IEREK PRESS Academic Research Community

http://www.press.ierek.com

ESSD

ISSN (Print: 2357-0849, online: 2357-0857)

Environmental Science and Sustainable Development

DOI: 10.21625/essd.v1i1.33

Challenges to the Multi-Functional Uses and Multifarious Benefits of Urban Green Spaces: Basis of Urban Biodiversity Planning and Management in the City of Manila, Philippines

Leonora Gonzales[1], Dina Magnaye[2]

[1]*Technical Adviser and Consultant, Department of Environment and Natural Resources,Visayas Avenue, Quezon City, Philippines*

[2]*Assistant Professor, School of Urban and Regional Planning, University of the Philippines, Diliman, Quezon City, Philippines and Affiliate Assistant Professor, University of the Philippines Open University, Los Banos, Laguna, Philippines*

Abstract

Urbanization is a global phenomenon which is projected by the United Nations to grow annually at 65 million between 2000 and 2030 in developing countries. As an archipelagic nation, the Philippines is considered to be a highly urbanized nation where over three-fourths of its population is estimated to reside in urban areas, posting a proportion of one person residing in rural areas for every three in urban areas. The National Capital Region (NCR), the core region of the country, registers a 100% urbanization level, and it is where the most densely populated areas converge. It generally exhibits an urban population growth rate that exceeds the national growth rate. Manila, the capital city of the Philippines, is the second largest and the world's most densely populated city given its small land area and huge human population. The concentration of people in this city and the urbanization processes are foreseen to create environmental stress leading to potential biodiversity losses coupled with other urban environmental occurrences such as flooding, air pollution, sea level rise, earthquakes, subsidence, traffic congestion, water pollution, among others. These natural and man-made hazards pose a challenge to the multi-functional uses and various benefits of urban green spaces (UGS). UGS play a significant role in enhancing the quality and resiliency of the environment as well as in improving the health and general well-being of city dwellers. It is in this context that the challenges and opportunities of UGS are examined. This paper attempts to identify and determine the factors that influence UGS as a basis for urban biodiversity planning and management.

Keywords

urban biodiversity; urban green space; green space; urban biodiversity planning and management; urbanization; urban ecosystem

1. Introduction

Urbanization becomes a worldwide phenomenon and cannot be easily disentangled with industrialization. The 2015 Revision of the World Population Prospects of the United Nations (UN) projects that the annual expansion of urban population in developing countries will reach more than 65 million between 2000 and 2030. It is worth noting that developing countries started to urbanize at calamitous rate with urban population growth of 188 percent between 1950 and 1975 (Annez & Buckley, n.d.). The rapid increase in population will create pressure to the utilization of human and natural resources, given hard competition among highly productive economic activities. As a consequence, urbanization catalyzes the growth of cities and at the same time diminishes biodiversity as evidenced by degradation or loss of the natural habitats of plants and animals and scarcity or endangerment of species.

The Article 2 of the Convention on Biological Diversity (CBD) refers to biodiversity 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 ecosystems" (UN, 1992). Likewise, the Philippine Biodiversity Strategy and Action Plan (PBSAP) defines biodiversity as the "variety and variability among living organisms and the ecological complexes in which said organisms occur" ("Department of Environment and Natural Resources", 2016) and is usually considered at three levels: genetic, species and ecosystem diversity. Biodiversity also refers to all species of plants, animals and microorganisms existing and interacting within an ecosystem (Altieri, 1999). The United Nations Environmental Program (UNEP) also characterizes biodiversity as the variety of life on Earth. It includes all organisms, species, and populations; the genetic variation among these; and their complex assemblages of communities and ecosystems (Benn, 2010).

Fundamentally, there is a positive interconnection between increasing urbanization and a decline in biodiversity (Hardman, 2011). The former is considered to be one of the most important predictors of biodiversity loss (Czech, Krausman, & Devers, 2000; Davis, 2013). Other main causes of biodiversity loss include changes in ecosystem composition, presence of invasive alien species, over exploitation of species, pollution, and contamination as well as global climate change.

Biodiversity is not so simply defined in urban contexts, particularly in the Philippines ("Department of Environment and Natural Resources", 2014). The Fifth National Report of the Philippine to the Convention on Biological Diversity (CBD) underscored that during the national consultation for the PBSAP in November 2013, the scope of biodiversity in the city is not as clearly defined as biodiversity in non-urban areas. There is hardly any literature about biodiversity that tackles urban localities. According to the report to the Secretariat of the Convention on Biological Diversity (2012), "the inattention to urban biodiversity may partly be shaped by the visible lack of habitable spaces in the city for plant and animal species to thrive. Furthermore, the report cited that "biologically dead rivers, impermeable open spaces and polluted storm water canals are but a few reasons why cities are inhospitable to biodiversity."

The highly urbanized character of the Philippines given an urban population, which is steeply growing from 48.6 percent in 1990 to 48.9 percent in 2010 ("Asian Development Bank", 2014), and with almost two-thirds of the population projected to live in urban areas by 2030 ("Department of Environment and Natural Resources", 2014) merit the formulation of the PBSAP that incorporates urban biodiversity. It is anticipated that biodiversity loss will be greatly felt in urban areas and its fringes where people are abound. Urban biodiversity planning and management becomes essential in the light of the many potential negative consequences of biodiversity loss brought about by a multitude of human activities.

2. Attributes and Importance of Urban Biodiversity

Urban biodiversity is the variety and richness of living organisms (including genetic variation) and habitat diversity found in and on the edge of human settlement, and ranges from the rural fringe to the urban core ("Secretariat of the Convention on Biological Diversity", 2012). Furthermore, the CBD Secretariat characterizes urban biodiversity to

consist of the remnants of natural landscapes (e.g. leftovers of primeval forests); traditional agricultural landscapes (e.g. meadows, areas of arable land); and urban–industrial landscapes (e.g. city centers, residential areas, industrial parks, railway areas, formal parks and gardens, and brownfields).

