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URBAN GREEN SPACES BIODIVERSITY IN THE PHILIPPINES: BENEFITS AND CHALLENGES

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Abstract: Urban Green Spaces (UGS) are landscapes consisting of vegetation within urban zones having rich biodiversity where the dependent faunal population abound. UGS are important components of urban planning and development since they provide various benefits for the well-being of urban residents. This review paper aims to present the benefits and challenges of UGS in the Philippines. Urban cities in the Philippines harbour biodiversity and endemic floral and faunal species. UGS provide ecosystem services including pollution abatement, flood control, and climate regulation. The use of urban parks and open spaces promotes social interactions and physical activities which improve overall health and well-being of the community. UGS in the Philippines face challenges in terms of rapidly changing demographic features and conflicting policies, leading to a reduction or loss of green spaces in the city. Updated Comprehensive Land Use Plans (CLUP) of Philippine cities are vital for ensuring the proper allocation and maintenance of public green spaces. A national land use policy that will harmonise existing local land use plans and zoning ordinances is warranted. Integrative and adaptive management of UGS by various stakeholders, right holders and urban community sectors is vital for its maintenance and sustainability.

Keywords: Urban green space, urban biodiversity, sustainability, wellbeing.

Introduction

The Philippines is a rapidly urbanising country with 54% of the total population residing in urban areas with an urban population growth of 2.4% annually (Philippine Statistics Authority PSA, 2020). According to a projection from United Nations Department of Economic and Social Affairs, more than 60% of the Filipino population will be living in urban settlements by year 2050 (UN-DESA, 2019). Globally, the urban population has continued to grow from 51.7% in 2010 and is expected to hit 60.4% by year 2030, with Africa and Asia seeing the most significant increase (UN-Habitat, 2024). In Southeast Asia, 55.6% of population is projected to be living in urban areas by 2030. In the same year, Southeast Asian countries of Brunei Darussalam and Malaysia will have more than 80% urban population, while Indonesia, Thailand and the Philippines will have more than half of its population living in urban areas (UN-Habitat, 2024).

The urbanisation in the Philippines is closely linked to the country's economic growth, high population density, poverty incidence and exposure to natural hazards (Asian Development Bank, 2022). Urbanisation processes affects landscape features and functions and promotes landscape fragmentation which may affect the natural urban environment and the green spaces in the city (Li *et al.*, 2022).

Urban green spaces (UGS) are natural landscapes within or around the urban environment. These features may include vegetation along the roads or within built structures, urban parks, abandoned lots, urban forests, residential yards, green walls, and green roofs (Palliwoda & Priess, 2021; Wooster *et al.,* 2022; World Health Organisation, 2023). Urban

green spaces support biodiversity. Urban green landscapes can harbour floral (Gao *et al.,* 2021, Anderson *et al.*, 2021), faunal (Reynolds *et al.,* 2021), and microbial (Gill *et al.,* 2020; Yan *et al.,* 2022) diversity.

Urban biodiversity accounts for the species richness, evenness, and distribution across urban landscapes and human settlements. It encompasses habitats, species, and genetic diversity. Although most of the urban biodiversity studies are focused on species diversity and richness, maintenance of urban green spaces promotes the conservation of these various levels of biodiversity (Schebella *et al.,* 2019; Uchida *et al.,* 2021).

Aside from biodiversity conservation, UGS has long been associated with ecosystem services and public health. Green spaces can help in pollution control, climate regulation and overall public health in urban settings. UGS controls air pollution in urban areas where high levels of air pollutants such as particulate matter ($PM_{2.5}$ and PM_{10}), nitrogen oxides, and volatile organic compounds are present (Galvez *et al*. 2020; Belaire *et al.,* 2022; Luo *et al.,* 2023; Han *et al.,* 2024). Urban ecosystems and various vegetation types can sequester carbon and abate harmful levels of atmospheric pollutants (Jaafari *et al.,* 2020; Bhandari & Zhang, 2022). Sevik and colleagues (2019) indicated that cedar trees may be used for biomonitoring of heavy metals in the atmosphere.

Additionally, Venter *et al.* (2024) found that urban green spaces improve air quality in a city level scale; however, meteorological factors such as precipitation, wind, and humidity may have greater effect than UGS. Aside from air pollution, noise pollution may reduce because of green spaces. A study by Feng *et al.* (2024) revealed that noise can be reduced by different UGS patterns and complexity. Urban areas with complex and high levels of green spaces have better levels of noise reduction. In addition, close proximity of UGS to the noise pollution source tends to have higher noise level decline (Feng *et al.,* 2024).

UGS also contribute to climate regulation and flood reduction in urban regions characterised by areas with impervious cover. These impervious surfaces can increase surface runoff and modify the natural hydrologic cycle and discharge rates (Sohn *et al.,* 2021). Urbanised areas provided with impervious surfaces can also alter natural ambient air and surface temperature. Built up areas have more buildings, asphalt and pavement that absorbs more heat than that of vegetated surfaces (Cordeiro *et al.,* 2023). Higher land surface temperatures in cities are often referred to as the urban heat island effect – which is influenced by anthropogenic factors, land cover, climate zones, and green spaces (Tinoy *et al.,* 2019; Bhandari & Zhang, 2022; Wang *et al.,* 2022).

