URBAN GREEN SPACES FOR BIODIVERSITY RECOVERY

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Recibido 17 de mayo de 2021 | Aceptado 27 de noviembre de 2021

Abstract – Global population growth has led to the loss of biodiversity, especially in urban areas. Biological diversity offers humans all the resources for survival. This article discusses the value of ecological diversity, the anthropogenic effect, and how the variety of living beings has adapted to urban green spaces. This literature review was based on the database available in *Google Scholar.* Man-made risks of resource demands have been amplified by new dangers such as climate change affecting the system of nature and humans. Urban green spaces are a form of restoration, rehabilitation of ecological diversity. For example, public and private courtyards, green corridors, green roofs, and other green infrastructure are positive for biodiversity and the health and survival of humans. The perception that biological, ecological, genetic, species, and ecosystems cannot be adapted has changed with urban green spaces suitable for a sustainable and resilient society in balance with the environment. These can only be obtained through formal and non-formal education at all levels. Establish strategies that identify and prioritize species and ecosystems through stricter enforcement of laws, norms, and management to save and slow the loss of what sustains life.

Keywords: biodiversity, biodiversity conservation, biodiversity corridors, green spaces, urban areas, urban biodiversity, urban green spaces.

Resumen – El crecimiento de la población a nivel mundial ha provocado la pérdida de biodiversidad especialmente en las áreas urbanas. La diversidad biológica ofrece a los seres humanos todos los recursos necesarios para la supervivencia. Este artículo expone el valor de la diversidad ecológica, el efecto antropogénico y cómo la variedad de seres vivos se ha adaptado a los espacios verdes urbanos. Esta literatura revisada se basó en la búsqueda de artículos de las bases de datos disponibles en *Google Scholar.* Los riesgos causados por el hombre de las demandas de recursos se han amplificado con nuevos peligros como el cambio climático que afecta tanto a la naturaleza como al sistema humano. Los espacios verdes urbanos son una forma de restauración, rehabilitación de la diversidad ecológica. Por ejemplo, patios públicos y privados, corredores verdes, techos verdes, u otras infraestructuras verdes son positivas para la biodiversidad, la salud y supervivencia de los seres humanos. La percepción de que los ecosistemas biológicos, ecológicos, genéticos y de especies no pueden adaptarse ha cambiado con espacios verdes urbanos adecuados para una sociedad sostenible y resiliente en equilibrio con

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el medio ambiente. La apreciación hacia los espacios urbanos solo se puede lograr a través de la educación formal y no formal en todos los niveles. Establecer estrategias que identifiquen y prioricen las especies y ecosistemas a través de una aplicación más estricta de leyes, normas y gestión para salvar y disminuir la pérdida de lo que sostiene la vida.

Palabras clave: biodiversidad, conservación de la biodiversidad, corredores de biodiversidad, espacios verdes, biodiversidad urbana, áreas urbanas, espacios verdes urbanos.

Introducción

The high incidence of population growth in urban areas and climate change has led to biodiversity loss and adaptation in urban green spaces. The United Nations Convention on Biological Diversity (UNCBD) as a multilateral treaty in 1992 that defines biodiversity also referred to as biological diversity as the variability among living organisms from all sources including, inter alia, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems. Species are organized at various levels, from entire ecosystems to biochemical structures that form the molecular basis of inheritance. Biodiversity covers different ecosystems, species, and genes. Ecosystems, species, and genes are fundamental in the representation of the biological diversity in the world because it supports all forms of life. For biodiversity, the key elements include the richness of local and global species; genetic diversity of populations and species; the spatial extent and state of natural habitats; and the functioning of ecosystems that are essential for humanity to survive (Savard et al., 2018). Is important to recognize the interconnection that exists of the biological diversity as the life on Earth between humanity and ecosystems because they are dependent on one another. Biological diversity offers humans all sources of survival and livelihood. As well, contributes to the resiliency, security, health, and balance of all the environments.

Biodiversity has been lost through human population growth, urbanization, deforestation, and extreme consumption of resources as established by many scientists, studies, literature, environmental conventions, organizations, and many others. Some of the factors of these losses are the destruction of habitats, disappearance of species, elevated temperatures leading to climate change. Although cities are centers of consumption and land-use change, they represent a considerable opportunity for forwarding global sustainability and environmental goals (Nilon et al., 2017). While habitat loss or change is correlated with the pattern of species loss in cities, the processes associated with habitat change underlying

urban species loss are not well studied or understood (Shochat et al., 2010). Even though anthropogenic actions have been fundamentally significantly irreversible to biodiversity loss, there is a window of hope in biodiversity adaptation in urban spaces. Human-dominated urban environments once considered ecological "lost causes" are functional ecosystems and are increasingly recognized as valuable targets for species conservation and biodiversity management. Research has shown that species living in cities can change rapidly in response to anthropogenic environments (Lambert & Donihue, 2020).

