Lahore

City Biodiversity Action Plan

The Urban Unit
Urban Sector Planning & Management Services Unit (Pvt.) Ltd.

City Biodiversity Action Plan

Lahore

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Acknowledgements

The successful preparation of the **Lahore City Biodiversity Action Plan** report would not have been possible without the visionary leadership and continuous support of **Mr. Omar Masood**, CEO of The Urban Unit. We also extend our sincere appreciation to the **The Secretary**, Forest, Wildlife and Fisheries Department and **Director General,** Parks and Horticulture Authority, Lahore for their invaluable support, particularly in facilitating field visits and site-level coordination. We are also grateful to **HOD Zoology, and Botany Department GCUL and PU Lahore**, for their support for data sharing and valueable insight regarding the project.

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Citation:
The Urban unit. 2025. Lahore City Biodiversity Action Plan. Environment Biodiversity and Climate Change Division. Lahore.

Contents

Figures

Executive Summary

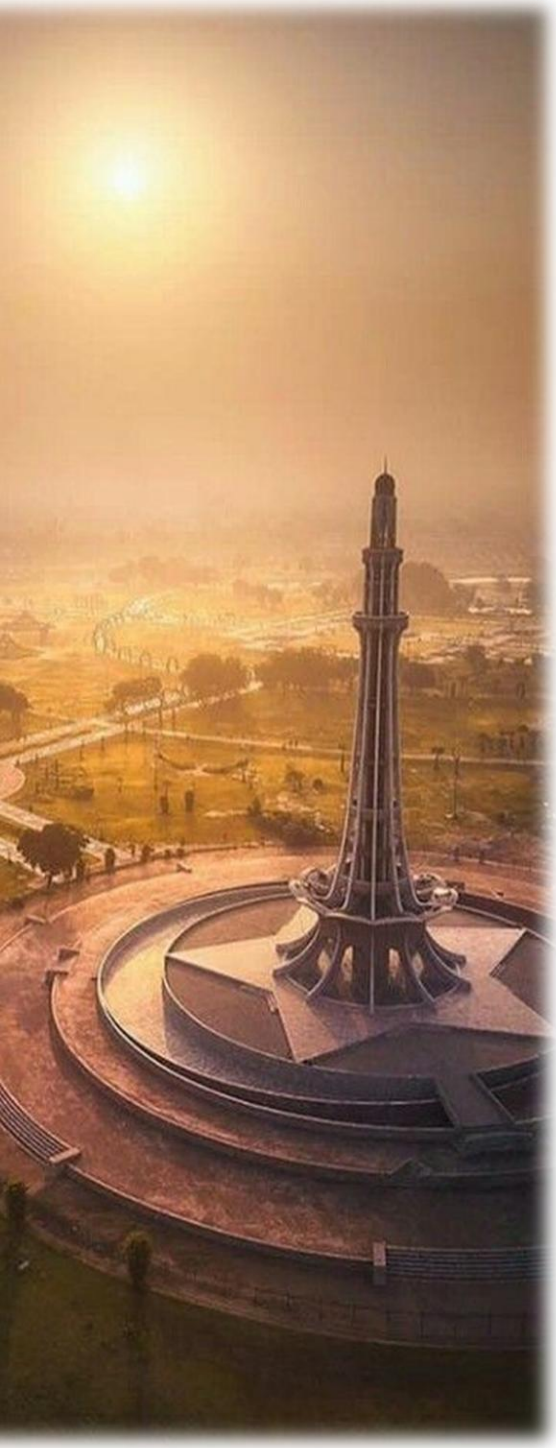
Lahore, the cultural and economic heart of Punjab, is experiencing unprecedented urban growth that places immense pressure on its natural ecosystems. Rapid urbanization, unplanned development, pollution, climate change, and the conversion of agricultural land into built-up environments have led to habitat fragmentation, biodiversity loss, and environmental degradation. In response, the Lahore City Biodiversity Action Plan (LCBAP) has been developed as a comprehensive strategic document to safeguard the city's remaining biodiversity and ecological assets while enhancing urban resilience and sustainability.

The LCBAP serves as a localized framework aligned with Pakistan's National Biodiversity Strategy and Action Plan (NBSAP), the Sustainable Development Goals (SDGs), and international commitments under the Convention on Biological Diversity (CBD) and the Kunming-Montreal Global Biodiversity Framework. It envisions an ecologically balanced Lahore where biodiversity is conserved, restored, and sustainably utilized for the well-being of current and future generations.

The action plan is based on a detailed baseline assessment of Lahore's biodiversity, including its urban forests, parks, riverine ecosystems (notably along the River Ravi), wetlands, agricultural peripheries, and scattered green spaces. These ecosystems are home to a range of native and migratory species of birds, mammals, reptiles, insects, and plants, many of which are increasingly under threat due to anthropogenic pressures.

The LCBAP outlines a series of action and strategies for the sustainability of habitat, wetland, agriculture, green spaces, built up, biodiversity, human wellbeing alongside key projects, such as rejuvenation of natural ponds and wetlands, green belts along transport corridors, urban forest expansion, and biodiversity-friendly urban design. It also proposes governance reforms and partnerships among government agencies, academia, civil society, and private stakeholders to ensure coordinated implementation.

Ultimately, the Lahore City Biodiversity Action Plan aspires to transform Lahore into a nature-positive city—where ecological integrity supports urban quality of life, climate resilience, and sustainable development. It serves not only as a roadmap for preserving Lahore's unique ecological identity but also as a replicable model for biodiversity planning in other urban centers of Pakistan.



Setting the Stage

1.1. The Vanishing Gardens: Lahore's Struggle to Reclaim Its Green Heritage

Lahore, a Mughal masterpiece where emperors planted verdant paradises like Shalimar Bagh, was known for centuries as the "City of Gardens." This legacy has been crumbled beneath concrete buildings today. Lahore now grapples with stunning biodiversity degradation as its ecological legacy is being devoured by rapid urbanization hence consumes its ecological heritage and city of concrete today.

Climate Resilient Punjab Vision Action Plan (2024) identified urbanization and new construction as one of the main drivers of deforestation in the province. The strategy points out a staggering 72 % decline in tree cover in Lahore in only eight years between 2007 and 2015.[1] In 2019, 40 percent of Lahore, approximately 715 sq kms, was developed, while parks occupied a 1.4 % (approximately 24 sq kms) of the district area [2]. According to the Parks and Horticulture Authority (PHA), Lahore's tree canopy coverage stands at a mere 1%, as reported in the 2023 State of the Environment Report for Punjab. This starkly contrasts with cities like New Delhi, India (23.6%), and Beijing, China (44.9%).Inside the city, the effects of deforestation, such as the rising average temperatures and urban flooding, are fast becoming the new normal.[3]

The expansion of residential schemes into Lahore's peri-urban fringe is converting agricultural land, leading to diminished green cover [4] . Compounding this, the city's existing built-up areas suffer from a shortage of local parks, many of which are inadequately maintained.

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[1] Shoaib, A., Islam, H.S. Urban Sustainability and Green Spaces: A Comprehensive Analysis of Spatiotemporal Variations and Residents' Perspective in Lahore, Pakistan. J geovis spat anal 8, 28 (2024). https://doi.org/10.1007/s41651-024-00190-4

2 Source : The Urban Unit

3 https://epd.punjab.gov.pk/system/files/Climate%20Change%20Book%20%283%29_compressed.pdf

4 Anwar, M.M.; Hashim, M.; Aziz, A.; Stocco, A.; Abdo, H.G.; Almohamad, H.; Al Dughairi, A.A.; Al-Mutiry, M. Urban Green Spaces Distribution and Disparities in Congested Populated Areas: A Geographical Assessment from Pakistan. Sustainability 2023, 15, 8059. https://doi.org/10.3390/su1510805

Figure 1: A view of Historical Shalimar Garden, Lahore

Lahore hold prominent administrative profile as it is the provincial headquarter of Govt of Punjab. The district administration is primarily governed by Deputy Commissioner Lahore, with key departments including Lahore development authority (LDA), Metropolitan Corporation Lahore (MCL), Water and Sanitation Agency (WASA), Park and Horticulture Authority (PHA), Divisional Forest Department, Wildlife Department, Tourism, Archaeology and Museums Department, Environment Protection Authority (EPA), and Ravi Urban Development Authority (RUDA). These key departments are involved and participating for the sustainable development, city biodiversity conservation, management, restoration of cultural heritage, maintaining urban infrastructure, and greening of city. Lahore historical and administrative profile reflects its resilience, adaptability and remarkable capacity to evolve over centuries. But pressure of contemporary urbanization and rapid modernization reveal the urgent need of sustainable urban planning.[5]

1.2. Geographical Profile

Lahore, is the capital city of Punjab province located in north-eastern part of the country at 31°11' – 31°42' N and 74°10' – 74°29' E and spread over an area of 1772 sq. kms. Lahore shared its boundary with Indian border from east and Amritsar is the city lies about 50km in east.[6]. Nankana Sahib district on western, Sheikhupura on the northern region, and Kasur lies on southern side of Lahore. The average elevation of Lahore is about 217 meters (712 feet) above sea level. The municipal structure of Lahore comprises of 10 Tehsils, 274 Union Councils and approx. 298 villages. Lahore is well-known as the "City of Gardens," home to several culturally and ecologically important gardens, including Shalimar Gardens, Lawrence Garden (Bagh-e-Jinnah), Jilani Park, Charbagh, Hazuri Bagh, Greater Iqbal park, Gulshan e Iqbal Park and among others conservation sites including Jallo Park, Lahore Safari Park, and Lahore zoo. Geomorphologically, Lahore situated on the Indo-Gangetic Plain rich with fertile, loamy and clayey soils.[7] The Lahore water

[5] Nawaz, M. S., & Akbar, S. (2020). Is Lahore's urban system ready to sustain climate change? The case in Pakistan. *European Journal of Climate Change*, *2*(2), 22-32.
[6] Sahni, S. (2021). Elements of Medieval Town in Indian and Pakistan City Borders: Case of Amritsar and Lahore. *History and Sociology of South Asia*, *15*(1-2), 37-52.
[7] Khan, H. U., Rashid, I., Israr, J., & Zhang, G. (2022). Geotechnical characterization and statistical evaluation of alluvial soils of Lahore. *Arabian Journal of Geosciences*, *15*(9), 845.

system is a complex combination of surface water from River Ravi which flows along the western fringes of Lahore and a basic component of Indus River System.[8] The climatic zone of Lahore falls with the subtropical semi-arid region followed by hot summers, winters and heavy monsoon season. The annual temperature of Lahore ranges from 5 °C in January to over 45 °C in June and July.[9] Lahore's precipitation is mainly concentrated in the monsoon season, resulting in significant but uneven rainfall with annual average 592mm.[10]

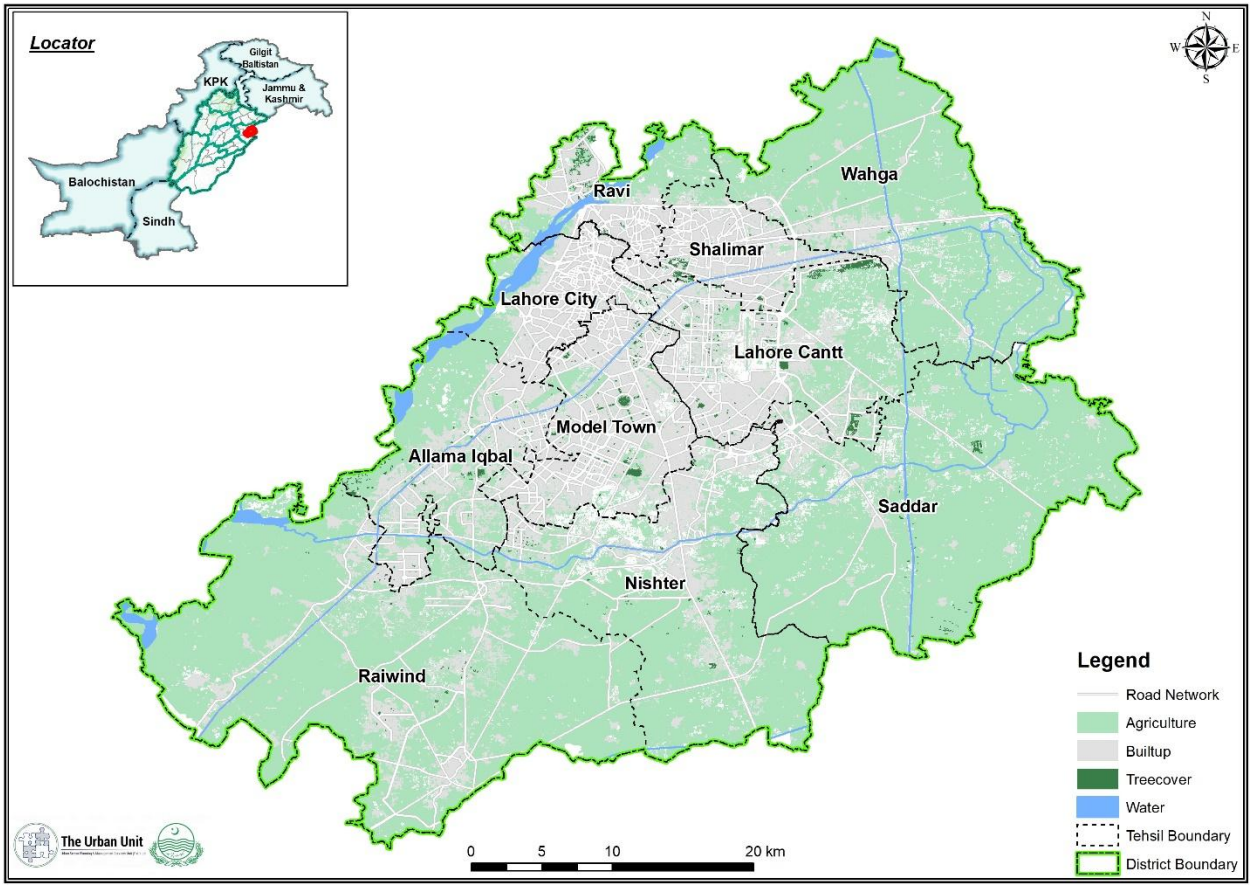


Figure 2: Geographical Location Map of Lahore City

1.3. Purpose of Biodiversity Action Plan

In the face of environmental concerns and fast urbanization, Lahore City's Biodiversity Action Plan (BAP) aimed at conservation, protection, management and enhancement of city biodiversity, ecosystem, species and genetic diversity within Lahore. The main purpose of BAP is the integration of biodiversity considerations

[8] Nasar-u-Minallah, M., Zia, S., Rahman, A. U., & Riaz, O. (2021). Spatio-temporal analysis of urban expansion and future growth patterns of Lahore, Pakistan. *Geography, Environment, Sustainability*, *14*(3), 41-53.
[9] Aslam, A., Rana, I. A., & Bhatti, S. S. (2022). Local climate zones and its potential for building urban resilience: a case study of Lahore, Pakistan. *International Journal of Disaster Resilience in the Built Environment*, *13*(2), 248-265.
[10] NASA Langley Research Center. (n.d.). *Prediction of Worldwide Energy Resources (POWER) Project*. NASA. Retrieved April 28, 2025, from https://power.larc.nasa.gov/

into local and national policies for the development of sustainable urban planning.[11] Other key purposes of BAP involve the conservation of native species habitat, restoration of green spaces, protection of ecosystem services, mitigation of climate change, community engagement and public awareness about the importance of conservation of urban biodiversity.[12,13] BAP also aims to engage local communities, scientific researchers, academicians and policy makers at one platform for the collective biodiversity conservation efforts.[14] It helps the city to adapt against rapid urbanization, urban heat island effects, environmental and infrastructural challenges by providing ecological balance between economic growth, environmental protection and social well-being.[15,16] The City Biodiversity Action plan is a binding document for the strengthening of administrational, managemental and human resource capacity building to improve the conservation effort and sustainable development within the Urban area of Lahore. The BAP will tool to prepared policies and guidelines for decision-making and planning to protect and conserve regional ecosystems and urban biodiversity in the Lahore.

1.4. Regional Significance of Biodiversity Action Plan

The Lahore city's Biodiversity Action Plan (BAP) hold significant regional values due to its diverse ecological, biological, cultural, and socioeconomic profile. The wide diversity of both native and introduced plant and animal species found in Lahore, greatly enhances the need of L-BAP for city resilience and sustainable environmental health. However, Lahore city is one of many cities in the world that is challenged with deteriorating environmental realities due to the rapid urbanization, urban sprawl, aquatic and land pollution, biodiversity migration, habitat degradation and infrastructure expansion.

Regionally, Lahore is a significant metropolitan hub that shapes Punjab's overall environmental trends. The integration of conservation and protection of biodiversity into urban planning, sets a precedent for other cities in the country and worldwide. As Pakistan is the member of Convention on Biological Diversity (CBD) and complies the conservation framework for sustainability.[17] Lahore BAP will promote national and international environmental commitments under light CBD and United Nation Sustainable Development Goals (SDGs) framework. The successful implementation of BAP in Lahore holds immense regional significance to preserve, restore, and sustainably manage the city's biodiversity and native ecosystem.

