International Journal in Management and Social Science
Volume 11 Issue 04, April 2023 ISSN: 2321-1784 Impact Factor: 7.088
Journal Homepage: http://ijmr.net.in, Email: irjmss@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal

ECOSYSTEM SERVICES AND HEALTH BENEFITS OF GREEN INFRASTRUCTURE IN CITIES

[1]Olaide Oladiran and [2]Grace Oloukoi (FNITP)

1. Doctoral Candidate, Built Environment, Department of Urban and Regional Planning, Lead City University, Ibadan.
2. Department of Urban and Regional Planning, Lead City University, Ibadan.

Abstract

Conversations studies urban ecology and other environmental research have prompted interest in green infrastructure. Addressing impact of the urban growth on the environment and on human well-being is the basis for development of Green Infrastructure in managing urban ecosystems. The research uses a thematic literature analysis to emphasize the ecosystem services and health advantages of green infrastructure in cities. There are four ecosystem service types: supporting, provisioning, regulating, and cultural services. Improvements in air quality, water filtration, physical activity, leisure time, and a drop in city surface temperatures are all beneficial to health. The social, ecological, and economic needs of green infrastructure, the services and functions of the ecosystem, the vegetation capable of generating a particular ecosystem, and the economic benefits of the ecosystem were identified as the four design processes for green infrastructure. Focusing on some place-based theories, the paper presents important design process for GI and its policy relevancies towards managing urban environment. The paper concludes that green infrastructure has acquired prominence in spatial planning, policy, and research and is a network of components that supports human health, quality of life, and advantages for the environment, economy, and society.

Keywords: *Ecosystem Service, Health Benefits, Green Infrastructure, Cities*

1.0 INTRODUCTION

Patrycia Brzoska and Aiga Spe (2020) opined that in recent years, the more comprehensive term "sustainability" has gained international recognition as environmental challenges have started to infiltrate urban discourse more and more. To evaluate the success of sustainability actions, a wide range of evaluation frameworks, sustainability indicators, and rating methods have been created. Undoubtedly, one of the key strategies for developing and evaluating sustainable urban development, policy, and management is urban ecology. Urban ecosystems can be assessed using a variety of techniques, but an integrated assessment approach that considers the full spectrum of ecosystem services required to maximize sustainability results is still elusive. A new idea known as "green" infrastructure, as opposed to traditional "grey" infrastructure, is connected to naturally occurring and artificially created ecosystems and the benefits they offer. Although

there isn't a single definition for "green infrastructure" that applies to all-natural, semi-natural, and constructed networks of multifunctional ecological systems in, around, and between urban centres at all temporal and spatial scales, this description is frequently accepted.

The term "eco" refers to a region of the world, while the term "system" refers to the coordinating elements, according to Balasubramanian. The habitat's living inhabitants and the environment in which they live work together as one cohesive system. An "ecosystem" is this ecological unit (Ma Q Li, 2021).

According to Elmquist (2015), an ecosystem is an ecological system made up of all the creatures and their surrounding physical environment. The nutrition cycles and energy flows connect these biotic and abiotic elements. According to the Ecological Society of America (2019), both internal and external forces influence ecosystems. External variables that do not directly affect an ecosystem, such as topography, parent material that creates the soil, and climate, control the ecosystem's general structure. For instance, decomposition, root competition, shade, disturbance, succession, and the kinds of species present all regulate internal variables. While the availability of these resources within the ecosystem is normally governed by internal factors, the resource inputs are often controlled by external activities. As a result, interior variables influence ecological processes as well as being influenced by them. The ecosystem's balance is maintained by these biotic and abiotic interactions. According to the National Geographic Society (2021), it includes humans as a vital component.

From spiritual and faith-based perspective, Green Infrastructure is relevant to sustenance of lives on earth, provision of food and medicine for human and modification of ecological systems (Genesis 1:30, KJV) of the Holy Bible and Quaran 36:33-36.

There are millions of species on the planet. Every organism depends on at least one other organism for energy, survival, and other life functions. Because of how interdependent creatures are on one another and their environment, this interacting system is known as an ecosystem. T. Elmquist et al (2015). A clearly defined habitat depends on the interactions between several ecosystem components. Humans gain greatly from the biotic and abiotic components of an ecosystem. The term "ecosystem services" refers to all these advantages. On earth, these services are necessary for life and biodiversity.

