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RESEARCH PAPER

NATURE-BASED SOLUTIONS: ASSESSING URBAN GREENSPACE AVAILABILITY IN ILIGAN CITY, PHILIPPINES

Audrey Rose A. Velayo[1], Peter D. Suson[1], Maricar M. Aguilos[2], Peng Zhao[3], Hernando P. Bacosa[1,*]

[1]Department of Environmental Science, School of Interdisciplinary Studies, Mindanao State University-Iligan Institute of Technology, Tibanga, Iligan City 9200, Philippines

[2]Department of Forestry and Environmental Resources, North Carolina State University, Raleigh, NC 27606, USA

[3]State Key Laboratory of Marine Resources Utilization in South China Sea, Hainan University, Haikou, 570228 Hainan, China

***Corresponding author:** hernando.bacosa@g.msuiit.edu.ph

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ABSTRACT. The continuous growth of urban areas, driven by population increase and commercial expansion, has led to urban problems like heat islands, pollution, and environmental damage. Greenspaces, defined as 'green' areas within cities that offer various advantages for human welfare and environmental quality, have become a vital strategy for addressing these significant urban issues. However, despite their clear advantages, the growth of greenspaces, particularly in the Philippines, is hindered by rapid urbanisation and an overemphasis on built infrastructure. Although extensive research exists on formal urban greenspaces, studies on informal greenspaces, especially within the Philippine context, have been limited. This study defines formal urban greenspaces as officially managed areas, such as parks, and informal urban greenspaces as unmanaged areas, like vacant lots or riverbanks. Surveys were conducted with 187 stakeholders from various sectors in Iligan City to identify their preferred nature-based solutions (NBS) and intervention types. GIS mapping was performed using quickOSM and Google Satellite through QGIS software version 3.4 to gather data on existing urban greenspaces per capita in Iligan City. The collected data were analysed using descriptive and frequency statistics. The findings indicated that mangrove restoration (62%) and urban tree planting (55%) were the most preferred interventions. GIS results showed that 72% of urban barangays failed to meet the WHO's minimum greenspace standard of 9 m2 per capita, with an average of 5.7 m^2 (SD = 2.3). The study recommends that future initiatives should concentrate on developing and expanding formal urban green spaces in the city's urban barangays by incorporating informal greenspaces into urban planning and improving greenspace management.

KEYWORDS: Urban green spaces, Nature-based solution (NBS), GIS mapping, Sustainable urban planning

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INTRODUCTION

As cities continue to grow and modernise, the balance between urban development and environmental preservation has become increasingly fragile. The rise of advanced technologies and industrialisation has undoubtedly transformed economies, but it has also brought about rapid urban expansion and significant environmental costs. (Beltikian, D. 2019). Recent data shows that 56% of the world's population lives in urban cities, and this figure might accelerate further, doubling its number by the year 2050 (World Bank, 2023). Moreover, according to the United Nations Conference on Trade and Development (UNCTAD), the growing urban areas and population occur at different rates but have been more noticeable in developing countries, particularly in Asia (Blachier, 2022; Foresight, 2023). Urbanisation has also been closely linked to the worsening of climate-related risks. As land cover changes and carbon sinks are lost to expanding grey infrastructure, urban areas contribute significantly to greenhouse gas emissions and the intensification of the greenhouse effect (Xu et al., 2016; Trenberth et al., 2015; WHO, 2013). These dynamics increase the frequency and severity of extreme weather events, such as the devastating floods seen in countries like Pakistan (Mann, 2017; Petoukhov, 2013). Global trends in urbanisation and environmental change are now visibly reflected at the local level, where rapid urban growth is transforming cities and increasing environmental risks. For instance, in the

Philippines, about 54% of the population, approximately 58.93 million individuals, live in urban spaces. This is due to the centralisation of most economic activities in cities, where citizens choose to migrate from rural to urban areas for occupational opportunities, better education, and hope for good living conditions (PSA, 2020; Mojares, 2013). However, challenges and environmental risks have been rising due to rapid urban population growth and centralisation in highly urbanised cities in the Philippines. Thus, there has been an extensive need for urban management and development to address the challenges posed by rapid urbanisation in most cities (Delos Reyes et al., 2020; Estoque, 2022).

On the other hand, urban greenspaces (UGS) are recognised as playing a crucial role in addressing the urban challenges found in most cities. These include environmental degradation, air pollution, and urban heat island effects, which can be managed through sustainable urban development that considers land use in urban areas and transforms concrete jungles into smart green cities (Addas, 2023). UGS are defined as areas of greenery or vegetation within city boundaries. They are vital for promoting sustainable land use, improving urban environmental conditions, and enhancing the overall well-being of city dwellers. Examples include parks, garden patches, nature reserves, grasslands, and other types of greenery (Subedi and Pokhrel, 2023). Two types of UGS commonly found in urban areas are formal UGS and informal UGS. Formal UGS are urban greenspaces that are officially recognised, designated, and managed by government authorities and organisations. These are often recreational spaces such as parks, playgrounds, nature reserves, allotment greens, and even cemeteries. Informal UGS, however, are unmanaged greenspaces or areas unofficially designated, often arising from spontaneous resident initiatives. Examples include vacant lots, green patches, pocket gardens in residential areas, and greenery along riverbanks (Pietrzyk-Kaszyńska, Czepkiewicz, and Kronenberg 2017; Falchetta and Hammad, 2023). Several studies have highlighted the positive impacts of these spaces. They enhance air and water quality, improve environmental conditions in urban areas, encourage social activities, and promote a better quality of life for city residents (Falchetta and Hammad, 2023; Revich, 2023; Addas, 2023). However, the availability of greenspaces is limited in countries like the Philippines. Their expansion has encountered various challenges due to rapid urbanisation, and urban planning in most cities tends to focus more on 'grey spaces' (Alejandre et al., 2022; Gonzales and Magnaye, 2016). While most studies have concentrated on formal urban greenspaces, research on informal greenspaces remains limited, particularly in the Philippines.

Thus, this study generally aims to assess the disparities in available urban greenspaces among the urban barangays of Iligan City. Specifically, this study aims to (1) determine the various stakeholder preferences and priority nature-based solutions interventions for Iligan City, (2) generate a spatial distribution map of informal and formal urban greenspaces in the study areas, and (3) determine the adequacy of available greenspaces per capita in the urban communities.

