



Review article

Towards a better understanding of Green Infrastructure: A critical review

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ARTICLE INFO

Keywords:

Chinese research
Ecosystem services
GI mapping
Multifunctionality
Spatial scales
Urban planning

ABSTRACT

Based on a comprehensive analysis of key definitions of Green Infrastructure (GI) and their conceptual evolution, we present a review of current GI mapping approaches at multiple spatial scales and their associated functional analyses. GI is an approach that is used to combine ecosystem services and human well-being to realize an efficient and sustainable use of spaces, hereafter named “GI concept”. The interdisciplinary database that forms the basis of our literature review includes peer-reviewed journal papers as well as books and documents published by international organizations, governmental agencies, and research institutions. By analyzing these publications – not only English but also Chinese articles – we present an exhaustive review that gauges the state and evolution of GI in chronological terms, and we discuss how GI should be further improved. We systematically examine what GI actually measures and question whether its current manifestations are consistent with its conceptual development. Furthermore, we seek to find out whether there are specific trends in the conceptual evolution of definitions of GI, and whether there are gaps between this evolution and the implementation of GI in the context of advancing sustainable development. We then draw attention to differentiation while analyzing GI functions and classifications. On this foundation, we discuss six primary principles and propose a number of ways of enhancing and applying GI in the future. Our review shows that, at this point in time, special emphasis on the core idea of multifunctionality is significant for depicting the ‘state of the art’ of the evolving GI concept. Finally, the study identifies multifunctionality as the solution best suited to enhance the GI concept and to open up potential avenues for further research.

1. Introduction

Green infrastructure (hereafter GI) has been identified as one of several key strategies for achieving sustainability. GI is regarded as beneficial because it can provide habitats for various biota and thereby protect terrestrial and aquatic ecosystems (Demuzere et al., 2014; EEA, 2011; Ignatieva et al., 2011). Both GI and ecosystem services (ESS) have been widely promoted as suitable strategies for improving environmental planning in relation to different spatial scales. The potential of GI and ESS is rooted in a holistic understanding of social, ecological and physical systems. GI was first introduced in the mid-1990s (Pauleit et al., 2011) and has since become part of the sustainability discourse used by a wide range of agencies, organizations, companies, community groups, and planners. This concept offers practical ways of dealing with the rising rate of land consumption and fragmentation at various scales, while enhancing interdisciplinary collaboration and information sharing at different levels and offering the potential to achieve sustainable development and a fair quality of life (Soule, 1991; Margules and Pressey, 2000; Conservation Measures Partnership, 2004, 2013;

McDonald et al., 2005; EEA, 2015). By reviewing the literature about the GI concept, we hope in the first instance to prompt planners to consider GI as a strategic approach to conservation and development that helps to drive environmental planning and land preservation towards sustainable development.

In addition, the concept should be examined in terms of its theoretical evolution in order to find out whether there are any major trends in it that point towards more efficient ways of implementing GI since the concept was first put forward (Mazza et al., 2011). To give an example of this, GI has been defined by The Conservation Fund (2004) as the interconnected network of natural and semi-natural areas, features and green spaces that support native species, maintain natural ecological processes in rural and urban areas, and contribute to the health and quality of life for human beings (The Conservation Fund, 2004). Two years after its first delineation The Conservation Fund updated their definition as “a strategically planned and managed network of natural lands, working landscapes, and other open spaces that conserves ecosystem values and functions and provides associated benefits to human populations, in order to link GI concept closely to its