There are three main attributes of biodiversity, namely composition, structure and functions which are described by Vold and Buffet (2000) as follows: "a) composition wherein the identity and variety of an ecological system, which is measured in terms of species, richness, and diversity; b) structure, which refers to the physical organization or pattern of a system extending from habitat complexity to the pattern of habitats or patches and other elements from the perspective of a landscape; and c) functions, which describe the results of one or more ecological and evolutionary processes in addition to a biotic processes, such as soil development and hydro logical cycles." These primary attributes of biodiversity are evident in an urban ecosystem and define the importance of protecting and preserving urban biodiversity.

Animal and plant species provide humans with food and all their basic needs (Vold and Buffett, 2000). In particular, forests and the terrestrial ecosystems provide environmental goods (i.e. food, fresh water, fuel, fiber); regulating services (i.e. climate regulation, flood regulation, disease regulation, water purification); supporting services (i.e. nutrient cycling, soil formation); and cultural services (i.e. aesthetic, spiritual, educational, recreational) ("United Nations Environmental Program", 2008).

2.1. Relating Biodiversity with the Urban Ecosystem

Urban ecosystems have usually been examined in terms of their impact on biodiversity, and they significantly affect adjacent ecosystems (Savard, Clergeau, & Mennechez, 2000). This offers valuable lessons by applying biodiversity concepts and principles to the urban ecosystem.

The 2012 Cities and Biodiversity Outlook (CBO) points to three major classifications of biodiversity concerns related to urban ecosystem. These include: a) those related to the impact of the city itself on adjacent ecosystems; b) those dealing with how to maximize biodiversity within the urban ecosystem, and c) those related to the management of undesirable species within the ecosystem (Savard, Clergeau, & Mennechez, 2000). While species' diversity and abundance are often related to the quality of urban life, the overabundance of some species can be at times undesirable (Adams, 1994), (Middleton, 1994).

Urban ecosystems tend to be characterized by unnatural or artificial ecosystems (Savard, Clergeau, & Mennechez, 2000) but the application of biodiversity concepts may lead to important management of natural ecosystems. Urban development creates opportunities for the introduction of non-native or exotic species, which lead to the extinction and elimination of a large majority of native species (Vale & Vale, 1976; Luniak, 1994; Kowarik, 1995). In addition, urbanization continues to be regarded as more lasting than any other types of habitat loss (McKinney, 2002). This constitutes a replacement that "threatens to reduce the biological uniqueness of local ecosystems" (Blair, 2001). This forms another conservation challenge to urban growth.

According to Czech et al., (2000) urbanization endangers more species and is more geographically ubiquitous in the mainland United States that any other human activity. Species threatened by urbanization also tend to be threatened by agriculture, recreation, roads, and many other human impacts, emphasizing the uniquely far-reaching transformations that accompany urban sprawl (Mckinney, 2002). Savard, Clergeau, and Mennechez (2000) added that habitat fragmentation can be extreme within urban ecosystems. In a park, shrubs abundance and distribution will influence the presence and abundance of bird species nesting in shrubs whereas park distribution, size, and abundance in a city will affect bird diversity (Savard, Clergeau, & Mennechez, 2000).

2.2. Examining the Role of Urban Green Space in Urban Biodiversity

UGS include domestic gardens, parks and, woodlands and provide a multitude of benefits to human urban population, as well as a vital habitat for wildlife ("A Brief Guide to the Benefits of Urban Green Spaces", 2015). Green

space also refers to turf-related surfaces as residential lawns, commercial or institutional turf surfaces, and public facilities, such as parks and playing fields (Heinze, 2011). In his research, Heinze identifies the environmental and human health benefits of green space as presented in the matrix below:

Environmental and human health benefits of green spaces.

Table 1. Source of basic data: Heinze (2011)

Type of benefit	Contribution to environmental and human health
Environmental benefits	
Erosion control and run-off prevention	Stabilizes and protects the soil against water and wind erosion.
Water purification	Absorbs rainfall and also traps as well as removes pollutants, which are broken down by the root system and soil microbes.
Air purification	Purifies and traps more than 12 million tons of dust, soil and other particulate matter. Important in urban areas due to the high incidence of asthma and other breathing disorders.
Temperature modification/energy and cost saving	Reduces air conditioning costs, potentially saving $6.3 billion (U.S., 2005)...despite the projected effects of climate change, addition of 10% green space in high density urban areas will allow cities to maintain current summer temperature levels (and thus current summer utility costs) for the next 70 years (up to 2080).
Oxygen generation	A 50 by 50 foot green space releases enough oxygen for a family of four on a daily basis, an average 18-hole golf course release enough oxygen for 4,000 to 7,000 people and green space along the U.S. interstate highway system releases enough oxygen for 22 million people.
Carbon sequestration	Sequesters carbon from the atmosphere.
Health benefits	
Recreation	Provides ideal surfaces for a variety of recreational and sports activity and high use activities including parks and playgrounds.
Increased physical activity/reducing obesity	Allows more active physical activity and reduces risk of obesity.
Healthcare/stress reduction	

Karuppannan et al. (2014) emphasized that UGS plays an important role in enhancing the quality of the environment, especially for urban biodiversity. They also cited that "there is a strong relationship between green open space, peoples' mental and physical well-being and presence of biodiversity and wildlife habitats within established built environments." He added that "UGS and biodiversity are crucial to sustainable cities because it involves social, economic and environmental issues and if managed properly, they result in ecological benefits for its inhabitants."

3. Urban Biodiversity in the Local Context: Manila City as a Representative Case Study

Manila City is a highly-urbanized city of the Philippines. The concentration of people in this city and the urbanization processes obtaining therein affect not only the terrestrial but also other ecosystems primarily due to the pressing demands for resources and the wastes generated. The unplanned growth of the city alongside the looming threats of climate change have resulted in perennial flooding in the City of Manila.

In terms of UGS, Manila City boasts of a network of parks and green spaces embodied in the 2005-2020 Manila Comprehensive Land Use Plan and Zoning Ordinance (MCLUPZO). The "City Beautiful Movement" was one of the five Plan Hi-Lights of the said document during the previous local dispensation. It consisted of sub Plans on "City Imageability", Open Space Network Plan, among others. However, these plans are held in abeyance pending the revision of the 2006 Comprehensive Land Use Plan (CLUP).