The processes by which the environment generates resources that we frequently take for granted, such as clean water, lumber, habitat for fisheries, and pollination of native and cultivated plants, are known as ecosystem services. The ecosystems in which humans live give commodities and services that are quite recognizable to us, whether we are in the city or a rural location WHO (2019).

The processes by which the environment generates resources that we frequently take for granted, such as clean water, lumber, habitat for fisheries, and pollination of native and cultivated plants, are known as ecosystem services. The ecosystems in which humans live give commodities and services that are quite recognizable to us, whether we are in the city or a rural location. National Geographic Society (2019).

Ecosystems are made up of a complex network of interactions between the local environment's living things, resources, and habitats, including the soil, rocks, minerals, water sources, plants, animals, fish, birds, and microorganisms. Numerous ecosystem services contribute to our overall health and happiness. Along with the provision of raw materials for industry and agriculture, these include the provision of resources for basic survival, such as clean air, water, and genetic resources for medicines. However, by providing accessible urban and rural spaces for leisure and contact with nature, ecosystem services also help to improve mental and physical health. Participating in physical activity in green places and witnessing natural ecosystems have significant impact on human health and well-being.

Green infrastructure refers to network of green spaces and pathways. These open areas, such as parks and gardens, allotments, woodlands, fields, hedges, lakes, ponds, playing fields, coastal habitats, as well as pathways, cycleways, or rivers, are examples of green infrastructure assets. Blue infrastructure refers to assets that involve water, while the term "green infrastructure" encompasses all of these. These resources include places for entertainment and learning, habitats for wildlife, and environmental functions like flood defense or air pollution absorption. We would live different lives if they didn't exist. They are essential infrastructure that enables us to exist as we do is identified as including these natural and semi-natural places, for this reason, Vich G et al (2019).

A "strategic network of natural and semi-natural areas with other environmental features that are planned and managed to provide a wide range of ecosystem services" is termed as "green infrastructure" Alcock Ian (2014)." In terrestrial (including coastal) and marine environments, green spaces (or blue spaces in the case of aquatic ecosystems) and other physical qualities are included. GI can be found in both rural and urban places on land." When these strategically planned networks of green elements are linked together, they can provide a variety of benefits, including supporting a green economy, improving quality of life, protecting biodiversity, and improving ecosystems' ability to provide services like disaster risk reduction, water purification, air quality, recreational space, and climate change mitigation and adaptation, Alcock Ian (2014).

According to Andersson Erik et al. (2019), Increased physical and mental health benefits in the neighbourhood are a result of green infrastructure, which is good for people's health. As physical health has improved, so has physical activity. More greenery in a location is linked to higher levels of physical activity and better physical health outcomes, even in small-scale initiatives like

pocket parks. Additionally, it has been shown that exercising outdoors is better for physical health indicators like blood pressure, obesity, and heart disease risk than exercising inside, according to Badru (2019). Spending time in natural settings, particularly those produced by low-green infrastructure elements like urban trees, is associated with lower levels of cortisol and other physical stress markers. Those who suffer from depression, anxiety, and mood disorders are less likely to seek treatment and medicine in areas with high amounts of urban greenery. This implies that stress and worry will hurt mental health. Badru (2019).

This paper presents the benefits that can be derived from Green Infrastructure as Ecosystem Services and human health. There are five sections in the paper. Following the introduction is a brief overview of literature to conceptualize Green Infrastructure. The next section describes the methodology approach for the paper. In the third and fourth section, ecosystem services and health benefits that can be derived from Green Infrastructure. The fifth section considers the policy implications of Green Infrastructure development in managing urban ecosystem.

2.0 METHODOLOGY APPROACH

Although regarded as relatively new, the two fields of study, namely green infrastructure and ecosystem services studies, have grown considerably over the past two decades. Therefore, quantitative literature studies have been conducted separately in both fields of study. Although the concepts of these have begun to be used together in urban planning-based studies, very few bibliometric analyses of joint studies have been made on its health benefits. For this reason, in this study the aim is by emphasizing ecosystem services and the health benefits of green infrastructure in cities. The methodology approach in this study is based on conceptual issues and literature reviews. The conceptual issues reviewed were used to discuss the implication of this study to green infrastructure studies and policies.