Historically, Lahore was rich in biodiversity that found along the River Ravi flood plains, in urban parks and across peri-urban agricultural landscapes. However, Lahore has experienced significant loss in its

[11] Dushkova, D., Ignatieva, M., Müller, N., & Nilon, C. (2025). Editorial for special issue "Integrating Biodiversity in the Urban Planning and Design Processes". *Urban Ecosystems*, *28*(2), 1-6.
[12] Tajamul, H., Murtaza, S., Gatoo, A. A., Wani, A. A., & Islam, M. A. (2024). City Biodiversity Index of Leh City. ISBN. *Division of Natural Resource Management, Faculty of Forestry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Benhama Ganderbal (J&K)*.
[13] Stanford, H. R., Hurley, J., Garrard, G. E., & Kirk, H. (2025). The contribution of informal green space to urban biodiversity: A city-scale assessment using crowdsourced survey data. *Urban Ecosystems*, *28*(1), 1-16.
[14] Panlasigui, S., Spotswood, E., Beller, E., & Grossinger, R. (2021). Biophilia beyond the building: Applying the tools of urban biodiversity planning to create biophilic cities. *Sustainability*, *13*(5), 2450.
[15] Shilky, Ekka, P., Upreti, M., Kumar, A., & Saikia, P. (2024). Nature-based solutions and ecological urban planning and design for the sustainable urban environments. In *Earth Observation in Urban Monitoring* (pp. 339-358). Elsevier.
[16] Combary, Y. E. F., Zemo, M. A. T., Hemchi, H. M., & Atchrimi, B. T. (2024). Monitoring and assessing of sustainable development in the urban area of Ouagadougou based on SDG 11.3. 1 indicator and the city biodiversity index. *Edelweiss Appl. Sci. Technol*, *8*, 1930-1943.
[17] https://www.cbd.int/countries?country=pk

biodiversity due to rapid urbanization and infrastructural development. Lahore BAP provides the framework of conservation of floral and faunal biodiversity by promoting plantation of native tree species in replacement of exotic tree species and by creating habitat for urban bird species, pollinators and small mammals. Lahore BAP highlighted the importance of protection of urban biodiversity, green spaces and urban wetlands including potential constructed wetlands for waste water treatment. It also focusses on the integration of biodiversity-friendly green spaces in housing societies and public spaces.[18] BAP promote establishment of ecological corridors for the movement of species between urban parks, university campuses and green belts. BAP also fosters the institutional collaboration between LDA, PHA, WASA and environmental NGOs for sustainable urban planning of Lahore.

[18] Sosa, M., & Ivanova, A. (2025). Assessment of Financing for Biodiversity Conservation in Mexico. Links between Biodiversity and Climate Change Adaptation Funds.

Methodology

Lahore Biodiversity Action Plan has been developed with an emphasis on inclusive, sustainable, and adaptable practices to ensure conservation and protection of urban biodiversity. The plan takes a multi-tiered strategy to address habitat assessment, species profiling, health & wellbeing assessment, ecological significance, and biodiversity loss within the Lahore as a key urban metropolitan of Punjab.

An extensive literature review and field surveys approach have been adopted for data collection and analysis. The key stakeholder involvements from local government entities, academic institutions, provincial departments, agencies, and community have been ensured to contextualized relevance and promote BAP ownership. GIS and remote sensing tools have also been used to map critical habitat, changes detection in land use, and evaluate ecological impacts in Lahore. The methodology adopted for the purpose of this plan is given below:

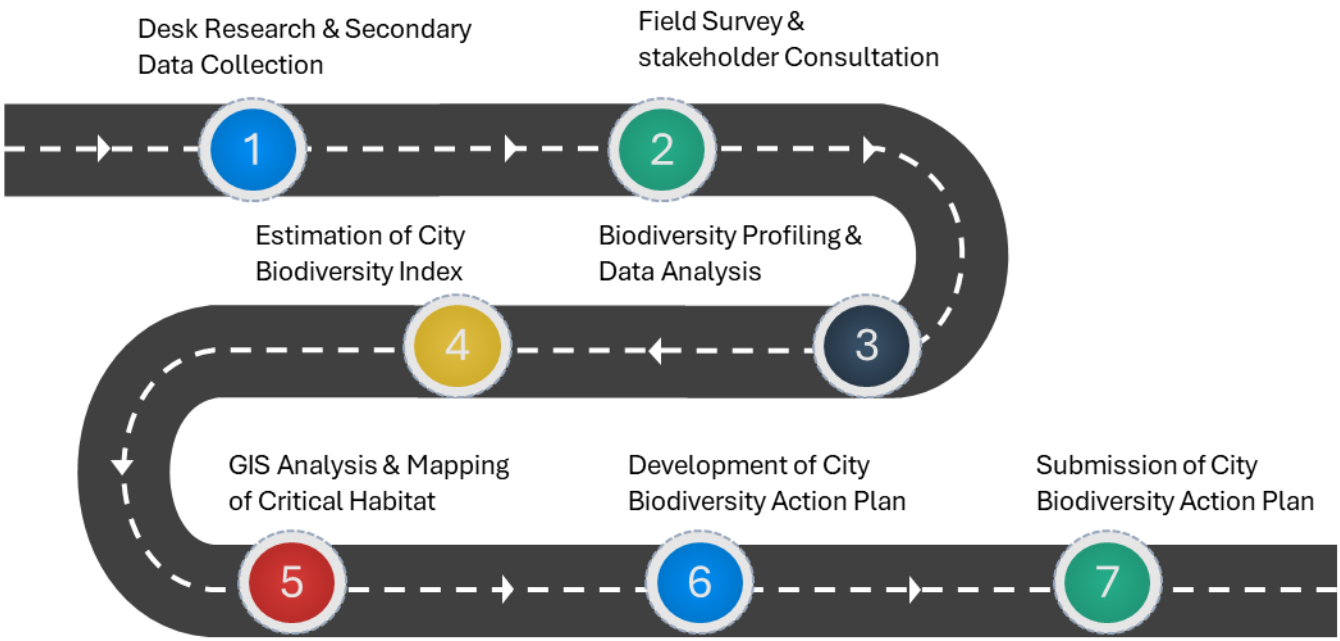


Figure 3: Methodology Map for Lahore – City Biodiversity Action Plan

2.1. Desk Research

During the initial phase of the study, a detailed desk research was conducted to understand the state of environment and biodiversity of Lahore city in past decades. Identification of potential survey locations were identified in Lahore for a comprehensive analysis of its flora and fauna. Desk research and secondary data was based on available published and unpublished material including reports, scientific journals, articles related to fauna, flora, green spaces, blue spaces, and threats of Lahore city biodiversity.

2.2. Field Visits and Biodiversity indicators

During the study key biodiversity indicators such as species richness, pollution level, human impact, habitat quality and associated threats and opportunities were identified. The specific methodologies were followed to conduct field survey and evaluate the biodiversity indicators for fauna and flora of city.

The Faunal Diversity

The diversity of vertebrates' fauna i.e. Mammals, Birds, Reptiles and Amphibians in different habitat were recoded through different methods including point count, transect method and direct count method. Furthermore, during each field visit, different evidence such as footprints, signs of paths and bird sound was recorded to enlist the animal presence in the area.

- **Point count Method:** The point count method is a common bird monitoring technique where observers record bird species and their numbers at specific locations, or "points," during a set period. During this method randomly, selected points in different habitats were observed for a fixed time (30 minutes) while staying there to made observations and count all the birds detected by sight or sound within a predetermined radius. The process was replicated at multiple sites to allow the collection of holistic data concerning the population sizes and species richness.
- **Transect Method:** The transect method is a widely used technique to assess the distribution and abundance of various animals' species across a specific area. A straight line known as transect (ranging from 2 to 3 km in length) was laid out, and organisms were recorded at regular intervals. Animal sightings along these transects were made to record distribution of animals including insects, birds, reptiles, amphibians, and mammals across the sites. This was a method for us to keep track of how species distributed along transect in response to environmental factors like vegetation, temperature, or moisture.
- **Direct Count Method:** This method was also applied to the build an inventory of animals in the study area. The Direct Count Method is considered one of the most applied techniques for estimating species abundance and diversity. This involved counting the animals directly in a defined area. This method was very ideal for species that were visible and not too abundant or dispersed. While it ensured high accuracy by counting every individual, it could be time-consuming and resource-intensive, especially for large populations. The method proved most effective in areas where animals were easily observable, making it suitable for smaller-scale studies or species that were easier to track.

The Floral diversity

A systematic and scientifically approach was used to evaluate the plant diversity in Lahore to ensure the detailed documentation of floral diversity. A variety of habitats were surveyed in the city including forest, park, wetlands, roadside plantings, green spaces, and agricultural areas. Floral diversity of the visited site was extensively documented using the quadrats and transect method, through which a systematic randomized species sampling and photographic documentation conducted for further analysis and identification. Plant species were identified based on phyllotaxy and floral morphology with the help of available literature and e-source flora of Pakistan[19] to ensure correct classification and developed a detailed species inventory.

- **Line Transect Method**: A 100 meters long linear strip was covered to record every species of plant visible along each transect.
- **Quadrats Method**: A randomized quadrats plots of $10m^2$ were laid at regular interval of 100m interval in forest plantation to record the shrubs and trees of each dense plantation area. All the plant species, their richness, frequency and abundance were recorded for further analysis and documentation.

Figure 4: A Glimpse of Field Assessment using Quadrat and Transect Method

2.3. Carbon Sequestration Assessment

Carbon sequestration in plants refers to the process of capturing and storing carbon dioxide (CO2) from the atmosphere through photosynthesis, where plants convert CO2 into organic compounds such as carbohydrates. Estimating the amount of carbon sequestered by plants involves calculating the carbon stored in various plant components (e.g., leaves, stems, roots).

The general formula to estimate carbon sequestration from plants is:

[19] http://legacy.tropicos.org/Project/Pakistan

$$\text{Carbon Sequestered (kg)} = Biomass\ (kg) \times Carbon\ Fraction$$

Where, Biomass (kg) is the total mass of the plant or plant component (e.g., tree, shrub, etc.).

Carbon Fraction is the proportion of the plant biomass that is carbon. Typically, the carbon content of plant biomass is about 50% (or 0.5), though this can vary depending on plant species.

Allometric equation for Plant Biomass estimation:

$$Biomass = a \times (DBH)b$$

Where, a and b are constants derived from empirical data as given:

$$Biomass\ = 0.1 \times (DBH)2.5$$

This would give the above-ground biomass in kilograms through DBH in centimeters,[20,21] while below ground biomass was calculated by multiplying above ground biomass with root to shoot factor of 0.26. [22]

During the visit, the diameter at breast height (DBH) were measured from trunk of trees at 1.3 meter above the ground by using measuring tape. The obstacle like branches, shoots, loose bark, and vines were excluded to ensure the accuracy.

Figure 5: A Glimpse of Measuring the Trees DBH

2.4. Vegetation Dynamics

Based on the GEE cloud platform, Landsat images of 2014 and 2024 were used to calculate the NDVI to analyze the characteristics of the spatiotemporal patterns of vegetation, and detect the factors that affect vegetation changes. This included the following steps:

- The landsat images of both years were obtained for preprocessing, including QA band cloud removal processing, and clear images that can fully displayed the study area.

[20] Brown, S., Schroeder, P., & Birdsey, R. (1997). Aboveground biomass distribution of US eastern hardwood forests and the use of large trees as an indicator of forest development. *Forest Ecology and Management*, *96*(1-2), 37-47.
[21] Chave, J., Andalo, C., Brown, S., Cairns, M. A., Chambers, J. Q., Eamus, D., Fölster, H., Fromard, F., Higuchi, N., Kira, T., Lescure, J.P., & Yamakura, T. (2005). Tree allometry and improved estimation of carbon stocks and balance in tropical forests. *Oecologia, 145*, 87-99.
[22] Ajani, A., & Shams, Z. I. (2016). Comparative status of sequestered carbon stock of Azadirachta indica and Conocarpus erectus at the University of Karachi Campus, Pakistan. *International Journal of Environment*, *5*(2), 89-97.

- The NDVI was calculated by using the band math, the spatial and temporal distributions of the NDVI were determined.
- Using the ArcMap, both of the years compared and the factors influencing the vegetation change in Lahore were detected from the perspectives of the climate, terrain, and anthropogenic factors.

2.5. City Biodiversity Index (CBI)

City Biodiversity Index was calculated using the guidelines given in "Handbook on the Singapore Index on Cities' Biodiversity". Twenty-eight (28) indicators given in this handbook were used for calculating the City Biodiversity Index (CBI). A city scoring higher has better ecological services, biodiversity health, and efficient government. The maximum score is 112 points. A score of 90-112 (Excellent) is considered a good score, which reveals that its ecosystems are healthy, its biodiversity is in good health, and that the government is efficient.[23,24] A score between 68-89 (Good) reflects cities with well-maintained biodiversity and effective ecological management, and score between 44-67 (moderate) indicates moderate biodiversity with room for improvement in conservation and governance efforts. If the City Biodiversity Index score is 1-43 than it means that biodiversity loss is very severe, ecosystem services are poor, and urban planning is also inadequate.

City Biodiversity Index Scoring Slab	
Point Scoring	**Status**
90-112	Excellent
68-89	Good
44-67	Moderate
1-43	Poor

2.6. SWOT Analysis

This analysis was used to identify strengths, weaknesses, opportunities, and threats related to biodiversity and conservation efforts in Lahore. SWOT analysis is very useful in strategic planning for conservation, sustainable development, and addressing biodiversity challenges.

[23] Jen, L., & Yuen, L. (2016). City biodiversity and its role in urban sustainability. *Environmental Management and Policy, 28*(3), 78–89.
[24] Arun, S., & Sreeja, V. (2021). City biodiversity index for sustainable urban planning. *Journal of Environmental Sustainability, 12*(1), 12–25.

Stakeholder Consultation

A stakeholder consultation session with local stakeholders at the site-specific level were conducted to obtain maximum information related to fauna and flora, threat to the local biodiversity, conservation effort being made, infrastructure deficiencies and requirements and possible measures to promote eco-tourism at specific site. The meetings with the representatives of Wildlife and Forest Department, academia, PHA, Zoo, and community was held. Discussion were made on the key factors responsible for biodiversity decline, habitat degradation and threat associated to the local biodiversity.

3.1. Consultation with Academia

A meeting session with different educational institutes were conducted including zoology, wildlife and botany departments of Government College University Lahore, University of the Punjab Lahore, and University of Education, Lahore to discussed the current condition of urban biodiversity, challenges identified in research, and suggestions for urban biodiversity improvements. Prof. Dr. Muhammad Tahir – Chairman Zoology department, GCUL, has appreciated the initiative of Urban Unit and collaboration with academia for better management and planning for biodiversity. He highlighted about the key threats and issues related to biodiversity including exotic species, habitat fragmentation, uncontrolled use of pesticides and herbicides and climate change impacts. Prof. Dr. Uzma Hanif – Chairman Botany department, GCUL, has added that, currently Lahore experiencing the declining of vascular plant species and incline of exotic species due to rapid urban expansion and reduction in green spaces. Prof. Dr. Zulifqar Ali – Associate Professor, Institute of Zoology, PU Lahore, has highlighted that urban areas have fewer fruiting trees and less green spaces which declining the number of bird species in Lahore. Dr. Zahid Bhatti – Professor, Department of Zoology, UoE, Lahore has authenticated the identification of animal's species which were recorded from Lahore. He has also emphasized that urbanization and introduction of non-native trees in Lahore is a big threat to the animals of this area especially birds.

Figure 6: Consultation with Zoological Experts of Academia

We had a meeting with renowned botanists from Government College University Lahore Dr. Zaheer ud Din – Distinguish Professor of Botany and Dr. Zafar Iqbal –Associate Professor of Botany along with Dr, Zahid Iqbal. Both of botanist showed serious concerns about environmental and ecological challenges impacting both green areas and diversity of Lahore. Dr. Zaheer pointed out that plantation of invasive plant species *i.e.,* Paper Mulberry, Lantana, Mesquite, Conocarpus and Eucalyptus threatens the survival of native species and also disturbs the ecological balance of city. He suggested that plantation of these species should be banned by government because various health concerns are linked to these species. He also suggested that to encourage the local people to plant native trees, they may be provided with native plants free of cost. Furthermore, students who participle in more than 10 plantation drives in their career may be given extra marks during interviews for jobs and those people who are already in service may be given increments. He

added that multi story buildings may be encouraged in the city so that more space may be available for green area. He emphasized the development of sustainable conservation strategies, afforestation programs and public awareness campaigns for the protection of biodiversity.

Figure 7: Consultation with Botanical Experts of Academia

3.2. Consultation with Divisional Forest Officer

A discussion session was held with Mr. Shahid (DFO, Lahore) and Mr. Majid (SDFO, Lahore). On 18th July, 2024, for Lahore Biodiversity action Plan, team briefed about the Urban Unit's initiative of BAP and other tasks under the R&D project. The data required for City Biodiversity index and Profiling of Lahore city. They explained the forest resources of Lahore, including designated forest parks, canal-side plantations, bela along the River Ravi. They highlighted the extensive plantation drives in Lahore, their importance in ecosystem services and urban biodiversity for urban sustainability.

Figure 8: Consultation with Forest Department, Lahore

3.3. Consultation with Director Lahore Zoo

A meeting was held with Mr. Muhammad Zahid Sheikh, Director Lahore Zoo, he discussed about the urban biodiversity and zoo management in Lahore. He highlighted that the public awareness, and engagement in wildlife conservation is crucial for urban sustainability. He added about the challenges of new animals that often experience transportation stress, environmental changes, and public interaction cause change in feeding and social behavior, therefore, they required initial quarantine and behavior monitoring before animals are shifting to enclosures. Furthermore, he addressed the winter smog is another challenge to captive animals as well as urban wildlife species which cause stress and required strategic planning to sustain the animal welfare.

3.4. Consultation with Safari Park Officials

During our visit to Safari Park, we had the opportunity to meet with the Dr. Rizwan (Senior Veterinary Officer) and Mr. Waseem (AD Wildlife). They briefed about the animals shifting challenges faced during the transfer of animals. They also highlighted various issues related to animal welfare at Safari Park *i.e.,* lack of community awareness, inappropriate feeding of animals by visitors, and insufficient number of staffs to manage the vast area of park. Moreover, AD added that extreme fluctuations in weather conditions of Lahore also contributes to change in feeding and habitats adaptability behavior.

3.5. Consultation with PHA Officials

A session with Parks and Horticulture Authority (PHA), Lahore, was held to collect the data regarding City biodiversity index and information about ongoing projects of biodiversity and landscape management in Lahore. Mr. Arsalan (Deputy Director PHA) brief the current zoning and projects of PHA in Lahore, maintaining parks and green spaces, conserving native trees and plant species, promoting urban forestry through Miyawaki forestation, and providing recreational services for local health & wellbeing. Currently, PHA focusing the greening of degraded green belts through adaptive sustainable designing to promote ecosystem resilience in Lahore.