The City of Manila was on the drawing board of Daniel Burnham when he introduced city planning in the country together with Baguio City. However, the concept revolved around aesthetics and landscape more than urban biodiversity consideration. Urban human settlements design and development looks at open spaces as a soft, non-structural engineering intervention to address resiliency. The existing network of more than 50 parks, plazas, and monuments around the city affords an opportunity for promoting urban biodiversity with proper planning, development and management of UGS towards conservation management.

3.1. Urban Green Space Inventory as a Supply Determinant of Urban Biodiversity

The supply of UGS can be analyzed through urban green space inventory (UGSI). This approach involves the gathering of UGS baseline data to include, but not limited to, general information, biophysical characteristics, ecological terrain, institutional landscape and financial arrangements with the use of spatial and mapping tools, such as the Global Positioning System (GPS) and ground validation.

Figure 1. Urban Green Space Inventory as a Supply Determinant of Urban Biodiversity

The study involved the conduct of UGSI to provide a clear and accurate understanding of the current "biodiversity stock" in a given area. A quick survey and collection of information of the kind of plant species found in an existing and potential biodiversity station generated the needed information and identified the level of biodiversity in terms of species richness and diversity. Such data was utilized in assessing the area's potential as a part of the hierarchy and network of biodiversity stations in promoting connectivity as input to biodiversity, planning, and management.

The UGSI performed in the study covered the determination of the extent of vegetative cover, impervious areas, land use compatibility, and other biophysical and ecological, as well as institutional and financial mechanisms that would make urban biodiversity stations sustainable. A survey instrument was designed in consultation with subject matter experts in key informant interviews (i.e., key resource persons from the scientific community, academe, national government agencies, non-government organizations (NGOs), and the local government units). The instrument was presented to two focus group discussions and pretested prior to the conduct of the inventory.

Actual ground verification of the data generated was also undertaken. This constituted the flora assessment of the vegetative cover of the parks more accurately indicating the species (whether endemic, native or indigenous, introduced and "naturalized" or exotic) present in the area. This was a step forward in analyzing the potential of a given area as an urban biodiversity station, which is characterized by substantial vegetative cover, high level or presence of native and indigenous species, with relatively bigger space made of impervious materials and enough to sustain connectivity of species.

3.2. Prevailing Conditions of the Urban Green Spaces in Manila City

3.2.1. Scope of Urban Green Space Inventory

Two districts in Manila City were selected namely: District 1 and District 5 (Fig. 1). District 1 became the focus of a slum upgrading project in the 1970s under the World Bank, while District 5 is considered to be the biggest district. Around 21 UGS were inventoried: five in District 1 and 16 in District 5. The table below shows the parks, plazas, and monuments that were covered by the UGSI:

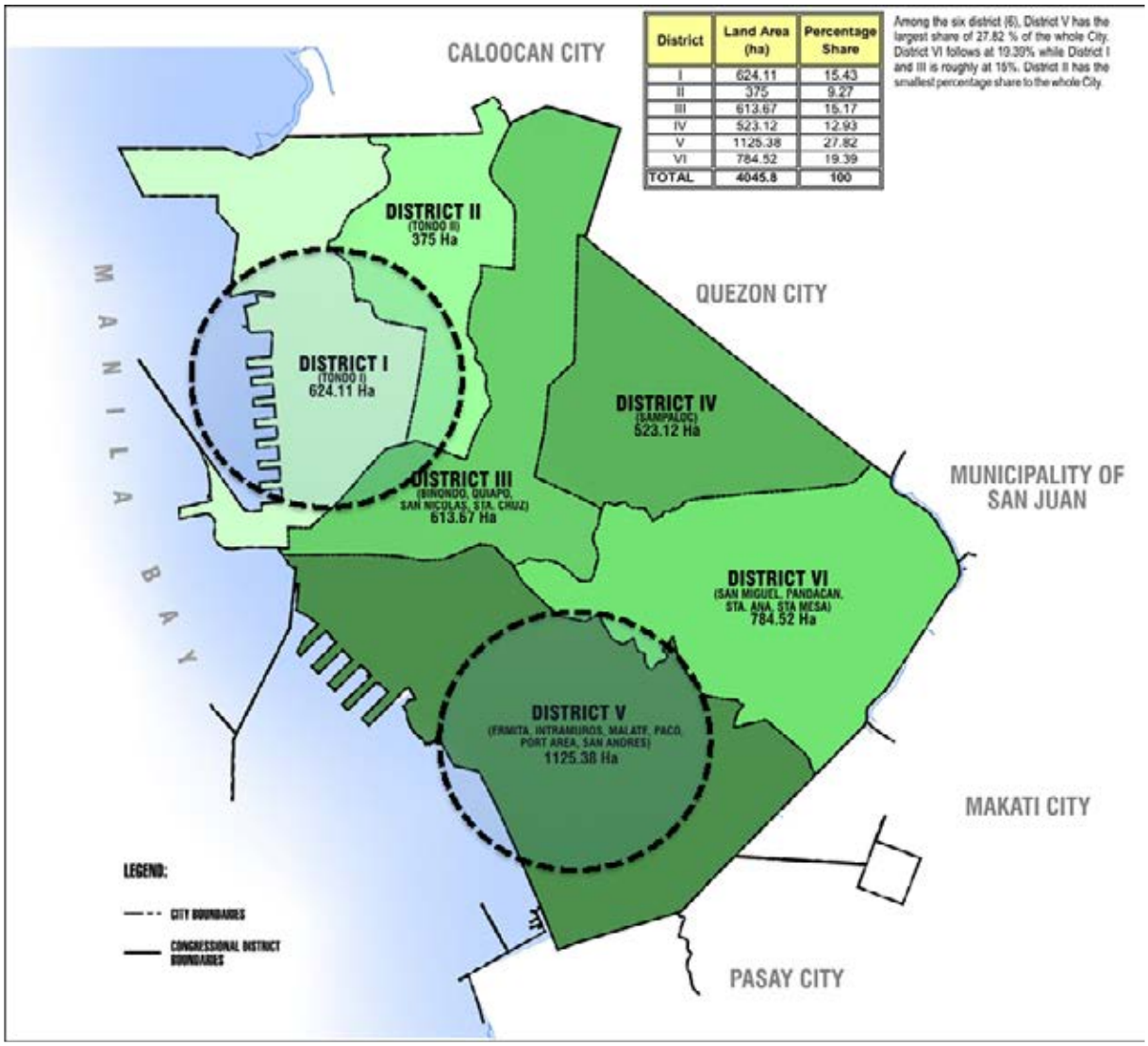
Table 2. Urban green spaces inventoried in District 1 and District 5 of Manila City, Philippines 8be6d6