MATERIALS AND METHODS

Study Area

In the northern region of Mindanao, Iligan City is classified as a highly urbanised, single-district city within the province of Lanao del Norte (Fig.1). It has an estimated population of 363,115 and a population density of 446 km^2, with an average household size of 4.2 (PSA, 2020). Iligan City's terrain varies from the coast to the mountains, covering a total land area of 813.37 km^2. The rapid urban expansion in Iligan City has placed significant pressure on its natural ecosystems. This has led to changes such as an increase in urban land area and the urban heat island effect, caused by reduced vegetation and dense populations (Trinidad, 2007; US EPA, 2025). The study was conducted and focused on the urban barangays of Iligan City. These include Barangays Acmac, Bagong Silang, Buru-un, Dalipuga, Del Carmen, Ditucalan, Kiwalan, Mahayahay, Maria Cristina, Pala-o, Poblacion, Puga-an, San Miguel, Santiago, Sta. Filomena, Suarez, Tambacan, Tibanga, Tomas Cabili, Upper Hinaplanon, and Villaverde. A 'barangay' is the smallest territorial and administrative local unit in the Philippines.

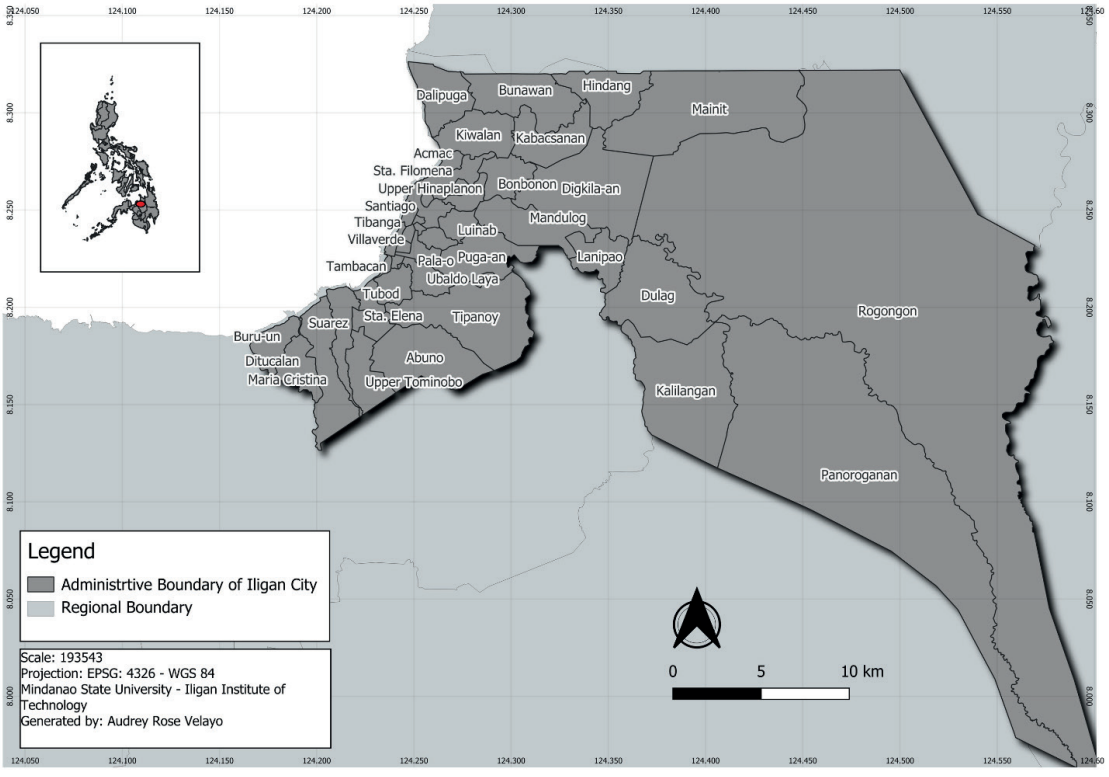

Fig. 1. Map of Iligan City, Philippines, showing its 44 barangays. The barangay is the smallest political unit in the Philippines

This study follows a cross-sectional quantitative design. A descriptive research design was used to collect socio-demographic data and stakeholder preferences, and to calculate the available greenspace per capita per urban barangay in Iligan City.

Stakeholder Survey

This study employed a purposive sampling method to gather a sample of 187 stakeholders from Iligan City (Etikan et al., 2016). An adapted questionnaire from Ferreira et al. (2022), presented in Appendix Fig. A.3, was used to determine stakeholder preferences and prioritise interventions. The questionnaire included items such as, 'Considering current and future challenges and priority interventions, which of the following solutions are essential? (select up to five options and rank them from most to least important)' and 'Among your selected five essential interventions, rank them by importance and priority.'

Before collecting data, the researcher identified potential participants by listing all city stakeholders. This list was then narrowed down to agencies and organisations involved in environmental planning, development, implementation, and resilience in Iligan City. Participants were selected based on the following criteria: (1) they were bona fide residents of the city, (2) they were at least 18 years old, (3) they were employees and experts from local and national government or non-government organisations, academia, and private sectors involved in environmental planning, development, implementation, and resilience, and (4) they represented all genders. Data collection took place on-site. Participants were given an informed consent form that outlined the study's title and main purpose.

Urban Green Spaces and Data Sources

Data on both formal and informal urban green spaces across the different barangays of Iligan City were collected using Geographic Information System (GIS) technologies, specifically through QGIS software and Google Satellite imagery. The QuickOSM plugin in QGIS was employed to extract OpenStreetMap (OSM) data, which served as the initial base map for identifying greenspaces. To enhance the accuracy and completeness of the dataset, manual digitisation was conducted, such as creating vector layers by tracing lines and polygons of visible greenspaces. The total area in square metres of the existing UGS in Iligan City per urban barangay and their population was also gathered from existing data from the local government units of Iligan City, including the barangay local government units. This information was then used as a basis to calculate greenspaces per capita for each barangay.