Biophysical Environment Profile

4.1. Habitat & Conservation Areas of City

Lahore holds varied habitat ranging from aquatic to terrestrial where the variety of flora and faunal diversity is inhabitant. These habitats comprise of riverine ecosystems, forest reserves, urban green spaces, parks, zoological & botanical gardens, wetlands, and linear plantations. In Lahore, Shahdrah reserve forest, Eno-Bhatti forest, Jallo forest, River Ravi, Riperine plantation are In-situ conservation areas whereas Lahore Safari park, Lahore Zoo and Botanical Garden are the Ex-situ conservation areas to conserve and protect the native biodiversity. The conservation and biodiversity areas of Lahore serve as breeding ground for both native and introduced species and essential part for the maintenance of ecological values of city.

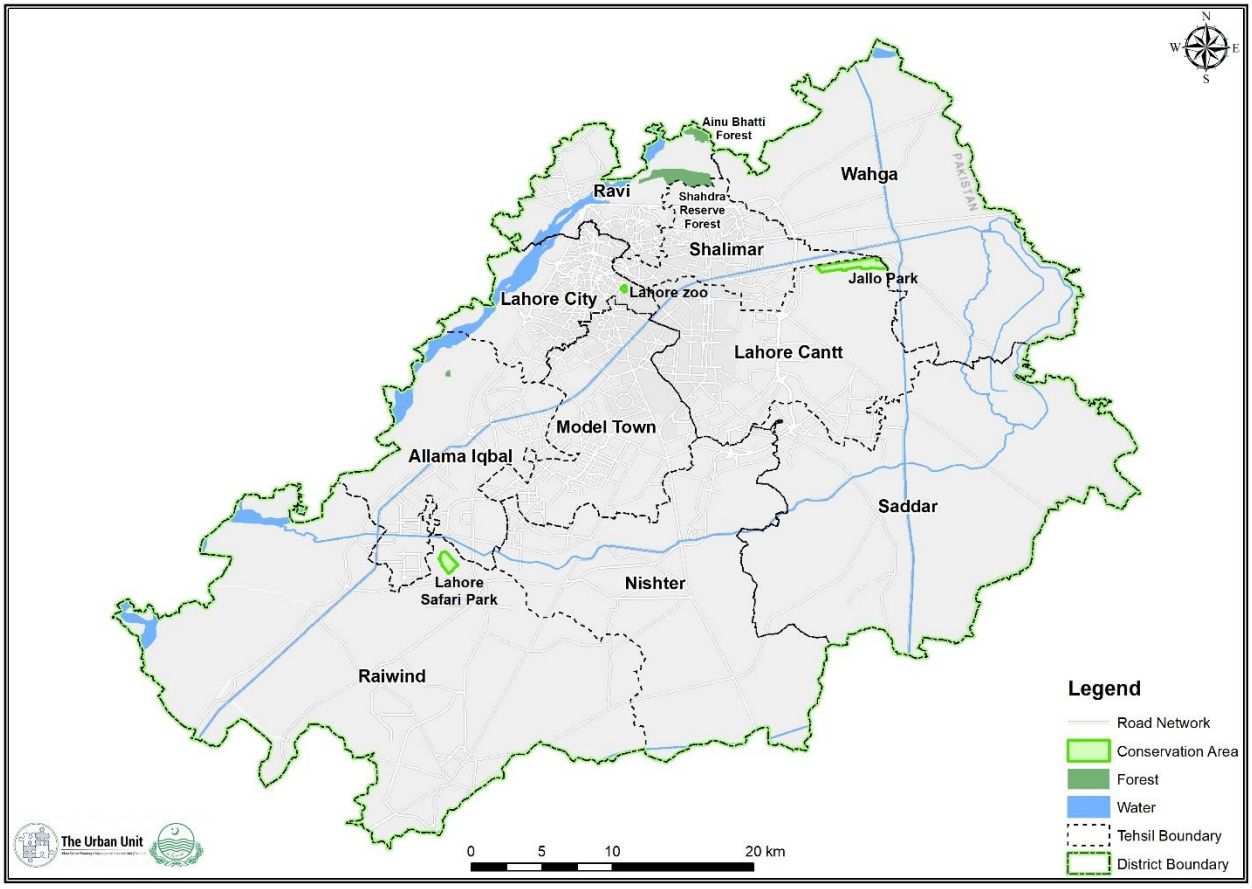


Figure 9: Spatial Distribution of Habitat & Conservation Areas of Lahore

4.2. City faunal Profile

A total of 69 birds' species was recorded from build-up areas, gardens and parks of Lahore during our survey. Out of the total birds 78% were local birds and remaining 22% were migratory. House crow is the most abundant species followed by Black kites, Rock pigeon, House sparrow and Common myna.

Figure 10: Some of Recorded Birds of Lahore – (a). Rock Pigeon (b). Kingfisher (c). Pond Heron

Previously, A studied was conducted in 1965, showed that the Lahore was home to diverse range of birds with 240 species.[25] After the three decades in 1992 only 101 bird species were recorded which further declined to 85 species in 2011, that indicating a drastic decline in numbers of bird.[26]

In 2007, a total of 74 birds were recorded the Lahore cantonment region including 13 summer visitors, 17 winter visitors, and 44 local residents.[27] Later in 2015, 53 species were reported from the UVAS, City Campus.[28] A recent survey recorded a total of 77 different bird species from Safari park Lahore between February 2021 and October 2024.[29] A detailed faunal diversity inventory has been constructed for Lahore city and attached as **annexure A.**

Lahore Zoo

Lahore Zoo is an ex-situ conservation area of Lahore, serving as recreational, wildlife conservation and research education. Lahore Zoo was established in 1872 and it is third oldest zoos in the world. Currently, Zoo houses a variety of animals around 1378 animals individuals of 135 species. These includes mammals, birds, and reptiles, amphibian and fishes, with some endangered species, bringing people into closer proximity with biodiversity and making them more environmentally aware. By offering a habitat for native as well as exotic species, the zoo plays a crucial role in achieving ecological balance. Its healthy green open spaces do much to purify the air as well as regulate temperature. It is also a recreational space that improves mental health and gives families and individuals a chance to connect with nature.

[25] Mirza, Z. B. (1998). *Illustrated handbook of animal biodiversity of Pakistan*. Centre for Environmental Research and Conservation.
[26] https://jang.com.pk/thenews/dec2011-weekly/nos-18-12-2011/she.html
[27] Iqbal, M. Z., Malik, S. A., Chaudhry, A. A., Yousafzai, A., Shakoori, A., Zahid, M., Ahmad, I., Fatima, M., Abdul, R., & Afzal, M. (2007). Birds of Lahore cantonment. *Pakistan Journal of Zoology, 39*(4), 203.
[28] Ali, Z., Shelly, S. Y., Bibi, F., & Ahmad, S. S. (2015). Ornitho-fauna of city and Ravi campuses of University of Veterinary and Animal Sciences, Lahore-Pakistan. *The Journal of Animal & Plant Sciences, 25*(3 Supp. 2), 389-396.
[29] https://ebird.org/hotspot/L15686828/bird-list

Figure 11: Captive Wildlife of Lahore Zoo – (a). Rhinoceros, (b). Brown Bear, (c). White Antelope, (d). Giraffe, (e). African Loin, and (f). Zebra

Safari Park

Lahore Safari park was established in 1981 over 242 acres and in 1998, it was handed over to the Punjab Wildlife and Parks Department by the Forest Department. Lahore Safari Park is a large natural habitat that provides a unique ex-situ habitat for wildlife conservation and education research. The large green areas of the parks serve as recreational ground for visitors and scattered tree canopy helps in carbon sequestration, improve air quality, and reduce the urban heat island effect. It is an area helps to aware people about the importance of wildlife and ecological balance and harmony linked to each species of the park. Besides this, it provides recreational benefits that promote family visits and contribute to well-being and mental health of local community.

Figure 12: Glimpses of Established Ground of Punjab Urial and Deer Safari in Safari Park

4.3. City Floral Profile

A total of 140 woody plant species and 33 palm species have been recorded from the parks and gardens of Lahore. The surveyed areas include Shahdrah reserve forest, Eno Bhatti reserve forest, Gulshan-e-Iqbal Park, Greater Iqbal Park, Jallo Park, Jilani Park, Nasir Bagh, Model Town Park, Lahore Zoo, and Lahore Safari Park**.** Out of 140 tree species recoded from Lahore 81 species were native, 54 were introduced and 5 species were invasive. The number of tree species from different visited areas in Lahore is showing that the highest number of tree species were recoded from Bagh-e-Jinnah (140), followed by Jilani Park (82), Greater Iqbal Park (80), Model Town Park (61), Gulshan-e-Iqbal Park (52), Nasir Bagh (43) Shahdra Reserve forest (13) and Eno Bhatti forest (09).

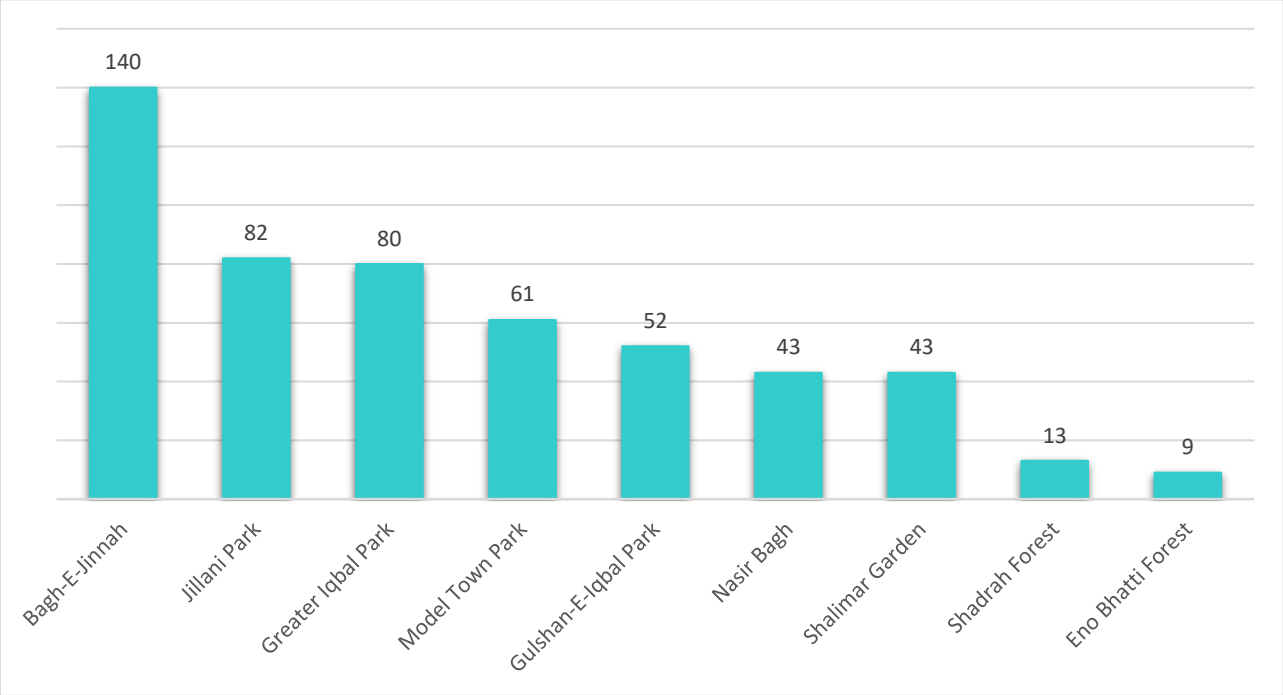


Figure 13: Trees Distribution in different Areas of Lahore

Species richness and diversity analysis is the tool to evaluate the habitat health, species richness, potential, and their significance level to others communities and habitat within the region. The Menhinick's Richness Index, Shannon Diversity index, and species evenness are measured for different parks and forest types of Lahore to evaluate the habitat health within each particular forest type on scale of 0-1 and above. The Menhinick's Richness and Shannon diversity Index values greater than 1 indicate that the area has diverse range of species whereas index value below 1 indicate the poor species richness and diversity whereas evenness index value with 1 indicating excellent evenness and decreasing values indicating decreasing trend of evenness. The calculated value of Menhinick's Richness Index varied from 0.78 (Nasir Bagh) to 2.43 (Shalimar Garden). The Shannon Diversity Index values ranged from 3.11 (Shalimar Garden) to 4.67 (Jilani Park). Similarly, Evenness Index (E5) values ranged from 0.79 (Bagh-e-Jinnah) to 0.94 (Nasir Bagh).

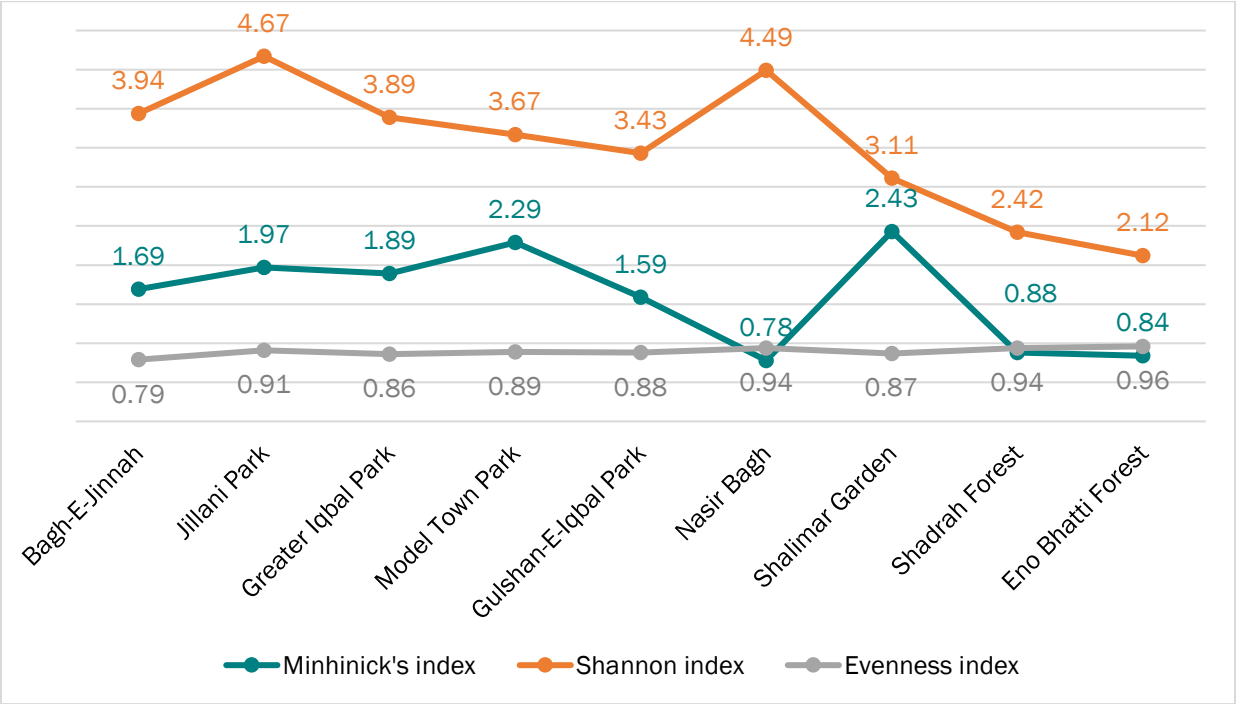


Figure 14: Biodiversity Indices of Different Sites of Lahore

Siddiqui *et al.*[30] reported a total of 94 plant species including exotic species belonging to 43 families from different localities of Lahore. Most commonly found species of trees in parks of Lahore include Neem, Peepal, Banyan, Sheesham, Amaltas, Jamun, Mulberry, Shisham, Sufaida, Sumbal, Alstonia etc. Iqbal *et al.*[31] reported 220 woody plant species from Botanical Gardens and two campuses of University of the Punjab Lahore.

Exotic species of plants in Lahore have posed a serious threat to the biodiversity and ecosystem mainly because they are invasive. They usually replace the native species by taking away resources such as water, sunlight, and nutrients. Consequently, native plants tend to decline or even become extinct. For instance, *Prosopis juliflora* (Mesquite) changes soil chemistry by increasing salinity, which is not favorable to native plants. *Broussonetia papyrifera* (Paper mulberry) and *Parthenium hysterophorus* (Gajarghass) are others invasive species that has spread all over Lahore. It grows rapidly and withstands a wide range of soils type, which allows it to overcome native species and disrupt the local ecosystem. *Eucalyptus* trees are highly water-intensive and posing challenges in water scarce region like Lahore. It also inhibits the growth of understory plants due to release allelopathic chemicals. These issues call for urgent management strategies, including monitoring, controlling, and restoring native habitats, in order to reduce the adverse

[30] Siddiqui, S., Shirazi, S. A., & Ali, A. (2016). A floristic analysis of selected parks in Lahore, Pakistan. *Journal of the Punjab University Historical Society (JPUHS)*, 29(2), 101-120.
[31] Iqbal, I. M., Shabbir, A., Shabbir, K., Naveed, M., Urooj, F., Butt, A., Khan, R., & Singh, N. (2020). Tree Flora of the Botanical Garden and two campuses of Punjab University Lahore, Pakistan.

effects of exotic species on the ecological integrity of Lahore's natural environment. A detailed floral inventory has been constructed for Lahore city and attached as **annexure B.**

Figure 15: Some of Common Trees of Lahore (a). Nagh Phali, (b). Eucalyptus Plantation, (c). Arjun, (d). Banyan Tree, (e). Kachnar, (f). Shisham

4.4. Vegetation Dynamics

The vegetation dynamics of Lahore analyze for a decade of 2014 and 2024. Lahore experienced a noticeable decline in vegetation cover, as indicated by a decrease in moderate vegetation and High Vegetation. High NDVI areas (>0.6) and moderate NDVI areas (0.4 – 0.6) reduced from 35.6 km^2 to 19.7 km^2 and 803.4 km^2 to 689.6 km^2 respectively. Whereas regions with Low vegetation (0.2 - 0.4) increased from 686.2 km^2 to 822.6 km^2. The decline is primarily attributed to rapid urban expansion, infrastructure development, and loss of agricultural and green spaces, especially along Ferozepur Road, GT Road, Saggian Bypass and Raiwind Road. New housing societies, road networks, and commercial zones have replaced many natural landscapes. The reduction in vegetation has worsened urban heat island effects and decreased ecosystem services. However, no vegetation areas (<0.2) have observed a minor improvement of 6.7 km^2 which led this city of Lahore towards sustainable Development. Immediate urban greening efforts and stronger environmental planning policies are required to restore ecological balance and ensure long-term urban sustainability in Lahore.