District	Park/Plaza/Monument	
District 1 (Tondo) (5)	Tahanang Masa Center Island Plaza Moriones Plaza Morga	Plaza La Liga Filipina Plaza Leon/Hernandez
District 5 (Ermita, Intramuros, Malate, Paco, Port Area and San Andres) (16)	Fort Santiago Liwasang Bonifacio Arroceros Park Alexander Puskin Monument Kartilya ng Katipunan Monument Olivia Salamanca Paco Park Plaza Dilao	Plaza Roma GOMBURZA Shrine Luneta Park Plaza Guerrero Ferguson Plaza Rajah Sulayman Plaza Salvador Rueda Remedios Circle Malate Park

3.2.2. Urban Green Space Situationer in District 1 and District 5 of Manila City

The UGS situationer covers the characterization and analysis of the presence of historical markings, condition of inventoried UGS, size of UGS, number of trees in inventoried UGS, species recorded, height of trees, total basal area, crown canopy, and vegetated area. Ground truthing and validation were adopted to describe the UGS in the relevant districts of Manila City.

Number of trees in inventoried areas. A total of 6,564 trees were inventoried, 6,476 mature trees in District 5 and 88 trees in District 1. In District 1, most (48) of the trees are found in Moriones Park followed by Plaza Morga (24



District	Land Area (ha)	Percentage Share
I	624.11	15.43
II	375	9.27
III	613.67	15.17
IV	523.12	12.93
V	1125.38	27.82
VI	784.52	19.39
TOTAL	4045.8	100

Figure 2. Location map for District 1 and District 5 of ManilaCity, PhilippinesSource: MCLUPZO 2005-2020 ec385abf1236

trees). Under District 5, a large number of mature trees were recorded in Luneta Park reaching a total of 3,424. Most of the mature trees in this district were also found in Arroceros Park (1,088 trees) and Fort Santiago (557 trees). The number of trees inventoried in District 1 and District 5 is presented in Figures 2 and 3, respectively.

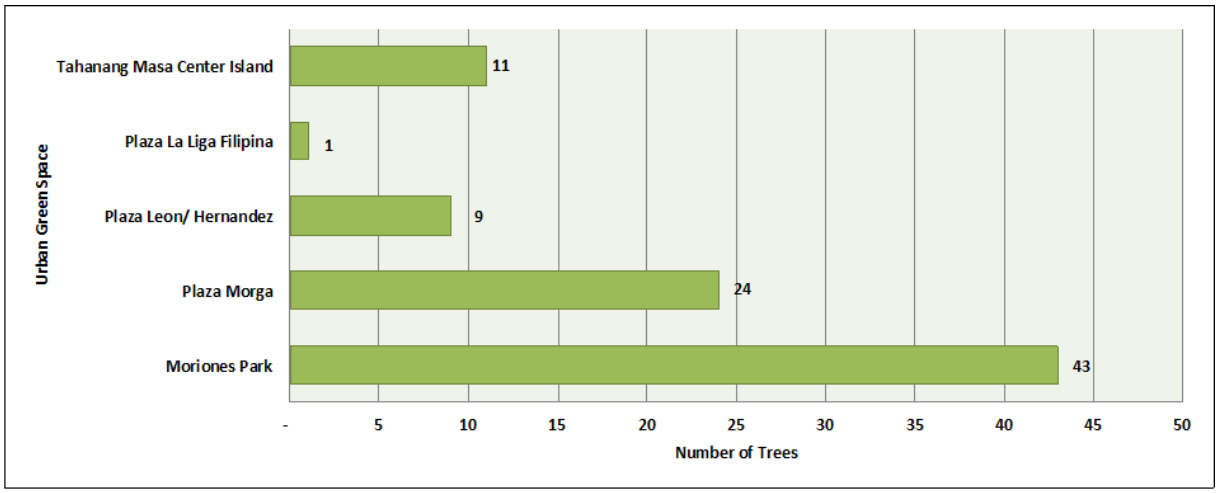


Figure 3. Numberof inventoried trees in District 1, Manila City, Philippines

Presence of historical markings. There are 20 out of 21 inventoried UGS that highlight the presence of historical monuments. Only Arroceros Park does not have a historical marking. The National Cultural Heritage Act of 2009 (Republic Act 10066) stipulates the significance of honoring illustrious persons or commemorative events of historical value based on the declaration of the National Historical Institute. Aside from historical monuments, these parks are well-lit by lamp posts, which are powered by non-renewable sources. Furthermore, the inventoried parks function as a venue for passive and active recreation, social gatherings, and public events, among others.

Condition of inventoried UGS. Among the inventoried UGS, six of them are heavily planted to include Liwasang Bonifacio, Alexander Puskin Park, Plaza Moriones, Luneta Park, Paco Park and Fort Santiago. Most of these parks are situated in District 5 of the City of Manila. The UGSI also revealed that the improvement of trees is necessary since a number of them have been exposed to extreme cases of vandalism and less attention (Fig. 4). Wounded trees were used as trash/disposal bins of cigarette butts. The tree cavities were also inserted with discarded clothes and other types of solid waste materials. Generally, the mature trees suffer decay and require immediate attention. Dead standing trees were observed in Plaza Bonifacio, Kartilya Katipunan and Alexander Pushkin Park and may pose danger to public.

Figure 4. Photos showing condition of inventoried urban green spaces

Size of urban green spaces. The largest green space is located in District 5. Luneta Park or Rizal Park has a total area of 580,000 sq m (Fig. 5) Fort Santiago ranks next with an area of 49,198 sq m and Arroceros Park with 23,881 sq m. These parks are also found in District 5. The smallest green space was Plaza La Liga Filipina in District 1 with an area of 258 sq m.

