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EVALUATION OF ECOSYSTEM SERVICES CONTRIBUTIONS ON URBAN FORESTS IN KUALA LUMPUR

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ABSTRACT

This study investigates the benefits of urban forests, focusing on the Kuala Lumpur Forest Eco Park (KLFEP), the world's oldest virgin forest, as a solution to the city's enduring challenges with urban risks and pollution. Through an analysis of ecosystem services, including supporting, regulating, provisioning, and cultural services, the research evaluates the contributions of KLFEP. Sustainable Development Goals (SDGs) achieved by urban forests are identified, with contextual insights drawn from document analysis of the Kuala Lumpur Structure Plan 2040 (KLSP2040), SDGs 2030, and related studies. Additionally, semi-structured interviews with professionals provide further perspectives on urban forest benefits and achievable SDGs. Thematic analysis is used to examine qualitative data. The findings reveal that KLFEP offers a healthy habitat, a diverse tree population, and air purification, enhancing regulating and supporting services. Its unique flora and fauna contribute to nutrient cycling, biological control, and provisioning services.

Moreover, Kuala Lumpur benefits significantly from recreation and ecotourism opportunities provided by KLFEP, contributing to cultural services. The study underscores the importance of urban forests, particularly KLFEP, as sustainable solutions to Kuala Lumpur's challenges. It aims to increase awareness about prioritising urban forests in development plans to protect remaining forest patches. Raising awareness among authorities and society about the significance of urban forests is crucial for informing landscape architecture planning and decision-making, ensuring the consideration of all urban forest benefits.

Keywords: Urban Forest, Ecosystem Services, Kuala Lumpur Forest Eco Park, Sustainable Development Goals, Forest Benefits.

1.0 INTRODUCTION

As the focal point of urban settlement, the burgeoning population in Kuala Lumpur has propelled rapid urbanisation, presenting both advantages and drawbacks to society (Kuala et al. et al., 2004). Numerous vacant lands have been repurposed to meet the needs of urban communities, facilitating rapid development of additional land, infrastructure, and amenities to accommodate the populace. Projections indicate that Kuala Lumpur's population is expected to surge from 1.73 million in 2020 to 2.3 million by 2050 (Kuala et al., 2021). However, this swift urbanisation has also adversely affected the natural environment, profoundly impacting the urban ecosystem. Makmom Abdullah et al. (2012) highlight various environmental challenges Kuala Lumpur faces, such as climate change, pollution, and water

scarcity. Despite concerted efforts to mitigate these issues, this study posits that urban forests are pivotal in addressing these challenges. Ecosystem services serve as a checklist to elucidate the benefits that urban forests can offer.

Urban forests serve as vital contributors to the urban landscape, preserving biodiversity, enhancing public health, and enriching daily life while meeting fundamental human needs (Franklin et al., 2007; Stupak et al., 2015; Sundara et al., 2021; Meyer et al., 2017). The perception of urban forests has evolved, varying across countries. Ambiguity in defining and understanding urban forests in Malaysia has impeded efforts to prioritise their preservation and sustainable development (McLean & Jensen, 2004). The Malaysian government has taken steps to address the decline of green spaces by designating urban forests under the National Forestry Act of 1984, thereby safeguarding these areas from disruptive activities. However, media reports have highlighted instances where urban forests have been degazetted to make way for development projects despite prior designation as permanently protected areas. This underscores the need for increased awareness regarding the significance of urban forests in societal and governance contexts.

Ecosystem services encompass the benefits derived from the environment essential for city sustainability, with urban forests often serving as primary providers (Nilon et al., 1999; Stupak et al., 2015). Understanding ecosystem services can inform governance and decision-making for future development (Gómez-Baggethun et al., 2010; Bayon, 2004). This study aims to delve deeper into these benefits, with two main objectives: to identify the contributions of urban forests to Kuala Lumpur city and to suggest suitable recommendations for enhancing urban forests. By elucidating the contributions of urban forests, this study intends to foster governance that recognises the importance of urban forests and paves the way for informed development that integrates urban forests as indispensable components of city planning.

2.0 LITERATURE REVIEW

History of Urban Forests in Malaysia

This study defines urban forests as any green area within urban or peri-urban regions that contains forests, tree groups, or individual trees. The evolution of urban forests in Malaysia has unfolded through distinct stages (Nowak et al., 1994; FAO, 2014; Lev, 2017). The interpretation of urban forests in Malaysia is diverse, encompassing existing forests within city areas and the deliberate integration of forests into urban design (Sundara et al., 2021; Justice et al., 1986).

Sweetheart (2017) delineates the progress of urban forestry in Malaysia across three significant periods. The first phase traces back to colonial times with the extensive planting of *Pterocarpus indicus* in Penang and Malacca (Koening, 1894; Burkill et al., 1966; Philip, 1999). The second phase took root in Kuala Lumpur through Beautification Programmes, marked by significant plantings of trees such as *Peltophorum indicus* and *Samanea saman* (Ayoub, 1989). The third phase focused on uniquely identifying the Malaysian landscape, initiated with the Landscaping the Nation Programme in 1995 (Sreetheran et al., 2011). The inception of the National Landscape Policy in 2006 aimed to conserve natural resources while enhancing aesthetics (Ahmad, 2013; Ibrahim, 2016). Amid concerns over deforestation and illegal logging, efforts to safeguard green areas intensified, leading to the National Forestry

Act of 1984 (Woon et al., 2002). This legislation facilitated the categorisation of forests into Permanent Forest Estates (PFE), preserving them based on their attributes (Yaakob, 2014). Subsequent forestry practices in Malaysia gravitated towards environmental preservation, spawning initiatives focused on sustainability, climate change mitigation, and biodiversity enhancement (Ratnasingam et al., 2011).

In Kuala Lumpur, the urban forest concept emerged with the ambition of citywide tree planting, as outlined in the Kuala Lumpur Structure Plan 1984 (Sreetheran, 2017). The Nationwide Tree Planting Campaign 1997 further bolstered this endeavour, setting a global record for the maximum number of trees planted in one minute in 2000 (BBC News, 2000; Nordin et al., 1997). In summary, Malaysia's sustained commitments to landscape and forest growth underscore the evolving understanding of urban forests. This underscores the importance of further investigation into the professional perception of urban forests, given the diverse definitions and relevance found in the data.