Limitations of the Study

The scope of this study is limited to assessing the availability of current green spaces in the urban barangays of Iligan City against the World Health Organization standard of 9 m^2 per capita. It also includes an analysis of preferred nature-based solutions among stakeholders in Iligan City. The study did not account for the people's organisation sector. It is recommended for future studies on nature-based solutions and stakeholders to include the people's organisation sector for more inclusive data representation. Furthermore, future studies should compare and analyse tree canopy cover and vegetation cover for each urban barangay in Iligan City. It is also strongly recommended that future studies expand the sample size and scope to assess other types of nature-based solutions beyond green spaces.

Data Analysis

To understand the differences and patterns in how various sectors view greenspaces in Iligan City, frequency and distribution statistics were used to analyse stakeholder preferences and priority interventions. The sociodemographic profile of the respondents, including age, gender, educational attainment, sector, income, years of residence, and civil status, was also analysed. These were calculated using descriptive statistics (frequency, mean, and percentage) in Microsoft Excel 2022.

For this part of the analysis, data gathered on urban greenspaces from quickOSM and Google Satellite through QGIS software, such as area and coordinates for greenspaces per capita, were analysed using frequency and descriptive statistics in Jamovi ver 2.3.28. The analysis focused on the size and distribution of green spaces per capita across Iligan's urban barangays. Descriptive statistics were combined with spatial mapping data, guided by the method used in a study by Laghai and Bahmanpour (2021).

RESULTS

Respondent's profile

This study involved 187 participants from various stakeholder sectors in Iligan City. As shown below in Fig. 2, most respondents were female (62.6%), with the remainder being male (37.4%). Among them, most were married (48.7%), followed by single individuals (44.4%), separated individuals (2.1%), and widowed individuals (4.8%). Additionally, the educational background of most stakeholders was college graduates (81.8%), followed by master's graduates (8.0%). Only a small percentage were college undergraduates (1.6%), which can be seen below in the appendix section (Fig. A. 1 and Fig. A. 2).

The sampled stakeholders represented four sectors, with 40% from the local government unit (LGU), 33.7% from the academe sector, 13.4% from non-governmental organisations (NGOs), and 12.3% from the private sector.

Stakeholder priority NBS types

Figure 3 shows the different types of nature-based solutions chosen as priority interventions by stakeholders from the four sectors: the private sector, academe, local government units (LGUs), and non-governmental organisations (NGOs). The results indicate that mangrove

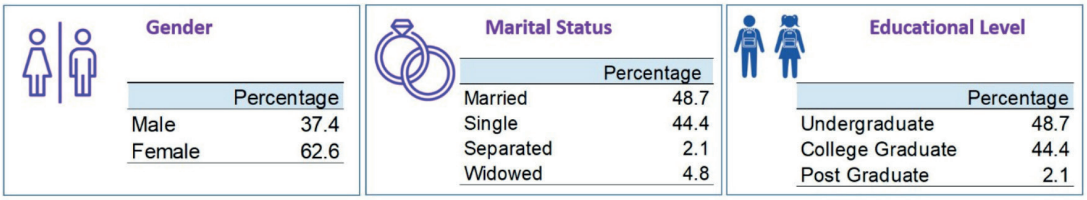

Fig. 2. Percentage distribution of stakeholders by sector, based on respondents; N=187 (Velayo et al. 2024)

restoration and conversion were the highest priority across all sectors. Most private sector stakeholders chose mangrove restoration and conservation (21.74%) and urban trees (21.74%) as priority nature-based solutions. These were followed by drainage corridors (13.04%) and riverbank rehabilitation (13.04%). The least preferred nature-based solutions among private sector stakeholders were stormwater pits (4.35%), green barriers (4.35%), and natural pools (4.35%).

Meanwhile, stakeholders from academia have chosen mangrove restoration and conservation as the most prioritised type of nature-based solution (36.51%). This was followed by urban trees (15.87%), and then riverbank rehabilitation (12.70%). The least chosen types of nature-based solutions in academia were wetlands and floodable parks (1.59%), followed by green barriers (3.17%). Similarly, most stakeholders in the local government unit (LGU) sector have also chosen mangrove restoration and conservation (32.89%) as a priority nature-based solution for climate action, followed by urban trees (26.32%). Lastly, most stakeholders from non-governmental organisations (NGOs) also responded that mangrove restoration and conservation (40.00%) is a priority nature-based solution. The least chosen nature-based solutions among the NGO sector were natural pools (4.00%) and green barriers (4.00%).

Figure 3 shows that mangrove restoration and conservation are the most prioritised type of Nature-based Solution (NBS) among various stakeholders (32.1%). The second most prioritised is urban trees (19.3%), followed by riverbank rehabilitation (14.4%). This implies that mangrove restoration as an NBS for addressing environmental issues, such as climate change impacts, is considered significant by most stakeholders. This further suggests that stakeholders from various sectors share a similar understanding of the importance and benefits of ecosystem services associated with mangrove ecosystems. Other types of NBS, such as green infrastructure, are also mentioned (Juanico, 2022). Iligan City has faced several challenges in sustainability and infrastructure development. These challenges include a growing population, the risk of natural disasters, poverty, and various environmental issues (Uniaty, 2015).

Mangrove restoration plays a key role in cities with coastal areas like Iligan City. Its proper management helps mitigate environmental degradation caused by human activities and also provides various ecosystem services, such

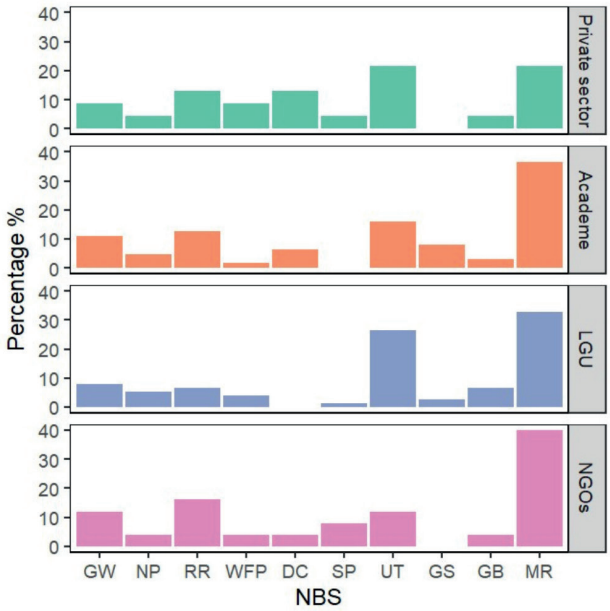

Fig. 3. Percentage distribution of the type of priority nature-based solutions among all stakeholders. Green walls (GW), natural pools (NP), rehabilitation of riverbanks (RR), wetlands and floodable parks (WFP), drainage corridors (DC), stormwater pits (SP), urban trees (UT), green shadows (GS), green barriers (GB), mangrove rehabilitation (MR)

