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Sustainable Management of Urban Green Infrastructure – The Challenge of Providing High-Quality Green in Multi-Storey Residential Construction

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Introduction

Vienna is known as one of the most liveable cities worldwide (Mercer, 2015), not least because of Vienna's green infrastructure (GI). These qualities of life and the trend of urbanisation lead to strong population growth in Vienna. It is predicted that the Viennese population will grow from 1.8 million (2015) to 2 million in 2029 (MA 23, 2014); to offer living space, the creation of up to 120,000 new homes is planned until 2050 (MA 18, 2014). The growth and the resulting exploitation pressure on the (green) areas pose a major challenge for the City of Vienna. The loss of green space induced by land use results in the reduction or loss of ecosystem services. The negative effects of the decline of green areas and the increasing soil sealing already occur especially in areas of high population density. Furthermore, increasing heat stress and risks related to natural disasters like the flood event in 2002 show the importance of green space in urban areas for the maintenance of ecosystem functions. Therefore, a challenge of the next years will be to maintain a high-quality and efficient network of GI.

At the moment, the floor area ratio ("Geschoßflächenzahl") and other values like the degree of soil sealing, the density rate for buildings, building heights etc. are the defining parameters for urban development in Vienna and regulate the degree of building coverage. The supply of the neighbourhoods with open/green space is determined only indirectly. Besides, those parameters are not able to state the quality of green space for humans. Vienna has already recognised the importance of GI and develops guides for developers and urban planners to contribute to encourage GI in the city (MA 18, 2014; MA 22, 2013; MA 22, 2015). But a clear framework for the conservation and provision of minimum standards for urban green space, however, is still missing; incentives for implementation of GI elements are primarily given through grants.

Some cities have developed defining parameters or policy instruments for GI to enable a management of open space supply and quality (e.g. Berlin: "Biotope Area Factor"; Malmö: "Green Space Factor"; Seattle: "Green

Factor", Helsinki...), but in the current practice of applying the green space factors almost only ecological aspects are taken into account (Kruuse, 2011; Szulczewska et al., 2014). Socio-cultural aspects such as usability, aesthetics or recreation are rarely considered. For urban planning and administration it would be important to start thinking about a green space factor which, beneath size and space consumption, also takes into account socio-cultural aspects.

The main objective of the "AddedValueGreen!" project was to develop a green and open space factor ("Grünflächenfaktor" or "GFF") which encompasses regulating, socio-cultural and economic effects of urban GI (uGI). The focus was on the management and intervention of private and housing-related spaces to secure a certain amount of high-quality open/green space on building lots. Through the evaluation of housing projects by using the GFF, deficits in the green space supply and quality can be identified and recommendations to improve the GI can be derived. Furthermore, it will be possible to integrate this evaluation tool into other planning levels or management tools.

Methods

Based on a comprehensive literature review, which also included an evaluation of practical international examples of green space factors like Berlin, Seattle and Malmö, relevant types of uGI were identified (Kruuse, 2011; Haase et al., 2014; MA 22, 2015). The approaches of the concept of ecosystem services (ES) as well as the concept of uGI formed the basis for the identification of possible service types and benefits of uGI and the service potential of project relevant GI elements. The goal was to display the advantages and added value of uGI elements and to rate them according to socio-cultural, regulatory and economic benefits. The findings of this literature study form the methodological framework for the development of a Viennese GFF (Figure 1).

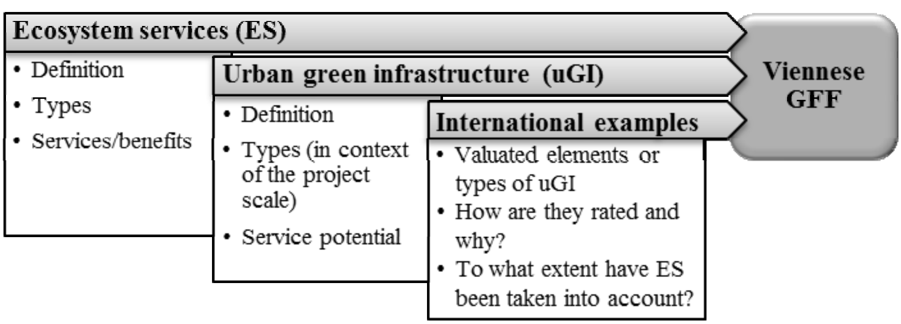

Figure 1. How to develop a GFF for Vienna

The aim of this paper is to give an overview of the literature-based consideration and the establishment of a methodological framework for a Viennese GFF.