As cited in Lee et al., (2015), there is some suggestion that size matters, with greater benefits associated with larger green spaces. Furthermore, they cited that “the size of the UGS may also dictate how it is used, in that larger spaces may be more likely to be used for physical activity, while smaller spaces are primarily used for “socializing” and “rest and restitution.” This denotes the health-promoting value of green space for relaxation and stress reduction as well as its social value as a platform for social cohesiveness. Thus, Luneta Park, Arroceros Park and Fort Santiago in District 1 demonstrate the principle of health promotion capability of a green space.

Figure 5. Selected photos of UGS

Species recorded. Indigenous and exotic species were both found in Districts 1 and 5 of the City of Manila. Indigenous tree species are those that have evolved in the same area, region, or bio type where the forest stand is growing and are adapted to the specific ecological conditions predominant at the time of the establishment of the stand (Dayan, Reaviles & Bandian, 2016). Exotic or introduced trees or invasive species are those that are bought to the country.

Of the total trees recorded, an equal proportion of indigenous and exotic species was recorded. The indigenous species are dominated by Narra (*Pterocarpus indicus*) (874 or 41%), Manila Palm (*Adonidia merrillii*) (488 or 23%), and Fire Tree (*Delonix regia*) (385 or 14%) (Fig. 6a). Comparatively, almost half of the inventoried trees (3,312 or 50.4%) are considered as exotic species, mostly Mahogany (*Swietenia sp)* (784 or 26%), Molave (*Vitex parviflora)* (385 or 13%) and Mango (*Mangifera sp)* (304 or 10%) (Fig. 7b). Exotic species are said to compete with indigenous species in terms of nutrient absorption and may have negative effects on the environment, local economy and human health.

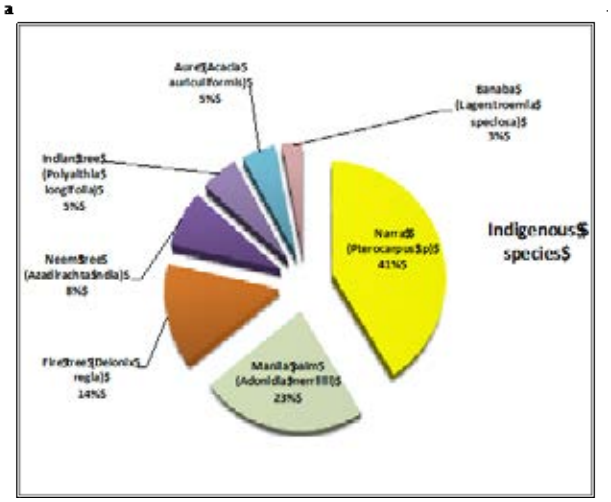


Figure 6. (a) Indigenous species inventoried, Districts 1 and 5, Manila City, Philippines space run: y

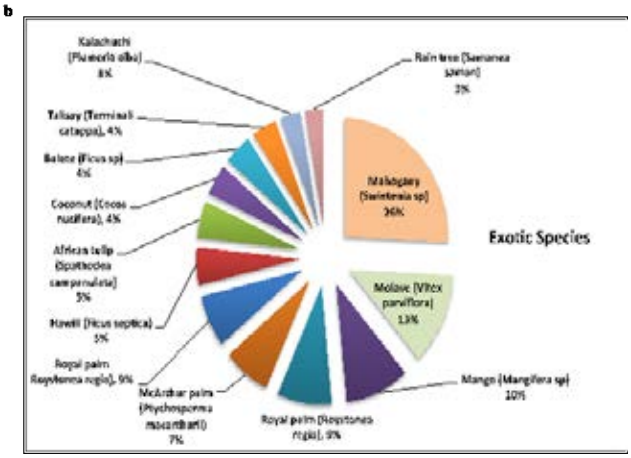


Figure 7. (b) Exotic species inventoried, Districts 1 and 5, Manila City, Philippines

Height of trees: The average height of trees in the surveyed UGS ranged from 3 meters to 12 meters (Fig. 8). In District 1, the average height of trees is from 3 meters to 12 meters and 5 meters to 11 meters in District 5. The smallest average height of 3 meters was observed in Plaza Leon Hernandez in District 1. The management of urban green spaces contributed to the short height of trees.

Crown Canopy: In District 1, the crown canopy ranges from 2 percent to 23 percent with the trees in Tahanang Masa Central Island recording the highest (Fig. 9a). The trees in District 5 have generally wider crown canopy