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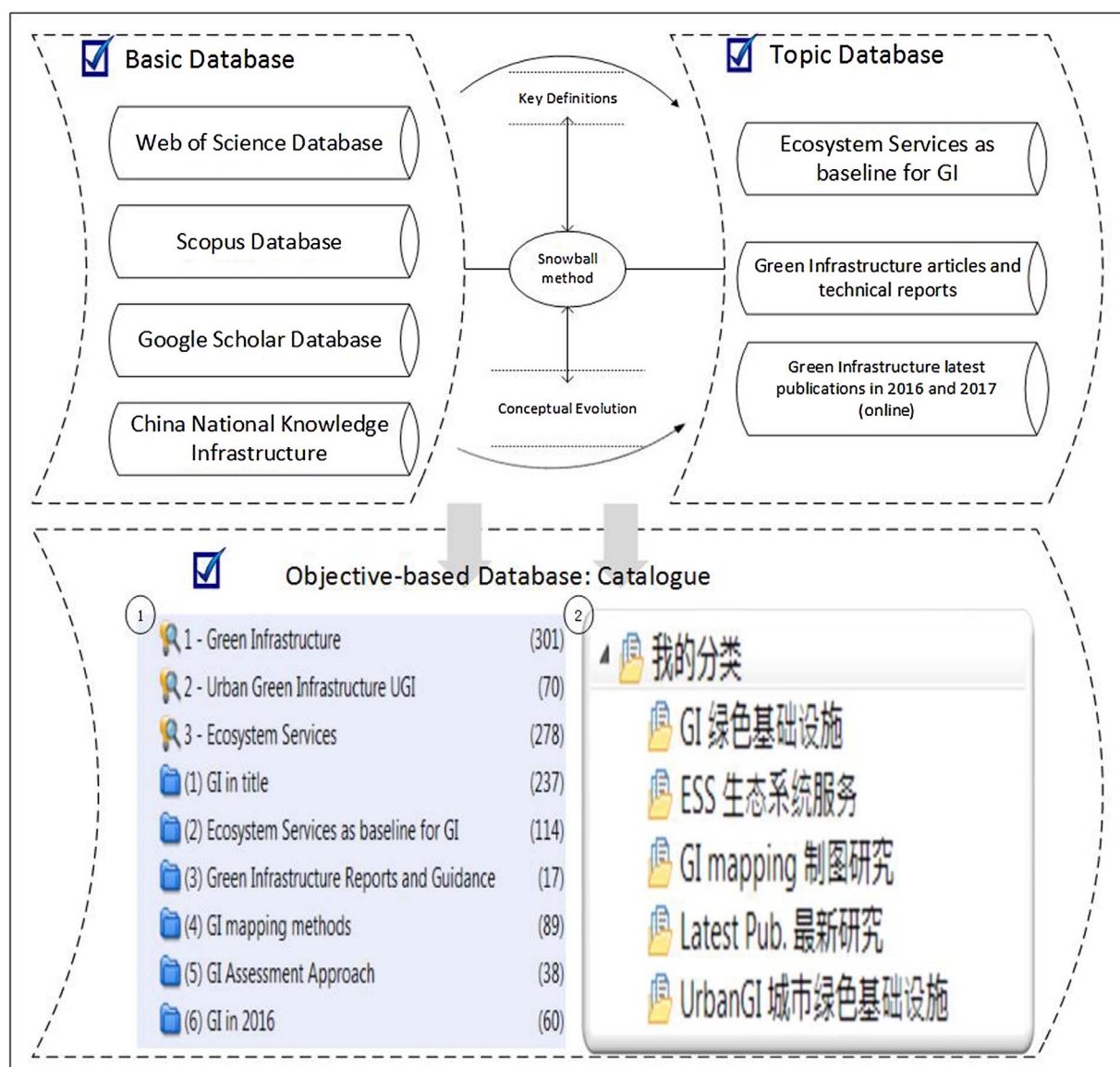


Fig. 1. Entire database management for basic, topical and objective-based catalogues.

implementation" (Benedict and McMahon 2006, p. 7). The natural features of this broad concept were not merely restricted to features that support native species i.e. GI definition in the year of 2004, but they include parks, forest reserves, terrestrial, freshwater, coastal and marine areas, as well as man-made elements, such as ecoducts and cycle paths (Naumann et al., 2011a, 2011b; European Commission, 2013). The range and extent of GI means it can perform several functions at several scales while simultaneously taking into account the multiple connections and interactions which are so essential in nature. It is for this reason that, in scientific debates, GI has often been described in terms of policy (Naumann et al., 2011b). The European working group 'Science for Environment Policy' has, for instance, strongly supported GI as a policy goal because it has the potential to offer 'win-win' or 'no-regret' solutions. Furthermore, the group asserts, it could promote integrated spatial planning by identifying multi-functional zones and incorporating habitat restoration measures into land use plans and policies (EC, 2012; EU, 2013). GI can also be a highly valuable policy tool to promote sustainable development and smart growth by meeting multiple objectives and addressing various demands and pressures (EEA, 2011). However, a broader approach to GI highlights the need for a holistic review of GI functions, from nature conservation to the social

benefits provided for residents at regional, urban and local, site-specific scales (Naumann et al., 2011a,b; Niemelä et al., 2010; Pauleit et al., 2011; Demuzere et al., 2014). Improved knowledge of the scales at which functions and benefits are provided for residents should be used to link the conceptual development of GI to appropriate levels of decision-making and implementation, whether continental or national, sub-regional or local (Sternlieb et al., 2013; Wyborn and Bixler, 2013). We find this issue to be in accordance with the synergy across boundaries (multi-scale integrated analysis) in the Sustainability Impact Assessment (SIA). Dealing with the complexity of interactions between different land uses, these reflections are also based on SIA which regards temporal and spatial scales, and the respective steering policies (Pérez-Soba et al., 2008).

Since its early days, GI has been defined in many different ways. We therefore need an exhaustive review of the development of the concept in order to capture its essence and achieve a better understanding and more effective implementation. A systematic review of GI, including the approaches necessary for GI mapping to support the planning process, has been lacking to date (Liquete et al., 2015). This study aims at defining the term Green Infrastructure (GI) from a possible complete bibliographical revision.

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