

# Green Infrastructure Concept and Conceptual Framework Evolution

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## Abstract

**A comprehensive analysis and review of the main definition of green infrastructure (GI) and the evolution of its conceptual framework. GI is a method that combines ecosystem services with human well-being to achieve space efficiency and sustainable development. Over time, the GI concept emphasizes the core concept of versatility, and the GI concept framework integrates with the ecosystem The relationship between services, ecosystem health and human well-being. Therefore, a comprehensive and in-depth understanding of green infrastructure can provide theoretical basis and practical guidance for the policy planning and implementation of projects and sustainable development.**

## Keywords

**Green infrastructure, sustainable development, conceptual framework.**

## 1. Introduction

The concept of green infrastructure was first introduced in the mid-1990s (Pauleit et al., 2011), as one of the key strategies for achieving sustainable development, and later became used by many institutions, organizations, companies, community groups, and planners. Continue to develop part of the discourse. In the past 30 years, the concept of green infrastructure has become a new category of infrastructure and an effective solution to meet and mitigate challenges such as climate change adaptation (Moore 2006; McPherson et al. 2009; Thom et al. 2009) , Alleviating the urban heat island effect (Coutts et al. 2007; Loughnan et al. 2008; Livesley 2010; Loughnan et al. 2010); managing sustainable water resources (Wong, 2011); supporting human health and well-being (Kent et al. 2011; Ely & Pitman 2014). It is worth noting that green infrastructure as an ecological entity has developed over time and has lower capital, maintenance and operating costs (Jaffe et al. 2010). Compared to traditional infrastructure or "grey" infrastructure, it has fewer negative impacts on the environment and significantly reduces the carbon footprint (Benedict et al. 2006, Laforteza et al. 2013). Compared to gray infrastructure that tends to be designed for a single function, green infrastructure networks often serve multiple functions.

To meet the challenge of integrating green infrastructure planning into urban development, and move towards a more sustainable, resilient and healthier city, new ideas are needed. This article provides a theoretical basis for supporting effective interventions in protecting, managing and restoring urban ecosystems while reviewing the development of green infrastructure and combing the theoretical development.

## 2. Philosophy of Green Infrastructure

The key theory behind the concept of green infrastructure is the moral relationship between humans and the natural environment, called environmental ethics (Leopold 1948). There is no doubt that environmental philosophy is a controversial field. Among the many conflicts and debates, the opposition between anthropocentrism and eco-centrism is considered to be one of the most common ecological moral dilemmas (Kortenkampn & Moore 2001). The "land ethics"

of Aldo Leopold (1948) represents an early ecological center position. Other scholars such as McHarg (1969) proposed the philosophy of "design and nature", while James Lovelock (1969) explored nature's ability to design itself. Australian scholar John Passmore (1974) stressed in his book "Human Responsibility for Nature" that there is an urgent need to change human attitudes towards the environment and land ethics. At the same time, the contradiction between the constantly developing eco-centricism and anthropocentricism explains the prevalence of paradoxical environmental ethical decision-making. To evaluate decisions that consider human and natural rights equally, stakeholders must weigh possible consequences and determine which one should be given priority (MacKinnon 2007).

From this "dual rights" perspective, green infrastructure may provide a missing link between people, nature and the built environment. For example, to determine the best use of land to support natural processes, ecosystems, and leisure and other residential needs, green infrastructure systems of different sizes can embody a dual rights-based approach that includes both human-centric values and Ecocentric values. This is achieved through the integration of multidisciplinary factors, such as reducing pollution, habitat and biodiversity, improving quality of life, food, energy, entertainment and scenic value. Therefore, green infrastructure can be a cost-effective solution to many problems simultaneously (Austin 2014).

### 3. Evolution of the Concept of Green Infrastructure

The introduction of the concept of green infrastructure upgrades the urban green space system into a coherent planning entity (Sandstrom 2002). It can be considered to be composed of all natural, quasi-natural and artistic networks of multifunctional ecosystems in, around and between urban areas at all spatial levels. The concept of green infrastructure emphasizes the quality and quantity of green spaces in and around the city (Turner, 1996; Rudlin and Falk, 1999), their multifunctional role (Sandstrom, 2002), and the importance of the interconnection between residences (van der Ryn and Cowan, 1996). If green infrastructure is actively planned, developed and maintained, it is possible to guide urban development by providing a framework for economic growth and nature protection (Walmsley, 2006; Schrijnen, 2000; van der Ryn and Cowan, 1996). This planned approach will provide many opportunities for the integration of urban development, nature protection and public health development.

Jingxia Wang and Ellen (2018) summarized three mainstream trends in understanding the concept of GI: First, they changed the relationship between natural systems and human beings: bringing nature back to the human community, realizing the ecology-centric and human-centric The balance between methods; secondly, from the initial green infrastructure initiative to specific practical issues. "To what extent can green infrastructure function as a practical measure?" This question makes us realize that how to carry out this process is still a challenge. When linking theory and policy to push GI to the forefront of policy, the best practice is the UK. GI can also be a very valuable policy tool to promote sustainable development and intelligent growth by meeting multiple goals and responding to various needs and pressures (Ministry of the Environment of Europe, 2011). Finally, the research on the definition of green infrastructure has turned to the understanding of its versatility. More and more researchers emphasize the importance of versatility as a basic attribute of sustainable development (Selman, 2009; EC, 2012; Maes et al., 2013; Madureira and Andresen, 2014). The core idea of green infrastructure is its versatility, which is also one of its biggest advantages (Davies et al., 2006; Kimmel et al., 2013; Civic, 2014).