3.0 CONCEPTUAL ISSUES AND LITERATURE OVERVIEW

A development idea known as "green infrastructure" (GI) aims to connect people to the natural environment by fusing development with nature. Green infrastructure refers to the provision of services in a way that benefits both people and the environment. On the other hand, GI was employed, depending on the circumstance, to demonstrate several advantages. Most definitions of "green infrastructure" emphasize connectedness and versatility. "Badiu et al" (2018). Although there isn't a universally agreed-upon definition of green infrastructure, there are common multifunctional applications, such as connecting community use with better air quality, water quality, and water quantity management by restoring the hydrologic function of the urban landscape, managing stormwater at its source, and frequently lowering the need for additional grey infrastructure, etc. Berg (2010) Streets, parking lots, and landscaped areas are examples of

contemporary built environment features that can incorporate green infrastructure initiatives. For controlling stormwater in highly urbanized and infill situations when development density is desirable and offshore mitigation is not an option, green infrastructure technologies can be a practical solution. According to Bivina (2019), green infrastructure is natural resource management that uses plants, soils, and natural processes to manage water and create better habitats. This definition comes from the United States Environmental Protection Agency. Bivina (2019).

There are seventeen (17) different kinds of green infrastructure, according to Allen (2014), that are best suited for urban, suburban, and rural setting. There are also Xeriscaping, Constructed Wetlands, Dry Ponds, Filter Strip, Green Roof, Green Wall, Hedgerows, Perforated Pipe, Permeable Pavement, Rain Garden and Bioretention, Rain Harvesting, Riparian Buffer, Soak aways, Infiltration Trenches and Chambers, Tree Canopy Expansion, Wet Pond.

Green Infrastructure

According to Bivina (2019), the use of green infrastructure in the built environment is one potential urban planning strategy for enhancing the sustainability of cities for growing urban populations and improving air quality. According to the United Nations, there will be 2.5 billion more people living in cities by 2050 than there were in 2018. On the other hand, major social, economic, and environmental issues, including poverty, unemployment, increased crime, political instability, a loss of biodiversity, pollution, and the depletion of natural resources, are faced by cities. Urban areas are major contributors to climate change as they are responsible for other human-made activities including agriculture and greenhouse gas emissions (2021). Numerous ecosystem services and naturally occurring solutions have been developed globally to address these issues, such as the creation of green infrastructure, which benefits both environmental protection and human well-being. Marie Brown (2018)