Despite common misconceptions that cities are poor in species, new evidence suggests otherwise and that urban green spaces are vital to support urban biodiversity (Aronson et al., 2017). How animals select and move between partially or fully disjunctive resource patches to meet their energy and life history requirements greatly accelerates our understanding of ecological processes and animal responses to changing environments (Stewart et al., 2019). Given the multi-faceted and multi-directional effects of urbanization on urban nature, a key question for developing sustainable and biodiverse cities is how different urbanization drivers translate to opportunities or challenges for urban biodiversity in general, and for different groups of species (von der Lippe et al., 2020). Urban green spaces are contributing to biodiversity supplying the cities with adequate vegetation to help with temperatures, pollution control, reproduction of species, conservation of plants, soil, and water. These important aspects of urban green spaces contribute to maintaining a sustainable, sufficient urban landscape, and consequently, the biodiversity gain.

In this literature review, I present the importance of biodiversity; the impact of urbanization, and anthropogenic actions that affect biological diversity. As well, how biodiversity has adapted creating urban green spaces and how the green spaces are critical for biodiversity adaptation and growth. This is fundamental culturally, socially, economically, and environmentally well-being for human beings' resilience and sustainability.

Method

I conducted a literature review using the database Google Scholar. My search strategy applied terms associated with seven concepts: *biodiversity, biodiversity conservation, biodiversity corridors, green spaces, urban areas, urban biodiversity, urban green spaces*. The words were identified creating relevance and relation to the role of ecology diversity, human-caused damages, and the new ways of contributing to slowing down the ecological loss. The scholarly literature used was a worldwide search of around 50 to 60 articles and studies from the year range of 2010 through 2021.

The review analysis started in 2010, the same year the United Nations General Assembly proclaimed as the International Year of Biodiversity. This year coincides with the 2010 Biodiversity Target adopted by the Parties to the Convention on Biological Diversity and by Heads of State and Government at the World Summit for Sustainable Development in Johannesburg in 2002. The goals stated in the Convention were: 1) to amplify public awareness on the importance of conserving and on the underlying threats the variety of living things; 2) raise awareness of the accomplishments by communities and governments, 3) promote solutions to reduce these threats; 4) turn to all individuals, organizations, and governments to take immediate steps to halt ecosystems loss and, 5) commence dialogue among stakeholders on the steps for the post-2010 period. Therefore, the range is amplified because of the global relevance of the year 2010 and all the exploration, analysis made after this year because of the international significance. Is relevant to point out that currently in 2021, Uchida et al. established that future studies that develop an understanding of these scaling relationships will be essential to both predict and conserve urban biodiversity on a rapidly urbanizing planet. This means that there is hope after 2021 of conserving and comprehending the importance of ecological diversity through urban green spaces.

Theoretical framework

Urban green spaces and biodiversity have a positive interconnection for the environment and human prosperity. They counteract the urban heat island effect, thereby reducing the energy costs of cooling buildings (Gunawardena et al., 2017). Urban greenery minimizes air, water, and noise pollution, and may offset greenhouse gas emissions through CO2 absorption. It provides stormwater attenuation, thereby acting as a measure for flood mitigation. Further ecological benefits include the preservation of biodiversity and nature conservation. Consequently, due to the range of environmental services they afford, urban green spaces can be viewed as a public good (Lee et al., 2015). As described above biological diversity has a crucial role in urban spaces creating a sustainable and resilient ambiance for people and the environment. Cities provide opportunities for new approaches to supporting biodiversity that would not be feasible in most rural landscapes. Green roofs and constructed wetlands are important decentralized eco-technologies for the adaptation of cities to climate change (Kowarik et al., 2020). Nature provides life support to humanity as material and non-material goods; is imperative to demonstrate and acknowledge that people cannot live without biological diversity. Is important to describe the relevance of biodiversity, the impact of humans, and establish the urban green spaces benefits. Nature provides life support to humanity as material and non-material goods (Figure 1).