Pakzad and Osmond (2015, 2016) outline the definition of four green infrastructures. It is a policy and strategic approach to the protection of land and species; it is a network of energy, materials and species flows, combined with multifunctional land use to maintain And improve ecological functions and provide related benefits for humans and ecosystems; it refers to the

integration of ecological functions into traditional infrastructure systems through natural and engineering networks to enhance their functions and significantly reduce their carbon footprint; Ecosystem solutions based on the concept of ecosystem services are designed to improve the sustainability of urban and built environments. It contains the triple bottom line concept-the social, economic and environmental aspects of the urban environment.

#### **4. Evolution of the Conceptual Framework of Green Infrastructure**

Jabareen (2009) defines the conceptual framework as a comprehensive understanding of the network or interconnection of concepts involved in a phenomenon, and explains the integrity of each concept relative to other concepts. The academic community has established different conceptual frameworks for green infrastructure from different perspectives. Pickett et al. (1997; 2001) proposed a comprehensive framework of human ecosystems to analyze the social, biological and physical aspects of urban systems. The two interrelated parts of the framework are: the human social system, including social systems and social cycles; the resource system, including cultural and socio-economic resources, ecosystem structures and processes. Grimm et al. (2000) revised Pickett's human ecosystem framework based on changes in land use and land cover related to social and ecosystem interactions. Although these two models help to understand the general concept of green infrastructure, they do not clearly deal with the relationship between ecosystems and public health (Tzoulas et al. 2007).

Based on Maslow's level of human needs, Macintyre et al. (2002) proposed a healthy neighborhood relationship framework, which includes natural characteristics that affect health (such as clean air and water, and prevention of infection), social and cultural services (such as education, Recreation and community integration) and economic (such as work and transportation) factors, but does not recognize the importance of biodiversity habitats in contributing to these factors.

Another comprehensive framework established by the World Health Organization is called the "Health Arch" (WHO, 1998). The model illustrates the genetic factors of environment, culture, socioeconomics, working and living conditions, communities, lifestyles, and public health. Paton et al. (2005) combined the "health arch" model with organizational development principles (social, environmental, organizational, and personal factors) and system theory to enhance the application within the organization.

In 2003, the Millennium Ecosystem Assessment Agency established a framework to assess changes in global ecosystems and their impact on human and ecosystem health. The framework uses socioeconomic factors to link ecosystem services to human well-being. According to this framework, ecosystem services are divided into four categories: supply, management, support, and culture; human well-being is divided into five categories: safety, access to basic resources, health, good social relations, and freedom of choice (MEA 2003). Although this framework is very broad and includes many parameters, it does not "clearly distinguish the biological, psychological, and epidemiological aspects of health" (Tzoulas et al. 2007).

The comprehensive and complex model developed by Van Kamp et al. (2003) integrates various factors that affect the quality of life, including personal, social, cultural, community, natural and built environments, and economic factors. However, the relationship between these factors is not clear. TEP (2008) established the GI framework, whose functions are as follows: managing surface water and reducing flood risk; adjusting the urban environment to adapt to the resilience of climate change; encouraging foreign investment and retaining high-value workers and entrepreneurs; promoting health activities, Recreation and social cohesion; restoration of areas suffering from (actual or preliminary) poverty; maintenance of employment opportunities in the natural economy; maintenance and enhancement of unique biodiversity, landscapes and heritage; and promotion of sports and cultural development.

Tzulas et al. (2007) and Austin (2014) proposed a framework through a combination of three systems (ecosystem services, ecosystem health, and human well-being), although the specific methods are different. Their framework explains the relationship between the ecological benefits of green infrastructure and human values. These benefits help improve human health and well-being while protecting and maintaining the environment and natural resources. Based on the philosophy of anthropocentrism and eco-centrism, Pakzad and Osmond (2015, 2016), based on existing theories and models, link green infrastructure, ecosystems and human health and happiness. Facilities can optimize the relationship between human health and well-being, ecosystem health and ecosystem services. The connection between these three systems is very clear: a healthy ecosystem in a green infrastructure environment can increase ecological and cultural services, thereby improving human health and well-being within the scope of individuals and communities.

## 5. Conclusion

With the continuous deepening of research on green infrastructure in the academic and practical circles, the concept has begun to emphasize social and cultural impacts from a purely natural perspective, and is directly integrated into ecological and environmental services and human well-being. The construction of the conceptual framework is also more comprehensive. By emphasizing the versatility of green infrastructure, a conceptual system is established from multiple perspectives, thereby laying a foundation for evaluating the performance of green infrastructure.

## References

- [1] Pakzad P, Osmond P. Developing a Sustainability Indicator Set for Measuring Green Infrastructure Performance [J]. *Procedia-Social and Behavioral Sciences*, 2016, 216: 68-79.
- [2] Pakzad P, Osmond P, Corkery L. Developing Key Sustainability Indicators for Assessing Green Infrastructure Performance [J]. *Procedia Engineering*, 2017, 180: 146-156.
- [3] Jingxia, Wang, Ellen, B. Towards a better understanding of Green Infrastructure: A critical review [J]. *Ecological indicators: Integrating, monitoring, assessment and management*, (2018) 758-772.