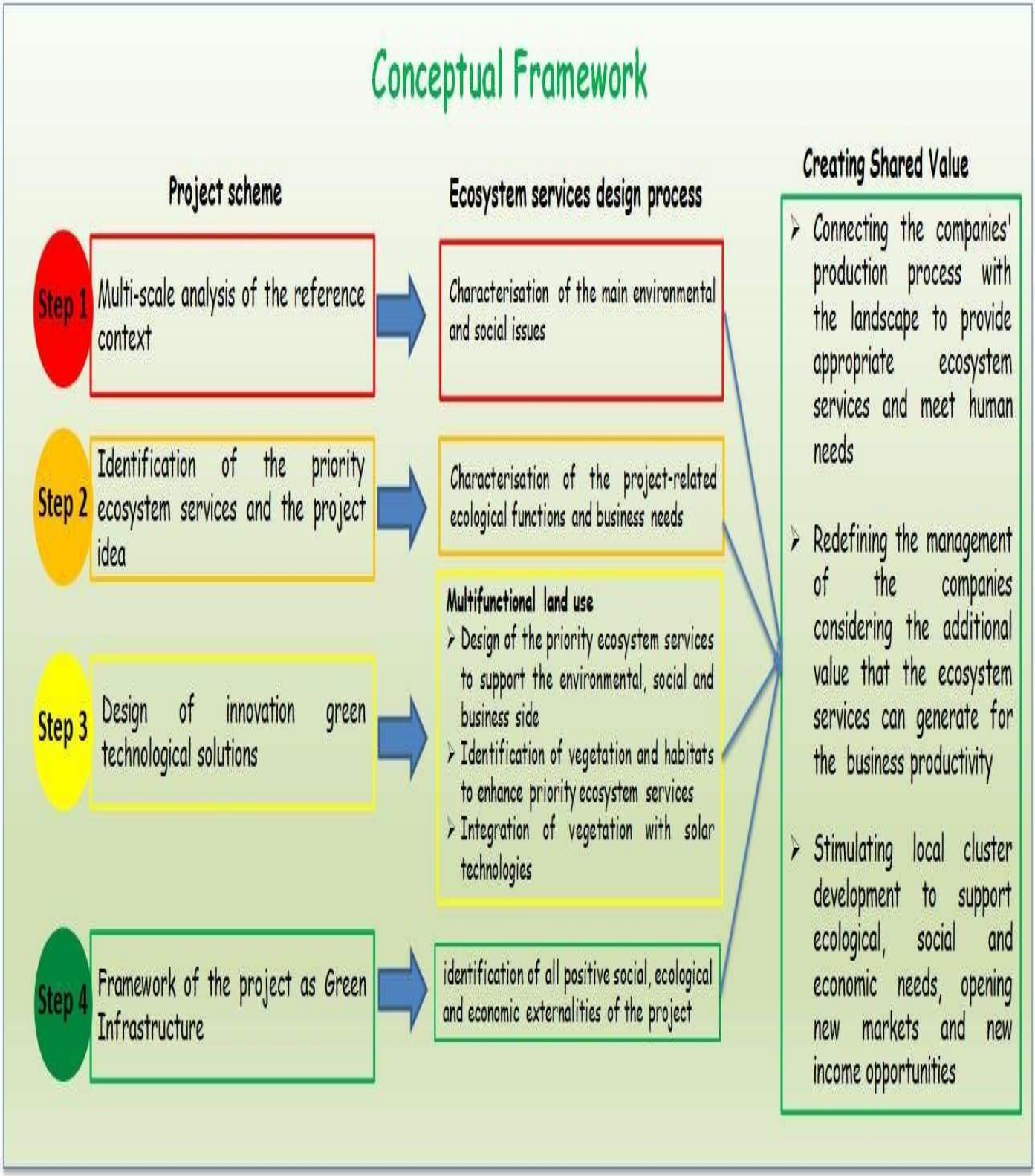
Ecology

Bodo (2021) said the ecological footprint and green infrastructure are related. The ecological footprint determines how much nature is required to sustain a certain population or level of economic activity. It keeps track of this demand through a system of ecological accounting. The reports contrast the biologically productive areas that people use for consumption with the biologically productive areas that are accessible in a region or globally (biocapacity). In a nutshell, it demonstrates how much the human economy depends on natural resources and acts as a gauge of how humans are harming the planet's ecology. The ecological footprint is the total area of biologically productive land needed to produce all human sustenance, including all fruits, vegetables, fish, wood, and textiles, as well as the area required for infrastructures like buildings and roads. Numerous scales can be used to calculate the ecological footprint. For instance, the

Global Footprint and City Ecological Footprint are the two measurements. According to Breuste et al. (2015), the former assesses ecological displacement while the latter measures ecosystem health.

Since the turn of the century, green infrastructure has become more and more well-liked by academics, urban planners, politicians, and practitioners everywhere. In his 2015 study on green infrastructure, ecosystem services, and human health, Christopher Coutts categorized the effects of the built environment, natural environment, and global ecosystem on local economies, communities, and lifestyles. In 2019, Donghyun Kim and Seul-Ki Song conducted an analytical assessment of community development and green infrastructure using 447 project case studies. The Sustainable Development Goals (SDGs) and Green Infrastructure were the focus of the work of Scott Hawken et al (2021). Their study represented an analytical innovation for putting green infrastructure and sustainable development goals into practice in cities. Several planning guidelines for green infrastructure were found by Boncinelli, Fabio, et al (2015). Most of these ideas are very theoretical and do not consider how green infrastructure is used and implemented in spatial planning. New management strategies for green infrastructure, ecosystem services, and their health advantages must also be taken into consideration to match today's reality and prospects in terms of environmental and urban planning. The way decisions are made is changing as a result of urbanization, population growth, and new problems, including socioeconomic obstacles, environmental deterioration, urban sprawl, and population growth. Thus, this essay focuses on the city as a unit of spatial design while discussing the ecological services and health advantages of green infrastructure.