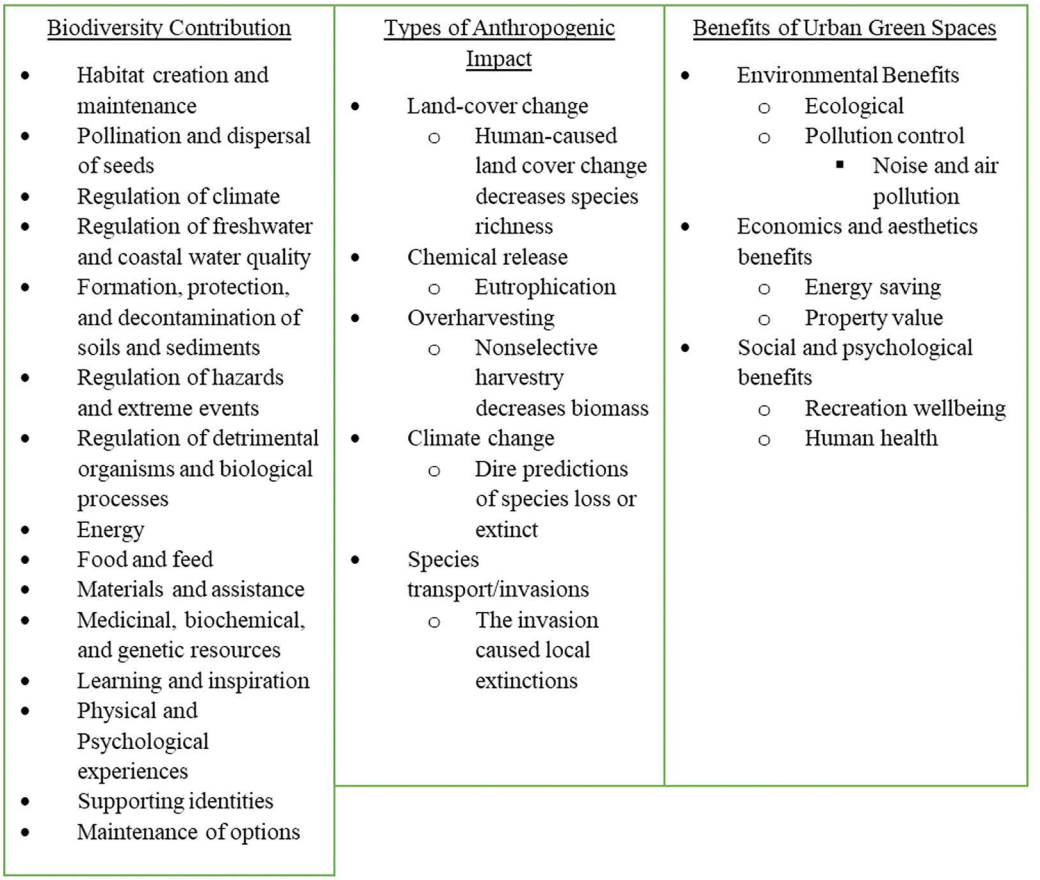

Figure 1. The first column presents the importance of establishing biodiversity, ecosystems functions, and its vital contributions to people as Dziba et al. established in 2019. In the second column, McGill et al. (2015) identified five (5) categories of anthropogenic impact on biodiversity, and in the last column, Haq (2011) presented a diversity of functions that benefits people's quality of life.

Figure 1 shows a summary of the aspects that represent the relation that humans must understand and apply with their environment. The basic contribution of nature shown above is essential for human health and it is threatened by human activities without any thoughts of future consequences. It has been shown on climate change, endangered species, development, contamination of air, water, and soil. These consequences to the environment are prerogative to give substantial significance to biodiversity conservation and create spaces for our environment to survive and adapt, consequently for humans' wellbeing. Urban green spaces have become a modern way of environmental, economic, and mental health benefits. Although, there is no theory of protection on how the human impact will change biodiversity but how it affects and modifies it. The relevance of these key articles that I have merged identifies on its own the relation and support that the three concepts can move forward to a balance in urbanization and people's quality of life.

Biodiversity relevance

Biodiversity involves all organisms in the world from microorganisms to animals and their connection to maintain balance. Biodiversity is usually described at three levels namely genetic, species and ecosystem, and all these three works together to create the unique path for life on the Earth (Verma, 2018). The concept of *biodiversity* is a combination of many points of view to describe the complexity of life. It encompasses ecological, genetic, and taxonomic hierarchies, including social, philosophical, ethical, and religious aspects. Therefore, biodiversity is a meta-concept, an integration of several already integrative concepts. Consider the usual definition that includes genetic and ecological diversity. These belong to two partially overlapping hierarchies, from genes within populations to species in communities, and ecosystems in different biomes (Cordero-Rivera, 2017).