Urban green spaces can influence the urban residents' overall public health and well-being. Urban biodiversity provides mitigating effects of air and noise pollution which are associated with respiratory diseases and stress (Hedblom *et al.,* 2019; Seposo *et al.,* 2021). A reduction in the urban temperature by green infrastructure helps in preventing heat stress and discomfort to individuals. Moreover, an improvement in the physical, psychological and overall health and life satisfaction have been linked to the provision and availability of UGS (Reyes-Riveros *et al.,* 2021; Giannico *et al.,* 2021). A greater interaction with green infrastructure and the proximity, availability, and accessibility of urban parks are correlated to the degree of well-being and health of urban residents (Ma *et al.,* 2019; Paul *et al.,* 2020). Physical activity was found to be positively correlated to the existence of green spaces and the provision of venues for walking, cycling, and physical training (Knobel *et al.,* 2021; Tan *et al.,* 2021).

In addition to physical well-being, UGS positively influences mental health. Ha *et al.* (2022) found that many small fragmented urban green areas lower psychological distress compared to few large green areas. The study of Yue et al. (2022) showed that urban vegetation positively affects mental health of an aging population. Furthermore, urban parks and

other green spaces are venues for social leisure activities and interactions. Huang and Lin, (2023) established that social health dimensions were influenced by the green spaces' characteristics, use and individual perception. While Xu and colleagues (2021) found that UGS was more correlated with social health than physical or mental health among Chinese urban residents. Various reviews and meta-analyses were also conducted to provide direct association of public health and urban greenery (Rojas-Rueda *et al.,* 2019; Yang *et al.,* 2021; Hunter *et al.,* 2021).

The biodiversity of urban green spaces supports the attainment of the United Nations (UN) Sustainable Development Goals (SDG). In general, biodiversity is closely linked to 14 United Nations Sustainable Development Goals (Convention on Biological Diversity, n.d.). The urban biodiversity directly advocates SDG 3, 11, and 15. SDG 3 focuses on the promotion of health and well-being of the public, while SDG 11 promotes conservation and sustainable use of terrestrial ecosystems. SDG 11 aims to make cities safe, inclusive, resilient, and sustainable.

In the Philippines, urban areas are highly vulnerable to natural hazards and disasters. Effective mitigation of the effects of these hazards requires nature-based solutions such as expansion and maintenance of UGS. Urban green spaces biodiversity contributes to risk reduction and proper management of natural disasters and events. Likewise, Philippine UGS are venues for physical, mental and social health of Filipinos that is directly linked with overall public well-being.

With the numerous benefits of urban green spaces in ecosystem services and well-being of urban settlers, studies that focus on UGS have received inadequate consideration especially in developing countries like the Philippines.

This research paper identified the different biodiversity studies conducted in Philippine cities and discussed various UGS benefits focusing on ecological (biodiversity conservation, pollution and flood control, climate regulation) and socio-health aspects. This paper examined the challenges and opportunities for the stakeholders to consider in order to sustainably manage green spaces in Philippine urban areas. It also provided a discussion on the current Philippine UGS policies and guidelines and developed a framework for sustainable management of UGS.

Methodology

Relevant published primary and secondary sources were used following a search on both the available literature on the subject matter at hand. Keywords urban green spaces, urban green spaces Philippines, UGS, Philippine UGS, Philippine green spaces, urban biodiversity, Philippine urban biodiversity, urban biodiversity benefits, and urban biodiversity challenges were utilised. Research curated following the search was classified and assessed. Studies conducted in provinces and non-urbanised regions of the Philippines were disregarded. Data from sampling sites within nature reserves, natural parks, protected areas, and key biodiversity areas within Philippine cities were also not considered. Biodiversity studies on different biological groups (i.e., flora, fauna, and microbes) were classified and tabulated. Only studies conducted between 1990 and 2022 were considered in this review.

Thirty-four (34) publications on biodiversity in highly urbanised cities in the Philippines were selected and further assessed (Table 1). Eleven (11) studies dealt with floral biodiversity; ten (10) were wildlife studies on terrestrial vertebrates; nine (9) studies dealt with invertebrate diversity; and there were two (2) on microbial diversity and two (2) on fungal diversity.

Ecological Benefits of Urban Green Spaces in the Philippines

Biodiversity conservation

Green spaces in Philippine cities harbour biodiversity (Table 1). The diversity indices vary from low to high and are dependent on the floral and faunal groups in the area where the

city is based. High floral diversity was recorded among ornamental plants and trees. For studies with diversity indices, highest Shannon diversity index of 2.78 was recorded among ornamental plants, while tree Simpson diversity index was computed as 0.94. Shannon diversity index for mushroom ranged between 2.51 and 3.09. In terms of faunal group and overall taxa, avifaunal diversity was recorded to be the highest with a Shannon diversity index of 3.53.

Aside from diversity indices, high number of species in different taxa were recorded. The highest number of tree species and avifauna were recorded in Metro Manila, the nation's urban centre. Based on the study of Moriwake *et al*. (2000), tree species richness in Metro Manila was dependent on the land use type. Residential areas with low population density have the highest number of tree species compared to business and commercial areas. In addition, urban parks with high green cover ratio support high tree diversity in Metropolitan Manila (Moriwake *et al.*, 2000). Avifaunal diversity, however, was found not dependent on large Philippine urban areas and tends to be lower in species richness in the city centre compared with city borders (Banzon *et al.,* 2022). This Philippine urban biodiversity scenario reflects the global urbanisation assessment which shows that urban areas harbour rich bird and plant species (Aronson *et al.,* 2014).

Approximately, 20% of the total species of birds, or 2,041 bird species, and 5% of the identified vascular plants inhabit the world's cities (Aronson *et al.*, 2014). Urban biodiversity was found to be affected by the expanse of green areas and networks (Beninde *et al*. 2015), therefore, maintenance and increase of public green spaces can promote conservation of diverse species in urban settings.