The most popular conceptual framework that are used to evaluate Green Infrastructure performance was developed by Samerato et al (2018). The framework presented four (4) steps of Green Infrastructure Project Design (Figure 1). This is represented diagrammatically below


Conceptual Framework
Project scheme
Ecosystem services design process
Creating Shared Value
Step 1
Multi-scale analysis of the reference context
Characterisation of the main environmental and social issues
Step 2
Identification of the priority ecosystem services and the project idea
Characterisation of the project-related ecological functions and business needs
Step 3
Design of innovation green technological solutions
Multifunctional land use
Design of the priority ecosystem services to support the environmental, social and business side
Identification of vegetation and habitats to enhance priority ecosystem services
Integration of vegetation with solar technologies
Step 4
Framework of the project as Green Infrastructure
identification of all positive social, ecological and economic externalities of the project
Connecting the companies' production process with the landscape to provide appropriate ecosystem services and meet human needs
Redefining the management of the companies considering the additional value that the ecosystem services can generate for the business productivity
Stimulating local cluster development to support ecological, social and economic needs, opening new markets and new income opportunities

Source: Samerato et al (2018)

Fig 1: The conceptual framework developed by Samerato et al.

As shown in figure 1, there are four steps in green infrastructure project design. These are:

- **Step 1:** Determine the social, ecological, and economic needs of GI and the context of reference, including landscape issues analysis on a regional level for GI, considering current vegetation types and the relationship between "pore space" and "full space".
- **Step 2.** Identification of the most important ecosystem services, as well as the primary biophysical structures and ecological functions that we wish to emphasize in the GI's design.
- **Step 3.** Indication of the pattern relationship and interaction between vegetation capable of producing specific ecosystem services and panel technology (height above the ground, distance between panels): characterization of the activities undertaken to reduce the risk of fire and shading of the panels due to uncontrolled vegetation growth.
- **Step 4**. Identification of social-ecological and prospective commercial benefits: definition of all ecosystem functions that can be supported by GI solutions, as well as potential economic income.

The framework was proposed in Southern Italy as a guide for the development of green infrastructure and adopted in Australia.

4.0 ECOSYSTEM SERVICES AND HEALTH BENEFITS OF GREEN INFRASTRUCTURE IN CITIES

4.1 Ecosystem Services

The idea of ecological infrastructure describes how plants and water in or near constructed environments contribute to the delivery of ecosystem services at various spatial scales (buildings, streets, neighbourhood, and regions). All "green and blue spaces" that can be found in urban and peri-urban regions are included in it, including parks, cemeteries, gardens, yards, urban allotments, urban forests, single trees, green roofs, wetlands, streams, rivers, lakes, and ponds. Scognamiglio (2016). Because many of the key fluxes and interactions required to comprehend the functioning of urban ecosystems stretch far beyond the metropolitan bounds defined by political or biophysical considerations, defining unambiguous boundaries for urban ecosystems frequently proves challenging. As a result, the relevant scope of urban ecosystem analysis extends beyond the city limits; it also includes the hinterlands that are immediately impacted by the energy and material fluxes from the urban core and suburban regions. European Environmental Agency (2010), which also includes cultivated fields, peri-urban woods, and municipal catchments. Although almost every ecosystem is relevant to meet the demands for ecosystem services in urban areas, the focus here is on the services offered there.

There are four ecosystem services which were identified by Oloukoi and Kehinde (2020).

1. **Supporting Services:** nutrients cycles, soil formation, and production
2. **Provision Services:** food, spices, raw materials, medicinal, minerals and energy (biomass, hydro and solar)
3. **Regulating Services:** waste decomposition, pest and disease control, water and air purification, carbon sequestration.
4. **Cultural Services:** recreation, scientific research, and discovery, historical and spiritual.