In many cases, biodiversity and ecosystems services have been used simultaneously. The reason is if ecosystem services are managed accordingly biodiversity will be retained and vice versa. The ecosystem services provided in urban areas are provisioning goods obtained from the ecosystems; regulating benefits obtained from ecosystem processes; cultural intangible benefits; supporting and habitat that are ecological functions underlying production (Anderson et al., 2013). Biodiversity also secures long-term flows of benefits from nature by providing resilience to disturbance and environmental change. These and other economic and social contributions are substantial, with recent estimates claiming that the economic value of benefits from biodiverse natural ecosystems maybe 10 to 100 times the cost of maintaining them (Rands et al., 2010).

Although biodiversity in its nature evolves and changes by natural causes it is important to understand that the acceleration of anthropogenic effect has affected severely and is a fact that must be taken under consideration. Human pressure and climate change have influenced the environment in all forms. Biodiversity may be adapting like some of the literature says to survive in urban spaces, but the real concern is if it can go at the same pace as anthropogenic activity and consequently climate change.

Anthropogenic and urbanization impact

The natural habitats have been transformed for human activities, such as silviculture, agriculture, mining, housing, and road construction, generating habitat loss and biome fragmentation. The distance between fragments and the composition of the new landscape has led to the isolation of natural populations, which limits dispersal, pollination, and gene flow. Consequently, has changed the communities' functional attributes, generating alterations or loss of important ecosystem purpose

(Coelho et al., 2020). For biodiversity to survive in the urbanized world we are currently living there must be a recognized and adequate policy action and there must be education towards our actions and effect on the environment. Biodiversity is under siege, with enhanced local and global extinction rates and the decline of once-abundant species. Current rates of human-induced climate change and land use forecast the Anthropocene as one of the most devastating epochs for life on earth (Savard et al., 2018). Threats on nature multiply by continued population increase demanding more resources. This amplifies existing risks and creates new risks like climate change affecting both nature and the human system. There is mounting evidence that human demands on natural systems are accelerating and could be undermining the stability of these systems. A pervasive failure to mitigate these impacts is now resulting in widespread biodiversity declines, and reductions in the benefits humans receive from natural systems (Venter et al., 2016). Direct estimates of biodiversity loss are challenging because of highly incomplete global species distribution knowledge and the difficulties of ascertaining actual extinctions. Instead, estimates of diversity loss have relied on indirect methods, such as the relationship between area and the number of species in that area, the species-area relationship, or the relationship between an area that is lost and the number of species confined to it, the endemics–area relationship (Keil et al., 2015).

As the world becomes urban, research and cities managers recognize the importance of providing an urban habitat that favors biodiversity, which could be the beginning of an urban movement to promote wild flora and fauna. Cities are the continuity of natural ecosystems and the main human ecosystem. The urban ecology visualization and ecosystem services promote planning and sustainable urban management (Smith et al., 2018). Since urbanization is progressively incrementing through the years, improvements in management and the sustainability of urban green spaces are necessary for better biodiversity benefits.

Urban green spaces

Urban green spaces have become an asset to the restoration and loss of biodiversity. Green infrastructure and restorative ecology, which involves incorporating green infrastructure (trees, capture, and use of storm-water runoff) into community design, and restoring, rehabilitating, and restoring/repurposing damaged ecosystems through active intervention to maximize biodiversity and the draw-down and sequestration of carbon dioxide (Handa, 2010). As well, filling the streets and parking lots of trees, creating small green areas known as "pocket parks", vegetation on facades, green roofs, and many other strategies that can create biological interaction.

Studies and literature demonstrate that urban green spaces have provided benefits over several years like mitigation of water stormwater runoff, air quality improvement from gas emissions, decrease in temperatures and biodiversity to adaptation. Urban green spaces fulfill a range of different roles, such as social spaces and areas for recreation and cultural purposes. They also have economic and environmental purposes. Indeed, urban greening projects have been undertaken to maintain and increase property values due to their esthetic characteristics and functionality (Lee et al., 2015).