Definition and types of uGI; services and assessment of uGI

Green Infrastructure (GI) covers a wide range and different scales and types of elements, including agricultural land, urban forests and water bodies as well as gardens, solitary trees or green tracks, amongst others. As studies show, GI forms a contrast to the grey infrastructure most dominant in cities and makes a major contribution to the urban climate and quality of life of city-dwellers (e.g. Bruse, 2003; Ely and Pitman, 2013). Investment in the maintenance and expansion of uGI therefore generates added value for the city and its residents.

Ecosystem services (ES) are direct and indirect benefits people obtain from ecosystems (Grunewald and Bastian, 2013). The most common classifications of ES are based on the MEA (2005) and the TEEB Study (2010)) that classify the ES in the categories: provisioning services, regulating services, habitat or supporting services and cultural services.

UGI has the potential to mitigate the increasing signs of environmental stress in cities and to make them more attractive to live in (De Ridder et al., 2004). Figure 2 gives an overview of the types of benefits uGI can offer. Urban ES can be classified into ecological, socio-cultural (social) and economic services. (in this case, the provisioning service “food” was assigned to the category “ecology”; the category “economy” has been complemented with the economic conditions mentioned in the concept of urban quality of life by Santos and Martins (2007).

UGI provides ecological, economic and social benefits which often coincide and are interconnected. Concerning the assessment of uGI it is important to note that its services depend on local conditions such as climate, population, structure of the built environment and traffic situation. Furthermore, size, structure, quality and setting of the greenery are also determining factors for the GI service potential (Bruse, 2003; Scharf and Simon, 2015). Evaluating and predicting impacts of uGI is therefore a complex issue which includes various factors. The effects of uGI features cannot be considered separately but need to be linked to the urban ecosystem conditions. To achieve the desired effects by urban greenery, strategically and well considered planning is crucial.

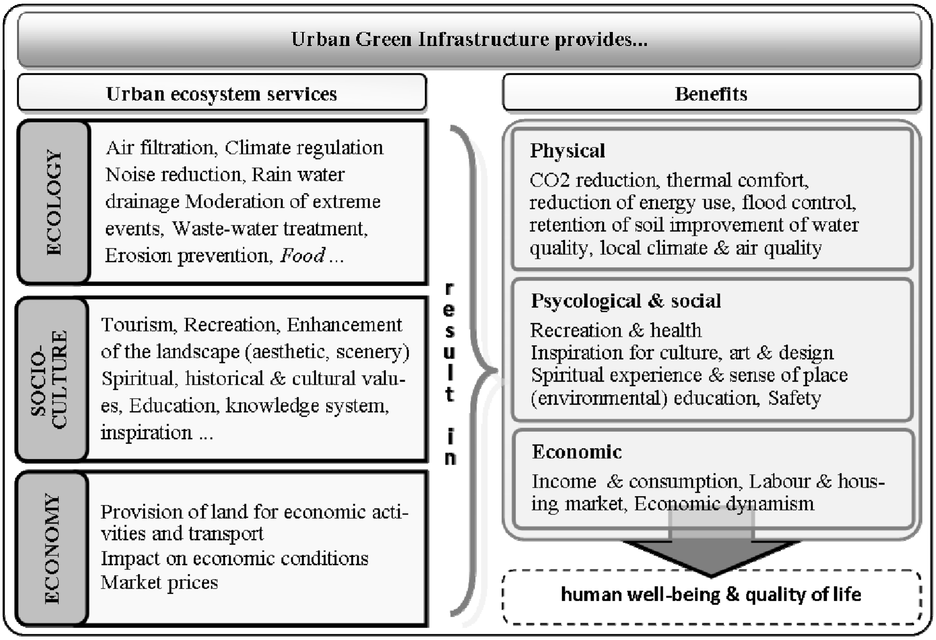

Figure 2. Urban green infrastructure and its resulting ecosystem services (modified from Haase, 2011, cited by Grunewald and Bastian, 2013; Demuzere et al., 2014; Santos and Martins, 2007)

Urban planning practices for the maintenance and development of uGI

To get an idea of how green space factors could be designed, how they work and how a Viennese green space factor could be implemented, examples of Berlin, Malmö, Helsinki and Seattle were analysed and discussed.

The analysed eco-spatial factors are striving to create and secure a certain amount of GI (Helsinki) or so-called "*ecologically effective areas*" (Berlin) in urban built-up areas and to "*minimise the degree of sealed or paved surface*" (Malmö). Seattle also mentioned aesthetic qualities of the landscape as a goal; also Helsinki included landscape into the valuation. Main objectives were ecologically motivated, e.g. the adaption to climate change by reducing storm water runoff or measures to reduce environmental impacts like heat stress.