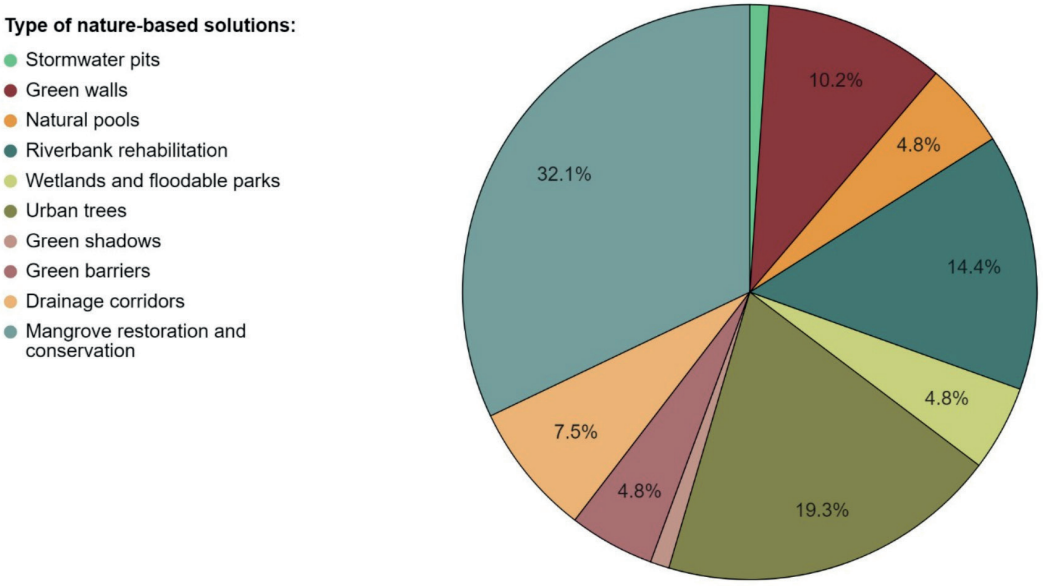

Fig. 4. Types of priority nature-based solutions across the four different sectors

as coastal protection and economic benefits to residents (De Juan, Gelcich, and Fernandez, 2017; Agustriani et al. 2023; Hilmi, Usman, and Iqbal, 2023). The strong preference for mangrove restoration indicates a wider recognition of the urgent need for ecosystem-based adaptation (EbA) strategies in urban planning. Furthermore, prioritising mangrove conservation and restoration aligns with ecosystem-based adaptation (EBA), which emphasises the crucial role of natural solutions for addressing urban challenges and climate change impacts (O'Leary et al., 2023).

Standard urban greenspace per capita and quantity in the urban barangays of Iligan City

Fig. 5 illustrates the spatial distribution of existing formal and informal greenspaces among the urban barangays in Iligan City. Most of the existing formal and informal greenspaces are clustered in more developed and built-up areas.

As shown in Table 2, Barangay Ubaldo Laya and Luinab have no existing formal greenspaces. However, despite this, both barangays have a significant number of informal greenspaces compared to other urban barangays in Iligan City. For instance, Barangay Ubaldo Laya has riverside, residential, and grassland informal greenspaces, while all informal greenspaces in Barangay Luinab are residential. This suggests that Barangay Ubaldo Laya is situated alongside natural and underdeveloped areas along riverbanks. These areas may offer several ecological and economic benefits to the local communities in Barangay Ubaldo Laya. They also have potential for recreational activities for the residents, such as passive and light physical activities, including community events (Barsukova et al., 2022).

This finding of an uneven number of formal greenspaces to informal greenspaces in urban barangays of Iligan City shows that while unmanaged vegetated areas provide ecosystem services and recreational value, their lack of formal recognition may limit their protection from development pressures. This is especially true in cities where urbanisation is rapid, like Iligan City (Biernacka et al., 2023).

Greenspaces in urban areas provide for the recreational needs of most residents within their localities, such as relaxation, leisure, and outdoor social activities, thus enhancing physical and mental well-being among residents. Consistent with this, a study by Turna (2022) in India found that urban greenspaces in cities are vital for recreational purposes among communities. It encourages outdoor activities and contributes to the enhancement of residents' quality of life. Another study by Huang et al. (2022) in China examined the behaviours among citizens and the role of the summer heat experienced in the city of Fuzhou. They found that the high temperatures impact public behaviours and that urban greenspaces play a significant role in remediating the urban thermal environment present in the city, promoting enhanced public health among residents.

Furthermore, as shown in Table 2, various barangays, such as Luinab, Tubod, Tipanoy, and Hinaplanon, are dominated by informal greenspaces rather than formal ones like residential and grassland types. This indicates that informal green spaces are widespread among residential neighbourhoods. It suggests that these areas host informal greenspaces, possibly due to residents' initiatives to create their own green spaces in various forms, such as backyard gardens, vacant lots, and green patches (Christoph et al., 2017). Consistent with this, multiple studies in Asia have found the crucial role of residents in informal greenspaces. For instance, a study conducted by Cedamon (2009) in

