on aesthetic and recreational services, while spiritual, educational and inspirational services were not considered when creating links to spatially explicit ecological structures. We conclude that an improvement and harmonization of methodologies, cross-country studies and an expansion of this line of research to a wider range of services and more user groups could help clarify relationships and thereby increase applicability for urban management and planning.

1. Introduction

Over the last 30 and especially over the last 10–15 years, urban green space has become an important research topic (Kabisch et al., 2015). With increasing urban populations, concerns about quality of life and human health and well-being have increased. With this, the interest in the potential and actual benefits of urban green spaces of all kinds – now widely referred to as urban green infrastructure – has grown (Benedict and McMahon, 2006). The Millenium Ecosystem Assessment defines four types of ecosystem services (ES): provisioning, regulating, supporting, and cultural (MEA, 2005). In this paper we focus on cultural ecosystem services

☆ This paper is a result of the European COST Action "Green Infrastructure Approach: linking environmental with social aspects in studying and managing urban forests" (GreenInUrbs). COST stands for Cooperation in Sciences and Technology. More information on GreenInUrbs can be found at www.greeninurbs.com.

* Corresponding author.
E-mail addresses: Tessa.Hegetschweiler@wsl.ch (K.T. Hegetschweiler), sjerp.devries@wur.nl (S. de Vries), arne.arnberger@boku.ac.at (A. Arnberger), simon.bell@emu.ee (S. Bell), michael.brennan@ucd.ie (M. Brennan), nathan.siter@tut.fi (N. Siter), asol@ign.ku.dk (A.S. Olafsson), Marcel.Hunziker@wsl.ch (M. Hunziker).

http://dx.doi.org/10.1016/j.ufug.2016.11.002
1618-8667/

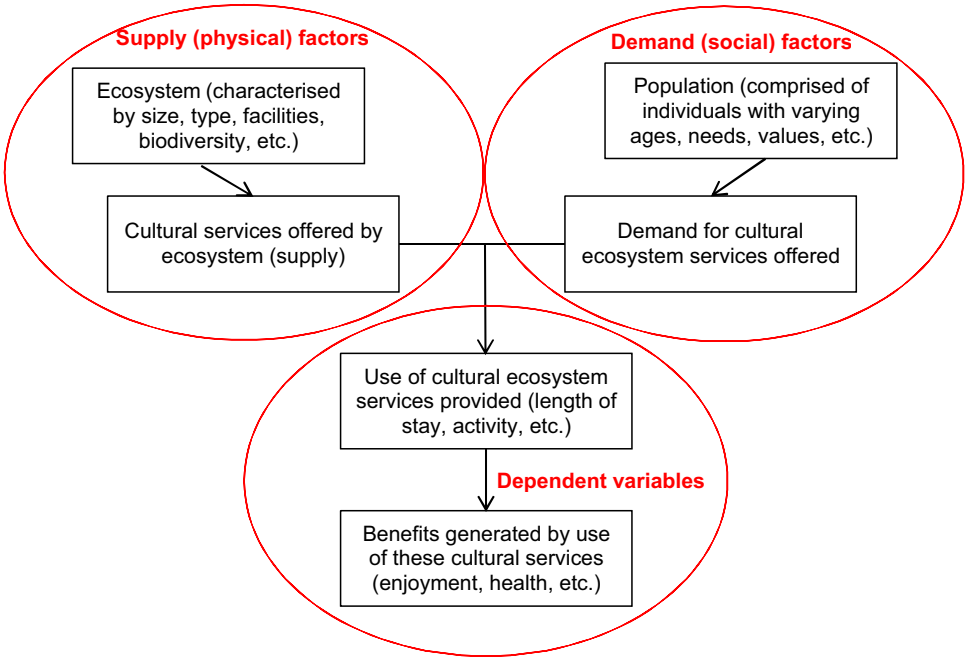

Fig. 1. The Confluence model showing how supply and demand factors determine the use of cultural ecosystem services.

(CES) associated with different types of public urban green space, including recreational, aesthetic, and spiritual experiences (Daniel et al., 2012). According to Daniel et al. (2012), these types are recognized but not yet adequately defined or integrated into the ES framework, being characterised as "intangible", "subjective" and "difficult to quantify". Despite this, Milcu et al. (2013) argue that capitalizing on the societal relevance of CES helps to address real-world problems. For example, they might serve as a useful gateway for addressing and managing nature in cities (Andersson et al., 2015). CES differ to some extent from other categories of ES because they normally require actual contact with the ecosystem by the individual for the benefits to materialize; the service has to be consumed or experienced on site. According to Haines-Young and Potschin (2013), they are – amongst other ES – mostly *final* ecosystem services which influence human well-being directly. This type has a strong link to the ecosystem function, process and/or structure that produces them and also suggests that attention should be paid to the location of both the supply of and the demand for these services. The widely used Cascade model (de Groot et al., 2010) reflects the origin of the ES concept in the natural sciences, suggesting a natural supply of benefits to humans from the ecosystem while paying relatively little attention to the demand for ES (see also Spangenberg et al. (2014)). Therefore, we propose a somewhat different model, the Confluence model (see Fig. 1) that is described as follows.

Clearly, not all urban green areas offer the same types, qualities and quantities of CES – factors such as green space size and physical composition, its design and layout, as well as any facilities form the basis for their supply. Not everyone has the same demands concerning urban green spaces (Schmithüsen and Wild-Eck, 2000; Arnberger, 2006). The characteristics determining demand for CES will be referred to as social or demand factors. They are the socio-demographic and socio-economic characteristics of the population, as well as their general preferences and value orientations (Plieninger et al., 2013). These factors determine the match between the supply offered and the services demanded. Actual use results from a spatial match between demand and supply. Knowledge about the combination of these factors helps in predicting the extent and range of possible benefits from different configurations of green infrastructure planned, designed and managed at a city or site scale. The model can be seen as a further development of the outdoor recreation decision process by Pigram 1983 (Pigram and Jenkins, 1999) in which characteristics of individuals and households form the demand and perception of resource characteristics and accessibility form the supply for outdoor recreation, resulting in decisions for the participation in outdoor recreation. The confluence model expresses these relationships in the context of ecosystem services and explicitly includes the benefits generated by the use of CES. Please note that the term "confluence model" has nothing to do with the confluence model explaining birth-order differences in intellectual performance (Zajonic and Sulloway, 2007), nor with the confluence model of sexual aggression by Malamuth et al. (2008).

According to the confluence model we can group research in this field into three categories:

- Studies mainly examining demand factors, e.g. preferences for green spaces, urban forests and parks or surveys of recreational use and activities, but paying little attention to green space physical aspects or only dealing with them in spatially non-explicit ways, e.g. using photos of landscape types. Examples include Arnberger and Eder (2015), Carvalho-Ribeiro and Lovett (2011), Conedera et al. (2015) or Eriksson et al. (2012).
- Studies primarily concerned with supply factors, e.g. physical or ecological characteristics of urban forests, but paying no attention to social aspects or only including them in minor ways, e.g. national forest inventories or interviews with foresters or policy makers about recreational aspects (Tomppo et al., 2010).
- Studies which establish links between demand factors such as user preferences, etc. and supply factors, such as the physical characteristics of specific locations (Burkhard et al., 2012; Plieninger et al., 2013).

While previous reviews have looked at associations between green space and human measures (Jorgensen and Gobster, 2010), we go further and quantify (a) how these linkages are made and (b) which factors are identified as significantly influencing (levels of) use and health and well-being benefits. We link social factors (the demand side) to spatially explicit physical factors (the supply side) in urban green infrastructure. Benefits arise as a match between