Interestingly, a high number of endemic species was also found to be present in Philippine urban areas. High species endemicity was recorded among Odonates and Anurans (Pelingen *et al*., 2021; Cabras *et al*., 2022). Some species were classified as vulnerable and almost threatened (Cabras *et al*., 2022; De Lima-Baron *et al*., 2022). Aronson *et al.* (2014) also identified 36 bird species and 65 vascular plants species thriving in the global urban areas belong to the International Union for Conservation of Nature (IUCN) Red List of threatened species. This data show the relevance of UGS in maintaining biodiversity including threatened species. The data indicates that urban areas in the Philippines can support a variety of species and shows the importance of Philippine urban green spaces for the protection and conservation of the declining wildlife population.

Most of the UGS biodiversity studies were conducted in highly urbanised Mindanao cities in southern Philippines (Table 1), although the highest urbanisation rate was calculated in Metro Manila (PSA, 2020). This may be due to the higher green spaces in Mindanao cities compared to the available UGS in Metro Manila or Metro Cebu. The limited study sites might restrict the urban biodiversity studies in the other Philippine cities and urban zones. It is important to note that key biodiversity areas, protected areas, and natural parks situated within some of the highly urbanised cities in the Philippines are often sites of biodiversity research which are not included in this review.

Likewise, biodiversity studies were mostly conducted in the university campuses situated within Philippine cities (Table 1). This shows that urban campuses are ideal green spaces for enhancing biodiversity and may serve as natural centres for biodiversity education and field experiments. Aside from university grounds, several types of green spaces in Philippine urban regions support biodiversity.

Memorial parks, urban parks, and major roads can serve as biodiversity sites. Cebu City Memorial Park have 61 floral species while Cebu urban parks have 100 ornamental plant species (Flores *et al*., 2020; Garces *et al*., 2022). Main roads of Metro Manila and Metro Cebu support 47 and 50 tree species, respectively (Sia Su *et al.,* 2018; Jumonong *et al.,* 2021). These results prove that Philippine biodiversity thrives in different types of urban green spaces and that green infrastructure must be maintained and

expanded to support higher number of species diversity that will contribute to biodiversity conservation.

Introduced and invasive species were recorded and tend to dominate Philippine urban floristic diversity. 95% of ornamental plants were recorded in Cebu urban parks (Flores *et al.,* 2020); while 85% of the trees were non-indigenous in Cebu national roads (Jumonong *et al.,* 2021). In Iloilo City urban parks, 70% of tree species are exotic species mainly mahogany, *Swietenia macrophylla* (Tutor *et al.,* 2017). Similarly, high percentage (50-70%) of non-indigenous species were recorded in Quezon City green spaces (Gonzales & Magnaye, 2017; Delos Santos *et al.,* 2022). Invasive alien species are one of the major threats in biodiversity and should be controlled and properly managed at multiple scales (*Aronson et al.*, 2017; Khan *et al.,* 2022).

Table 1: Biodiversity studies in Philippine urbanised cities

	Total Number of Species	Index of Diversity	Philippine City	Urban Area	Reference
Floral diversity					
Native and Exotic Plants	61 species	H' = 2.69	Cebu City, Visayas	urban cemetery	Garces *et al.,* 2022
Vegetation	52 species (1 endemic)	H' = 1.04 - 2.65	Quezon City, Metro Manila	university campus	Delos Santos *et al.,* 2022
Trees	50 species	nd	Cebu City, Central Visayas	urban roads	Jumonong *et al.,* 2021
Ornamental plants	100 species	H' = 0.77 - 2.78	Cebu City, Visayas	urban parks	Flores *et al.,* 2020
Pteridophytes	23 species	nd	Davao City, Mindanao	university campus	Morales, 2018
Lycophytes	5 species				
Bryophytes	5 species	nd	Davao City, Mindanao	university campus	Medina & Carreon, 2018
Mangrove	9 species	H' = 0.70	Malabon and Navotas Cities, Metro Manila	urban river	Relacion *et al.,* 2018
Trees	47 species	nd	Quezon City, Metro Manila	urban roads	Sia Su *et al.,* 2018
Trees	34 species	D = 0.43 - 0.91	Bacolod and Iloilo Cities, Western Visayas	urban green spaces	Tutor *et al.,* 2017
Trees	70 species	D = 0.80 - 0.94	Quezon City, Metro Manila	urban green spaces	Gonzales & Magnaye, 2017
Trees	201 species	nd	Metro Manila	urban green spaces	Moriwake *et al.,* 2000