In most samples, the calculation of the green space factors of a project area expresses a ratio between built-up areas and green space. The range of rated elements varies between 9 (Berlin) and 21 (Seattle); Helsinki calculates with 5 main element categories and 43 sub elements. The different types of elements, surfaces or greenery (e.g. occurrence of green roofs and walls, permeable pavement, open water, trees, storm water infiltration facilities …) are weighted according to their environmental value based on expert knowledge.

In all of the studied examples a target or minimum level of green was defined, which should reach between 0.5 (Seattle, Helsinki) and 0.6 (Malmö, Berlin) for residential areas; Berlin also defined a minimum factor for the amendment and extension of structural systems or buildings (0.3-0.6 dependent on the degree of sealed surfaces). There are also differences in the determination of the minimum factors according to the form of building usage or land use (e.g. housing, commercial/hybrid forms).

The existing eco-spatial factors take into account mainly ecological aspects. But ecological indices only cover a part of the benefits people obtain from uGI; economic and especially socio-cultural aspects of greenery also play an important role for the liveability in cities because they refer to a lot of residential needs (e.g. recreation, social interaction …) (Szulczewska et al., 2014). Nevertheless, social benefits are addressed just in some of the analysed samples, e.g. in Malmö, where lot areas with restricted access for the disabled aren't rated (factor 0). Kruuse (2011) also mentioned that it is planned to include the topics "biodiversity" and "social qualities" into the "Green Space Factor" of Malmö. The Helsinki Green Factor calculated a so-called "expert score" based on four categories including "functionality" and "landscape" (City of Helsinki, 2014).

Although residents benefit from the socio-cultural services of GI primarily applied for environmental reasons, a conscious attention to them already in the planning process can generate added value. Therefore, the Viennese GFF includes ecological as well as socio-cultural aspects into the score, combined with economic considerations (Figure 3).

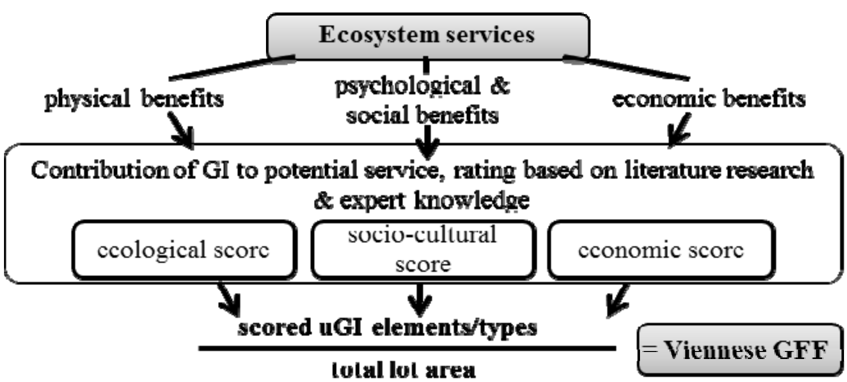

Figure 3. Calculation scheme of the Viennese GFF

Each category score as well as the total score should reach a defined target or minimum factor according to the building usage (housing, commercial/hybrid forms) and the type of built-up area (e.g. late-nineteenth-century buildings).

Discussion and conclusion

Through literature study of the existing green space factors a starting position has been created. Ecological aspects have been taken into account within these planning instruments, but it would be essential to attach more importance to socio-cultural aspects of GI and to include them into the development process. Besides aesthetical components and the usability of GI human well-being has moved to the top of political programmes against the backdrop of the issue of the ageing population as well as the increasing number of civilisation diseases.

Therefore, it is necessary to develop a tool to calculate the GFF in the planning process for new housing development areas (neighbourhood scale) as well as for single plots. An automated or online calculation tool (as e.g. in Helsinki or Seattle) will help the planners to get an overview of the achieved factor and to adjust their planning. This can be a basis for decision-making and argumentation for the urban planning and administration to strengthen the case for the benefits and value of uGI. In addition, a standardised sheet could assist and make it easier for juries to evaluate planning projects.

It should be noted that also conditions and factors outside the lot (location within the urban area, exposure of GI elements, age of vegetation ...) have a major impact on the quality and service potential of GI. A certain amount of imprecision therefore arises especially in larger urban planning areas, where the design of the adjacent land at the time of the valuation is still open. The location of the building project to be evaluated thus plays an important role in the evaluation of the uGI service potential.

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