4.2 THE HEALTH BENEFITS

Source: U.S. Environmental Protection Agency

Fig. 2: Environmental, social, economic, and public health benefits of green infrastructure

Green infrastructure fosters community identity and a sense of well-being, improves safety, enhances exposure to the natural environment, lowers exposure to dangerous conditions and substances, and gives economic advantages to both the community and the individual. Green infrastructure is the integration of ecosystems and nature into cities, towns, and regions to produce a variety of positive outcomes, including improved storm water management, public health, and clean air. It is a planned system of natural areas and open spaces at the regional level, including parks and nature preserves, river corridors, greenways and paths, forests, and wetlands. It comprises parks, rain gardens, green streets, green walls and roofs, community gardens, and the urban forest at the scale of neighbourhood and individual sites. This fact sheet provides

information that city and regional planners, public health specialists, municipal authorities, and community leaders can utilize to improve individual and community health. The health of a community is influenced by a variety of social and environmental issues, some of which green infrastructure may help to mitigate. Understanding the health advantages of green infrastructure is made easier by using the three "pillars" of sustainability (economy, environment, and equality). Following further definitions, best practices, and examples, Table 1 below provides instances of how green infrastructure supports health through each of these pillars.

Economy	Environment	Equity
Green infrastructure investments provide jobs and enable green communities that promote physical activity, resulting in reduced healthcare costs.	Street trees and other components of the urban forest provide health benefits for urban populations by improving air and water quality, reducing heat island effects, and supporting walkable communities.	Green infrastructure can address the conditions that lead to disparities in health outcomes for poor and marginalized communities (environmental justice).

Table 1: Pillars of Green Infrastructure that promote Health

Source: American Planning Association (2015)

The nexus between ecosystem services and health benefits of Green Infrastructure is well captured in some Sustainable Development Goals SDGs target. The Sustainable Development Goals (SDGs), also referred to as the Global Goals, are a collection of 17 global objectives that are interconnected and serve as a "blueprint for a better and more sustainable future for all." The Sustainable Development Goals (SDGs) were established by the UN General Assembly (UN-GA) in 2015 to complete them by 2030. They are a part of the United Nations General Assembly's 2030 Agenda, also referred to as Agenda 2030. Diaz-Sarachaga, Jose Manuel (2016). The Millennium Development Goals, which were replaced by the Sustainable Development Goals (SDGs) in the Post-2015 Development Agenda, ran out of steam in 2015.

There are 17 Sustainable Development Goals (SDGs): No Poverty, Zero Hunger, Good Health and Well-Being, Quality Education, Gender Equality, Clean Water and Sanitation, Affordable and Clean Energy, Decent Work and Economic Growth, Industry, Innovation and Infrastructure, Reduced Inequality, Sustainable Cities and Communities, Responsible Consumption and Production, Climate Action, Life Below Water, Life on Land, Peace, Justice, and Stability. The SDGs are broad and interconnected, but a UN Resolution passed by the General Assembly two years later (6 July 2017) makes them more "actionable." The resolution specifies specific targets for each goal and includes indicators that will be used to monitor progress toward those goals. Typically, the goal's completion year falls between 2020 and 2030. Some of the goals, according to Jose Manuel Diaz-Sarachaga (2016), have no specified completion date.

It is clear that;

- The idea of GI is to use active management of nature and for the benefits of ecosystem.
- These advantages can range from recreational activities to supporting health, supplying food or clean air, creating green jobs, and many other things. The more GI aspects are linked together, the more benefits we can harness, attaining more SDGs.

GI also exemplifies the SDGs' mindset: a partnership approach (SDG 17), in which GI elements are valuable community assets that must be managed to maximize benefits for all stakeholders. Agendas 1, 2, 3, 6, 11, and 13 strong support for green infrastructure. Jose Manuel Diaz-Sarachaga (2016).

SUSTAINABLE DEVELOPMENT GOALS CHAT

Source: UN Sustainable Development Goals Chat of 2015

Fig. 3: Sustainable Development Goals Chat

The idea of Green Infrastructure is not new in the field of urban planning, urban studies, and urban ecology. It is like a new wine in an old skin. There are old space-based theories that are very relevant to Green Infrastructure even though, they were not regarded as Green Infrastructure when they were evolving. For example, the Garden City Theory of Ebenezer Howard **(year)** focus on bringing nature into the planning and development of cities. This of course will be able to check urban expansion at the expense of nature and agricultural lands. However, the benefits of Ebenezer Howard Garden City Theory are establishing green parks, create permanent belt for agricultural lands, and controlled urban expansion by limiting city population size whereby creating new lands for urban development.