Underappreciation of urban forests in Kuala Lumpur

Forests have long been recognised as invaluable natural assets, providing many benefits for urban development, natural resources, and economic prosperity. Unfortunately, news of forest exploitation remains common worldwide. Malaysia recently faced a concerning incident of illegal deforestation in the Bukit Tabur rainforest, eliciting strong negative reactions from local communities and environmentalists. The state government intervened, asserting that the deforestation activities were unauthorised, and promptly ordered their cessation (Lee et al., 2021). Regrettably, forest reserves being degazetted is not uncommon in Malaysia. In 2016, the then Minister of Natural Resources and Environment, Datuk Seri Wan Junaidi, disclosed that permanent forests in Kuala Lumpur had diminished from 106.10 hectares to 68.27 hectares due to road and infrastructure developments (Abas, 2016). Even the oldest virgin forest in Kuala Lumpur, KLFEP, previously known as Bukit Nanas Forest Reserve, has a history of being degazetted for development. Initially gazetted as a permanent Forest reserve in 1906 with a total area of 17.5 hectares, it shrank to 9.3 hectares after the construction of K.L. Tower, now a prominent tourist destination in Malaysia (John. et al., 1990; JungleBoy, 2014).

The exploitation of forests has resulted in numerous environmental issues, including climate change, habitat degradation, the urban heat island effect, air and noise pollution, and water resource scarcity (Kuala et al., 2021; Abdullah, 2012). Furthermore, reducing urban forests undermines their role as carbon sinks, ecological corridors, and biodiversity assets, as emphasised in the KLSP2040. The depletion of urban forests could lead to significant losses in carbon sequestration potential by 2030. However, government efforts to safeguard natural areas, including forests and green spaces, are noteworthy. The Twelfth Malaysia Plan (RMK-12) fosters a prosperous, inclusive, and sustainable country, focusing on advancing green growth (Minister's Office of Malaysia, 2021). This plan emphasises environmentally friendly economic development, aiming to reduce carbon emissions by 45% by 2030 and achieve carbon neutrality by 2050. It also aims for 120 cities to attain sustainable city status, supported by preservation and conservation initiatives. These objectives align with the vision of the Kuala Lumpur Structure Plan 2040 (KLSP2040), which aims to create a greener city with a low-carbon approach.

In summary, despite significant urban forest losses, Malaysia is actively transitioning towards sustainable urban planning and green growth. However, continuous professional involvement in protecting urban forests remains crucial.

Understanding ecosystem services

Ecosystem services encompass humans' diverse benefits from ecosystems, supporting, enriching, and sustaining life (Bolund et al., 1999; De Groot et al., 2002; Haines-Young et al., 2018; Taylor, 2020). These services represent the outcomes of ecological processes that yield advantages for human populations, as outlined in the Common International Classification of Ecosystem Services (CICES V5.1) by Haines-Young and Potschin-Young (2018). Bolund and Hunhammar (1999) similarly highlight ecosystem services as encompassing the benefits obtained by humans from ecosystems, with the term 'services' denoting 'benefits,' emphasising the value ecosystems offer to living and non-living entities, particularly humans.

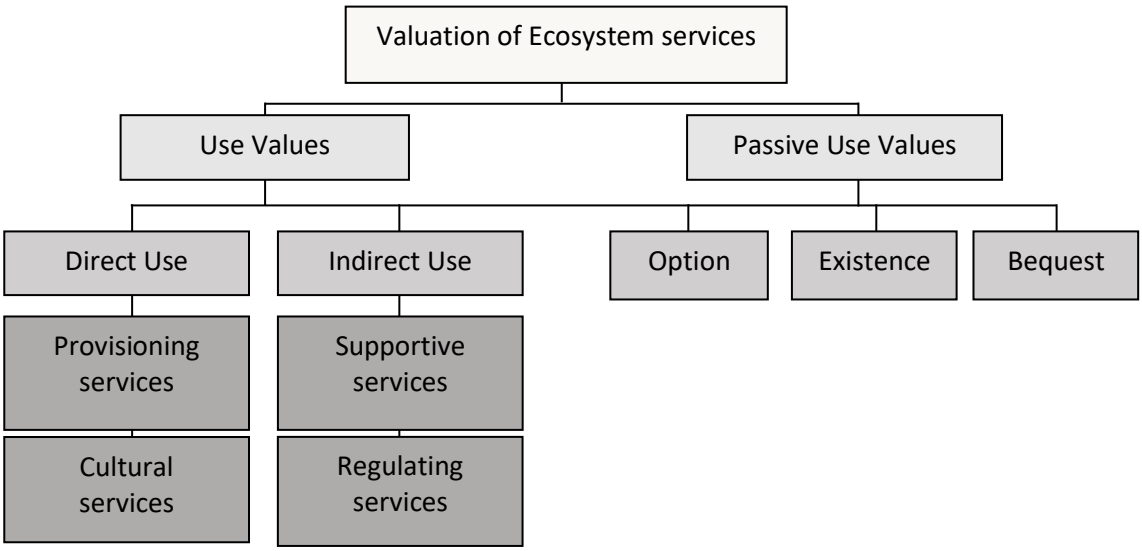

Fig 1: Valuation of Ecosystem services
(Source: https://www.millenniumassessment.org)

Valuing these ecosystem services entails considering both use values and passive use values. Use values encompass services directly or indirectly utilized by humans, categorised into four main groups: supporting services, regulating services, provisioning services, and cultural services. Meanwhile, passive use values hold significance even without direct utilisation, owing to people's awareness of their existence. These passive values encompass existence, bequest, and option values. As this study emphasises, a comprehensive understanding of ecosystem services, including their ecological, economic, and social dimensions, is essential for recognising the extensive contributions of urban forests in Kuala Lumpur. Ensuring the preservation of these services is crucial for fostering a sustainable environment, with social, economic, and ecosystem services playing pivotal roles in this research.