The definition of urban green spaces which is agreed on by ecologists, economists, social scientists, and planners is public and private open spaces in urban areas, primarily covered by vegetation, which are directly (e.g. active or passive recreation) or indirectly (e.g. positive influence on the urban environment) available for the users (Haq, 2011). Exposing how diverse types of urban green spaces impact ecosystem service performance could help policymakers and urban planners to optimize green space planning and maximize ecosystem services provision. However, many studies focus on how vegetation types like trees, shrubs, herbaceous, or vegetation communities perform in ecosystem services provision (Song et al., 2020). There are numerous types of urban green spaces like wetlands, public and private yards, green corridors, vegetation communities that are diverse and influence the social needs and preferences that determine the ecological value.

The impact of *urban green spaces* as an ecosystem service has strengthened the community's involvement in conservation strategies and preservation awareness. The United States Environmental Protection Agency (EPA, 2021) with other partners has created the concept of *smart growth. Smart Growth* consists of strategies for conservation and development encouraging the protection of health and the natural environment making the communities more resilient, sustainable, attractive, and inclusive. There are ten principles developed as strategies for the communities to create and maintain the neighborhood. The principles are: 1) mix land uses; 2) take advantage of compact building design; 3) create a range of housing opportunities and choices; 4) create walkable neighborhoods; 5) foster distinctive, attractive communities with a strong sense of place; 6) preserve open space, farmland, natural beauty, and critical environmental areas; 7) strengthen and direct development towards existing communities; 8) provide a variety of transportation choices; 9) make development decisions predictable, fair and cost-effective and 10) encourage community, stakeholders collaborations in development decisions (EPA, 2021). The principle that captures the outreach, education, the importance of urban green spaces and biodiversity is number six. It establishes plans for term long-term conservation and protection of the community's environment and improvement of quality of life. The United States Environmental Protection Agency partners with national,

local, and regional to help communities identify areas of preservation, high-quality habitats creating proactive conservation planning.

Conclusions, limitations, and further recommendations

Urban green spaces contribute notably to biodiversity. The contribution of urban green spaces to biodiversity is the form of connectivity of habitats and corridors being a way of biodiversity conservation and management. Thus, establishing or maintaining connectivity among patches is essential to facilitate biodiversity conservation (Kong et al., 2010). There is a belief that not only there has to be an awakening in the scientific world of how biodiversity is crucial to life itself but also there must be an outreach to the public in general of how important these urban green spaces are and the effect on human's wellbeing and existence.

Highly urban-oriented persons compared to less urban-oriented persons have a positive reaction to urban greenery-related aesthetics and sounds of nature. Environment-related attitudes influence perceptions of green space. Moreover, our findings support the idea that biodiversity per se also influences perceptions; people value green space significantly more with high than with low measured biodiversity. Urban planning needs to provide city inhabitants with green spaces that are species-rich, lush, varied, and rich with natural sounds (Gunnarsson et al., 2017). Biodiversity appears to be a crucial element of urban landscape aimed at ensuring the well-being of humans and non-human living elements and, as such, should be employed to enhance the quality of urban life (Carrus et al., 2015).

The topics of biodiversity, urban green spaces, and the importance that each has for the quality of life and the environment should be incorporated in all the development and planning stages. This literature review was limited by the articles found under *Google Scholar*. It is important to expand the searches and keywords under other data bases, and keep discussing the relevance of urban green spaces and how they can help biodiversity conservation.

The new vision of creating urban green spaces is essential for preserving what is left of biodiversity and for the future of the environment and human beings. These green corridors' natural settings draw the people to spend more of their time enjoying them and they offer interactions deeper and more significant interactions, proceeding to a positive outcome. In the end, it could lead to the contribution to better future sustainable urban green spaces. For city planning, these issues should be essential. It is important to determine the vulnerable areas and subsequently identify the degree of their resistance or vulnerability in this context. Based on the knowledge of these parameters, it is possible to plan appropriate measures (adaptation and mitigation) in the planning policies (Belčáková et al., 2019).

Rands et al. (2010), Aronson et al. (2017), and Lambert & Donihue (2020) concurred on the challenge biodiversity encounters in the urbanization effect and that there must be a deeper analysis of its relevance. They believe in improving biodiversity management strategies and conservation. Environmental education is an outreach for the public and stakeholders towards environmental preservation. Is essential to develop strategies and establish priorities in mitigation and management of biodiversity conservation for the environment to survive. Biodiversity can be conserved, restored, and used in a sustainable and resilient way attacking the culture, impacting the society economically and from a preservation point of view. The role of biodiversity to society by adapting to urban green spaces is a step in the right direction on the survival of all species including humans.

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