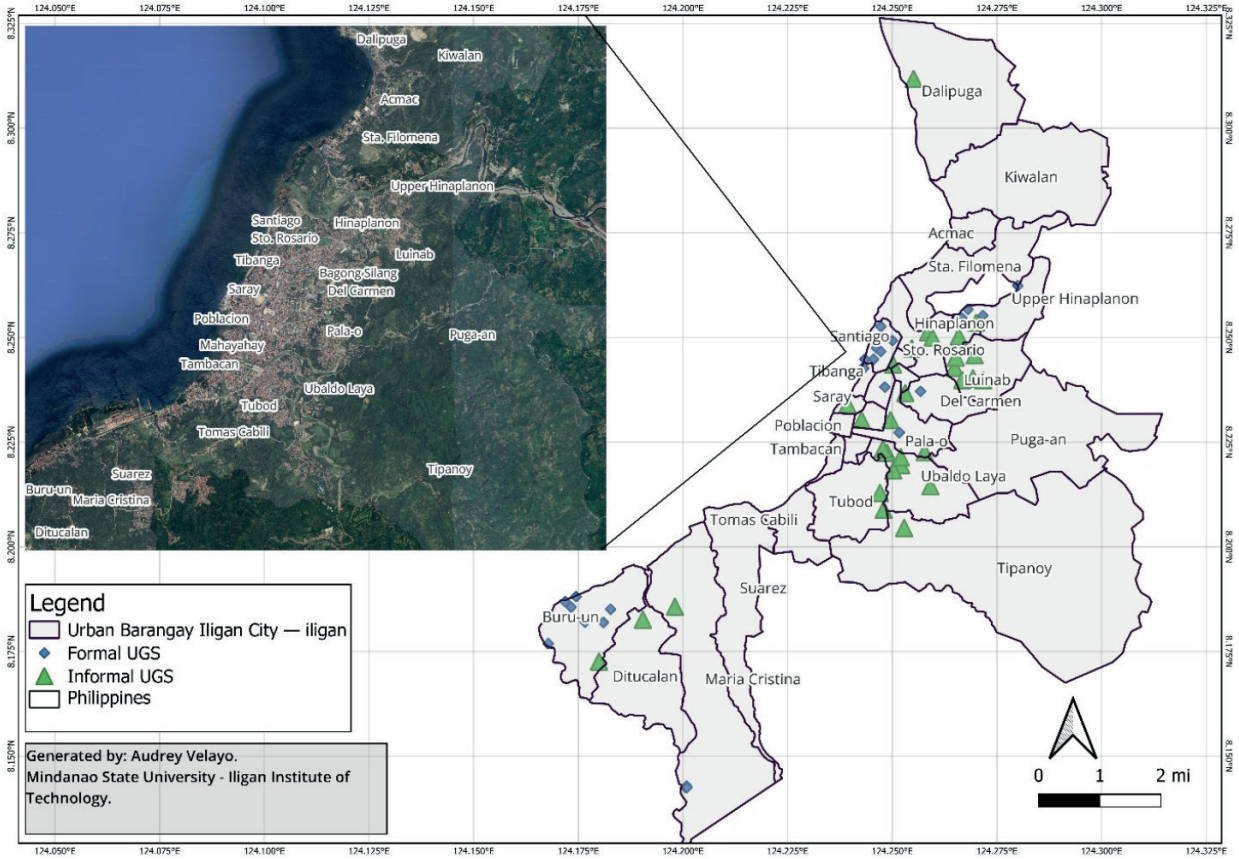

Fig. 5. The urban barangays in Iligan City and their formal and informal urban greenspaces. The green triangle icon represents the location of informal UGS, and the blue diamond icon represents the location of formal UGS. Default CRS projection: EPSG:4326 - WGS 84

Table 2. Classification of urban greenspace found in the urban barangays of Iligan City and their numbers

Barangay	Type of green areas	Count	Urban greenspace classification
Ubaldo Laya	RiversideResidentialGrassland	231	InformalInformalInformal
Pala-o	CemeteryRoadsidePark	112	FormalInformalFormal
Kiwalan	PitchSchool greenery	11	FormalFormal
Tubod	Grassland	2	Informal
Tipanoy	Residential	1	Informal
Villa-verde	CemeteryPark	11	FormalInformal
Saray	Grassland	1	Informal
Buru-un	ResidentialResortPlayground	131	InformalFormalFormal
Maria-Christina	PrivatePark	11	InformalFormal
Hinaplanon	ResidentialGrassland	21	InformalInformal
Upper-Hinaplanon	ResidentialPitch	14	InformalFormal
Del Carmen	RecreationalPlayground	11	InformalFormal
Dalipuga	RecreationalRecreational	11	InformalFormal
Sto.Rosario	Grassland	1	Informal
Sta. Filomena	Cemetery	1	Formal
Santiago	PlaygroundPitch	11	FormalFormal
Tibanga	Pitch	2	Formal
Luinab	Residential	6	Informal
Tomas Cabili	Pitch	1	Formal
Ditucalan	Residential	1	Informal

Leyte found that initiatives by local government units within barangays led to efforts, particularly with Leyte's active residents, to manage informal greenspaces in their communities (Thahir, 2016; Dangol, 2019). Informal green spaces, especially in residential areas of urban cities, typically result from residents' initiatives as they offer various benefits, such as recreational value and enhancement of the urban environment for the community (Katalin, 2019; Cipriano & Garcia, 2019; Mahmoudi et al., 2019).

Meanwhile, as shown in Figure 6A, informal greenspaces are more prevalent than formal greenspaces in the urban barangays of Iligan City. This suggests that the city's urban landscape is defined by a greater presence of unmanaged or natural green areas compared to formally designated and managed green spaces within its urban barangays.

Aside from resident initiatives in forming informal greenspaces, several factors may also contribute to the insufficient formal greenspaces and abundance of informal greenspaces in an area. These include neglected maintenance of certain areas leading to informal greenspace, urbanisation constraints, a lack of municipal capacity, and resource allocation for the management of green spaces (Katalin, 2019; Piotr et al., 2021). Several studies have also highlighted the importance and the need for proper regulation and utilisation of unmanaged areas along rivers. For instance, these areas naturally restore barren lands or unmanaged areas along riverbanks to facilitate comfortable recreational spaces while accounting for the preservation of existing natural landscapes (Demashkieh, 2022; Barsukova et al., 2022; Olaj & Fikfak, 2012).