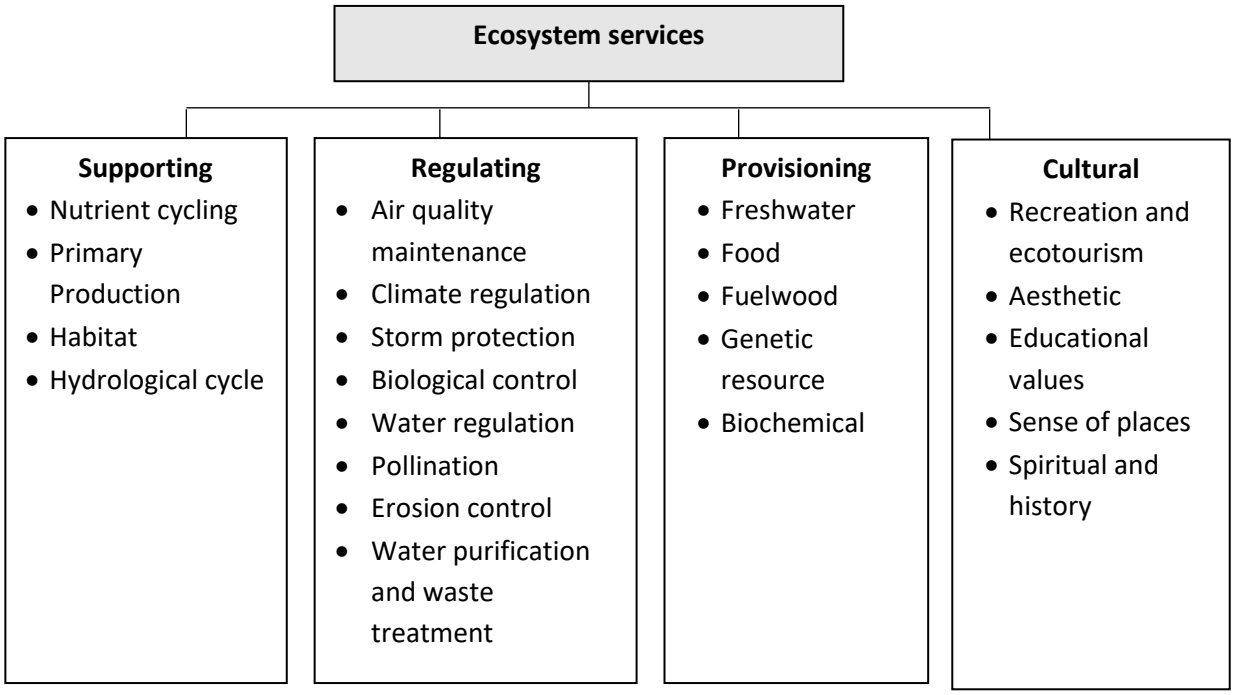

Fig. 2: Ecosystem services functions and subfunctions
(Source: https://www.millenniumassessment.org)

According to Pascual U. et al. (2010), ecosystem services are categorised into four functions: supporting services, regulating services, provisioning services, and cultural services. Supporting services are deemed the most critical, as they underpin the production of all other ecosystem services, providing long-term processes necessary for maintaining the Earth's basic form and cycles. On the other hand, regulating services are indispensable for moderating and maintaining natural phenomena through ecosystem processes, without which living organisms would struggle to sustain their existence. Provisioning services encompass the tangible benefits extracted from nature. In contrast, cultural services encompass the non-material benefits that contribute to individual and societal development, enhancing emotional, psychological, cognitive, and well-being. The benefits of urban forests will be elucidated based on these four ecosystem service functions.

Ecosystem services contribution by urban forests

In terms of supporting services, urban forests play a pivotal role in providing habitats for wildlife, which in turn fosters the retention of native species and biodiversity within urban areas (Livesley et al. et al., 2016; Alvey et al., 2006; Llausa Roe, 2012; Korpilo et al., 2018). Furthermore, urban forests serve as habitats for numerous plant species, contributing to primary production in the ecosystem. Primary production is facilitated through photosynthesis, which generates energy and oxygen crucial for sustaining life. This process is fundamental for various ecosystem services, including the nutrient cycle, which underpins regulating, provisioning, and cultural services (Larcher, 2003; He et al., 2007; Lee, 2011; Lahr et al., 2018). In protected urban forests, natural litter and organic matter enrich soil quality, stimulating nutrient cycling and supporting the production of foods consumed by animals and plants. Additionally, urban forests function as biological corridors within urban landscapes, fostering expanded ecosystem interactions (IUCN, 1994). The extensive vegetated coverage

in urban forests enhances hydrological processes, increasing water absorption and evapotranspiration rates (Lerner et al., 1990; Livesley et al., 2016; Vergopolan & Fisher, 2016).

Regarding regulating services, urban forests significantly influence microclimate balance, as trees mitigate carbon emissions and produce oxygen (Bernatzky, 1983; Givoni, 1991). Furthermore, vegetation in urban forests improves air quality by filtering pollution particles, mitigating the greenhouse effect, and reducing the need for fossil energy, thereby decreasing greenhouse gas emissions and associated costs (Svensson et al., 2002; Huang et al., 1987). Urban forests also mitigate stormwater runoff by increasing soil water absorption, thereby reducing soil erosion and retaining soil moisture and quality (Lerner et al., 1990; McPherson et al., 1997; Livesley et al., 2016). Moreover, urban forests contribute to natural stormwater harvesting, enhancing water quality and purification processes (Llorens & Domingo, 2007; Gallo et al., 2012). The biodiversity of flora and fauna in urban forests promotes species diversity and pollination, enriching the urban environment (Van Rossum & Triest, 2012).

Urban forests provide provisioning services by offering food sources and freshwater, enhancing food security for living organisms (Jahnige, 2004; Poe et al., 2013; Kowalski et al., 2019). Notably, the management of food production in urban forests is less intensive than in agriculture, as products such as fruits, timber, and biochemical resources are naturally generated without artificial habitats or technologies (Akinbamijo, 2004). Timber harvesting is also practised in urban forests, ranging from extensive areas to street plantings (Nowak et al., 2001; Padoch et al., 2008). Furthermore, urban forests harbour valuable genetic resources for conservation strategies, species restoration, seed banks, DNA banks, disease and pest studies, and sustainable forest management practices (Rajora et al., 2001; Dawson et al., 2014).

In cultural services, urban forests provide spaces for recreational activities such as exercise, jogging, hiking, picnicking, sightseeing, and learning about nature (Kleiber, 2001; Heyman, 2012). This exposure to nature fosters societal awareness and strengthens neighbourhood relationships. Additionally, the presence of nature in urban forests cultivates a sense of belonging and sentimental attachment among urban residents (Stedman et al., 2003). Urban forests also promote physical and mental well-being by providing settings for exercise and reducing ultraviolet radiation and air pollution (Dwyer et al., 1992; Bang et al., 2016). In Japanese culture, trees hold cultural and spiritual significance, with practices like "forest bathing" enhancing physical and spiritual well-being (Park et al., 2010). Moreover, urban forests preserve natural and cultural heritage, foster interest in ecotourism and enhance a city's natural identity (Liu et al., 2006; Deng, 2010; Cetin et al., 2018). Overall, urban forests offer aesthetic, cultural, and recreational values that enrich the urban environment and promote societal well-being.