Fungal diversity					
Lichens	30 species (1 endemic)	nd	Davao City, Mindanao	university campus	Medina & Carreon, 2018
Mushroom	47 species	H' = 2.51 - 3.09	Cagayan de Oro City, Mindanao	urban community	Perpetua *et al.,* 2014
Microbial diversity					
Actinomycetes	235 isolates	nd	Quezon City, Metro Manila	urban green space	Daquioag & Penuliar, 2021
Myxomycetes	28 species	nd	Quezon City, Metro Manila	urban park	Macabago *et al.,* 2010
Invertebrate Diversity					
Coleoptera	31 species (29 endemic)	nd	Davao City, Mindanao	urban green spaces	Cabras *et al.,* 2022
Odonata	22 species (10 endemic)	nd	General Santos City, Mindanao	urban park	Dela Cruz *et al.,* 2021
Odonata	6 species	H' = 0.52 - 1.21	Davao City, Mindanao	urban green spaces	Perez & Bautista, 2020
Lepidoptera	39 species	H' = 1.63 - 2.99	Zamboanga City, Mindanao	university campus	Sebua & Nuneza, 2020
Butterflies	15 species	nd	City of Manila, Metro Manila	urban park	Nacua *et al.,* 2019
Macroinvertebrates	10 species*	nd	Quezon City, Metro Manila	university campus	Magbanua *et al.,* 2019
Odonata	9 species (1 endemic)	nd	Davao City, Mindanao	university campus	Medina & Cabras, 2018
Lepidopteran	15 species (1 endemic)				
Microcrustacean	13 species (2 endemic)	nd	Metro Manila	urban river	Dela Paz *et al.,* 2018
Odonata	12 species (2 endemic)	H' = 0.48 - 1.47	Cagayan de Oro City, Mindanao	urban wetlands	Jomoc *et al.,* 2013
Vertebrate Diversity					
Avifauna	53 species (9 endemic)	H' = 1.69 - 3.13	Davao City, Mindanao	urban green spaces	Banzon *et al.,* 2022
Anura	23 species (13 endemic)	nd	Davao City, Mindanao	urban green spaces	De Lima-Baron *et al.,* 2022
Avifauna	8 species	H' = 1.172	Cagayan de Oro City, Mindanao	urban community	Cabigquez *et al.,* 2021
Anura	5 species (4 endemic)	nd	Baguio City, Luzon	urban green spaces	Pelingen *et al.,* 2021

Avifauna	34 (7 endemics)	H' = 2.44 - 3.53	Davao City, Mindanao	urban roads	Yurong *et al.,* 2020
Avifauna	58 species (13 endemic)	H' = 2.87 - 3.24	Cagayan de Oro City, Mindanao	urban community	Ascaño II *et al.,* 2016
Anura	8 species	nd	Cebu City, Visayas	urban forest	Supsup *et al.,* 2016
Reptilia (Lizards)	26 species				
Reptilia (Snakes)	15 species				
Chiroptera	8 species (2 endemic)	nd	Cagayan de Oro City, Mindanao	urban river	Lobite *et al.,* 2013
Avifauna	70 species (6 endemic)	H' = 1.29 - 2.34	Taguig and Quezon Cities, Metro Manila	urban green spaces	Vallejo *et al.,* 2008
Amphibia	6 species (1 endemic)	nd	Quezon City, Metro Manila	university campus	Ong *et al.,* 1999
Reptilia	13 species (2 endemic)				
Avifauna	47 species (7 endemic)				
Mammal	10 species (1 endemic)				

Pollution Abatement and Carbon Sequestration

Urban areas are often characterised as having poor air quality and high levels of noise pollution. Air pollutants in urban areas are mostly from anthropogenic activities (Schwela, 2000) that increase the risk of developing respiratory diseases and mortality (Jaafari *et al.,* 2020; Seposo *et al.,* 2021). In the City of Manila, high levels of particulate matter, nitrogen dioxide and ozone were recorded in three urban parks (Galvez *et al.,* 2020). High levels of these airborne pollutants were recorded near urban roads where vehicles add to the levels of air pollution.

The presence of pollution tolerant trees along major roadways in Metropolitan Manila contribute to the sequestration of air pollutants (Sia Su *et al.*, 2018). In terms of noise pollution, decibel (dB) levels of between 65 and 75 dB are the norm in commercial and residential areas near major urban roads (Mappala & Javier, 2008). This result is higher than the Philippine noise standards for both commercial and residential areas (Mappala & Javier, 2008).

Urban air quality improvement and noise pollution reduction are one of the beneficial functions of urban vegetation (Velasco *et al.,* 2013; Jaafari *et al.*, 2020). The presence of green spaces in Philippine cities has been proven to sequester and reduce carbon and other air pollutants in the atmosphere. In Metro Cebu, green areas with tree cover can sequester 14,807 Mg of carbon in a year (Pansit, 2019). In the same Philippine urbanised city, Parilla *et al.* (2018) reported the carbon sequestration and storage capacities of molave (*Vitex parviflora*) and mahogany (*Swietenia macrophylla*) tree species. Molave trees can sequester 3.80 Mg C/ha per year while mahogany trees can sequester 3.41 Mg C/ha per year. In addition, molave and mahogany trees can store Carbon by 36.21 Mg C/ha and 207.76 Mg C/ha, respectively. Carbon sequestration rates might be significantly lower

as compared to carbon emission in urban areas. However, increasing the size of the UGS and maintaining the existing urban tree cover will help improve the carbon sequestration capacity and noise reduction ability of vegetation in urban areas. Proper selection and utilisation of trees species (i.e., pollution tolerance, optimum foliage cover, native trees) can also support air pollution abatement.

The arrangement of green spaces near urban roads and development of green corridors will mitigate air pollution and significantly reduce noise levels (Margaritis & Kang, 2016). The use of appropriate urban plant types with suitable morphological characteristics as vegetation barriers will help in the improvement of air quality along urban roads (Barwise & Kumar, 2020).

Flood Control

Urban flooding in Philippine cities is a complex problem that may be resolved by the use of nature-based solutions, which includes the expansion of UGS. The increased flood risk in Philippine cities is influenced by the climatic, geophysical and infrastructural factors in the Philippine urbanised regions. Rapid urbanisation has caused the expansion of built-up areas characterised by impervious surfaces as opposed to natural or agricultural landscapes. The Philippine tropical climate is characterised by high precipitation rates and an average of 20 typhoon weather events annually. Most of the Philippine' major cities are also located near bodies of water with some cities situated in low-lying regions experiencing land subsidence (Eco *et al.,* 2020). The country's urbanised regions are extremely vulnerable to flooding because of climate changes, rising global sea levels and poor drainage infrastructure.