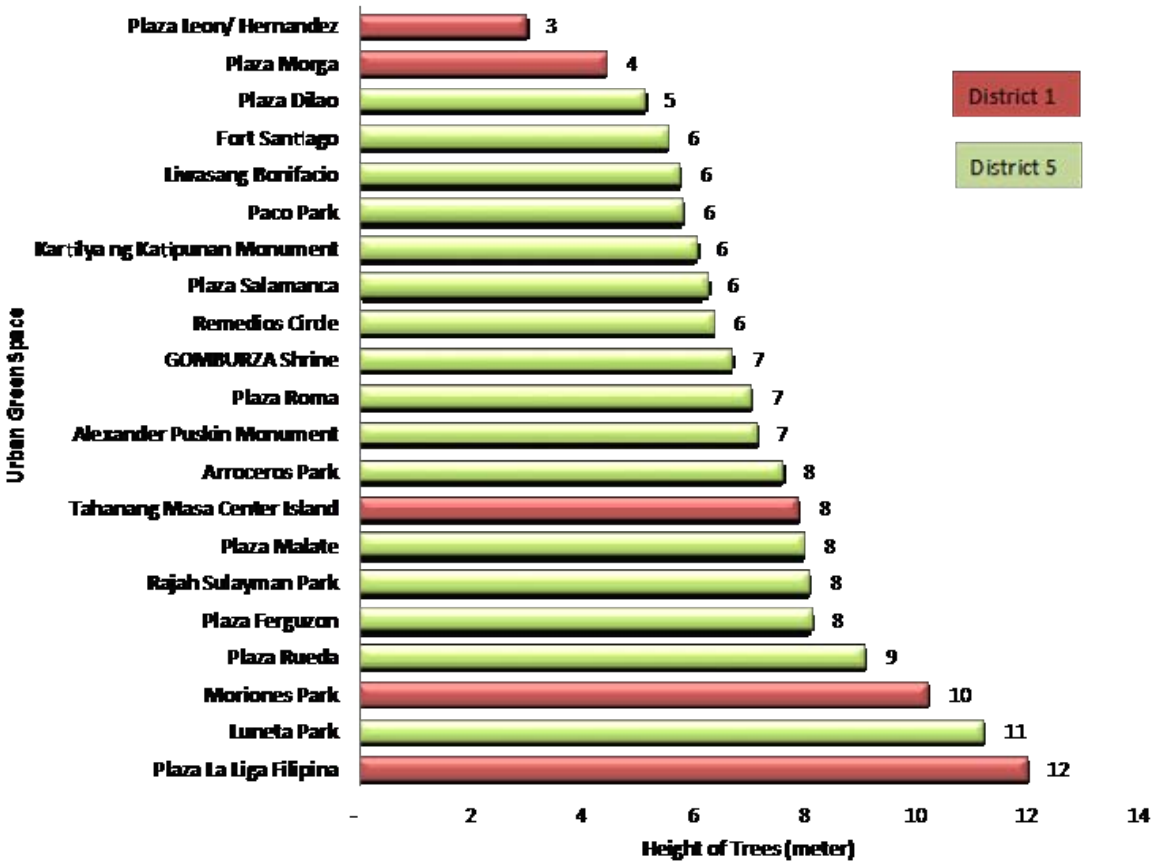


Figure 8. Average height of trees in surveyed urban green spaces

from 2 percent to 47 percent. The trees in Plaza Roma have the highest crown cover of 47% and the lowest in Remedios Circle Park (2%).

Vegetated Area: The vegetated area of a given green space is estimated through the crown canopy. Generally, the trees in District 1 have a lower vegetated area, ranging from 7 sq m to 317 sq m compared with the trees in District 5 with a vegetated area of 54 sq m to 81,694 sq m (Fig. 9a and Fig. 10b). The trees in Luneta Park have the highest vegetated area (81,694 sq m), followed by the trees in Arroceros Park (6,438 sq m).

Tuli and Islam (2014) enumerated the beneficial effects of vegetation to include its potential to reduce air temperature of a micro climate between 3^oC-4^oC; ensure sustainable breathing space; provide shade which reduces air temperature of an exposed area by 1^oC-2^oC; screen solar radiation that leads to reduced air temperature, among others. These beneficial effects can be generally realized in District 5.

Total basal area. The highest basal area per hectare was recorded for Rajah Sulayman Park (410 sq m/ha) followed by the Luneta Park (291 sq m/ha) and Plaza Ferguzon (159 sq m/ha) (Fig. 11). These trees are all found in District 5 of Manila City. The trees in District 1 have the lowest basal area, ranging from 1 sq m/ha to 6 sq m/ha. This could be explained by the small diameter of the trees during assessment.

The Mississippi Wildlife, Fisheries and Parks (”Mississippi Wildlife, Fisheries, & Parks”, n.d.), indicates that the percentage of canopy cover is correlated with basal area whereas both increa se, less sunlight reaches the ground, obstructing the growth of shrubs and other grasses. Furthermore, this organization reported that high basal area can lead to a reduction in the growth of trees and may not be able to compete with other trees for crown space, nutrients, and moisture.

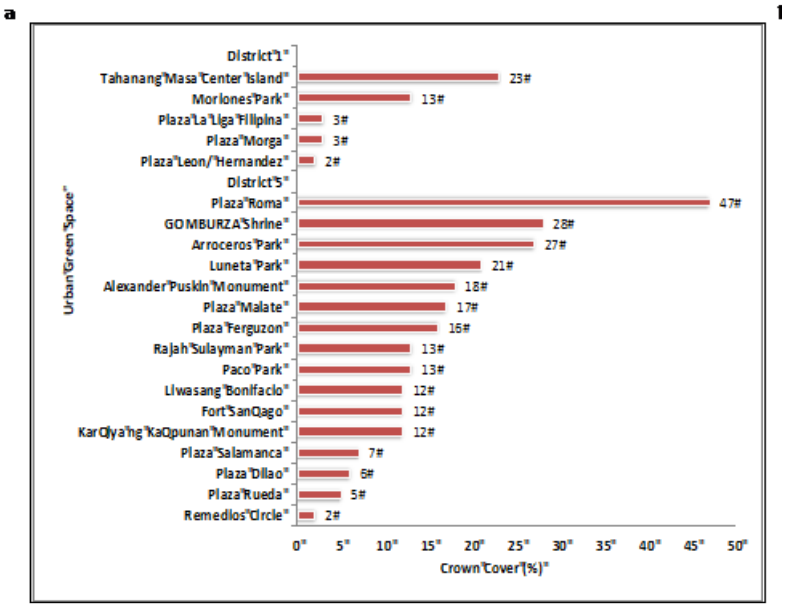


Figure 9. (a) Crown cover of inventoried trees, District 1 and District 5, Manila City, Philippines

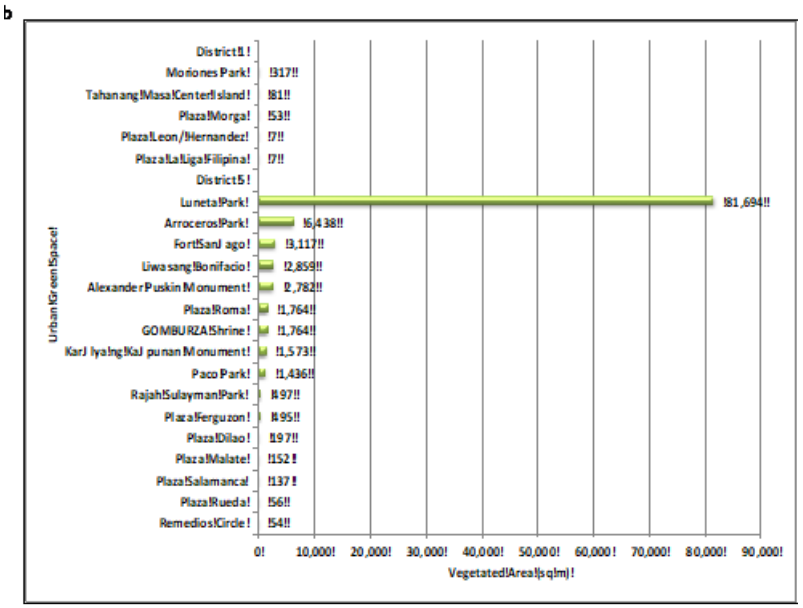


Figure 10. (b) Vegetated area of inventoried trees, Districts 1 and 5, Manila City, Philippines

3.3. Correlating Urban Green Space Condition with Urban Biodiversity Planning and Management

The maximization of the multi-functional uses and multifarious benefits of UGS rely on how they are planned and managed to ensure biodiversity preservation and protection, particularly on the local level. Urban biodiversity planning and management should be anchored on sustaining the various functions and values of UGS to include ecological, economic, and social planning, as well as other multi-dimensional values. The non-priced environmental benefits of UGS are necessary components of an urban biodiversity plan, such as attractive and pleasant urban landscapes, safety, peaceful and hazard-free environment, health promoting recreational, and social networking opportunities, among others.