3.0 METHODOLOGY

This study employed a qualitative methodology, which included document analysis and semi-structured interviews.

Table 1: Research objective of the study

Research Objective	Method	Documents/Participants
To identify the contributions of urban forests to Kuala Lumpur. To suggest suitable recommendations for enhancing urban forests.	▪ Document analysis ▪ Semi-structured interview ▪ Document analysis ▪ Semi-structured interview	▪ KLSP2040 ▪ SDG 2030 ▪ 15 Articles Regarding KLFEP ▪ KLCH (Respondent 1) ▪ JLN (Respondent 2) ▪ ILAM (Respondent 3) ▪ FDPM (Respondent 4)

Two methods were employed to achieve the research objectives. Document analysis involved reviewing three types of secondary data:

1. **Kuala Lumpur Structure Plan 2040 (KLSP2040):** This document outlines the developmental direction of Kuala Lumpur until 2040, providing insights into urban planning and its impact on ecosystem services.
2. **Sustainable Development Goals 2030 (SDG, 2030):** Extracted from the Department of Statistics Malaysia, SDG 2030 indicators were segregated to identify those relevant to ecosystem services.
3. **Articles regarding KLFEP:** Fifteen articles were selected through a Google Scholar search using keywords related to Bukit Nanas and Kuala Lumpur Forest Eco Park (KLFEP), aiming to gather data pertinent to KLFEP.

The data documents were analysed using NVivo10 software. Prior to screening, themes were identified to ensure alignment with the four ecosystem services functions: supporting services, regulating services, provisioning services, and cultural services. Themes were categorised into three sections: Kuala Lumpur planning, the contribution of urban forests, and achievable SDGs.

Participants were selected from Kuala Lumpur City Hall Council (KLCH), Jabatan Landskap Negara (JLN), Institute of Landscape Architects Malaysia (ILAM), and Forestry Department of Peninsular Malaysia (FDPM) for semi-structured interviews. The interviews aimed to gather insights on urban forests' contribution and achievable SDGs from professionals' perspectives.

Interview data underwent thematic analysis, with themes categorized based on the four ecosystem services functions. The themes were further classified into Enhancing Urban Forests and Achievable SDGs. Manual analysis was conducted, with interview responses compiled in Microsoft Excel to identify and discuss the most frequently mentioned themes.

4.0 RESULTS AND DISCUSSION

The Contribution of Kuala Lumpur Forest Eco Parks

To address the first objective, document analysis was employed as the primary method to investigate the contribution of urban forests. The data were analysed using NVivo10 to extract insights into Kuala Lumpur's future development goals and actions, particularly focusing on urban forests. KLSP2040, a strategic proposal for resource management and adaptation to environmental and socioeconomic changes, was scrutinised to understand its implications for urban forests. Additionally, fifteen articles related to Kuala Lumpur Forest Eco Park (KLFEP) were selected to glean information about its environmental, social, and economic contributions. The screening process facilitated an exploration of KLFEP's benefits for Kuala Lumpur.

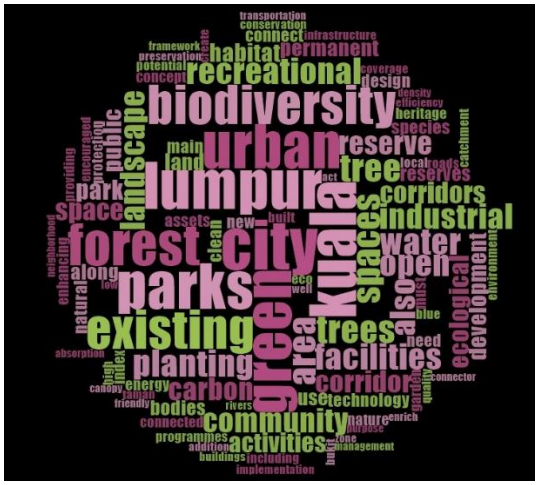

Fig. 3: Word frequency on Kuala Lumpur Structure Plan 2040 generated from NVivo

Fig. 4: Word frequency on contribution of Kuala Lumpur Forest Eco Park generated from NVivo

Figure 3 presents word clouds highlighting the planning aspects of KLSP2040, reflecting the integration of urban forests into Kuala Lumpur's development. Data from KLSP2040 underwent screening using NVivo to assess its potential benefits for urban forests. Several words frequently used in KLSP2040 are significant to urban forests. Notably, Goal 3, SV 1, "Integration of Nature in Urban Development," outlines plans to prioritise the preservation and development of forest reserves, urban forest parks, rivers, and water bodies to maintain ecological balance and biodiversity. KLSP2040 aims to preserve green reserves' width and current activity, emphasising the importance of permanent forests and developing recovery plans and guidelines.

Additionally, urban forests will be gazetted as permanent forest reserves for recreational purposes, enhancing community well-being. SV1.2 highlights connecting all green areas with blue corridors to form ecological nodes, enhancing the city's ecosystem. A biodiversity index will be established to monitor habitat and biodiversity status, while SV 1.3 focuses on increasing green intensity through tree plantings and heritage tree preservation. Furthermore, SV2.2 proposes developing void and derelict spaces into pocket parks and plazas. The word cloud in Figure 3 emphasises words such as forest, biodiversity, green, parks,

tree, planting, carbon, recreational, habitat, corridor, and ecological, aligning with Goal 3's objectives.

Beyond urban forests, KLSP2040 also aims to transition Kuala Lumpur into a low-carbon city by 2050, targeting carbon neutrality. PR1 outlines efforts to reduce vehicle usage by promoting green and low-carbon vehicles and increasing green areas and infrastructure like rain gardens and permeable pavement. Community involvement and education initiatives aim to raise awareness about biodiversity richness, encouraging conservation efforts. Various recreational programs will activate community spaces, enhancing comfort and usage. Despite focusing mainly on ecosystem improvements, KLSP2040 aligns with RMK-12, although it only marginally covers urban forests.

Figure 4 depicts the word frequency of contributions offered by KL Eco Forest, as identified in articles about KLFEP. A total of 15 articles were screened, segregating data based on ecosystem services functions.