Green spaces can reduce flood risk in urban areas (Kim *et al*., 2016; Zimmermann *et al.,* 2016). Urban green spaces can increase the infiltration and percolation process of the soil, thereby, reducing runoff. Vegetation in UGS can also increase the interception capacity which contributes to flood reduction (Zimmermann *et al.,* 2016). Expansion and management of UGS in Philippine cities coupled with sustainable land use planning, reliable drainage infrastructure systems, and efficient waste management will contribute significantly to a reduction in urban flooding.

Climate Regulation

Philippine UGS has also been proven to lower temperatures in the cities (Estoque *et al.,* 2017; Rejuso *et al.,* 2019). Using Climate Engine tool and satellite images, Rejuso *et al.* (2019) revealed that there is an inverse relationship between land surface temperature and amount of vegetation in Mandaue City – a highly urbanised Philippine city. A correlation was also found between Mandaue city's land surface temperature and the extent of its built-up areas.

Vegetation is capable of reducing urban temperatures especially in Philippine cities where high levels of incoming solar radiation are common throughout the year. Trees, shrubs, grasses, and even bare soil can help to lower land surface temperatures in Philippine cities (Rejuso *et al.,* 2019; Cruz *et al.,* 2021). Urban flora provides shade that lowers atmospheric and surface temperatures by intercepting insolation to be absorbed by buildings or roads (Rabena *et al.*, 2020). Trees and other flora can make use of solar radiation for evapotranspiration, thus contributing to a decrease in temperatures (Li & Liu, 2021). Green spaces in Philippine cities are important in regulating temperature and other climate conditions since they are normally exposed to higher insolation especially during summer or the dry season. Urban trees and vegetation were studied to reduce the temperature in cities by between 1.5 and more than 2°C (Tan *et al*., 2016; Zhang *et al.*, 2017; Cruz *et al.,* 2021).

Health Benefits of Urban Green Spaces

Urban green areas and human health have positive linkages and well documented in developed countries and states (Lee & Maheswaran, 2010). In the developing countries, like the

Philippines, very few studies were conducted on UGS connection to human health. However, there is a growing discussion among national government agencies, such as the Department of Environment and Natural Resources (DENR), and Local Government Uunits (LGU) regarding the importance of UGS in contributing to the liveability of Philippine cities and overall public health.

In the green city indices among Asian capitals, Metropolitan Manila was found to have only 5 square metres of green space per individual (Siemens, 2011). This is way below the level recommended by the World Health Organisation (WHO) of 9 sqm of green space for individual and an ideal of 50 sqm of UGS per individual (WHO, 2012). The WHO recommendation of green space availability per capita is to promote better health of urban residents and is a key indicator of sustainable cities. The Alliance for Safe, Sustainable, and Resilient Environments (ASSURE, 2019), a Non Government Organisation (NGO) in the Philippines, estimated that 52 square kilometres of public green spaces are needed to meet the WHO minimum standard.

Public open spaces and urban parks in Philippine cities are venues for physical recreational, and social activities. Some famous urban parks such as Quezon City Memorial Circle (Figure 1), Ninoy Aquino Park, and La Mesa Ecopark in Quezon City; Rizal Park (Figure 2), Intramuros, and Paco Park in City of Manila; Ayala Triangle Gardens and Legazpi Active Parks in Makati City; Burnham and Botanical Parks in Baguio City; Bacolod Public Plaza in Negros Occidental; Pasonanca Park in Zamboanga City and San Agustin Botanical Park in Tagum City Davao are sites for physical and recreational activities that promote overall health and well-being of residents and local tourists.

The rapid urbanisation and global COVID-19 pandemic raised awareness among Filipino urban residents as to the importance of public green spaces for their overall health. This translated to the Philippine local governments establishing more urban parks and expanding

Figure 1: Quezon City Circle Urban Park showing memorial shrine, picnic, and playgrounds

Figure 2: Rizal Park in the City of Manila with the façade of the National Museum of Anthropology

green spaces in their localities. One example is the Tree Park Network Project in Iloilo City that aims to establish urban eco parks, beach and mangrove ecological forests and green bike lane networks to restore biodiversity and promote public health.

Social Benefits of Urban Green Spaces

In Philippines' urbanised cities, residents developed the culture of having leisure and social activities in shopping malls. The massive patronage of shopping malls is evidenced by expansive shopping centres in Philippine cities. However, this 'mall culture' does not negate the need for public green spaces. Saloma *et al.* (2021) outlined how hyper-conditioned environments in the Philippines differ from public green spaces in terms leisure and sense of belongingness. Air-conditioned shopping malls provide an enclosed secured spaces for family dining, social gatherings, watching movies, shopping, and other leisure activities.

However, urban green spaces provide a more natural aspect with different vegetation of trees, shrubs, ornamental plants and grasses, and ponds and water fountains. Philippine city parks often have a playground for children, fitness equipment and spaces for physical exercise.

Urban green spaces offer opportunities for education and aesthetic enjoyment (Chen & Jim, 2008). The greeneries in urban parks have attractive colours, shapes and sizes that appeal to ones' visual senses. Ornamental plants, diverse flora and unique park designs are visually attractive for enjoyment of city residents. Green spaces by the bays and rivers provide natural landscapes for visual pleasure. Natural sounds from birds and other wildlife and nice scents from diverse flora are both pleasing to the olfactory and auditory senses. In terms of educational opportunities, open green spaces are important sampling sites for scientific studies. As discussed earlier, urban biodiversity studies in the country were found to be mostly conducted in university open spaces. Green landscapes, likewise, stimulate creativity and serve as areas for educational activities.