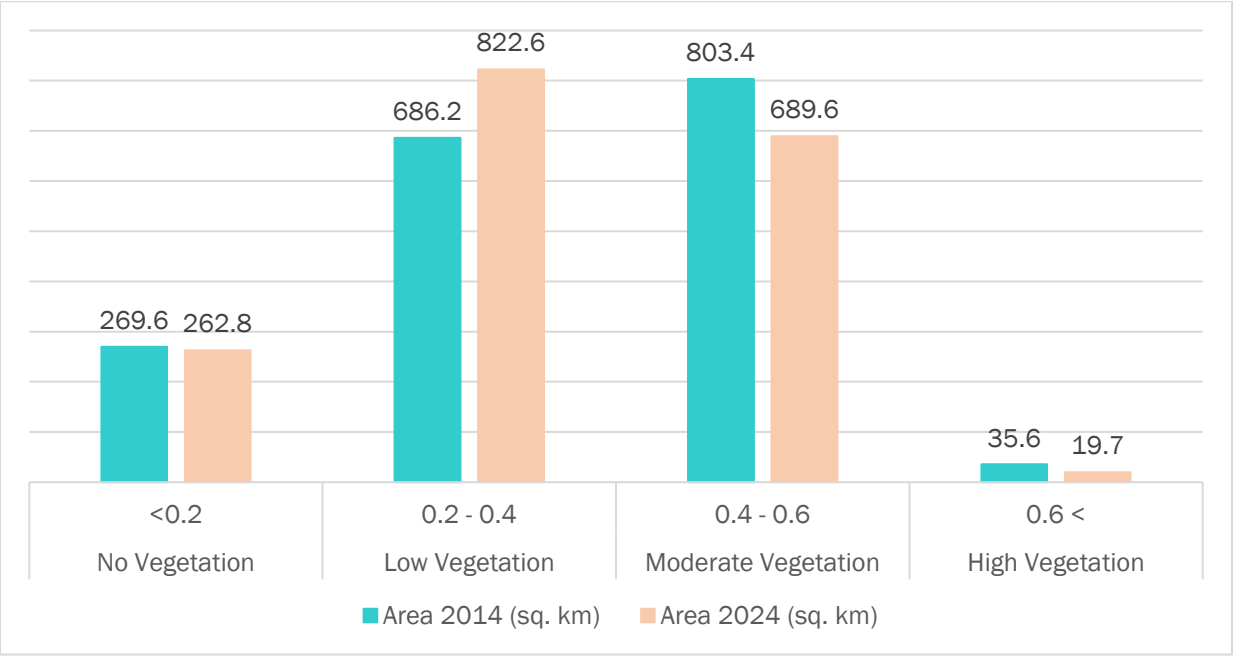


Figure 16: Vegetation Change Analysis in 2014 and 2024 of Lahore

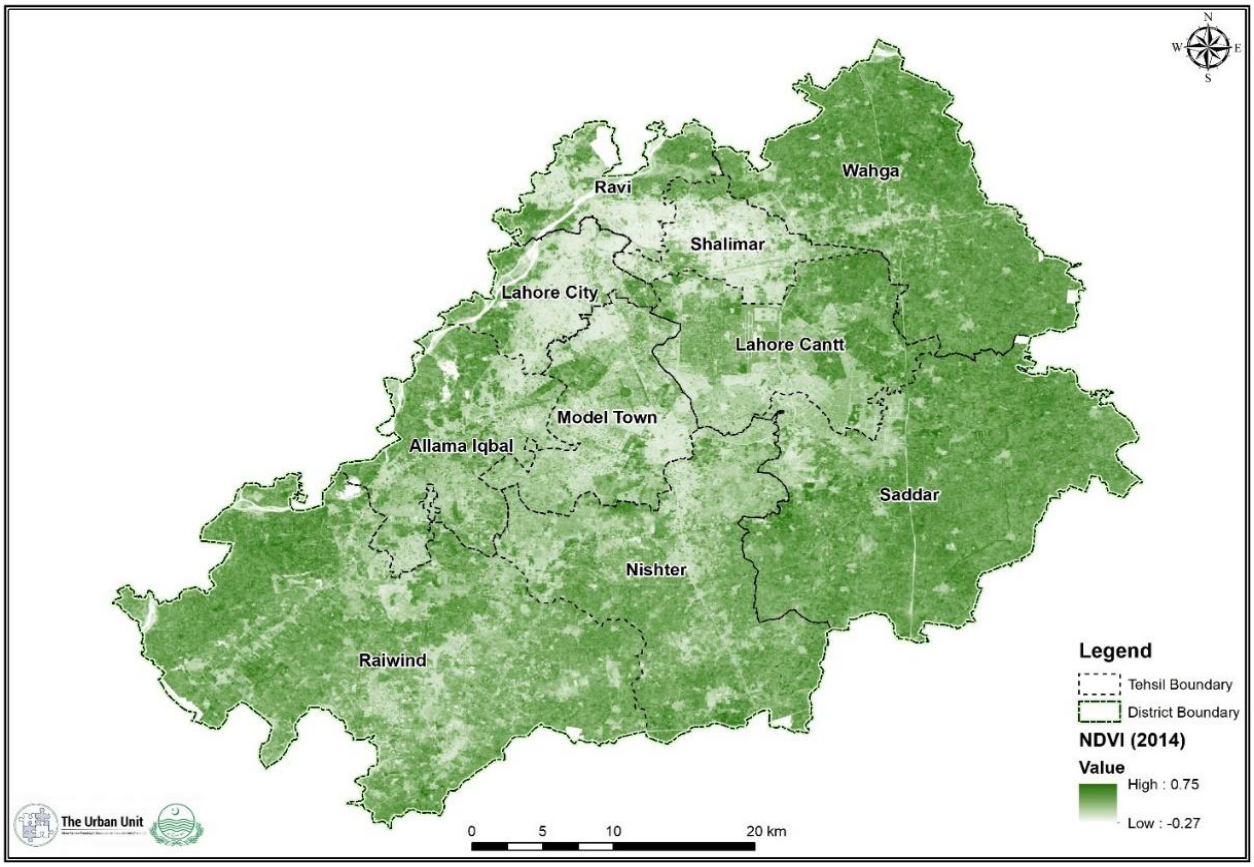


Figure 17: Vegetation Change Analysis in 2014 of Lahore

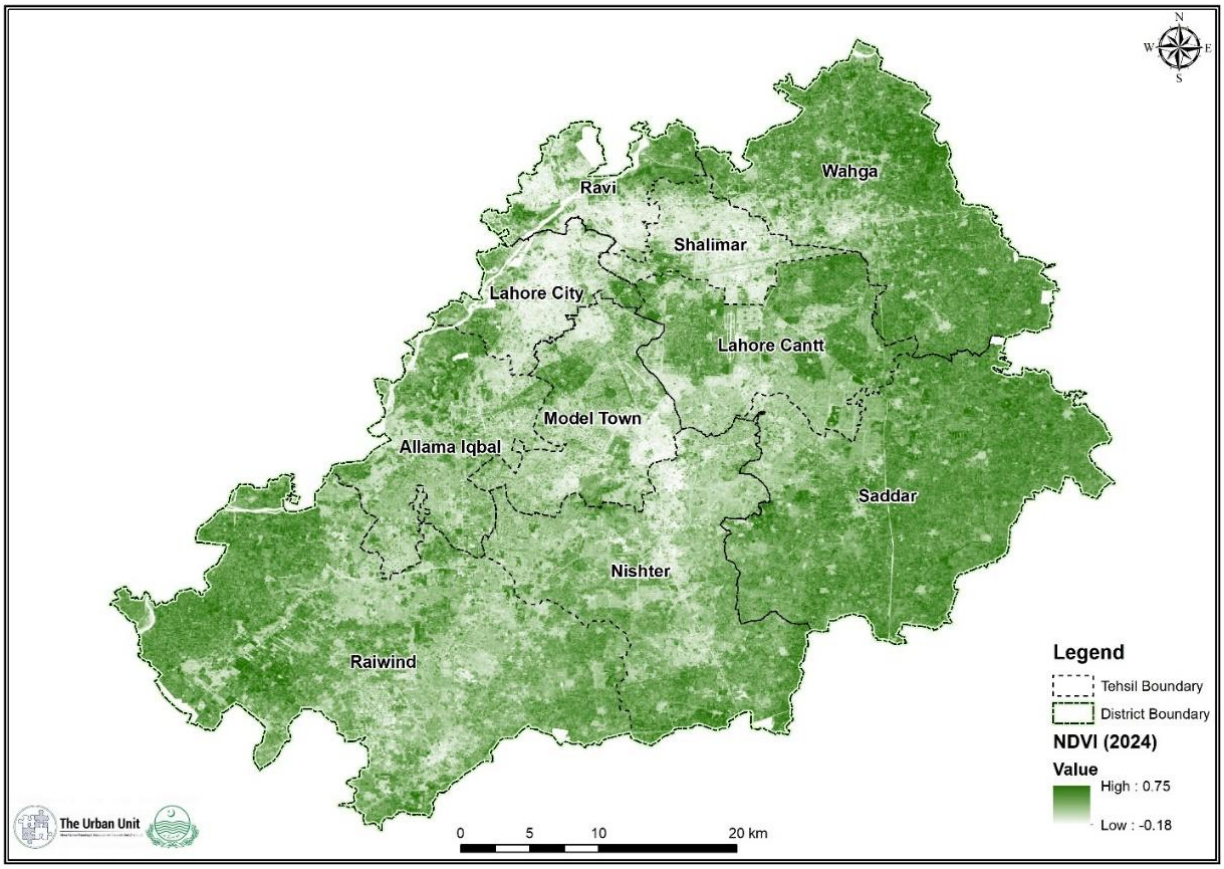


Figure 18: Vegetation Change Analysis in 2024 of Lahore

4.5. Tree Biomass and Carbon Stock Estimation

The analysis of tree biomass and carbon stock estimation for different tree species revealed the significant differences in biomass accumulation and carbon stocking. Tree species that are native to region like Shisham, Phulai, Kikar, Banyan, and Arjun have the greatest AGB and BGB accumulation, as these species exhibit higher Diameter at Breast Height indicating the mature and vigorous growth and development of trees.

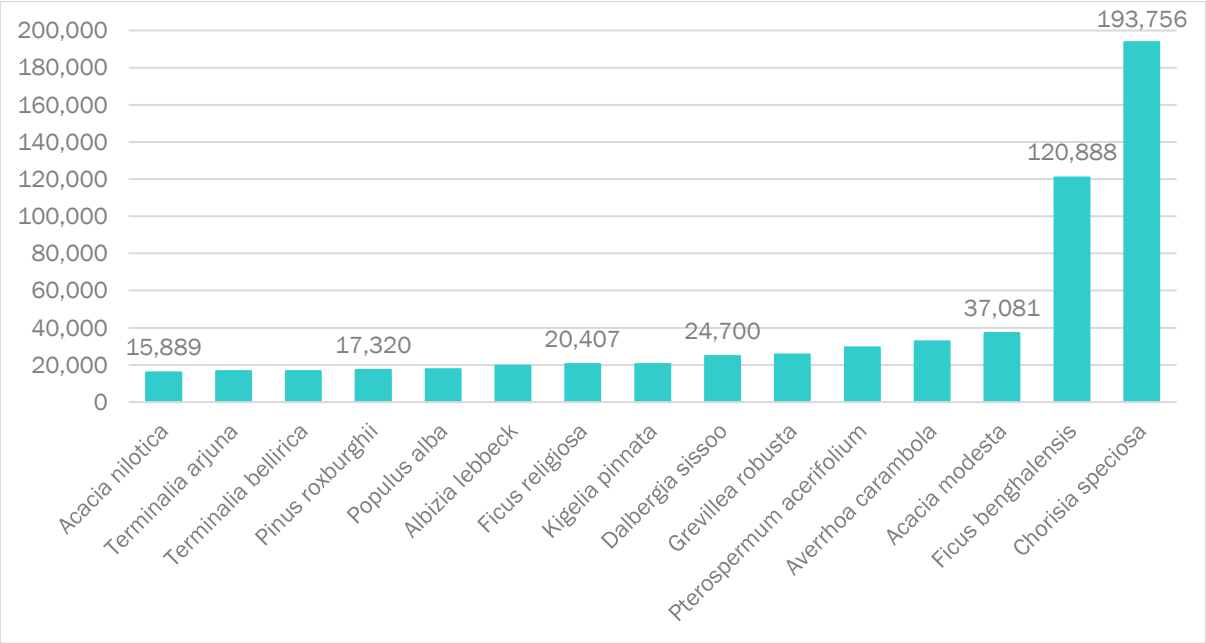


Figure 19: Tree Biomass and Carbon Stocking of different species in Lahore

Similarly, the species with high accumulation of AGB and BGB can store up to 40,000 kg of carbon in individual plant species. It demonstrating that, native species significant contribution to ecosystem services and carbon sequestration. A detailed analysis of all the studied sampled species developed to represent the comparative analysis of aboveground, belowground biomass and carbon storage potential.

Table 1: A detailed Assessment of Tree Biomass and Carbon Stocking of of Plants in Lahore

Local names	Botanical Names	DBH (cm)	AGB (Kg)	BGB (Kg)	Total Biomass(kg)	Carbon Stock (Kg)
Cotton tree	Ceiba pentandra	15.0	87.1	22.7	109.8	54.9
Jacaranda	*Jacaranda mimosifolia*	22.9	249.9	64.9	314.81	157.4
Jatropha	*Jatropha curcas*	24.0	282.2	73.4	355.5	177.8
Amrood	*Psidium guavajava*	24.0	282.2	73.4	355.5	177.8
Bakain	*Melia azedarach*	33.0	626.5	162.9	789.4	394.7
Conocarpus	*Conocarpus erectus*	35.6	754.1	196.1	950.1	475.1
Lasura	*Cordia myxa*	36.0	777.6	202.2	979.2	489.9
Hareer	*Terminalia chebula*	101.6	1044.81	271.65	1316.46	658.23
White fig	*Firus virens*	*48.26*	1617.96	420.66	2038.62	1019.31
Reetha	*Sapindus mukorossi*	50.8	1839.32	478.22	2317.54	1158.77
Bottle brush	*Callistemon lanceolatus*	50.8	1839.32	478.22	2317.54	1158.77

Alstonia	*Alstonia scholaris*	55.88	2334.21	606.89	2941.1	1470.55
Toot	*Morus alba*	55.88	2334.21	606.89	2941.1	1470.55
Sukh chain	*Pongamia pinnata*	57.0	2452.94	637.76	3090.7	1545.35
Sohanjna	*Moringa oleifera*	58.42	2608.57	678.22	3286.79	1643.39
Mango	*Mangifera indica*	60.96	2921.43	759.57	3681	1840.5
Beri	*Ziziphus nummularia*	63.5	3213.17	835.42	4048.59	2024.29
Kathal	*Artocarpus heterophyllus*	66.04	3544.19	921.48	4465.67	2232.83
Leagerstroemia	*Lagerstroemia speciosa*	66.04	3544.19	921.48	4465.67	2232.83
Fish poison tree	*Barrangtonia asiatica*	*73.66*	4656.71	1208.14	5864.85	2932.42
Jamun	*Syzygium cumini*	73.66	4656.71	1208.14	5864.85	2932.42
Sagwan (teak)	*Tectona grandis*	73.66	4656.71	1208.14	5864.85	2932.42
Kachnar	*Bauhinia variegata*	73.66	4656.71	1208.14	5864.85	2932.42
Toon	*Toona ciliata*	187.96	48435.47	12593.22	61028.69	3051.34
Neem	*Azadirachta indica*	81.28	5956.06	1549.35	7505.41	3752.7
Bail geri	*Aegle marmelos*	83.22	6317.84	1642.63	7960.47	3980.23
Amaltas	*Cassia fistula*	84.0	6466.93	1681.4	8148.33	4074.16
Dhokra	*Anogeissus acuminata*	86.36	6930.77	1802	8732.77	4366.38
Cluster fig	*Ficus glomerata*	*88.9*	7451.68	1937.43	9389.11	4691.55
Suffaida	*Euclyptus camaldulensis*	91.44	7995.4	2078.8	10074.2	5037.1
Drooping fig	*Ficus cunia*	*99.06*	9766.65	2539.32	12305.97	6152.98
Moolsari	*Mimusops elengi*	100.0	10000.0	2600.0	12600.0	6300.0
Ashok tree	Saraca asoca	100.0	10000	2600	12600	6300
Ulta ashoq	*Polyalthia longifolia*	104.14	11067.25	2877.48	13944.73	6972.36
Gul e must	*Butea monosperma*	104.14	11067.25	2877.48	13944.73	6972.36
Simbal	*Bombax ceiba*	109.22	12466.81	3241.37	15708.18	7854.09
Mohangni	*Swietenia macrophylla*	114.3	13967.4	3631.52	17598.92	8799.46
Royal palm	*Roystonea regia*	132	20018.65	5205.84	25224.49	12612.24
Red Juniper	*Juniperus virginiana*	140	23193.03	6030.18	29223.21	14611.6
Kikar	*Acacia nilotica*	144.78	25221.23	6557.51	31778.74	15889.37
Arjun	*Terminalia arjuna*	*147.32*	26342.33	6849	33191.33	16595.66
Behra	*Terminalia bellirica*	147.32	26342.33	6849	33191.33	16595.66
Chir	*Pinus roxburghii*	149.86	27492.5	7148.05	34640.55	17320.27
Poplar	Populus alba	151	28018.33	7284.76	35303.09	17651.54
Kala shirin	*Albizia lebbeck*	157.48	31121.7	8091.64	39213.34	19606.67

Peepal	*Ficus religiosa*	*160.02*	32391.84	8421.87	40813.71	20406.85
Gul-e-fanoos	*Kigelia pinnata*	160.02	32391.84	8421.87	40813.71	20406.85
Shisham	*Dalbergia sissoo*	172.72	39206.36	10193.65	49400.01	24700
Silver Oak	*Grevillea robusta*	*175.26*	40663.71	10572.56	51236.27	25618.13
Kanak champa	*Pterospermum acerifolium*	*185.42*	46815.69	12172.07	58987.76	29493.88
Kamarak	*Averrhoa carambola*	193.04	51774.78	13461.44	65236.22	32618.11
Phulai	*Acacia modesta*	203.2	58858.5	15303.21	74161.71	37080.85
Banyan	*Ficus benghalensis*	326.0	191886.3	49890.4	241776.8	120888.4
Buddha pink	*Chorisia speciosa*	393.7	307548.44	79962.59	387511.03	193755.51

A remote sensing analysis of Lahore has been carried to evaluate the above ground biomass of Lahore from carbon stock of has been predicted. Currently Lahore has approximately 13.2 million tonne above ground biomass which stores approx. 6.6 million tonnes carbon stock.