Table 2: Matrix Coding Of Articles About Kuala Lumpur Forest Eco Park With Ecosystem Services Function

Articles	A : Supporting services	B : Regulating services	C : Provisioning services	D : Cultural services
1 : Justice, C. L. (1986)	1	0	0	0
2 : Mahdzar, S. S. S. & Samsudin, I. L. (2018)	3	3	1	5
3 : Sulaiman, B., & Boyce P. C. (2010)	1	1	0	2
4 : Sarkar, S. K. (2016)	1	0	0	6
5 : Aziz, A., et. al. (2017).	8	3	4	20
6 : A. Rahman, A., et. al. (2017)	2	3	1	5
7 : Salleh, N., et. al (2017).	26	25	34	9
8 : Forest Department of Peninsular Malaysia (2019)	1	1	1	1
9 : Syafiqah, A., et. al. (2014)	0	0	0	1
10 : Aziz, I. S. A. (2018).	1	1	0	1
11 : Mariapan, M., et al (2015)	5	6	3	10
12 : Mohd-Taib, F. S., et. al. (2014)	6	5	4	0
13 : Forest Department of Peninsular Malaysia (2009)	4	3	6	8
14 : Yusop, M. Y. M., et al (2021)	3	0	4	1
15 : Sarkar, S., at. al. (2015)	2	0	1	4

Referring to Table 2, 15 articles related to KLFEP were segregated by screening the contribution of KLFEP related to each ecosystem services function. Cultural services had the highest point, followed by supporting services, indicating the substantial amount of data on the contribution of ecosystem services. Despite sharing similar data, regulating services received slightly lower points than supporting services. In contrast, provisioning services acquired a high score despite KLFEP being a protected forest where forest products are not produced.

Regarding supporting services, most of the data in the articles pertains to habitat provisioning. Two articles reported the abundance of species in KLFEP, highlighting its role as the centre of habitat and biodiversity in Kuala Lumpur (Aziz et al., 2017; Salleh et al., 2017). KLFEP, having never been logged, boasts trees that can live up to several hundred years. Primary production ranked second in data screened from the articles. One article referred to KLFEP as the green lung of Kuala Lumpur, emphasising its significance as the main source of oxygen supply to the city (Forest Department of Peninsular Malaysia, 2019). The hydrological and nutrient cycles yielded an equal amount of data screened from NVivo10.

Regarding hydrological cycling, some articles mentioned KLFEP's function as a water catchment area for Kuala Lumpur (Forest Department of Peninsular Malaysia, 2009). Nutrient cycling occurs with the assistance of living and non-living organisms in the forest. KLFEP serves as the primary site for nutrient cycling in Kuala Lumpur, attracting plants and animals for food sources. Decomposition is also prevalent in KLFEP, given the significant interaction between living and non-living organisms, making it one of Kuala Lumpur's main food providers (Mohd-Taib et al., 2014).

Regulating services garnered the highest data points concerning pollination, air purification, and climate regulation. Like supporting services, KLFEP's abundance of species attracts many animals for food, aiding in pollination (Mohd-Taib et al., 2014). Additionally, KLFEP offers the city various species of pollinators, seeds, and pollination. Regarding air purification and climate regulation, the dense tree cover in KLFEP helps purify the air, provide oxygen, and regulate temperature (Aziz et al., 2017; Forest Department of Peninsular Malaysia, 2019). Some articles also mentioned KLFEP as a water catchment area that helps purify and regulate water for living organisms. KLFEP also acts as erosion control, given the trees' ability to hold soil. While KLFEP could serve as storm protection due to its significant surface water runoff and dense tree cover, articles found did not mention it as a storm mitigator. However, one article reported a landslide in the Bukit Nanas area.

Based on the data in the matrix coding in Table 2, provisioning services in KLFEP primarily consist of genetic resources. KLFEP is home to various vegetation, including trees, rare herbs, ferns, climbers, palms, bamboo, and other native vegetation (Forest Department of Peninsular Malaysia, 2019; Mariapan et al., 2015). While some species can be used for timber, medicinal purposes, and food, KLFEP is protected from supplying forest products for economic gain. Besides serving as a home for centuries-old trees, KLFEP also houses threatened species, such as *Anisoptera costata, Shorea sumatrana, Magnolia Montana, Memecylon campanulate,* and *Shorea sumatrana*. Additionally, KLFEP harbours many interesting species, including the local endemic plant *Tarenna rudis (Rubiaceae)*, which is rare and found only in Selangor, along with various indigenous plants from ground level to emergent layers, promising a bright future for genetic resources in Malaysia.

As for cultural services, most ecosystem services collected revolve around recreation and ecotourism. The aesthetic value and natural forest heritage of KLFEP attract many visitors locally and globally for tourism purposes (Aziz et al., 2017). While few articles emphasise foreigners' attraction to KLFEP, most foreigners are drawn to the diversity of flora and the pleasing environmental views of KLFEP. Aesthetic value ranked second highest in matrix coding (Sarkar et al., 2015). Education value and sense of place were the most frequent ecosystem services subfunctions mentioned. The trails facilitate interaction between visitors and the surrounding environment, offering insights into KLFEP's vegetation while wandering inside. The amenities and facilities in KLFEP contribute to visitors' sense of place.

The contribution of Urban Forest in Kuala Lumpur based on Professional Perspective

Based on the semi-structured interview results, professionals actively working to enhance urban forests have noted several contributions to them.

Fig. 5: Contribution of Urban Forest based on professional's perspective from interview

Based on Figure 5, the urban forest contributions highlighted by professionals include air filtration, carbon reduction, temperature mitigation, and providing healthy environments for humans, flora, and fauna. The document analysis findings also revealed that respondents frequently mentioned these contributions. The second most mentioned contribution pertained to urban forests serving as a green network in the city, fostering economic growth, promoting education and awareness, and providing habitats for urban wildlife. Fewer respondents discussed the role of urban forests as sources of forest products and water filters, as many professionals believe that urban forests in Kuala Lumpur have limited capacity in these aspects. Respondent 4, representing the Forestry Department of Peninsular Malaysia (FDPM), noted that forest product extraction is prohibited in protected forests in Kuala Lumpur. Regarding the water filtration capacity of urban forests in Kuala Lumpur, some respondents argued that despite their small size, they still serve as significant water filters and basins due to their prominence among the city's green areas. Only one respondent mentioned the potential for urban forests to conserve energy, suggesting that this could be achieved by integrating green technology.