The frequency of community residents' visiting the UGS and the regular clearing of bushes interfere with the growth of trees and induce the establishment of other plant species that may create environmental harm. This necessitates the engagement of the community in tree planting, conservation, protection as well as initiation of guided nature walk for visitors. The local government can initiate the conduct of training and identify environment-

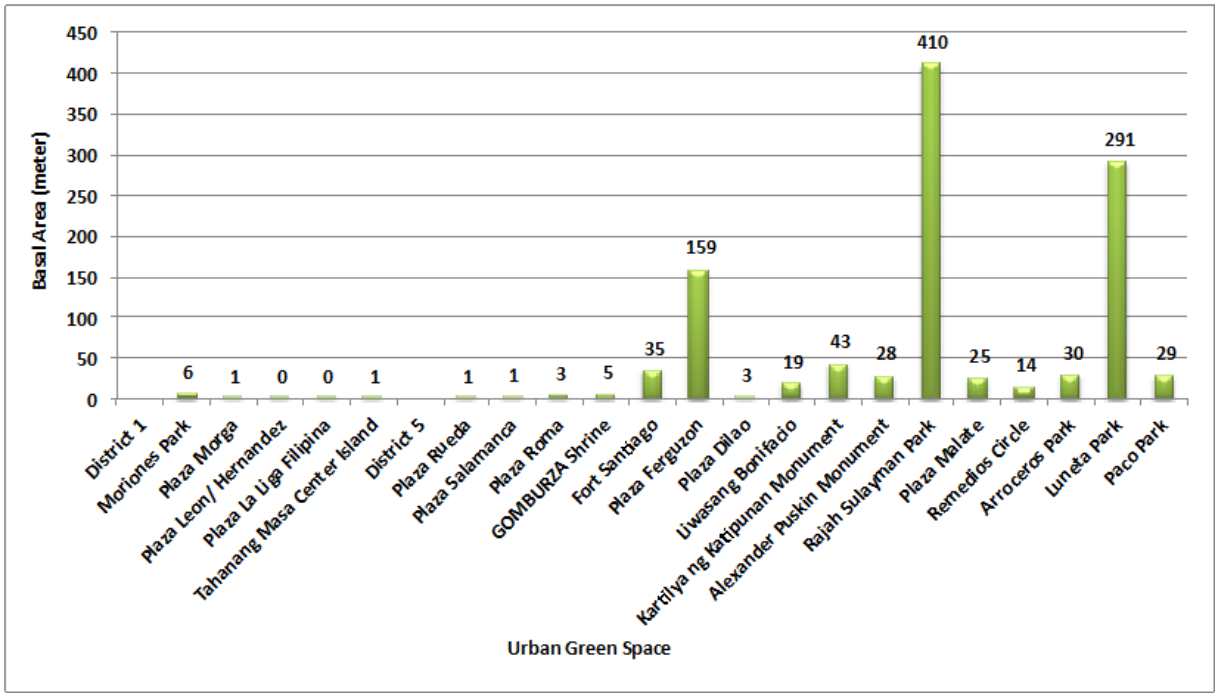


Figure 11. Basalarea of inventoried trees, Districts 1 and 5, Manila City, Philippineson management.

friendly alternative livelihood. These form part of the continuous management of UGS to ensure protection and enhancement of species composition and distribution to sustain habitats for biodiversity.

The continuous growth of invasive species or exotic species, especially those damaging species, should also be managed through biological control by means of natural enemy introduction; chemical control or the use of pesticides (herbicide or insecticide) mechanical control, such as hand pulling and other manual removal of destructive plants; and ecosystem management, which involves the exposure of an entire ecosystem to regular treatment that favors the growth of native species over exotic plants (Simberloff, 2000). An urban biodiversity management plan should cover activities that will hasten the growth of invasively introduced species and effectively manage them once they are already existing in a green space.

The success of a UGS also relies on its ability to enable a greater number of people utilize them for a wide array of outdoor and cultural activities. An urban biodiversity plan needs to introduce designs that highlight comfortable UGS for a number of users. The UGS should be designed to allow a large area of vegetation that creates a comfortable environment that reduces air temperature, create shaded cool area, and ensure provision of health benefits.

3.4. Conclusion and Recommendations

The integration of urban biodiversity in the development of urban human settlements is becoming an essential component of local development planning and management. Cities are the primary consumers of natural resources and home to an ever-increasing human population. Thus, the urban ecosystem needs to promote a better relationship between man and the environment.

Given the observed general conditions of the UGS in Districts 1 and 5 of the City of Manila, which are a) 5 out of 21 parks are heavily planted; b) 20 out of 21 inventoried UGS were observed to highlight historical monuments; c) the largest green space is located in District 5; d) indigenous and exotic species were both found in almost equal proportion in Districts 1 and 5; e) management of UGS contributed to the short height of trees; f) crown canopy ranges from 2 percent to 47 percent in the two districts; g) generally, the trees in District 1 have a lower vegetated area compared with the trees in District 5; and h) the highest basal area per hectare was recorded in District 5 and

the lowest in District 1, the following are recommended in the formulation of an urban biodiversity development and management plan for the City of Manila:

Design UGS with large area for vegetation. The local government can engage in the planting of the right species of trees at the right places in order to improve the micro climatic conditions of urban human settlements. The community should also be encouraged to adopt vertical or roof gardening to enhance biodiversity and promote connectivity. Aside from these, native or indigenous species can be replanted and restocked.