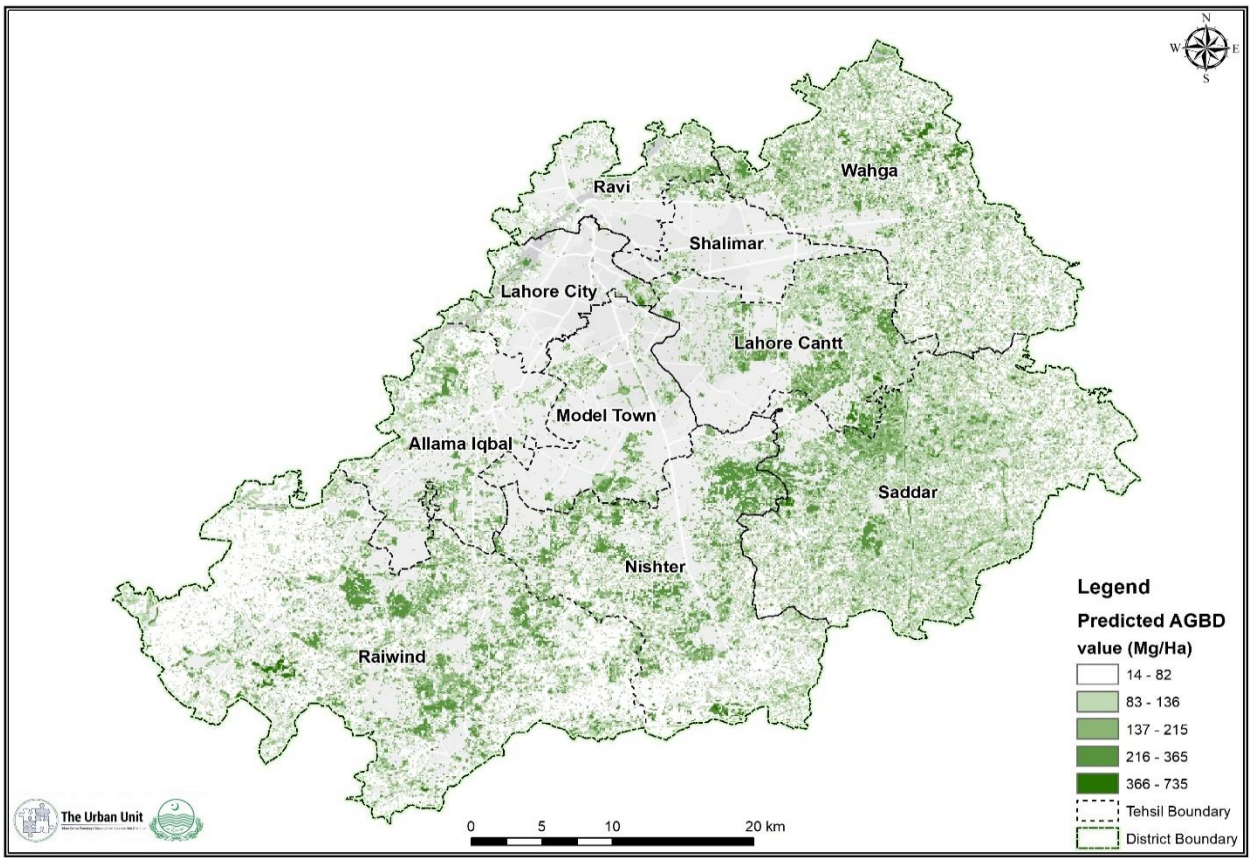


Figure 20: Aboveground Biomass Analysis of Lahore – 2023-24

4.6. Green Spaces and Open Ground Audit

There are many historic and important parks and gardens in Lahore which play key role to control air pollution and provides excess supply of fresh air. The Parks and Horticulture Authority (PHA) develop and maintain the parks and gardens in Lahore. The total green area in Lahore based on remote sensing data including parks (24.3 Sq. km) and forests (7.7 Sq. km) is 32 sq. kms, which is only 1.8% of total area (1772 sq. kms) of Lahore.

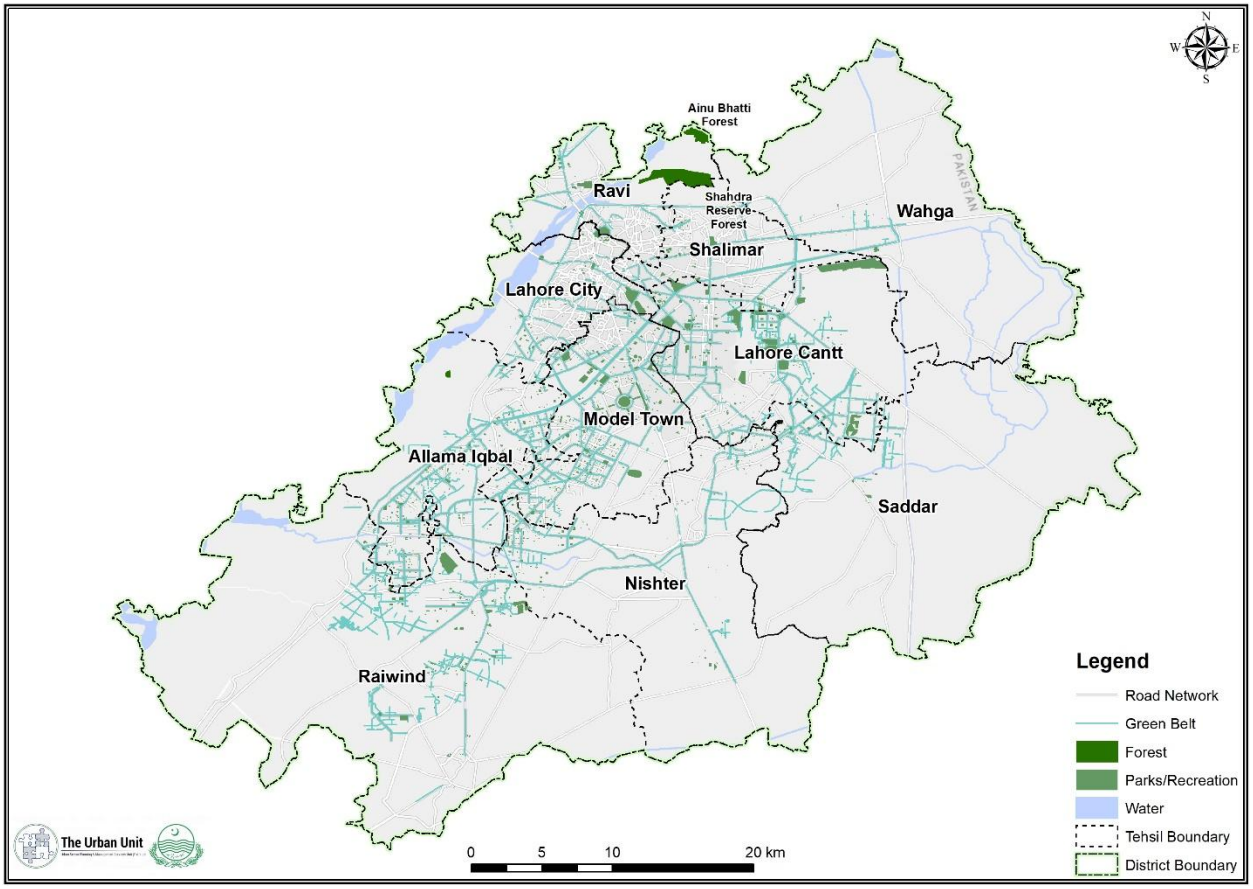


Figure 21: Spatial Distribution of Green Spaces and Open Ground in Lahore

Gulshan-e-Iqbal Park

Gulshan-e-Iqbal Park is the major green space and recreational space in the city with an area of over 67 acres. It is situated in the suburban locality of Allama Iqbal Town. It also features a vast artificial lake and a mini-zoo with a variety of animal and bird species, including Pigeons, Peacocks, and Deer. Furthermore, Crow, Sparrow, Squirrel, Owl, Parrot, Dog, Dove, Cat, Koel, Kingfisher and Parakeet were also observed in the park. Common native trees include Mango, Shareen, Gold mohr, Tun, Simbal, Gul-E-Nishtar, Jetofa, Dharek, Buddah, Jamun, Ulta ashok, Alstonia, Biri pata, Arjun, Peepal, Tali, Almond, Acacia, Neem, Sheesham, Eucalyptus etc. Presence of diversity in trees and plants in Gulshan-e-Iqbal Park maintains the temperature level, fights against air pollution, and provides shades for the visitors to enhance the

microclimate. It also enhances ecological services along with recreational facilities for the birds and pollinators.

In November, 2024 data regarding the inventory of woody tree from Gulshan-e-Iqbal Park was collected. A total of 52 tree species were documented. Highest number of plants were represented by Sufaida (231), followed by Alstonia (124), English Tali (104), Amaltas (88), Jetofa (43), Kanak champa (43), Molsari (40), Terminalia (36), Dokra (29) and Seeda ashooq (26). Other species of plant were in less numbers.

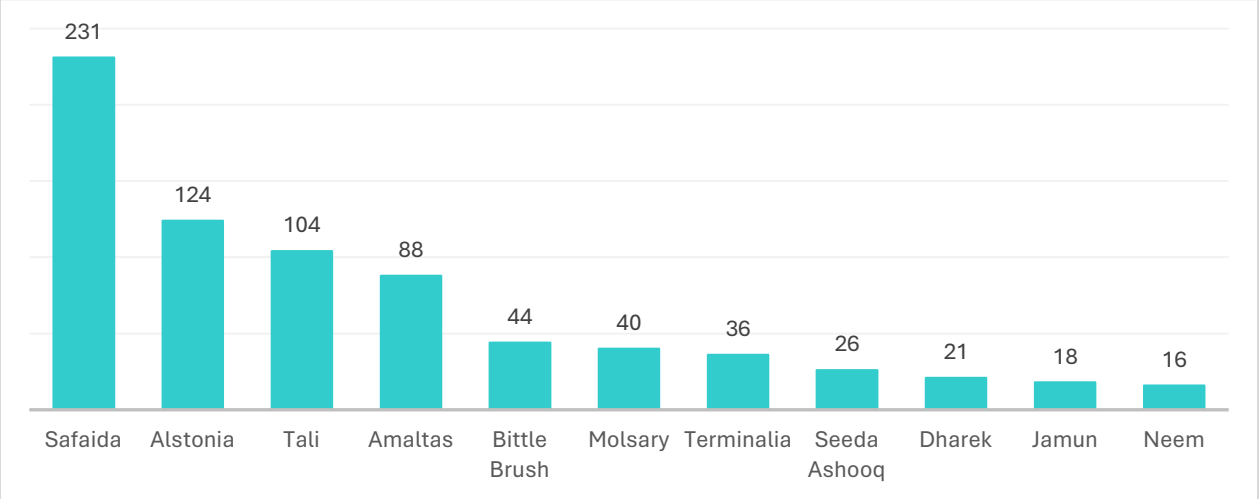


Figure 22: Most Abundant trees of Gulshan e Iqbal Park, Lahore

Bagh-E-Jinnah

Bagh-E-Jinnah is situated on the Lawrence Road, Mall Road, Lahore, right across from the Lahore Zoo and next to the Governor's House. The area of this park is 141 acres. A prominent feature within Bagh-E-Jinnah is the Quaid-E-Azam Library, housed in the Victorian-era Lawrence and Montgomery Halls. The park also contains plant tissue culture laboratory formed by collaboration of Lahore College for Women University and PHA. The park also includes areas designated by the Parks and Horticulture Authority (PHA) for conservation purposes. Park is extremely crowded during weekend as many families visited the park for picnic and other recreational activities.

In addition to nearly all sorts of annual flowers, it contains wide variety of trees such as Neem, Shisham, Peepal, Banyan, Bamboo, Jand, Chinar, Ashok, Kanak champa, Jacaranda, Mango, Papaya, Acacia, Bottle palm, Golden palm, Kangi (Sago) palm, Yucca (Needle pam), Fish tail palm, Body flax, Common flax, Jamun, Alstonia, Monstera, Mulberry (Shahoot), Moolsari, Budda, Belgiri, Guava, Amaltas, Simbal, Biri patta, Ulta ashok , Arjun, Bottle brush, Berha, Pine Tree etc.

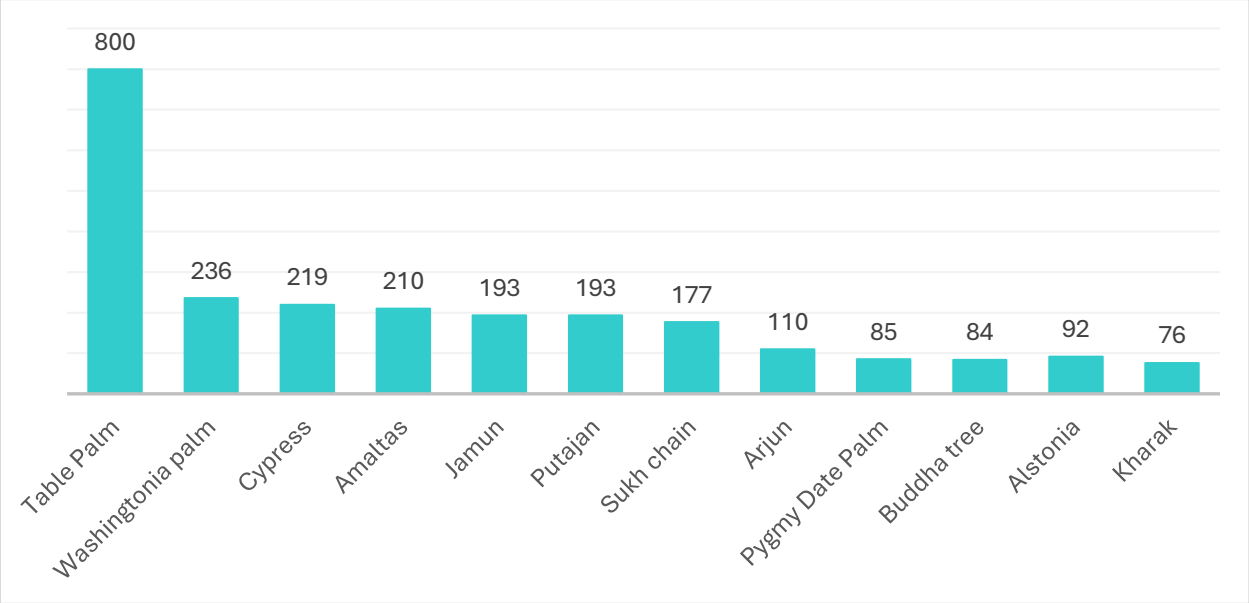


Figure 23: Most Abundant trees of Bagh Jinnah, Lahore

The park is also home to a variety of animals such as Owls, Bats, Common babbler, Gray-headed Canary-Flycatcher, Black-throated Thrush, Common chiffchaff, Black-crowned night heron, Gray-bellied cuckoo, Indian paradise-flycatcher, Red-breasted flycatcher, Golden oriole, Shikra, Asian green bee-eater, Warbler, Citrine wagtail, Indian robin, Little egret, Indian pied starling, Red collared-Dove, Brown-headed barbet, Prinia, Bank myna, Little swift, Blue-throated barbet, Spotted dove, Yellow-footed green-pigeon, Indian pond-heron, House sparrow, Eurasian collared-Dove, Laughing Dove, Asian koel, White-throated Kingfisher, Alexandrine Parakeet, Common tailorbird, Greenish warbler, Jungle babbler, Rock Pigeon, Black kite, Rose-ringed parakeet, House crow, Red-vented bulbul, Common Myna and Western Yellow Wagtail.

Plants and native trees in Bagh-e-Jinnah facilitate local wildlife and biodiversity while presenting an aesthetic setting for recreation and leisure. Altogether, the green spaces collectively contribute to the environmental health of Lahore, its recreation, and cultural value.

Figure 24: A view of Bagh e Jinnah

Jilani Park (Racecourse Park)

Jilani Park, formerly called Racecourse Park, is in front of the renowned Services Hospital on Jail Road. It covers an area around 86 acres. Jilani Park is rich in biodiversity, with a variety of plants and trees that help with soil stabilization, water filtration, and air quality improvement. The presence of water bodies supports local wildlife, including birds and insects, which contributes to pollination and seed dispersal. This park offers recreational services through walking tracks and green spaces, promoting physical activity and community well-being.