Achievable SDGs about the existence of urban forests

In order to explore the Sustainable Development Goals (SDGs) achievable through urban forests, this study compared 17 indicators from the Sustainable Development Goals 2030 (SDG2030), the contributions of urban forests identified in the literature review, and the contributions of the Kuala Lumpur Forest Eco Park (KLFEP).

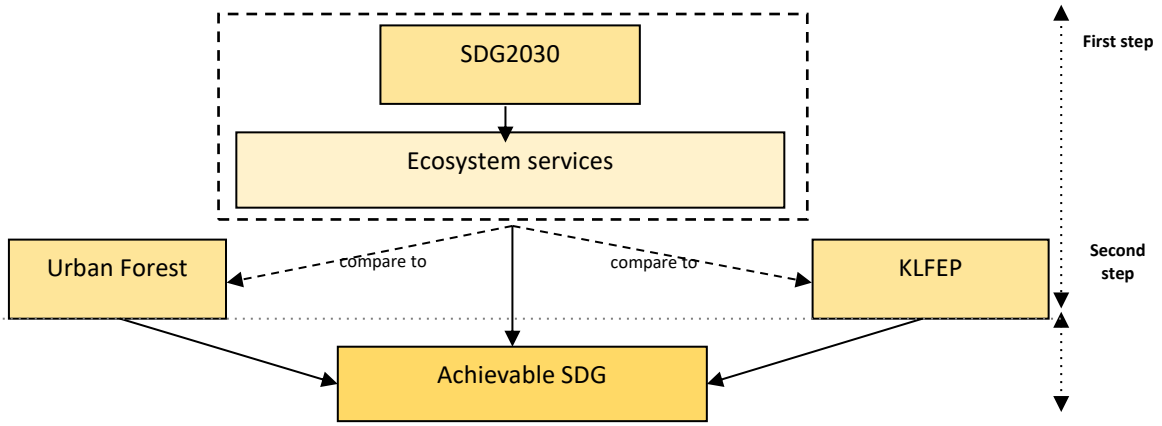

Fig. 6: Evaluation Process for Achievable SDGs

Figure 6 depicts the evaluation process for identifying achievable SDGs. Initially, 17 SDG2030 indicators were assessed alongside ecosystem services relevant to urban forests identified in the literature review and KLFEP data from document analysis. This involved screening SDG targets and indicators related to urban forests in the literature and data from KLFEP analyzed using NVivo10. The aim was to anticipate which SDGs could be realized through the presence of urban forests in a city. In the subsequent step, the SDG targets and indicators identified in the first step were compared with the contributions of urban forests and KLFEP to understand their similarities.

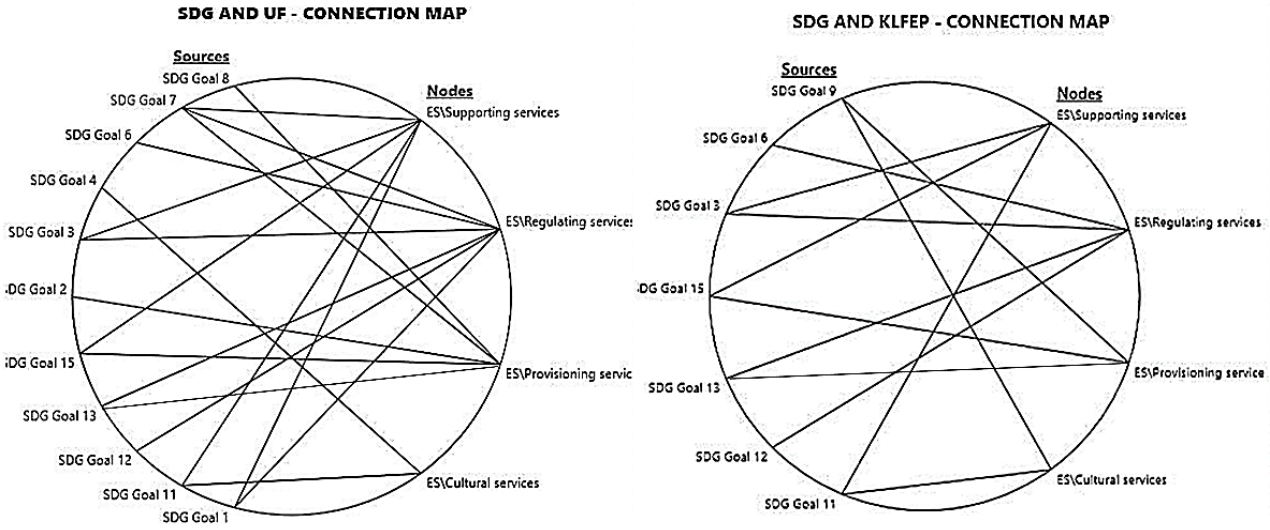

Fig. 7: Connection map of SDGs and urban forests and KLFEP generated from NVivo

Figure 7 depicts two connection maps illustrating the primary SDGs achievable through urban forests and KLFEP. For urban forests, the attainable SDGs include Goal 1: No Poverty, Goal 3: Good Health and Well-Being, Goal 7: Affordable and Clean Energy, Goal 11: Sustainable Cities

and Communities, Goal 13: Climate Action, and Goal 15: Life on Land. Meanwhile, the key SDGs that KLFEP can achieve are Goal 3: Good Health and Well-Being, Goal 9: Industry, Innovation and Infrastructure, Goal 11: Sustainable Cities and Communities, Goal 13: Climate Action, and Goal 15: Life on Land. Notably, the similarities in achievable SDGs are Goal 3: Good Health and Well-Being, Goal 11: Sustainable Cities and Communities, Goal 13: Climate Action, and Goal 15: Life on Land.

Urban forests significantly contribute to SDG 3: Good Health and Well-being by providing spaces for physical activity, enhancing mental well-being, and improving air quality. Moreover, they advance SDG 11: Sustainable Cities and Communities by conserving natural heritage and bolstering urban resilience. They also play a role in SDG 13: Climate Action by mitigating climate-related risks and reducing urban heat island effects. Additionally, urban forests contribute to SDG 15: Life on Land by fostering biodiversity, preventing deforestation, and safeguarding genetic resources.

Similarly, KLFEP has the potential to contribute to Goal 3: Good Health and Well-Being. As a prominent recreational area, it promotes community health and well-being. Moreover, its diverse range of species can help reduce illness from air pollution, aligning with Target 3.9. While KLFEP contributes to preserving natural heritage, it can improve inclusivity to align with Target 11.7. Additionally, KLFEP serves as a buffer against climate disasters, aligning with Target 13.1. Finally, KLFEP supports SDG 15: Life on Land by providing habitat for various species, aiding in ecosystem restoration, and preventing deforestation.