Also, the theory of Urban Ecology is very relevant to Green Infrastructure. The theory focusses on urban ecosystems which integrate natural, built and socioeconomic system of the environment. The benefits derived from Urban Ecology Theory is that focuses on the design of environmental amenities for people in cities and reducing the environmental impacts of urban regions. It ensures balance of nature and built environment to achieve a resilience in cities. Resilience in the sense that urban areas are densely populated and if there is no balance nature and built environment may not work symbiotically.

Urban Forestry Theory which focusses on the planting, maintenance, care and protection of tree populations in urban settings also support Green Infrastructure. The major components aof urban forestry theory are trees, shrubs, and green space as well as the soil and water that support them and its benefit is to see the role of trees is an essential function of city planning and urban infrastructure.

4.3 IMPLICATION FOR GREEN INFRASTRUCTURE STUDIES AND POLICIES

A network of interconnected green and/or blue areas called "green infrastructure" (GI) is built through a strategic planning approach to solve challenges including landscape fragmentation, ecological and social effects of urban sprawl, and land conservation. GI can be used to plan urban areas in a way that protects and upholds the integrity of natural and cultural functions and ensures the cities' long-term viability (sustainability). Governments are frequently in charge of implementing GI because of their mission to plan and invest in urban infrastructure. They can influence what types of infrastructure are renewed and expanded, as well as how to encourage more environmentally friendly and sustainable cities.

There is still a lot of uncertainty in planning practice over how to apply the GI approach, at what scales, and at what stages of the planning process, despite numerous outstanding practice examples of mature spatial planning systems that incorporate a GI approach. Additionally, it is not always clear how to maximize the approach's integrative capacity to support long-term progress. To help national, regional, and municipal governments better understand how GI may be formed, maintained, and improved in urban contexts, this policy brief was created. In summary, it is crucial to remember the following critical policy messages:

i. Because of unsustainable urbanization, many cities have lost green places. Continuous GI development monitoring is essential for identifying areas where the action is needed to prevent green spaces from disappearing.
ii. Cities could combat natural capital deterioration and loss, as well as the ecosystem benefits that this capital can deliver. Governments oversee urban infrastructure planning and investment. They have significant influence over the type of infrastructure built, renewed, or expanded, as well as the promotion of greener and more sustainable cities.

iii. The most important aspect of GI implementation is a shared strategic vision among policymakers and planners, which is implemented through an integrated planning process that incorporates various sector policies and levels of governance.

iv. The Strategic Environmental Assessment (SEA) is a policy tool that can be used to include GI in strategies, plans, and programs. Incorporating GI into SEA could aid in the development of a common framework for implementing GI in all cities, in which GI is promoted not only as a sectoral element of planning but also as a tool for improving strategic thinking and positioning ecological processes and benefits as relevant planning criteria for more resilient territorial development.

5.0 CONCLUSION

This paper presents an overview of ecosystem services and health benefits of Green Infrastructure. It is evident from the literature that Green Infrastructure may connotes a new concept in the management of urban space which is developed to address ecological sustainability and human well-being crisis. Existing theories such as Ebenezer Howard Garden City Theory indicates that application of Green Infrastructure have been from the time immemorial in urban studies, urban planning and urban ecology. It is therefore important that the development of Green Infrastructure should not be done in isolation but it should be integrated into urban land use planning given that it is a crux to sustain the ecosystem, supports human health foster carbon sinking controls, extreme urban heat and flooding.

References

Alcock, I., White, M. P., Wheeler, B. W., Fleming, L. E., & Depledge, M. H. Longitudinal (2014). Effects on Mental Health of Moving to Greener and Less Green Urban Areas. *Environmental Science & Technology*, *48*(2), 1247–1255. https://doi.org/10.1021/es403688w

Andersson, E., Langemeyer, J., Borgström, S., McPhearson, T., Haase, D., Kronenberg, J., Barton, D. N., Davis, M., Naumann, S., Röschel, L., & Baró, F. (2019). Enabling Green and Blue Infrastructure to Improve Contributions to Human Well-Being and Equity in Urban Systems. *BioScience*, *69*(7), 566–574. https://doi.org/10.1093/biosci/biz058

Badiu, D. L., Onose, D. A., Niță, M. R., & Lafortezza, R. (2019). From "red" to green? A look into the evolution of green spaces in a post-socialist city. *Landscape and Urban Planning*, *187*, 156–164. https://doi.org/10.1016/j.landurbplan.2018.07.015.