There are over 82 different kinds of trees in the park, which add to its attractiveness and draw visitors. The park is home to over 100 different kinds of flowers and bushes. The trees of Jilani park include Neem, Shisham, Peepal, Ashok, Kanak champa, Mango, Papaya, Bottle palm, Golden palm, Kangi (Sago) palm, Yucca (Needle pam), Fish tail palm, Body flax, Common flax, Jamun, Alstonia, Shahoot, Moolsari, Budda, Belgiri, Guava, Amaltas, Simbal, Biri patta, Ulta ashoq, Arjun, Pinkam bodi, Bottle brush, Berha, Pine Tree etc. Common variety of animals found in Racecourse Park includes Cats, Stray dogs, Bats, Cranes, Squirrel, Eagles, Kites, Butterflies, Garden lizards, Parrots, Sparrows, Pigeons, Owls, Common myna, Dove, Ducks and Ants.

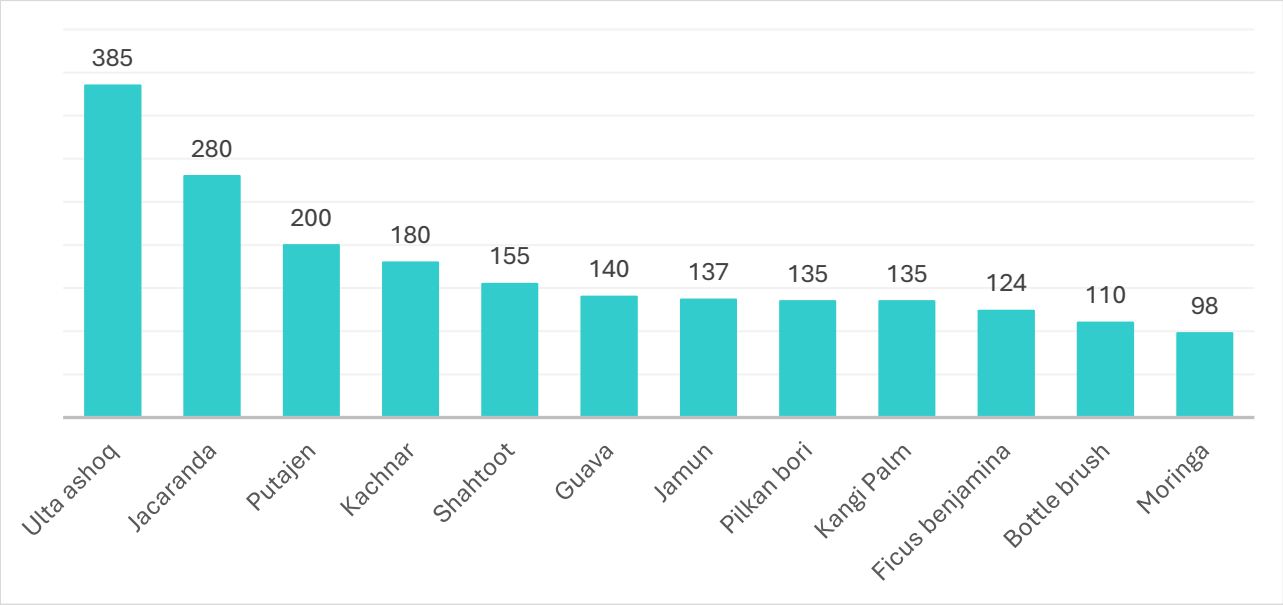


Figure 25: Most Abundant trees of Jillani Park, Lahore

Greater Iqbal Park

Greater Iqbal Park is one of the biggest urban parks in Lahore. The Badshahi Mosque and Minar-e-Pakistan are next to Greater Iqbal Park, also known as Minto Park. The 125-acre Greater Iqbal Park is home to lakes, a diverse variety of vegetation, Minar-e-Pakistan, and a dancing fountain. Important ecosystem services from this diverse green cover are to purify air by removing the pollutants CO_2 and particulate matter. Various species of birds and insects inhabiting the park help in pollination and controlling pests. It helps to regulate

temperature in this urban area because of a significant number of trees, thereby countering the effects of an urban heat island. As a significant recreational space, the park affords opportunities for physical activity and social interaction that supports mental health and well-being.

We recorded 80 plant species from this park including Bottle Brush, Kachnar, Alstonia, Seedha Ashoq, Ulta Ashoq, Desi Kachnar, Neem, Date Palm, Shahtoot, Conocarpus, Bismarkia Palm, Kangi Palm, Amaltas, Ficus, Melaleuca, Boardh, Sacred Fig, Eurasian Smoke Tree, Gul Cheen, Foxtail, Date Palm, Indian Almond, Jacaranda, Tabebuia, Peepal, Bakain, Sheesham, Simbal, Pine, Walnut Tree, Jamun, Gul Mohar, Mahogany, Mango, Mexican White Oak, Sukh Chain, Gul-E-Nishtar, Phoenix Palm, Fig, Banyan, Silver Palm, Washington Palm, Melia, Eucalyptus, Table Palm, Flame Tree.

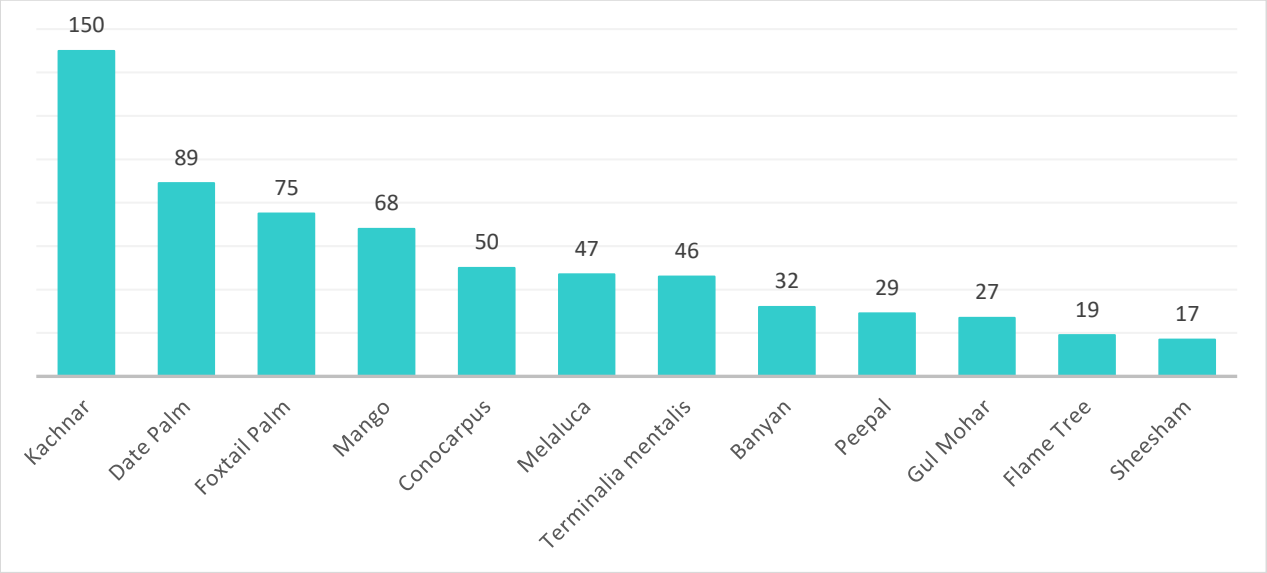


Figure 26: Most Abundant trees of Greater Iqbal Park, Lahore

The animals recorded from this park include Pigeons, Crows, Sparrows, Parakeets, Mynas, Parrots, Pond heron, Kingfisher, Owl, Dove as well as seasonal migratory birds. Mammals such as Rats, Cats, Squirrel, Stray dogs are also recorded from this area.

Jallo Park

Jallo Park on Jallo Road in Lahore extends to Canal Road. Covering 461 acres, the park has a butterfly house that hosts varied collections of plants and butterflies and contains botanical collections as well as themed gardens. The common plants recorded from this park include Yucca, Kanak champa, Banyan, Conocarpus, Kachnar, Sohanjana, Keekar (desi), Tali, Guava, Mango, Jamun, Shehtoot, Shisham, Arjun, Alstonia, Pinus, Bottle brush, Gold fax, Body fax, Bismarckia palm, silver palm, Sukh chain, Neem, Peepal, Ber, Amaltas and Gul mohar.

Apart from its rich flora, the park also has various species of animals like Asian black bear, Chinkara, Sambar, Indian cobras, Mugger crocodiles, Common peacock, Bengal tiger, Bear, Ostrich, Deer, Black buck, spotted

deer, Nilgai, Urial, Sand boa and Black cobra are also present. The park also accommodates a variety of birds such as Parrots, Koels, Sparrows, Mynas, Parakeets, as well as insects like Bees, Butterflies, and Ants.

Biodiversity in this park plays a very important role in providing essential ecosystem services within Lahore city. Pollination is one of the key services providing support to agricultural productivity and food security, depending on the presence of pollinators like honeybees, butterflies, and birds. All these species contribute to the pollination of crops like fruits, vegetables, and flowers that enhance both the local food production and economy. The gardens also attract tourists and nature lovers who then visit these gardens and thereby increase the demand for recreational services and eco-tourism. The presence of so many species of plants and trees help in purifying air and water and lessen the heat island effect and thereby make Lahore a habitable city. Moreover, the green area offers recreational services, which is important for mental comfort and physical exertion.

Nasir Bagh

Nasir Bagh is found at Lahore's Lower Mall, Anarkali Bazaar. Along with that, there are numerous important historical places in Lahore too close to it, like Urdu Bazaar, Old Anarkali, and Government College University, Lahore. A significant number of visitors, approximately 50 families visited park per day. Students from nearby universities visited the park regularly. The lake here at Nasir Bagh has several plants and trees covering the whole place. But the park has one major drawback: the absence of a fence or boundary. As a result, drug addicts can easily enter the park, which affects the experience for families and other visitors. Trees include Neem, Ficus (Bodhi), Eucalyptus, Gul mohar, Banyan, Common flax, Beri patta. Ulta ashok, Arjun, Peepal, Mango, Jamun, Mulberry, Kanghi palm, Amaltas, Table palm, Bottle brush, Morpankh, Bottle palm etc.

Fauna is mainly represented by birds: such as Pigeons, Crows, Mynas, Sparrows, Cranes (bagla), Owls, Parrots, Dove, Eagles, Kites and sometimes migratory birds. Other fauna of the park includes Squirrels, Cats, Stray dogs, Bats, Garden lizards, Butterflies, Ants and Bees. Nasir Bagh has native and ornamental plants that help provide important ecosystem services. Green areas in Nasir Bagh help sequester carbon from the atmosphere and, therefore, contribute to climate change mitigation. Birds, butterflies, and bees inhabit the park, providing necessary pollination and pest control. The park is also a venue for relaxation and physical exercise in a peaceful environment, which positively affects mental health and community cohesion.

Shalimar Garden

Shalimar Garden is a UNESCO World Heritage site and diverse plant species present here help in air purification and soil erosion control, while also offering aesthetic and recreational services. It is situated in Shalimar Town, Lahore. Shalimar Garden is an 80-acre park famous for its stunning gardens, walking paths, and picnic spots. The flora of Park contains a vast variety of tree species like Neem, Peepal, Ber, Eucalyptus, Tali, Almond, Mango, Mulberry, Plum, Pomegranate, Jacaranda etc. The park is also inhabited by various birds like Parakeets, Mynas, Sparrows, Bulbuls, Doves, Cats, Dogs, Owl, Warblers, Koels, along with insects such as Butterflies, Bees, and Ants. Furthermore, the variety of birds found in this park contributes to pest control and seed dispersal.

Model Town Park

Model Town Park is a key green space in Lahore with diverse trees, shrubs, and flowering plants that help with air purification and microclimate regulation**.** It is in Model Town, Pakistan. It covers 72 acres of space. This park has an impressive display of trees and plants like Mango, Alstonia, Amaltas, Tali, Shahoot, Jamun, Neem, Kachnar, Ulta ashok, Moolsari, Gab, Simbal, Date palm, Bottle palm, Washigtonia palm, Gul-e-cheen, Bakain, Tabebuia, Melaleuca and rare species, such as the Cook pine (*Araucaria columnaris*), as well as the Blue Jacaranda (*Jacaranda mimosifolia*).

Paths of parks are paved through lush greenery and bursts of colorful flowers. Common animals in this park include Peacocks, Rabbits, Ducks, Cats, Owl, Sparrows, Koels, King Fisher, Crow, Mynas, Bulbuls, and Doves etc. The park supports a variety of bird species that assist in insect control and contribute to the park's biodiversity**.** Similarly, water bodies in Model Town Parks regulate water quality and temperature. This green space also provides a tranquil environment for recreation, helping to reduce stress and improve mental well-being.

4.7. Health & Wellbeing Impact Assessment

Health and Well Being Assessment in Lahore is crucial due to fluctuating environmental conditions in Lahore. Health of residents is adversely affected by various factors *i.e.,* high pollution levels, rapid urbanization and loss of green spaces.[32] During the survey in various parks, most of the visitors were of the view that green spaces have significant impact on their physical and mental health. They feel relaxed and fresh from their frustrated lives after visiting these parks.

Health & wellbeing impact assessment was computed through the measure of total population of city per 1000 that depends upon the total area of parks, protected and conservation areas accessible to local community. The results reveled that the only 0.2 hectares of green space is available per 1,000 people in Lahore which is very less as compared to the international standard. According to WHO guidelines, there should be at least 9 square meters of green space per person. It is equivalent to 0.9 hectares per 1,000 people and a widely accepted for urban planning and health-related initiatives.[33] Therefore, In Lahore there is an unmet need to increase availability of green space from 0.2 hectares to 0.9 hectares per 1,000 people. Similarly, it found that 65% of the city population lives within 400 meters accessibility of green spaces**.** However, the remaining 35% lacks access to green spaces for their recreation and improvement of health and wellbeing.

[32] Jabbar, M., Nasar-u-Minallah, M., & Yusoff, M. M. (2024). Measuring human-environment interaction for human health in Lahore, Pakistan: Toward a nature-based solution. *GeoJournal*, *89*(4), 172.
[33] https://www.euro.who.int/en/health-topics/environment-and-health/urban-health/activities/urban-green-spaces-and-health

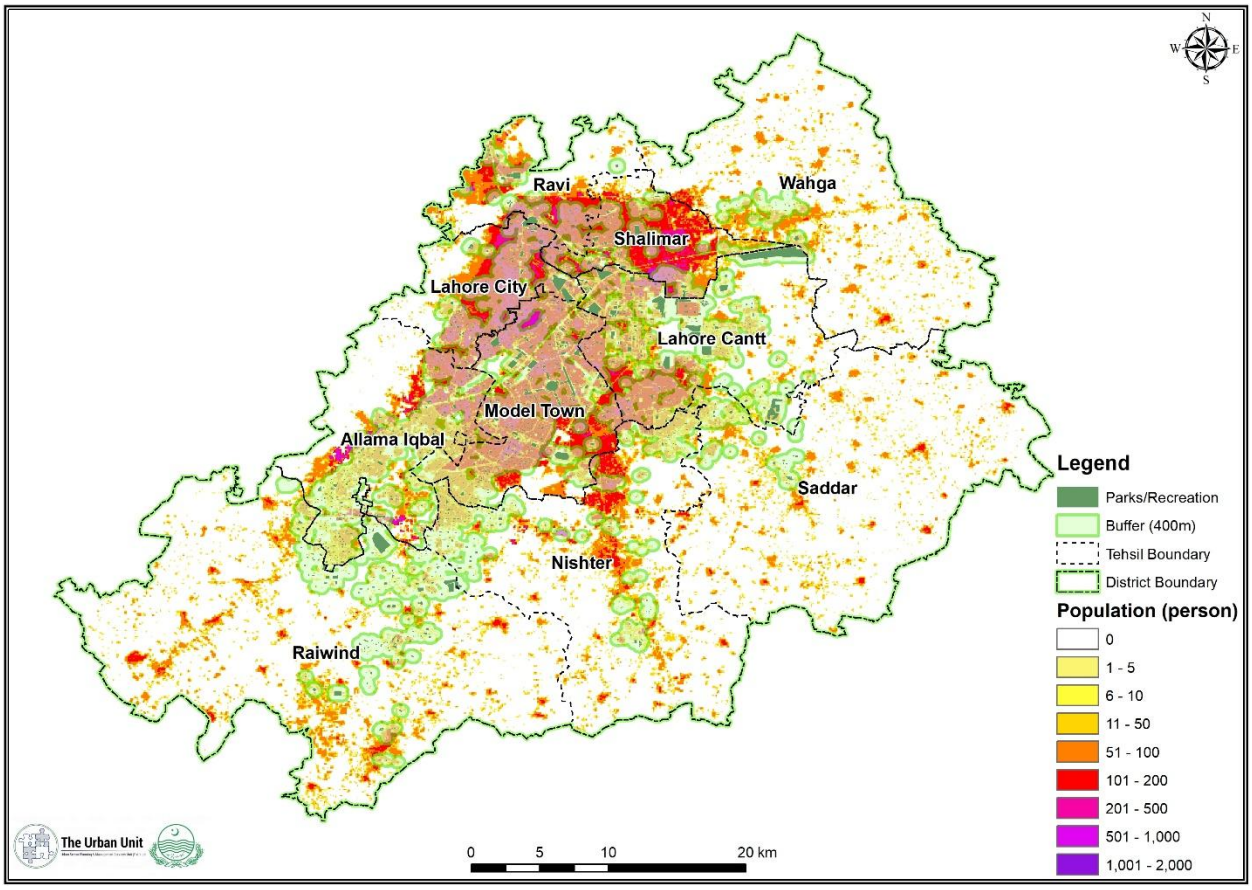


Figure 27: Population Living Near Green Spaces and Open Ground in Lahore

4.8. Soil

The soils of Lahore reflect the city's unique geographical setting in the alluvial plains of the Punjab region, shaped over centuries by the River Ravi and its tributaries. Generally, the soils are sandy loam to silty clay, with good fertility due to the historical deposition of nutrient-rich sediments from river flooding. However, rapid urban expansion, unplanned construction, and shrinking green spaces have led to soil compaction, loss of organic matter and declining fertility in many areas. In peri-urban and agricultural zones, intensive farming practices, excessive use of chemical fertilizers, and industrial effluents have further contributed to soil degradation and contamination with heavy metals. The sealing of natural soil surfaces by concrete and asphalt across much of the city has also disrupted natural drainage, groundwater recharge, and soil aeration, limiting the ability of urban soils to support healthy vegetation. Conserving soil health through sustainable land use planning, green infrastructure development, and community-driven afforestation programs is essential to preserving Lahore's environmental balance and ensuring the resilience of its urban ecosystem.[34]

[34] Khan, H. U., Rashid, I., Israr, J., & Zhang, G. (2022). Geotechnical characterization and statistical evaluation of alluvial soils of Lahore. *Arabian Journal of Geosciences*, *15*(9), 845.