Another important consideration is not only the number of green spaces but also their size. According to the World Health Organization, the recommended standard for every city is at least 9 m2 of greenspace per individual (Russo and Cirella 2018). Table 3 presents the available urban greenspaces per capita in every urban barangay in Iligan City. Among the urban barangays, Tomas Cabili exhibits the highest amount of formal greenspace per capita, at 16.11 m^2. This is followed by Barangay Santiago with a greenspace per capita value of 13.98 m^2, and then by Barangay Sta. Filomena (12.04 m2/capita). This suggests that these urban barangays in Iligan City offer residents sufficient access to greenspaces for various opportunities for outdoor recreation and leisure activities.

Meanwhile, Barangays Hinaplanon (10.86 m2/capita), Tambacan (11.89 m^2/capita), and Pala-o demonstrate a moderate amount of formal greenspaces. These fall just above the minimum standard of 9 m^2 per capita recommended by the World Health Organization. This suggests that the efforts of local authorities and residents in these urban areas are sufficient to meet the minimum standard for city greenspaces. Enhancing and expanding green spaces, particularly in urban environments, helps to counter the negative effects of increasing urbanisation worldwide. This is achieved by reducing pollution, promoting sustainable land use, and improving urban ecosystems (Giorgo et al., 2022; Samfira, 2022).

In contrast, Barangays Acmac (3.57 m^2/capita), Bagong Silang (0.64 m^2/capita), Del Carmen (0.70 m^2/capita), Ditucalan (0.16 m^2/capita), Mahayahay (0.78 m^2/capita),

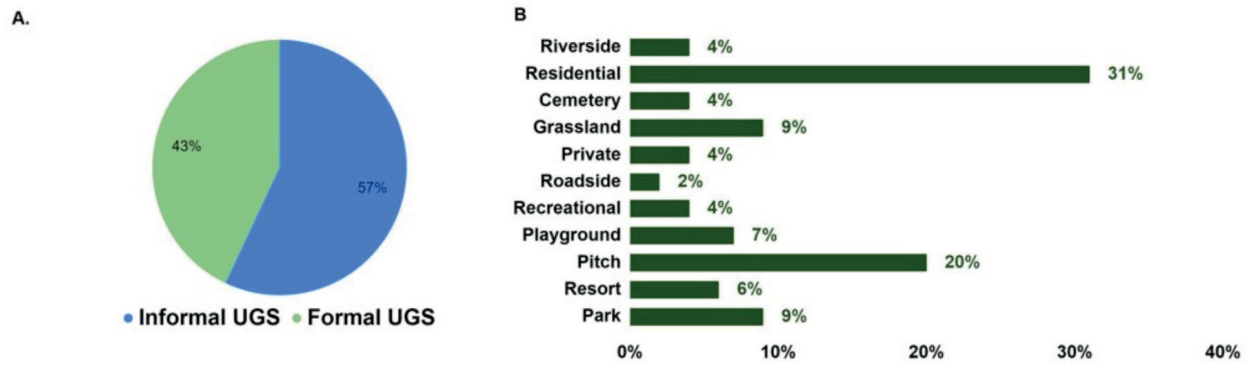

Fig. 6. A. Percentage distribution showing the proportion of formal and informal UGS. B. Percentages of the types of formal and informal UGS found in Iligan City. Informal UGS N=31, Formal UGS N=19

Table 3. Available formal greenspace per capita among the urban barangays in Iligan City

Barangay	Population	Available greenspace (sqm)	Available greenspace per capita (m^2)
Tomas Cabili	9676	600.45	16.11
Santiago	9212	659.10	13.98
Sta. Filomena	7005	581.74	12.04
Tambacan	19 261	1620.07	11.89
Pala-o	10 778	944.67	11.41
Upper Hinaplanon	6551	603.24	10.86
Dalipuga	21 470	2930.40	7.33
Buru-un	16 835	2616.99	6.43
Kiwalan	7710	1872.57	4.12
Acmac	6856	1921.11	3.57
Suarez	18 649	11 351.21	1.64
Maria Cristina	11 811	8078.96	1.46
Poblacion	3613	2619.65	1.38
Tibanga	8089	7571.17	1.07
Villaverde	5514	6144.51	0.90
Mahayahay	7965	10 251.64	0.78
Del-carmen	9662	13 836.37	0.70
Bagong Silang	6104	9539.14	0.64
San Miguel	3801	13 085.18	0.29
Ditucalan	4039	26 033.27	0.16
Total:	217 443	140 478.69	Mean greenspace per capita: 5.57

Poblacion (1.38 m^2/capita), and Villa Verde (0.90 m^2/capita) fall below the minimum World Health Organisation recommended greenspace per capita. Overall, the existing urban greenspace in Iligan City totals 5.57 m^2/capita, indicating that Iligan City does not meet the minimum greenspace standard. This highlights the need for local authorities and other concerned groups to address the lack of formal greenspaces in these urban barangays of Iligan City. The absence of available formal green spaces, particularly in urban areas, can present various challenges to residents' well-being and the general urban environment. For example, a study by Keh et al. (2023) found that residents' well-being is jeopardised by the negative consequences of natural greenspace destruction, as these urban greenspaces are crucial for fostering social interaction and human health. Furthermore, another study conducted by Addas (2023) stressed the significance of expanding greenspaces for the development of an intelligent city, promoting an improved quality of life for residents, better urban environmental conditions, and crucially, to tackle the threats posed by climate change in cities.

DISCUSSIONS

This study received responses from a total of 187 participants representing various stakeholders in Iligan City to assess their preferences for different types of nature-based solutions. The participants' profiles showed diversity in both gender and educational attainment. The majority of responses came from the city's local government unit. This indicates the significant roles these sectors play in urban, environmental planning, and policy development in Iligan City. However, the participant pool for this study also revealed limited engagement from non-governmental organisations (NGOs) and the private sector. This underrepresentation restricts stakeholder inclusivity, which may limit opportunities for cross-sectoral collaboration, especially in integrating solutions that address local issues. Furthermore, this underrepresentation also highlights another limitation of the study's sample. Therefore, this paper recommends a more inclusive and representative approach to stakeholder mapping for future research. Meanwhile, mangrove restoration and conservation emerged as a highly prioritised nature-based solution among all stakeholders in Iligan City, suggesting a shared perception of their value in addressing the city's needs. For coastal cities like Iligan, this finding underscores the importance of mangroves for climate adaptation, particularly regarding ecosystem services such as mitigating storm surges and flooding. Moreover, these findings align with broader literature on ecosystem-based adaptation (EbA), where mangrove conservation is recognised as a cost-effective and efficient solution to environmental degradation and climate change impacts (Cuenca-Ocay, 2024).