In summary, urban forests and KLFEP significantly contribute to achieving multiple SDGs. They promote healthier lifestyles, sustainable urban communities, climate resilience, and biodiversity conservation. Recognising these interconnected roles underscores the potential of urban forests in Kuala Lumpur to contribute to SDG 3, SDG 11, SDG 13, and SDG 15. However, addressing existing gaps, such as enhancing inclusivity, will further optimise their contribution to achieving the Sustainable Development Goals.

Achievable SDGs about the existence of urban forests

Four respondents, professionals in the landscape architecture field, were interviewed to delve deeper into the achievable SDGs with the existence of urban forests. Initially, the question focused on inquiring about ongoing efforts related to KLFEP that align with the SDGs. However, it was understood that not all respondents were directly involved with KLFEP. Consequently, the revised question aimed to gather insights into current efforts to achieve SDGs about urban forests and to compile a list of achievable SDGs. "Current efforts" refer to the ongoing projects undertaken by the respondents in Kuala Lumpur, while the list of SDGs is based on the professionals' perspectives.

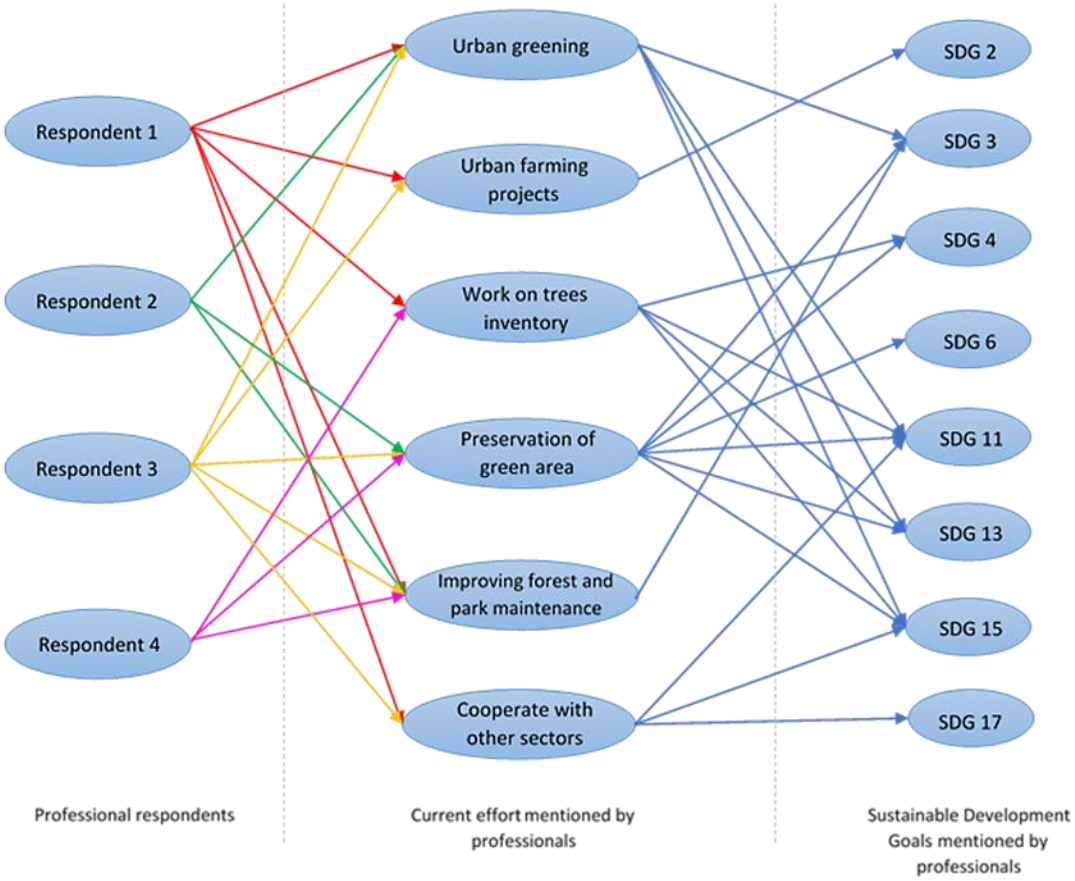

Fig. 8: Current effort of professionals in achieving SDGs relating to urban forests

Based on Figure 8, professionals are engaged in nine ongoing initiatives that align with the SDGs related to the presence of urban forests. These efforts include urban greening, entailing tree planting in vacant spaces, and urban farming to support Goal 2: Zero Hunger by planting native trees. Additionally, tree inventories are conducted to monitor and evaluate tree health and growth. Emphasis is placed on preserving green areas, with the aspiration that other cities will follow suit, contributing to Malaysia's achievement of specific SDGs such as Goal 4: Quality Education, Goal 11: Sustainable Cities and Communities, and Goal 15: Life on Land.

Urban greening, considered crucial for building sustainable cities and achieving a low-carbon society, is seen as a pathway toward SDG 3, SDG 11, SDG 13, and SDG 15. Professionals are also actively enhancing the maintenance of urban forests and parks, focusing on public safety and comfort, thereby supporting Goal 3: Good Health and Well-being. Urban farming offers potential for food production, including planting edible trees in urban areas. However, its implementation within the Kuala Lumpur Forest Eco Park (KLFEP) is constrained by space limitations. Collaboration with public and private sectors is essential for project expansion and raising public awareness, contributing to Goal 17: Partnerships to Achieve the Goal.

Despite the potential contributions to several SDGs, achieving Goal 2: Zero Hunger within the context of KLFEP is considered challenging due to restrictions on extracting forest products in the protected area. Therefore, based on these efforts, it is concluded that seven SDGs could be attained (Goal 3: Good Health and Well-being, Goal 4: Quality Education, Goal 11: Sustainable Cities and Communities, Goal 13: Climate Action, and Goal 15: Life on Land) within the context of KLFEP, with Goals 2 and 6 omitted.