Waste segregation. Ecological waste management through waste segregation should be demonstrated in public UGS. Composting facilities have to be provided to produce organic fertilizers and other soil conditioning agents, which can be utilized as growth inducer of plants.

Careful and responsible urban planning. Urban land use plans should be developed to discourage conversion of natural ecosystems that will eventually destroy critical habitats and lead to biodiversity loss. Land uses should also promote the identification of activities that will restore damaged ecosystems and mitigate high human impact.

Community participation in urban biodiversity planning and management. The local government needs to enhance the participation, capacities, and involvement of local communities in the protection and conservation of existing natural habitats as well as restore the multi-functional uses of degraded natural habitats through awareness raising, research and development, capacity building and law enforcement.

References

1. A Brief Guide to the Benefits of Urban Green Spaces. (2015). Retrieved from http://leaf.leeds.ac.uk/a-brief-guide-to-the-benefits-of-urban-green-spaces/

2. Adams, L. W. (1994). *Urban wildlife habitats: A landscape perspective*(Vol. 3). Minneapolis: Univ. of Minnesota Press.

3. Altieri, M. A. (1999). The ecological role of biodiversity in agroecosystems. In M. Paoletti (Author), *Invertebrate Biodiversity as Bioindicators of Sustainable Landscapes*(1st ed., pp. 19-31).

4. Annez, P. C., & Buckley, R. M. (2009). Urbanization and growth: Setting the context. *Urbanization and growth*,*1*,1-45.

5. Asian Development Bank. (2014). *Republic of the Philippines national urban assessment*,*97*,5-7.

6. Benn, J. (2010). *What is biodiversity? United Nations Environmental Program.* p. 2.

7. Blair, R. B. (2001). Birds and butterflies along urban gradients in two ecoregions of the United States: is urbanization creating a homogeneous fauna?. In *Biotic homogenization* (pp. 33-56). Springer, Boston, MA.

8. Czech, B., Krausman, P. R., & Devers, P. K. (2000). Economic associations among causes of species endangerment in the United States: associations among causes of species endangerment in the United States reflect the integration of economic sectors, supporting the theory and evidence that economic growth proceeds at the competitive exclusion of nonhuman species in the aggregate. *AIBS Bulletin*, *50*(7), 593-601.

9. Davis, D. E. (2013). Exploring the effects of urbanization on biodiversity in remnant forests of the Charlotte metropolitan region. *Department of Geography and Earth Sciences, University of North Carolina*, 2.

10. Department of Environment and Natural Resources – Biodiversity Management Bureau. (2014). *The fifth national report to the Convention on Biological Diversity*(Rep.). Foundation for the Philippine Environment and Philippine Tropical Forest Conservation Foundation.

11. Department of Environment and Natural Resources. (2016). *Philippine Biodiversity Strategy and Action Plan (PBSAP) 2015-2028*.

12. Hardman, S. (2011). How does urbanization affect biodiversity? Retrieved from https://ecologicablog.wordpress.com/2011/11/06/how-does-urbanization-affect-biodiversity-part-one/

13. Heinze J. (2011). *Benefits of green space*. Chantilly VA: Environmental Health Research Foundation.

14. Karuppannan, S., Baharuddin, Z. M., Sivam, A., & Daniels, C. B. (2014). Urban green space and urban biodiversity: Kuala Lumpur, Malaysia. *Journal of Sustainable Development,7*(1), 1-16.

15. Kowarik, I. (1995). On the role of alien species in urban flora and vegetation. In P. Pysek, K. Prach, & M. Wade (Eds.), *Plant Invasions — General Aspects and Special Problems*(pp. 85-103). Amsterdam: The Hague SPB Academic Publishing.

16. Lee, A. C. K., Jordan, H. C., & Horsley, J. (2015). Value of urban green spaces in promoting healthy living and well being: prospects for planning. *Risk management and healthcare policy*, *8*, 131.

17. Local Government of Manila. (2006). *Manila City Comprehensive Land Use Plan and Zoning Ordinance.* 2005-2020.

18. Luniak, M. (1994). The development of bird communities in new housing estates in Warsaw. *Memorabilia Zoologica*, *49*, 257-267.

19. Mckinney, M. L. (2002). Urbanization, Biodiversity, and Conservation. *BioScience,52*(10).

20. Middleton, J. (1994). Effects of urbanization on biodiversity in Canada. *Biodiversity in Canada: a science assessment for environment Canada. Environment Canada, Ottawa*, 15-20.

21. Mississippi Wildlife, Fisheries, & Parks. (n.d.) Basal area: A guide for understanding the relationships between pine forests and wildlife habitat. *Private Lands Habitat Program*.

22. Reaviles, R. S., & Bandian, D. B. (2006). Indigenous forest tree species in Laguna Province (Philippines). *DENR Recommends (Philippines)*.

23. Savard, J. P. L., Clergeau, P., & Mennechez, G. (2000). Biodiversity concepts and urban ecosystems. Landscape and urban planning, 48(3-4), 131-142.

24. Secretariat of the Convention on Biological Diversity. (2012). *Cities and biodiversity outlook.*(p. 8).Montreal.

25. Simberloff, D. (2000). Introduced species: The threat to biodiversity and what can be done. *ActionBioscience. org original article.*

26. Tuli, S. M., & Islam, N. (2014, December). Impact of vegetation in urban open spaces in Dhaka City; in terms of air temperature. In *30th International PLEA Conference*.

27. United Nations Department of Economic and Social Affairs, Population Division. (2015). *World Population Prospects - Population Division*. Retrieved from https://esa.un.org/unpd/wpp/

28. United Nations Environmental Program. (2008). *Payment for ecosystem services: Getting started: A primer*. S.l.: Katoomba Group.

29. United Nations. (1992). The 22nd meeting of the SBSTTA and the 2nd meeting of the Subsidiary Body on Implementation meet in Montreal, Canada from 2 to 13 July 2018Read More. Retrieved from https://www.cbd.int/.

30. Vale, T. R., & Vale, G. R. (1976). Suburban bird populations in west-central California. *Journal of Biogeography*, 157-165.

31. Vold, T., & Buffett, D. A. (2000). *Ecological concepts, principles and applications to conservation.* Biodiversity BC.