Based on international guidelines, such as the World Health Organization's standard of around 9 m^2 of green space per capita, the findings of this study reveal that the green spaces in the urban barangays of Iligan City are well below this target. This result is similar to other growing cities. For example, a study by Nambazo and Nazombe (2024) reports that 20% of Malawian neighbourhoods fail to meet the 9 m^2 standard, particularly in high-density districts. Likewise, similar findings have emerged in other Philippine cities. In a study by Ibañez et al. (2024), results showed that Pasay City falls below the World Health Organization's minimum required green space per capita. Projections suggest a need for an additional 925.72 m^2 of green space by 2032 to meet the needs of its growing population. The inadequacy and limited availability of urban green spaces can have profound detrimental impacts, affecting both environmental and socioeconomic aspects for urban dwellers (Gbadegesin et al., 2024; Uslu et al., 2024). The inadequacy and limited availability of urban green spaces in most urban barangays in Iligan City highlight the need for urban green planning focused on improving both the accessibility and availability of these spaces.

The results of this study also found an uneven number of formal and informal greenspaces in the urban barangays of Iligan City. This finding indicates disparities in the distribution of urban greenspaces across Iligan's barangays. Some areas in barangays such as Tomas Cabili, Santiago, and Sta. Filomena surpass the World Health Organisation's (WHO) minimum standard of 9 m^2/capita, while others, including Ditucalan, Mahayahay, and Villa Verde, remain critically below this threshold. This suggests uneven access to greenspaces among residents in Iligan City. Meanwhile, resident-managed greenery in barangays like Ubaldo Laya and Luinab plays an important compensatory role by providing ecological and social functions where formal greenspaces are lacking. While these unmanaged vegetated or informal greenspaces, such as riverbanks, vacant lots, and residential greenery, offer important ecosystem services and recreational benefits, their lack of formal recognition may leave them vulnerable to various types of development such as infrastructure, particularly in rapidly urbanising cities like Iligan City. Globally, regions with dense urbanisation often see uneven greenspace access. Cities in countries from the Global South have received far less cooling and air-quality benefits from urban vegetation than their northern counterparts (Li et al., 2024). In this study's findings, Iligan City's formal parks and large green areas appear to be concentrated in select zones, leaving other neighbourhoods largely devoid of vegetative or green cover. Similar patterns have been observed elsewhere in the Philippines. For example, Banguilan (2024) found that in Metro Manila, most localities scored below the 9 m^2/person standard advocated by the WHO, with greenspace clustered in specific areas. Thus, the uneven distribution of greenspaces across Iligan City's urban barangays highlights broader urban planning challenges, particularly in terms of accessibility and equity. Those barangays with adequate greenspaces benefit from improved recreation opportunities, reduced urban heat, and enhanced public health, while those barangays that were found to be critically below the WHO standard may likely face greater exposure to environmental and social risks. The underrepresentation of formal greenspaces and the undervaluation of informal ones in Iligan City underscore the urgent need for inclusive urban planning that formally integrates both types of greenspaces into local development agendas to ensure environmental equity and long-term climate resilience.

Furthermore, the study's results found that most types of greenspaces in several urban barangays, such as Luinab, Tubod, Tipanoy, and Hinaplanon, are dominated by residential and grassland types. This suggests that these areas contain informal greenspaces that may have emerged from resident initiatives within these barangays. These efforts might include creating green spaces in various forms, such as backyard gardens, vacant lots, and green patches (Christoph et al., 2017). Consistent with other studies, most informal greenspaces, like backyard gardens, residential greenery, and green patches, have also been seen as a result of community-driven initiatives. Although these informal greenspaces offer significant recreational and environmental benefits to urban well-being and its residents, their lack of formal recognition, often being spontaneous and undermanaged, may make them vulnerable to various urban developments (Rupprecht & Byrne, 2017; Thong et al., 2024). Meanwhile, several studies highlight the crucial role of community-led initiatives in improving the management of these informal greenspaces. For example, a study in Beijing, China, showed how resident-driven regeneration practices, such as small-scale gardening, have played a significant role in public space renewal in historical communities and their greenspaces through spontaneous actions and resident participation (Zhang & Xin, 2023). In line with this, another study by Eslit (2023) in Barangay Acmac revealed how community-led initiatives have emerged as a significant driver of local environmental protection. It highlighted their empowering process through a bottom-up approach, which has enabled residents to engage in collaborative decision-making and sustainable practices for local environmental protection.

CONCLUSIONS

Overall, the results of this study demonstrate aspects of urban green planning in Iligan City. Among the stakeholders in Iligan City, mangrove restoration and urban trees are the most preferred and priority nature-based solutions (NBS) types for Iligan City. This is followed by urban trees, highlighting a shared understanding among various stakeholders regarding their importance for protection, enhancing urban environments, and their socio-economic benefits. Moreover, disparities in formal and informal greenspaces are present among the urban barangays in Iligan City, with informal greenspaces being more abundant than existing formal urban greenspaces. In addition, most urban barangays fall behind the recommended standard greenspace per capita set by the World Health Organisation (WHO) for cities. Thus, this study suggests a multi-stakeholder approach that also includes community participation for comprehensive urban green planning. This aims to accelerate community-led initiatives for managing informal greenspaces and for the enhancement of formal greenspace development, protection, and maintenance. This would satisfy the World Health Organisation Standards for greenspace per capita in the urban barangays of Iligan City. It also involves the conversion of informal green spaces (e.g. vacant lots, grasslands, residential greenery, and underdeveloped areas) into formal greenspaces like pocket parks, urban trees, and green barriers. This can be achieved through strengthened urban land use plans that prioritise greenspace development and by incorporating informal urban greenspaces into the urban planning frameworks of the city government and barangay local government, in collaboration with other sectors and government agencies. However, it is important to note that green spaces found in private lands and properties may be subject to further consideration due to potential legal concerns and restrictions. Furthermore, this study has found an abundance of residential types of informal greenspaces among the urban barangays of Iligan City, indicating resident-driven initiatives. Hence, it is also recommended that local authorities and other concerned groups provide incentives for these informal residential types of greenspaces among residents as part of Iligan City's overall effort in enhancing urban greenspaces.