Additionally, UGS also provides opportunities for communities to come together and enhance social cohesion (ASSURE, 2019; Jennings & Bamkole, 2019). Social interactions are often limited in urbanised environments. Philippine urban parks and public open spaces

improve social interaction among all sectors of the society including the low-income residents (ASSURE, 2019). The migration of rural population to urban centres resulted to increased cultural and ethnic diversities in urban areas. Access to open green spaces enhance social ties among urban residents of different backgrounds and age classes.

Public green spaces can also host social events like concerts, athletics, town fiestas and festivals that promote social interaction and generate revenue for local government agencies and communities. The Philippines Department of Tourism (DOT) is planning to include urban park visits as part of tourism activities for local and foreign tourists to enjoy (Rocamora, 2022). This will encourage social interactions, culture and learning among urban park visitors.

Challenges in Philippine Urban Green Spaces

Rapid Urban Population Growth

The Philippines is one of the Southeast Asian countries that experiences rapid urbanisation (Table 2). UN-DESA (2018) reported that Metropolitan Manila and Davao City are one of the most populated cities in Asia. Currently, 59 million people or 54% of the Filipino population resides in urban areas (PSA, 2020). By year 2030, Davao City and Metropolitan Manila are projected to have 2.25 million and 16.84 million inhabitants, respectively (Table 2). By year 2050, it is projected that 102 million Filipinos will be inhabiting Philippine cities (World Bank 2017). Metropolitan Manila has a population of 13.4 million Filipinos and a growth rate of 1.29% from 2010 to 2020 (Table 3). Four highly urbanised cities namely, Quezon, Manila, Caloocan and Davao, registered a population of more than 1 million (PSA, 2020). Among the Metropolitan Manila cities, Taguig City posted the highest growth rate of 3.24, while Quezon City has the highest total population with more than 2.9 million (Table 3).

The fast-growing urban population in the Philippines is associated with increasing population density. Urban population growth and high rate of movement of people from rural regions to urban areas, demands improved infrastructure, housing, and basic human necessities. This contributed to the growing number of informal settlers in Philippine cities experiencing unsuitable living conditions. In year 2018, 2.45 million Filipino people live in

Table 2: Population and Average Annual Rate of Change in Asian cities (UN-DESA, 2018)

Asian City	City Population in a Given Year (in thousands)			Average Annual Rate of Change (%)	
	2000	2018	2030	2000-2018	2018-2030
Bangkok, Thailand	6,395	10,156	12,101	2.60	1.50
Beijing, China	10,285	19,618	24,282	3.60	1.80
Davao City, Philippines	1,152	1,745	2,256	2.30	2.10
Dhaka, Bangladesh	10,285	19,578	28,076	3.60	3.00
Ho Chi Minh, Vietnam	4,389	8,145	11,054	3.40	2.50
Jakarta, Indonesia	8,390	10,517	12,687	1.30	1.60
Kuala Lumpur, Malaysia	4,176	7,564	9,805	3.30	2.20
Manila, Philippines	9,958	13,482	16,841	1.70	1.90
Phnom Penh, Cambodia	1,149	1,952	2,805	2.90	3.00
Seoul, Republic of Korea	9,879	9,963	10,163	0.00	0.20
Singapore City, Singapore	3,914	5,792	6,342	2.20	0.80
Tokyo, Japan	34,450	37,468	36,574	0.50	-0.20

slum areas which account for more than 604,000 individuals in Metro Manila and 227,000 in peri urban areas near Metro Manila (Navarro *et al.*, 2021).

High urban population density and migration rates put pressure in establishing and maintaining urban green spaces within the Philippine cities. Efficient land use and sustainable urban environmental management must be in place to address this serious urban issue. Slum upgrading programs that will improve the physical housing conditions and social environment can be implemented (Edelman, 2016). This programme will promote community development as informal settlers make use of their own savings and labour to improve their housing situation with financial assistance from both private investors and government agencies. With the physical improvements in the slum areas, pockets of green spaces or vertical gardens can be incorporated in the community urban areas. High urban migration rates may decrease with the decentralisation of Philippine economy and industries in Metropolitan Manila. Infrastructure and industries should be established in other regions of Philippines to reduce urban migration, population density and land scarcity in highly urbanised cities.

Land Use Planning and Policies

Land use planning is an important component of sustainable urban development and impacts all facets of human development (Lebrilla & Lorenzo, 2021). Effective land use planning is directly associated with the eight Sustainable Development Goals (SDG) set by United

Table 3: Total population and growth rates of the Philippines and highly urbanised cities in NCR from years 2000-2020 (Philippine Statistics Authority PSA, 2020)

	2000	2010	2015	2020	Growth Rate 2010-2020 (%)
Philippines	9,954,400	11,858,714	12,879,387	13,486,560	1.67
Metropolitan Manila	9,932,560	11,855,975	12,877,253	13,484,462	1.29
City of Manila	1,581,082	1,652,171	1,780,148	1,846,513	1.12
City of Mandaluyong	278,474	328,699	386,276	425,758	2.62
City of Marikina	391,170	424,150	450,741	456,059	0.73
City of Pasig	505,058	669,773	755,300	803,159	1.83
Quezon City	2,173,831	2,761,720	2,936,116	2,960,048	0.70
City of San Juan	117,680	121,430	122,180	126,347	0.40
City of Caloocan	1,177,604	1,489,040	1,583,978	1,661,584	1.10
City of Malabon	338,855	353,337	365,525	380,522	0.74
City of Navotas	230,403	249,131	249,463	247,543	-0.06
City of Valenzuela	485,433	575,356	620,422	714,978	2.19
City of las Piñas	472,780	552,573	588,894	606,293	0.93
City of Makati	471,379	529,039	582,602	629,616	1.75
City of Muntinlupa	379,310	459,941	504,509	543,445	1.68
City of Parañaque	449,811	588,126	665,822	689,992	1.61
Pasay City	354,908	392,869	416,522	440,656	1.15
Pateros	57,407	64,147	63,840	65,227	0.17
Taguig City	467,375	644,473	804,915	886,722	3.24

Nations (Lebrilla & Lorenzo, 2021) including good health and well-being which is also one of the benefits of urban green spaces.