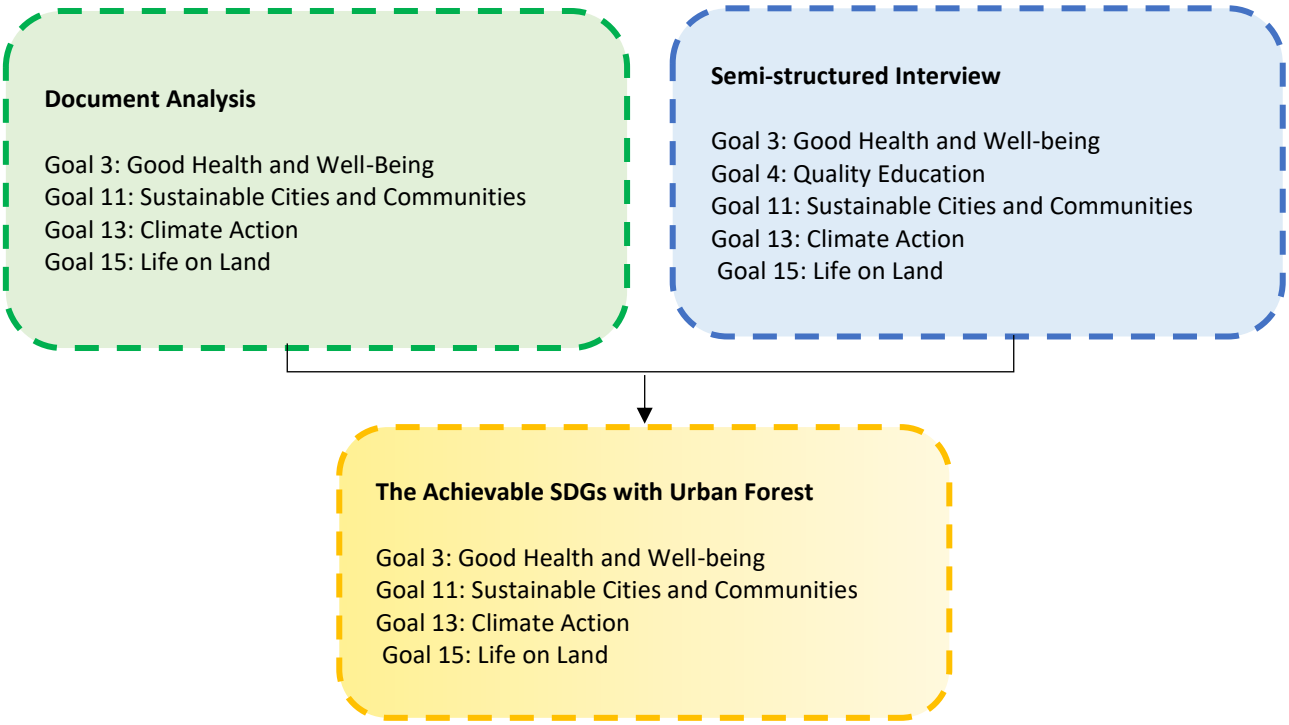

Fig. 9: Achievable SDG with the comparison of document analysis and semi-structured interview

Figure 9 compares the analysis of the attainable SDGs from document analysis and semi-structured interviews. The only disparity between both analyses is that the attainable SDGs from semi-structured interviews include Goal 4: Quality Education, as two professionals (interview respondents) are involved in efforts related to SDG 4. From both analyses, the outcomes of attainable SDGs with urban forests are Goal 3: Good Health and Well-being, Goal 11: Sustainable Cities and Communities, Goal 13: Climate Action, and Goal 15: Life on Land. Therefore, by highlighting the contribution of urban forests, particularly KLFEP in Kuala Lumpur, the focus is on achieving SDG 3, SDG 11, SDG 13, and SDG 15.

5.0 CONCLUSION

Having an urban forest in an urban area is vital for the well-being of the environment, economy, and society. This study has demonstrated that urban forests offer a multitude of contributions. Most notably, urban forests make significant contributions to ecosystem services aligned between KLFEP and studies on urban forests. The findings reveal that urban forests are crucial in advancing several Sustainable Development Goals (SDGs). They substantially contribute to SDG 3: Good Health and Well-being by providing a natural environment that encourages physical activities, supports mental health, and improves air quality.

Additionally, urban forests contribute to SDG 11: Sustainable Cities and Communities by preserving natural heritage, improving urban resilience, and creating more sustainable and livable urban environments. They also play a role in SDG 13: Climate Action by mitigating the impacts of climate change through carbon sequestration, reducing the urban heat island effect, and providing buffers against climate-related disasters. Furthermore, urban forests support SDG 15: Life on Land by promoting biodiversity within urban areas and providing

habitats for various species.

KLFEP represents Kuala Lumpur's urban forest and plays a crucial role in contributing to the SDGs. While KLFEP may not contribute significantly to provisioning services due to restrictions on forest product extraction, it excels in supporting other ecosystem services and achieving SDGs related to health, sustainability, climate action, and terrestrial life conservation. The achievable SDGs about urban forests, including KLFEP, are Goal 3: Good Health and Well-being, Goal 11: Sustainable Cities and Communities, Goal 13: Climate Action, and Goal 15: Life on Land. This underscores the importance of urban forests in achieving sustainable urban development goals.

To further enhance the contributions of urban forests to SDGs, several recommendations are proposed:

1. **Comprehensive Urban Forest Planning:** Holistic planning and management of urban forests are essential to ensuring sustainable urban development. This approach should encompass biodiversity conservation, recreational opportunities, and air quality improvement, aligning with urban forests' multifaceted contributions to SDGs.
2. **Awareness Campaigns:** Public awareness campaigns are needed to educate the community about the value of urban forests. By highlighting the tangible benefits of green spaces, such as mental health support and improved air quality, citizens can become more proactive in preserving urban forests, thereby supporting health and sustainable communities' SDGs.

3. **Urban Greening Projects, Including Urban Farming:** Promoting urban greening initiatives, including urban farming, can optimize green spaces within Kuala Lumpur. Urban farming, in particular, can contribute to Goal 2 (Zero Hunger) by introducing edible trees into urban areas and enhancing the capacity of the urban ecosystem to provide for its inhabitants.
4. **Prioritise Genetic Resource Conservation:** Conservation of genetic resources within urban forests is crucial for preserving biodiversity and supporting sustainable development goals. By prioritising the conservation of rare and valuable species, Kuala Lumpur can align with SDG 15 (Life on Land) and ensure that urban forests continue to provide genetic resources for future generations.

In conclusion, by implementing these recommendations, Kuala Lumpur can maximize the potential of its urban forests to advance sustainable development goals, creating a more harmonious and resilient urban landscape.

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