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APPENDICES

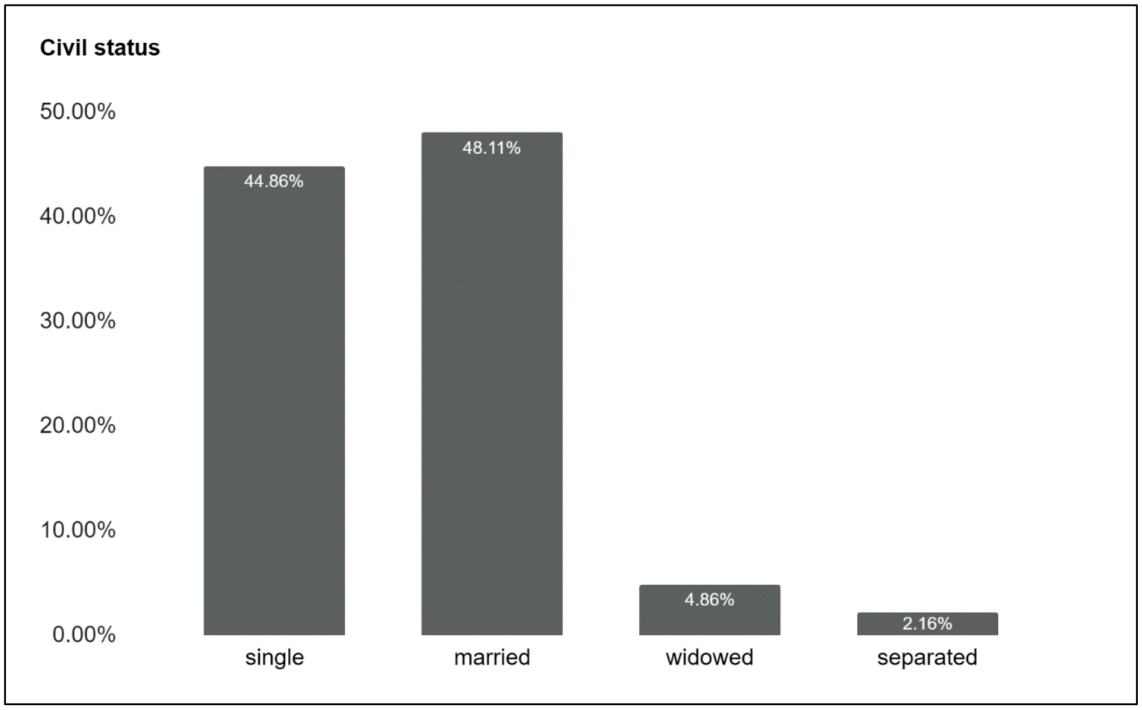

Fig. A. 1. Respondent's civil status; N=187.

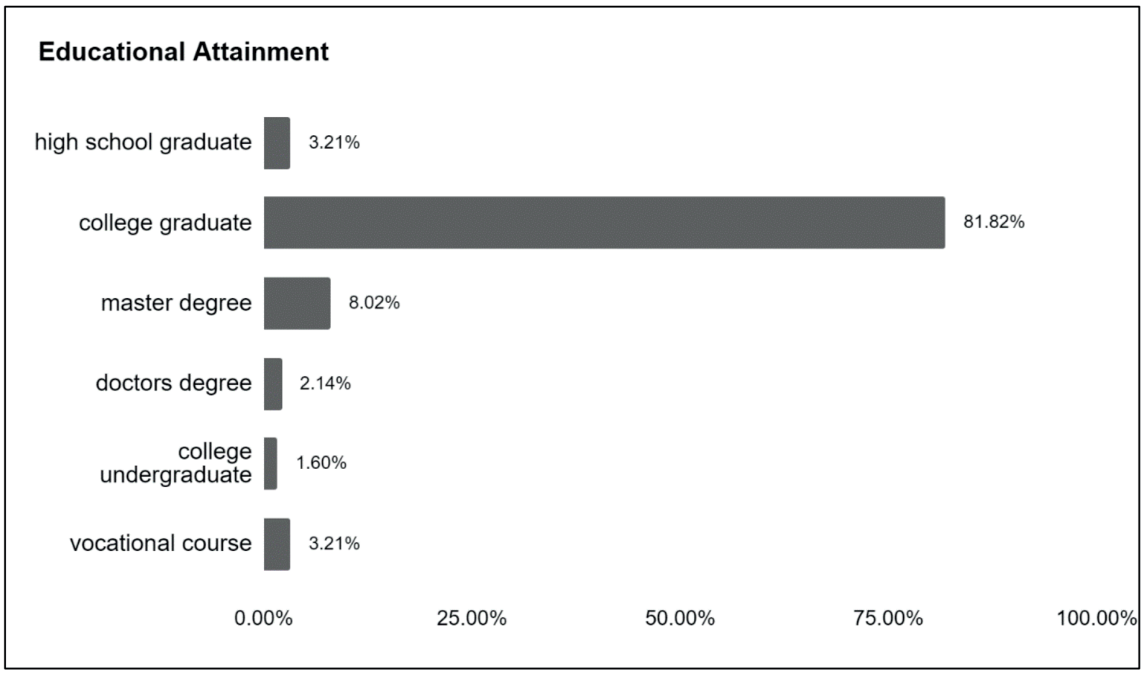

Fig. A. 2. Respondent's educational attainment; N=187.

IV. Policy prioritization

Facing the actual and future challenges and priority interventions, which of the following solutions are fundamental? (choose up to five options and arrange them from most to least important).

A. Green walls 

B. Natural pools 

C. Riverbank rehabilitation 

D. Wetlands and floodable parks 

E. Urban Trees 

F. Green shadows 

J. Green Barriers 

K. Drainage corridors 

M. Mangrove conservation and restoration 

1. Among your chosen 5 fundamental interventions. Rank them according to importance and priority.

Fig. A. 3. Questionnaire on stakeholder preference and priority NBS survey questionnaire (Ferreira, 2020)