Land use planning is the transparent process by which land resources are allocated for economic or social use (Corpuz, 2013). The Philippine total land area is generally classified into three: Protected areas, alienable and disposable lands, and privately-owned lands (Lebrilla & Lorenzo, 2021). However, the distinctions between these classifications are unclear and various agencies have different approaches with regards to the classification of land.

The existing land use planning and policies in the Philippines' is fragmented and sector based. Government agencies dealing with environmental protection, housing, local governance, agriculture, indigenous rights, have their own land use policies which are sometimes conflicting and overlapping (Senate Economic Planning Office, 2015). For example, protected areas are within the scope of the National Integrated Protected Areas System (NIPAS) Act of 1992 and governed by the national government, including the DENR, may also be under the jurisdiction of the LGUs, based on the Local Government Code of 1991, if this land area is under their locality.

In terms of the public open green spaces and urban parks, related Philippine national and local policies are existing (Table 4). Public Lands Act and Revised Forestry Code define different land classifications in the Philippines. The Presidential Decree, PD 957 requires 30% of the open spaces to be assigned to subdivision developers who usually use it for roads. The Local Government Code directs all Philippine cities and municipalities to develop their Comprehensive Land Use Plan (CLUP) for the proper allocation of land resources. The CLUP is also promulgated by the Housing and Land Use Regulatory Board (HLURB) in line with Executive Order (EO) 648. As directed by HLURB, CLUP must incorporate Climate Change Adaptation and Disaster Risk Reduction plans for the city or municipality concerned.

The Comprehensive Land Use Plan of LGUs serves as the basic instrument that will guide local officials and stakeholders on land use planning to achieve spatial development and socio-economic growth. It contains provisions to include the allocation of public open spaces and greeneries for the city residents' wellness and health. It gives local executives and officials the power to plan and manage UGS and public open spaces. The Quezon City CLUP 2011-2025 contains 10 chapters with one chapter that discusses the city's Green Lung Network. This chapter presents the extent of green spaces in Quezon City including major parks, watershed area, parks by the rivers, community parks and open spaces.

Table 4: Philippine policies related to urban parks and green spaces

Commonwealth Act 141	Public Lands Act
Republic Act 826	An Act Creating the Commission on Parks and Wildlife, Defining its Powers, Functions and Duties
Republic Act 10066	An Act Providing for the Protection and Conservation of National Culture Heritage
Republic Act 7160	The Local Government Code of the Philippines
Presidential Decree 1559	Revised Forestry Code of the Philippines
Presidential Decree 1096	National Building Code
Presidential Decree 957	Subdivision and Condominium Buyers' Protective Decree
Republic Act 7279	Urban Development and Housing Act
Executive Order 648	Charter of the Human Settlements Regulatory Commission

Meanwhile, in Davao City, a zoning ordinance requires 10% of a project land area with one hectare or more be devoted to urban green space. Even with this existing city ordinance, public open space and green zones are still limited according to an environmental group - Interface Development Interventions for Sustainability (IDIS) and do not conform with the WHO recommendation of 9 sq m of green space per person (IDIS, 2019).

The Comprehensive Land Use Plan and Zoning Ordinance of most Philippine cities and municipalities are outdated and thus ineffective. Only 78 out of 146 Philippines have updated CLUP and three cities have no existing land use plan (Asian Development Bank, 2022). In Metro Manila, only five cities have updated CLUP and in Metropolitan Cebu, CLUP has not been updated for thirty years (World Bank, 2017). This can make development plans incoherent and haphazard and may lead to reduction of public green spaces. Aside from outdated plans, implementation of required public open spaces and green spaces are not enforced. In addition, the CLUP does not contain explicit guidelines of identification, planning and management of public spaces and UGS (ASSURE, 2019).

Improvement of the current land use policies and planning must be made for the continuous provision of public green spaces for urban communities. A national land use policy and framework overarching all existing local land use plans and ordinances and aligning all existing policies must be legislated. Since the national land use act is not yet passed by the Philippine Congress, comprehensive land use plans containing appropriate land use for UGS and open spaces, must be consistently prepared and updated by cities and municipalities. Better coordination and complementing policies of different agencies regrading public green spaces must be enforced. Finally, capacity building for personnel involved in preparation of land use plans must be observed.

Sustainable Management of UGS

Sustainability of Philippine urban parks and green spaces are confronted with issues in the planning, policies, and urban growth. ASSURE (2019) organisation comprehensively discussed how public open spaces including green spaces must be planned and implemented. It outlines relevant aspects for the effective management of UGS and public spaces – that it should consists of the scope and purpose of planning, existing open and green spaces and demand, community and stakeholder engagement, drivers and trends, gap analysis and strategic priorities and actions. This can serve as an important reference for urban managers of parks and open spaces.