Bivina, G. R., & Parida, M. (2019). Modelling Perceived Pedestrian Level of Service of Sidewalks: A Structural Equation Approach. *Transport*, *34*(3), 339–350.

https://doi.org/10.3846/transport.2019.9819

Breuste, J., Artmann, M., Li, J., & Xie, M. (2015). Special Issue on Green Infrastructure for Urban Sustainability. *Journal of Urban Planning and Development*, *141*(3), A2015001. https://doi.org/10.1061/(asce)up.1943-5444.0000291

Brzoska, P., & Spāģe, A. (2020). From City- to Site-Dimension: Assessing the Urban Ecosystem Services of Different Types of Green Infrastructure. *Land*, *9*(5), 150. https://doi.org/10.3390/land9050150

Diaz-Sarachaga, J. M. (2020). Combining Participatory Processes and Sustainable Development Goals to Revitalize a Rural Area in Cantabria (Spain). *Land*, *9*(11), 412. https://doi.org/10.3390/land9110412

Diaz-Sarachaga, J. M., Jato-Espino, D., & Castro-Fresno, D. (2018). Is the Sustainable Development Goals (SDG) index an adequate framework to measure the progress of the 2030 Agenda? *Sustainable Development*, *26*(6), 663–671. https://doi.org/10.1002/sd.1735

Du, Y., Xu, Y., Wang, X., Liu, L., & Ma, PEEG (2022). Temporal–Spatial Transformer for Person Identification. *Scientific Reports*, *12*(1). https://doi.org/10.1038/s41598-022-18502-3

Elmqvist, T., Setälä, H., Handel, S., van der Ploeg, S., Aronson, J., Blignaut, J., Gómez-Baggethun, E., Nowak, D., Kronenberg, J., & de Groot, R (2015). Benefits of restoring ecosystem services in urban areas. *Current Opinion in Environmental Sustainability*, *14*(14), 101–108. https://doi.org/10.1016/j.cosust.2015.05.001

Semeraro, T., Aretano, R., Barca, A., Pomes, A., Del Giudice, C., Gatto, E., Lenucci, M., Buccolieri, R., Emmanuel, R., Gao, Z., & Scognamiglio, A. (2020). A Conceptual Framework to Design Green Infrastructure: Ecosystem Services as an Opportunity for Creating Shared Value in Ground Photovoltaic Systems. *Land*, *9*(8), 238. https://doi.org/10.3390/land9080238

Semeraro, T., Pomes, A., Del Giudice, C., Negro, D., & Aretano, R. (2018). Planning ground-based utility scale solar energy as green infrastructure to enhance ecosystem services. *Energy Policy*, *117*, 218–227. https://doi.org/10.1016/j.enpol.2018.01.050

Sullivan, W. C., Frumkin, H., Jackson, R. J., & Chang, C.-Y. (2014). Gaia meets Asclepius: Creating healthy places. *Landscape and Urban Planning*, *127*, 182–184. https://doi.org/10.1016/j.landurbplan.2014.03.005

van den Berg, A. E., Maas, J., Verheij, R. A., & Groenewegen, P. P. Green space as a buffer between stressful life events and health. *Social Science & Medicine*, *70*(8), 1203–1210. (2010). https://doi.org/10.1016/j.socscimed.2010.01.002

Vich, G., Marquet, O., & Miralles-Guasch, C. (2019). Green streetscape and walking: Exploring active mobility patterns in dense and compact cities. *Journal of Transport & Health*, *12*, 50–59. https://doi.org/10.1016/j.jth.2018.11.003

Vich, G., Marquet, O., & Miralles-Guasch, C. (2019). Green exposure of walking routes and residential areas using smartphone tracking data and GIS in a Mediterranean city. *Urban Forestry & Urban Greening*, *40*, 275–285. https://doi.org/10.1016/j.ufug.2018.08.008

.