4.9. Water Bodies and Wetlands

The water bodies and wetlands including ponds, water channels, River Ravi and other water bodies in Lahore is 28.4 sq. km which is 1.6% of the total area of Lahore. These areas are comparatively lower than the green areas of Lahore. The blue area of Lahore decreased 0.11% between 1993-2003. After that it increased 0.10% from 2003 to 2013 and 0.07% in next decade between 2013-2023. Overall, there is 0.06% increase in water bodies in Lahore.[35] The water bodies of Lahore are crucial for aquatic biodiversity for environmental sustainability and bioremediation. Some of key aquatic species includes egrets, pond herons, kigfishers, wagtails, catfish, murrels, Indian flapshell turtle and others.

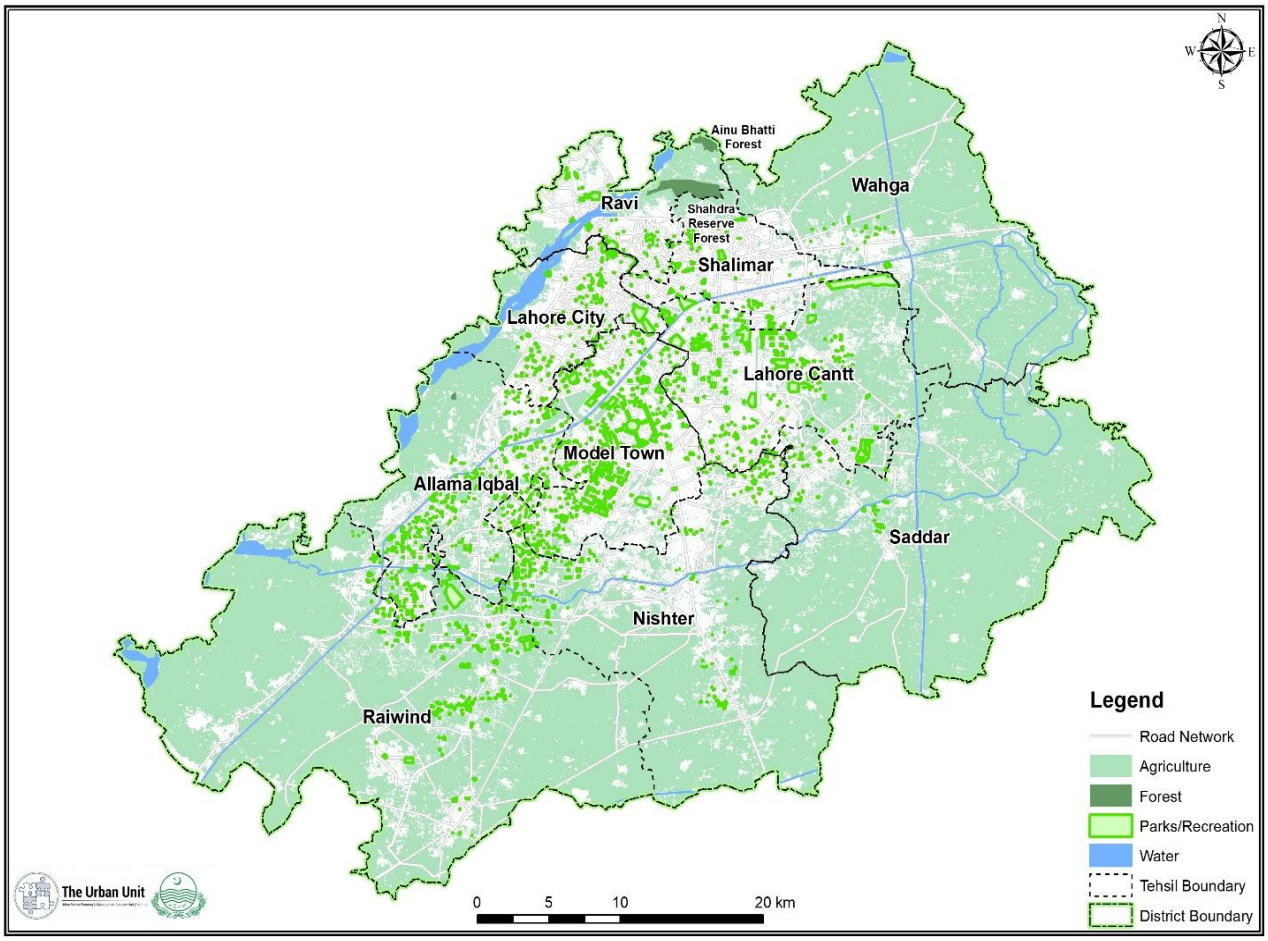


Figure 28: Water Bodies and Water Permeable Areas of Lahore

4.10. Temperature

The strikingly Ed Hawkins warming stripes for Lahore from 1875 to 2024 are depicted the temperature changes over Lahore, that how the city's climate has changed in the past 150 years. As the decades pass,

[35] Rafique, M., Majeed, M. A., Shakeel, A., Iqbal, T., & Raza, Z. (2024). Land use land cover change detection of district Lahore using GIS and remote sensing (1993-2023). *Pakistan Journal of Forestry, 74*(1), 24-31.

the colors gradually shift from lighter blue. By the late 20th century, the stripes turn yellow and orange, which reveals the sign of warming. During the last two decades, the deep reds dominate, revealing summers that grow hotter and more relentless with each passing year. It is the story that city is heating up, heatwaves becoming the norm, where extreme weather conditions will affect the residents. For Lahore's residents, these stripes are a call to action—a reminder that the choices we make today will determine how liable this city remains for generations to come.

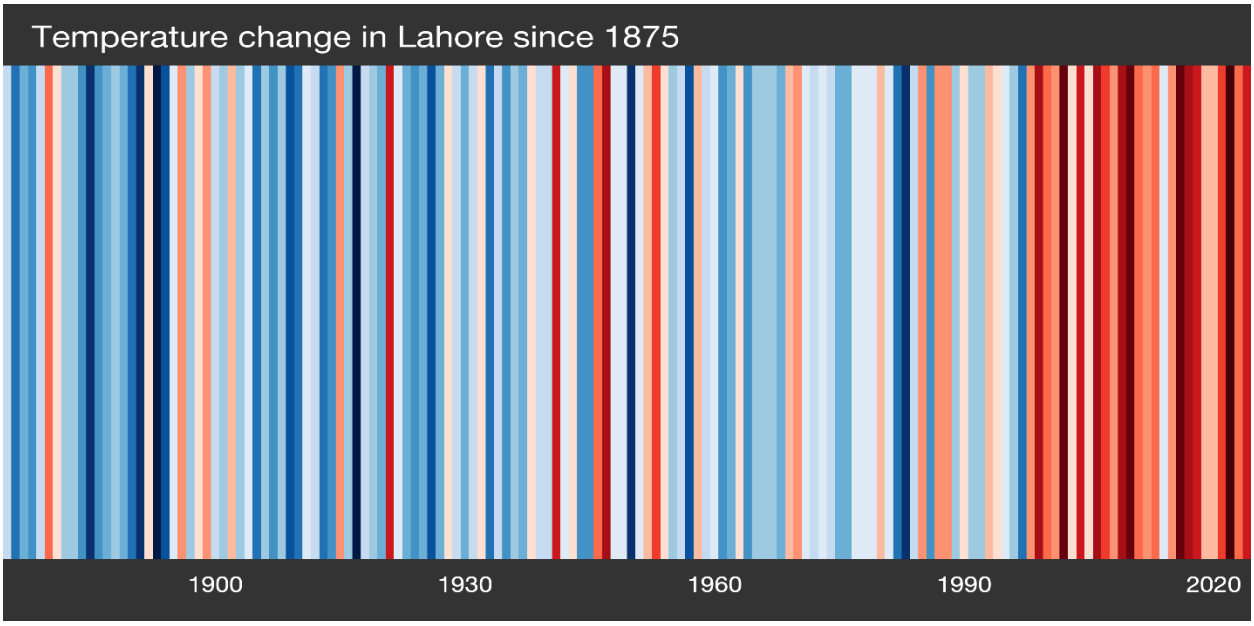


Figure 29: Ed-Hawkins warming stripes of Lahore

The GIS/RS analysis of Temperature reveals striking land surface temperature variations across Lahore city, showing in 2024LST acquired from MODIS, that how land surface temperature varies between the city's urban centres and suburban peripheries. The hottest areas reach a scorching **38.8°C**, while the lowest temperature remain at **30.7°C**—an **8.1°C gap** that means drastically differentiate annually.

The pattern is clear: densely built-up neighborhoods with sparse greenery under intense heat, while areas with more trees and open spaces stay relatively cooler. The marked boundaries of Lahore's tehsils highlight just how much climate conditions can shift within a single city which proves that urban design and green cover directly shape how heat impacts our daily lives. The temperature dynamics in Lahore have been significantly influenced by rapid urbanization and land use changes over recent decades in Lahore.

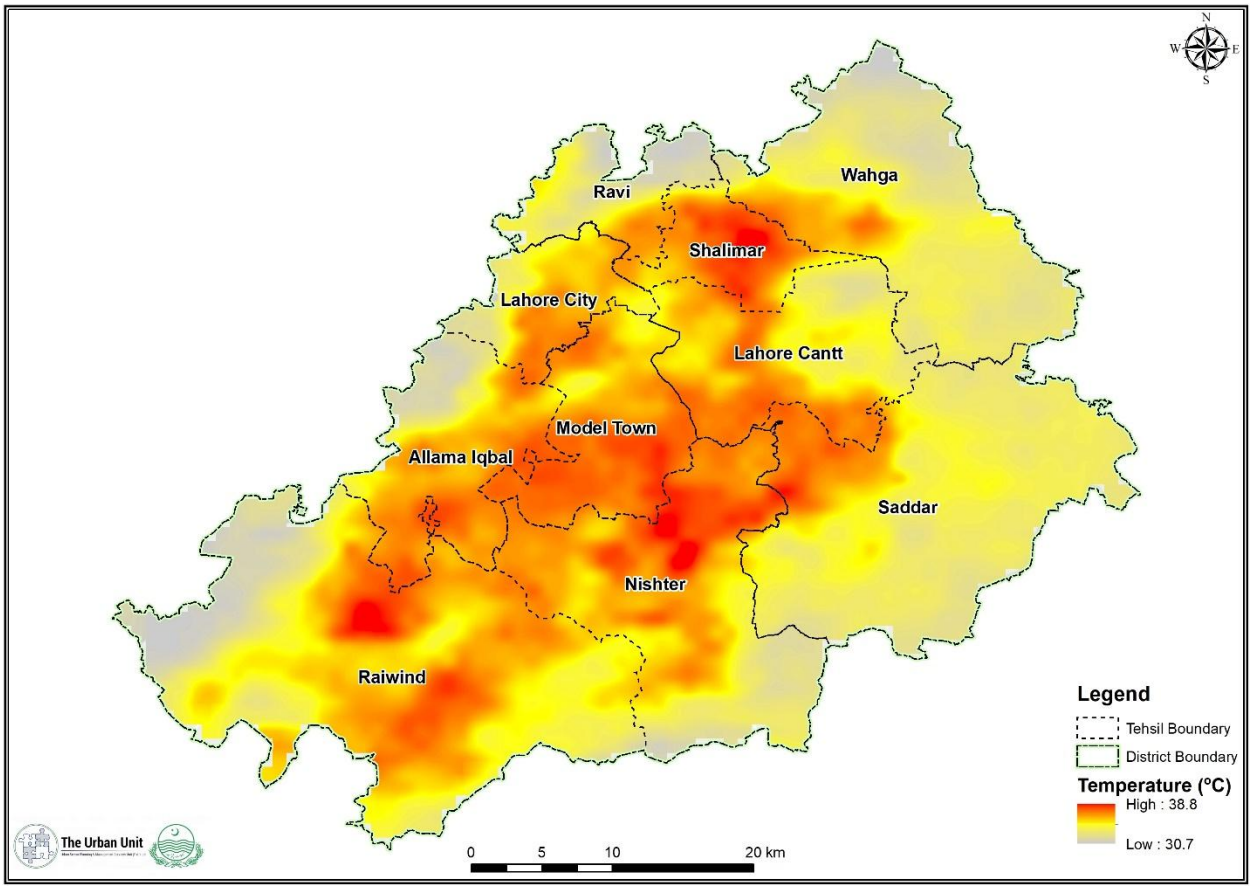


Figure 30: Annual Temperature average of Lahore - 2024

4.11. Precipitation

Lahore experiences a diverse range of precipitation patterns that are closely tied to its geographical location and changing climatic conditions. The city's rainfall is largely influenced by the monsoon season which typically spans from July to September, bringing intense but uneven rainfall across different parts of the city. These monsoon precipitations play a crucial role in replenishing groundwater, supporting agriculture in surrounding areas**,** and cooling down the otherwise hot summer temperatures**.** However, climate variability over recent years has led to shifts in precipitation patterns, with some seasons experiencing heavier-than-usual downpours, resulting in urban flooding, while others witness prolonged dry spells.[36] Urban expansion, combined with reduced green cover and increasing surface impermeability due to construction, has further altered the natural water absorption capacity of the land, intensifying the impacts of both heavy rains and drought-like conditions**.** These changing precipitation dynamics highlight the need for improved urban

[36] Ghafoor, A., & Nawaz, R. (2020). Changes in climatic parameters in metropolitan city of lahore, Pakistan. *Journal of Environmental and Agricultural Sciences*, *22*(3), 23-33.

drainage systems and sustainable water management practices to ensure the city can adapt to future climatic shifts.[37]

The annual precipitation map of Lahore is depicted the spatial distribution of rainfall within the Lahore city highlighting key areas in north eastern part of city such as Ravi, Wahga, Shalimar, Lahore Cantt, Model Town, Allama Iqbal Town, Saddar etc has received the highest rainfall upto 865 mm (high), some areas received the lowest 573mm during the 2024.

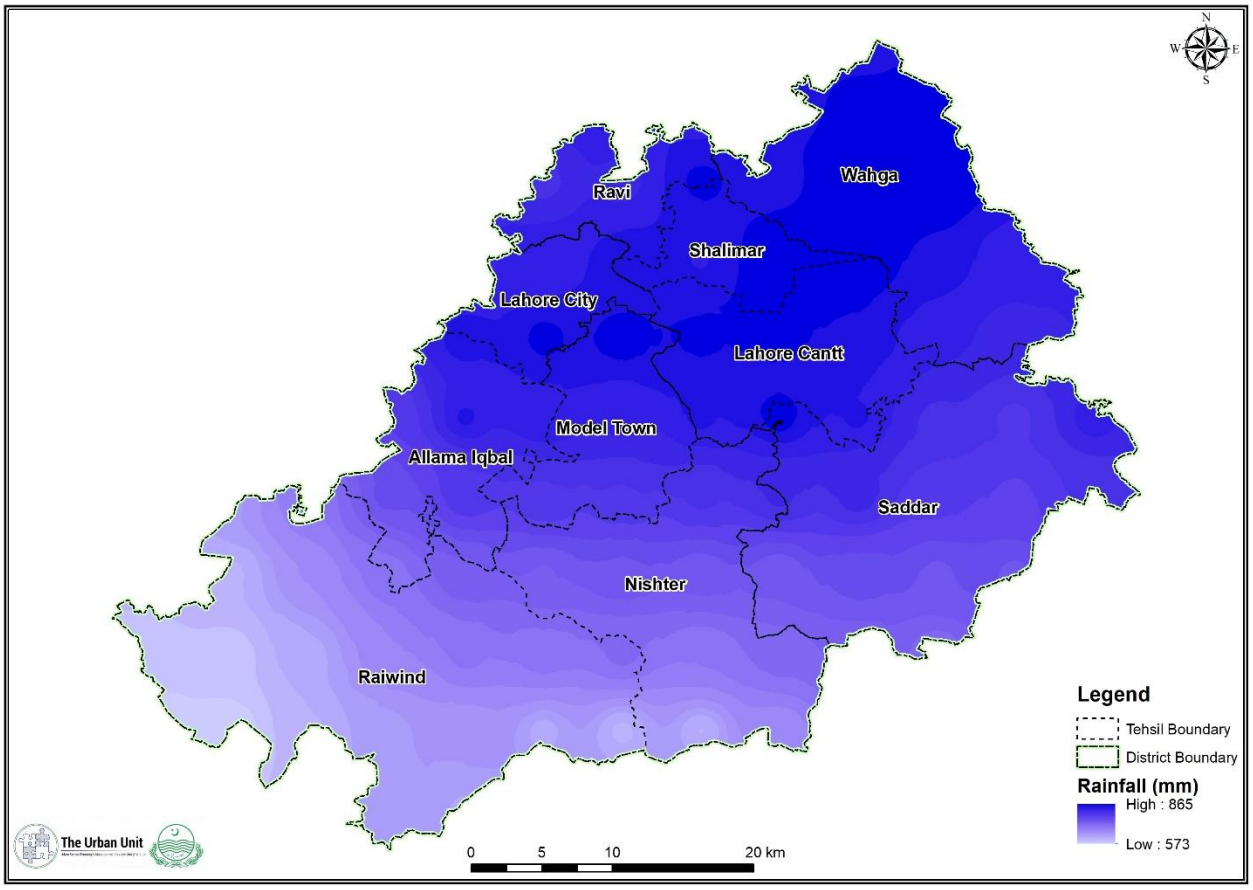


Figure 31. Annual Precipitation average of Lahore - 2024

4.12. City Biodiversity Index

The 9th Conference of Parties to the Convention on Biological Diversity (CoP IX), which was held in Germany in 2008, is where the Singapore Index (SI), often referred to as the City Biodiversity Index (CBI), was created. In order to create the CBI, the Singapore National Parks, the Secretariat of the Convention on Biological Diversity (SCBD), and the Global Partnership on Local and Subnational Action for Biodiversity conducted a

[37] Nawaz, Z., Li, X., Chen, Y., Guo, Y., Wang, X., & Nawaz, N. (2019). Temporal and spatial characteristics of precipitation and temperature in Punjab, Pakistan. *Water*, *11*(9), 1916.

series of expert workshops from 2009 to 2011. Then, in 2021, a manual known as the user's manual on the Singapore on Cities' Biodiversity was created. [38]

The CBI is a method for self-assessment that cities can use to assess how well their efforts to conserve biodiversity are doing about their unique baselines. It consists of two parts: (a) the "Profile of the City," which gives background information about the city; and (b) The 28 indicators, which are based on the rules and methods described in the User's Manual on the SI on Cities' Biodiversity, quantify native biodiversity, biodiversity ecosystem services, and biodiversity governance and management. The index computation must be performed every five years so that the city may assess its progress in mainstreaming biodiversity protection.