More (2005) discussed five models for the management of UGS and protected areas. These include: (1) fully public model, (2) public utility model, (3) outsourcing, (4) private-non-profit and (5) private-profit models. In fully public model, the government agencies handle the management of the parks. In the second model, parks can act as public utility, wherein utility costs are handled partly by visitors. Outsourcing model involves contracting of services to private companies. Private models involve the private management of parks and protected areas by non-profit non-government organisations or private companies.

Currently, there is no single management strategy being implemented in Philippine UGS. This may be due to the unique characteristics of urbanised cities: public needs or demand for UGS, available land resources, funds, and governance. In the case of Arroceros Forest Park in the City of Manila, direct management rests on a non-government organisation – Winner foundation (Ancheta *et al.*, 2017). However, various institutions are collaborating to ensure the sustainability of the urban park. The city government of Manila, NGOs and University of the East have participated in the management and volunteer works; Metrobank and Manila Doctors Hospital are contributors for the financial needs of the urban forest park.

The sustainable management of urban green spaces is complex and multifaceted (Figure 3). It should integrate ecological, economic, and social approaches. Ecological approaches must consider maintenance and expansion of green spaces that provide biodiversity, ecosystem services, pollution control and climate regulation. Socio-economic approaches include valuation of physical and ecosystem services and financial management, social psychological health, social interactions, and overall well-being.

Philippine UGS management should be integrative, innovative, and adaptive. Implementation and integration of UGS studies in the natural and social sciences are useful in successful management. Collaborations of various stakeholders: Government, NGOs, private companies, academy, and local citizens are important to maintain and even expand green spaces. The mayors and other local executives and officials are the main managers and planners of public parks within their localities. They should be able to direct the planning and design and allocation of resources for successful UGS management. Implementation and continuous monitoring and evaluation of management of UGS must be in place to ensure sustainability. Government and private partnership can also be done to maintain and support the financial needs of UGS in the Philippine.

Research areas for urban park management can be supported by various tertiary educational institutions in the country. Aside from research, Philippine universities can provide extension services, training, and instruction for the managers and other stakeholders of the urban parks. Since Philippine university grounds harbour rich flora and fauna, biodiversity conservation policies of universities can be formulated. The University of the Philippines in Quezon City published a biodiversity handbook that will serve as an important reference for university stakeholders to sustainably manage the university's biodiversity (University of the Philippines Diliman, 2020). Universities can likewise establish linkages with LGUs for the regular clean-up drive and volunteer work in the urban parks in their locality. Homeowners in low density villages and subdivisions can establish and maintain urban gardens and neighbourhood parks. Residents in high-density areas can establish vertical gardens or pocket green spaces. City developers and builders should incorporate innovative technologies to make green buildings and structures. Adaptive strategies are likewise recommended since urban areas have fast-changing demographic features and shifting environmental conditions.

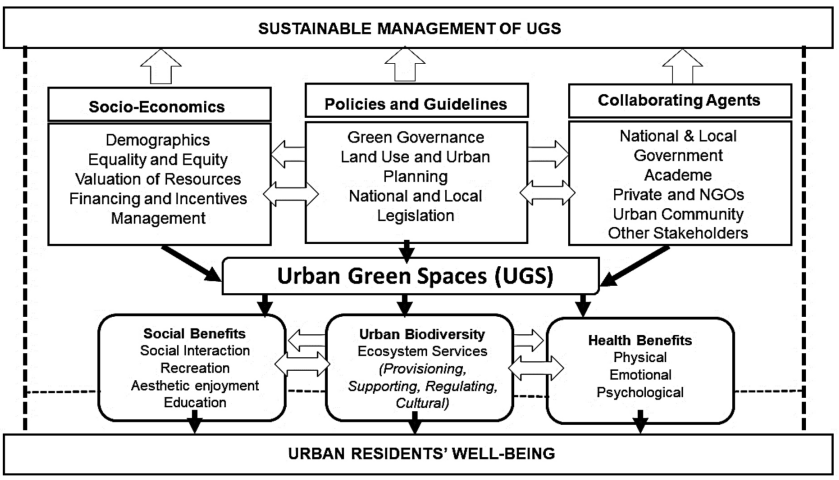

Figure 3: Framework showing the integration of different aspects of sustainable management of urban green spaces

Conclusions and Recommendations

The urban green spaces in the Philippines provide ecological, social and health benefits. Ecological benefits include biodiversity conservation, pollution abatement and mitigation, flood control and climate regulation. The expansion of green areas for ecological benefits may be done by increasing UGS in residential areas and promoting community gardens with native plants. The effects of invasive alien species within urban green spaces must also be mitigated and controlled for UGS to continue sustaining rich biodiversity. Incorporation of green infrastructures such as green roofs, urban parks, and public open spaces can help reduce flooding in cities in Philippines.

The socio-health benefits include promotion of social interaction, recreational and fitness activities and improvement of health and well-being. Continuous research must be conducted in establishing the link between Philippines' urban green spaces and the social, health and economic aspects of human development research. It must also consider species functions, biodiversity patterns, patch size, human interactions effects on urban and peri-urban biodiversity.

The management and sustainability of green spaces in Philippine cities are facing issues in rapid urban population growth, uncoordinated urban policies, and weak land use planning. Increased biodiversity studies in other urbanised and semi urban regions of the Philippines must be performed to serve as bases for land use planning and sustainable city management. A national land use policy is highly endorsed to harmonise all existing local and departmental policies. Collaborative and adaptive sustainable management approaches should be employed to Philippines' urban parks and green spaces for the overall benefit of urban residents.

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Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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