The City Biodiversity index (CBI) of Lahore has been calculated and composed based on the user manual handbook CBI Technical Series No. 98, 2021 approved by Secretariat of the Convention on Biological Diversity (CBD) and National Parks Board, Singapore. The defined criteria and calculation for each indicator has been evaluated to avoid biased approach and to kept accuracy of result. All the 28 indicators have been taken and calculated on the basis of available data sets and Lahore city obtained a total of 45 *point score out of* 112 *in baseline year 2024-25. All the indicators are evaluated through the data of Secondary published reports, articles and departmental data. as recommended in user manual.*

Core Components	Sr. #	Indicators	Maximum Score	Obtained Score
Native Biodiversity in the City	1	Proportion of Natural Areas in the City	4 Points	1
	2	Connectivity Measures or Ecological Networks to Counter Fragmentation	4 Points	0
	3	Native Biodiversity in Built Up Areas (Bird Species)	4 Points	2
	4	Change in Number of Vascular Plant Species	4 Points	1
	5	Change in Number of Native Bird Species	4 Points	0
	6	Change in Number of Native Arthropod Species	4 Points	0
	7	Habitat Restoration	4 Points	2
	8	Proportion of Protected Natural Areas	4 Points	0
	9	Proportion of Invasive Alien Species	4 Points	2
Ecosystem Services provided	10	Regulation of Quantity of Water	4 Points	4
	11	Climate Regulation Benefits of Trees and Greenery	4 Points	0
	12	Recreational Services	4 Points	1

[38] Chan, L., Hillel, O., Werner, P., Holman, N., Coetzee, I., Galt, R., and Elmqvist, T. 2021 Handbook on the Singapore Index on Cities' Biodiversity (also known as the City Biodiversity Index). Montreal: Secretariat of the Convention on Biological Diversity and Singapore: National Parks Board, Singapore.

	13	Health and Wellbeing Proximity/Accessibility to Parks	4 Points	2
	14	Food Security Resilience Urban Agriculture	4 Points	1
Governance and Management of Biodiversity	15	Institutional Capacity	4 Points	4
	16	Budget Allocated to Biodiversity	4 Points	1
	17	Policies, Rules and Regulations Existence of Local Biodiversity Strategy and Action Plan	4 Points	1
	18	Status of Natural Capital Assessment in the City	4 Points	3
	19	State of Green and Blue Space Management Plans in the City	4 Points	1
	20	Biodiversity Related Responses to Climate Change	4 Points	1
	21	Policy and/or Incentives for Green Infrastructure as Nature-based Solutions	4 Points	0
	22	Cross-sectoral and Inter-agency Collaborations	4 Points	4
	23	Participation and Partnership: Existence of Formal or Informal Public Consultation Process Pertaining to Biodiversity Related Matters	4 Points	3
	24	Participation and Partnership: Number of Agencies/Private Companies/ NGOs/Academic Institutions/International Organisations with which the City is Partnering in Biodiversity Activities Projects and Programmes	4 Points	2
	25	Number of Biodiversity Projects implemented by the City Annually	4 Points	0
	26	Education	4 Points	4
	27	Awareness	4 Points	1
	28	Community Science	4 Points	4
		Maximum Total:	**112 Points**	**45**

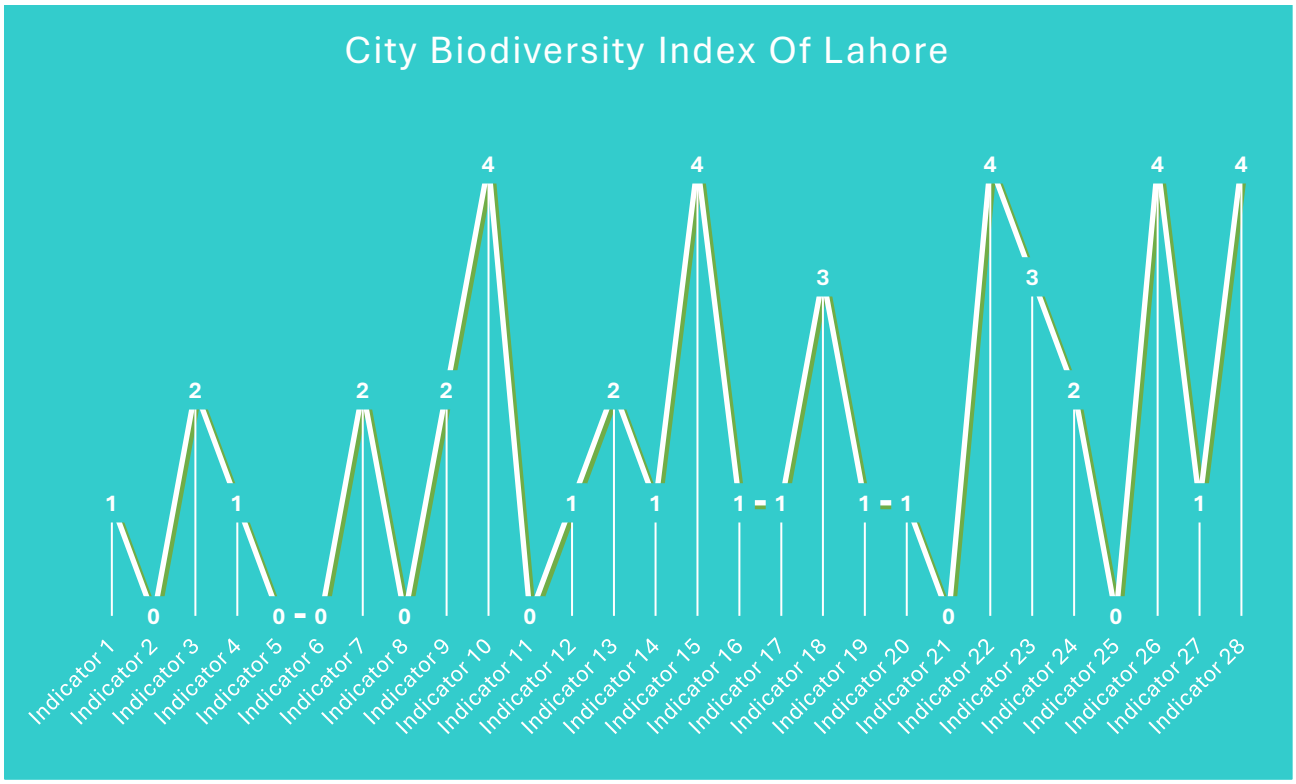


Figure 32: Summary of City Biodiversity Index of Lahore

Issues & Challenges

Lahore city currently experiencing a lot of issues & challenges that are significant component of ecosystem services, biodiversity conservation, and ecotourism, but the variety of leading issues and challenges that need to be overcome to improve the management efforts and goals to be achieved.

5.1. SWOT Analysis

The SWOT analysis of Lahore city has been conducted based on the field assessment, biodiversity evaluations from reports, articles, scientific research publications, and repeated consultation sessions with department, community, institutions and stakeholders and represented as given.

STRENGTH

- Lahore is home to sustainable recreational hub with over 250 parks and gardens. These green spaces contribute to climatic regulation, support urban biodiversity and recreational activities.
- Iconic green spaces including Shalimar Gardens, Jilani Park, and the Lahore Zoo contribute to the conservation of certain species, offering habitat for wildlife within an urban setting. These places also raise public awareness about wildlife conservation.
- Lahore is a stopover point for aquatic birds, especially along the Hiran Minar and Ravi River, which support species like the Bar-headed Goose and Indian Skimmer.
- Being close to River Ravi and having extensive canal system supports aquatic and semi-aquatic species and plays a crucial role in urban cooling, air purification and flood management.
- Lahore serving as research and conservation hub, various initiatives are ongoing to address the challenges of biodiversity.
- Lahore has potential of urban forestry and urban afforestation Initiatives to contribute the urabn sustainability. Currently initiative has also been taken by PHA for park to estavlish Miyawaki forest. These initiatives contribute to carbon sequestration, habitat restoration, and improved ecological balance within the city.

WEAKNESS

- Due to rapid urban sprawl and infrastructure development, critical natural habitats are being encroached in Lahore. As Shahdara Forest and Hudiara Drain wetlands are shrinking due to infrastructure development, reducing vital habitats for wildlife and affecting the city's ecological balance.
- Pollution (Air, water, and soil) significantly degrades the health of green areas and ecosystems. The Ravi River, once home to many aquatic species, suffers from industrial waste and sewage disposal, which harms water quality and aquatic life.
- Introduction of non-native plants and animal species threatens native biodiversity.
- There are many green spaces in Lahore like Shalimar Garden, Model Town Park, and Gulshan-E-Iqbal Park etc. However, these are isolated from one another, which disrupts ecological connectivity and impairs wildlife movement, leading to decreased genetic diversity.
- A lack of comprehensive studies and monitoring of local biodiversity hinders informed decision-making and effective conservation planning.
- Parks and Zoos such Jilani Park and Lahore Zoo are overcrowded due to limited options for recreation, causing overuse and degradation of facilities.
- In Nasir Bagh, there is no boundary wall around the whole park due to which drugs addicts and snatchers easily entered in the park. Due to this drawback, Nasir Bagh is not a safe place for visitors. Similarly, there are fewer security staff and lack of security cameras at Shalimar Garden and Jallo Park also threaten the visitors at these places.
- In most of the parks in Lahore drinking water is hardly available for visitors. Furthermore,

washroom facilities are either not available, poorly managed or in limited numbers as compared to the number of visitors.

OPPORTUNITIES

- Integrating green infrastructure into urban development projects, such as green roofs, vertical gardens, and eco-friendly zoning regulations will improve biodiversity.
- Expanding green spaces and integrating biodiversity-friendly practices in urban planning could support wildlife and improve ecological health.
- Collaboration between local government, non-government organizations and NGOs can be helpful for biodiversity initiatives.
- Research capacity building and Expertise development for wellbeing of wildlife and biodiversity as Institutions of Lahore have well-established departmental expertise in the field of botany, zoology, wildlife, forestry and environmental science.
- Local communities' involvement and institutional engagement in tree plantation drives, and conservation activities may be helpful in conserving the city's biodiversity resources.

THREATS

- Raising temperature and erratic rainfall impact ecosystems, putting stress on native species and altering habitat. The number of migratory birds is constantly declining and there are reports of altering migration routes and settlement in new areas. The number of birds like Bar-Headed Geese**,** Ducks**,** and Swans has declined in recent years in Lahore.
- Expansion of Lahore's urban area is leading to destruction and fragmentation of natural habitats. Which may lead migration of species that depend on these ecosystems for food, shelter, and breeding.
- Lack of maintenance and overuse of parks and gardens, these spaces are degrading, limiting their ecological benefits. Non-availability of sufficient funds is also a serious challenge.
- Urban afforestation of Non-native and invasive alien species including Gajarghas, Musqut and eucalysptus are the major threats to native biodiversity.

Vision & Objectives

6.1. Vision

The Lahore – City biodiversity Action Plan is aimed to support the vision:

"Conservation and revival Lahore's natural habitats, integrated green spaces, enrich native biodiversity, support climate resilience, and sustainable, healthier, and livable urban ecosystem"

6.2. Mission

The Lahore City Biodiversity Action Plan is missioned to,

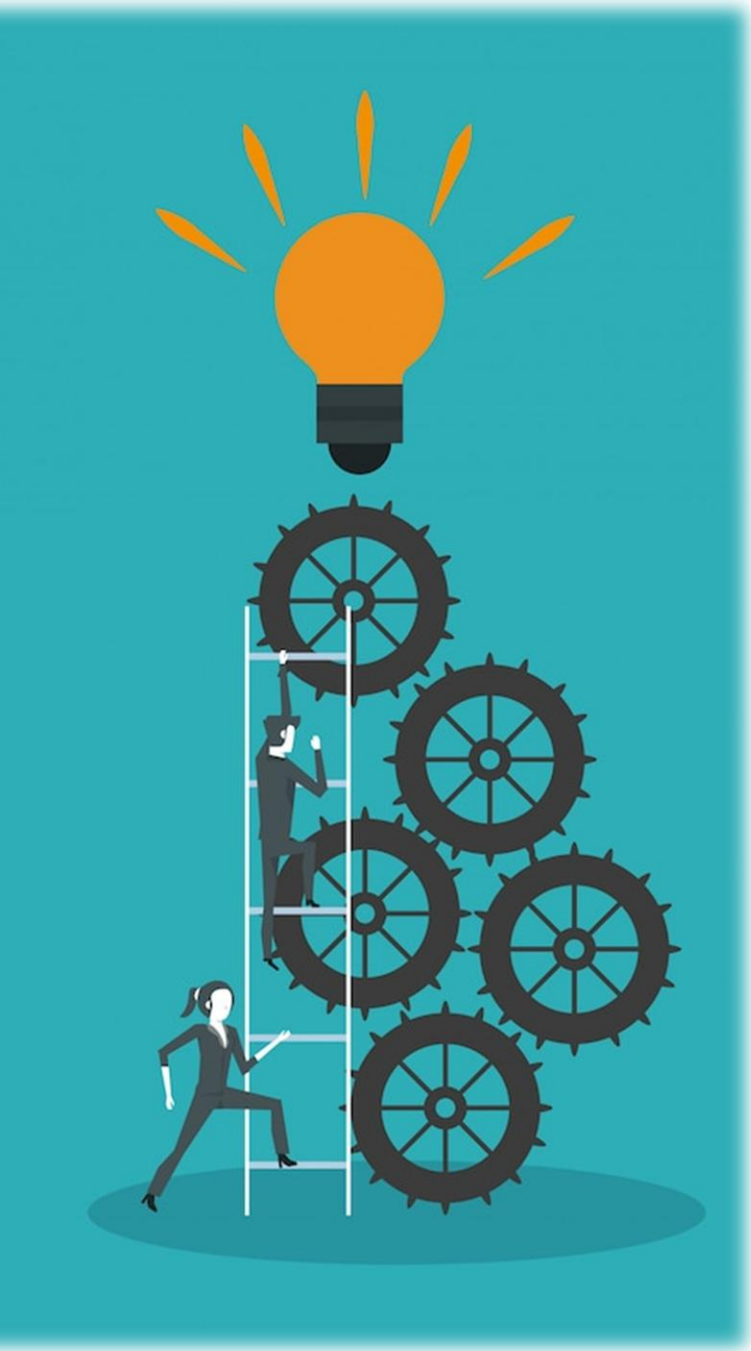
"Protect, restore, and sustainably manage the city's natural ecosystems by implanting biodiversity conservation into urban planning and development. Conserve native species, improve ecological connectivity, and promote nature-based solutions that strengthen climate resilience and support sustainable livelihoods. Through inclusive governance, community engagement, and responsible land-use practices, create a healthier, more livable, and sustainable city."

6.3. Objectives

The Lahore Biodiversity Action plan is developed to achieved the following objectives:

- To assess the status of fauna and flora and their distribution within urban spaces.
- To track the impact of urbanization, climate change, and other environmental factors on biodiversity over time.
- To provide a framework for incorporating biodiversity into urban development and land-use planning.

- To identify actions to improve green spaces, water management and the preservation of local ecosystems
- To engage community in biodiversity monitoring and conservation efforts.
- To developed a strategical document for policymakers to adopt informed strategies and policies for biodiversity conservation in urban areas.



Biodiversity Actions & Strategies

7.1. Habitat & Conservation Areas

The objective of habitat & conservation areas theme is widely covering the restoration, conservation, and management of key biodiversity and habitat areas of Lahore to promote the sustainability and regulate the urban ecological balance. Some of the following are the identified actions and strategies to achieve the objective of the theme.

- Planting a variety of wild plants bearing nectaries and fruits as *Morus alba, Ziziphus nummularia, Ficus carica, Kigelia pinnata, F. benghalensis, Acacia modesta and* others that will provide nectaries to insect and fruits to birds living in natural areas like Shahdrah forest, Eno Bhatti forest and jallo forest.
- Forest plantation should be adoptive approach to maintain the stratification forming vertical habitats including ground cover to large tree with dense canopy for nesting and roosting all types of animal diversity.
- Imposed a strict ban on introduction of exotic species with natural areas to avoid the natural habitat destruction and species invasion.

- A strategical approach should be adapted to replace the existing exotic plantation i.e. *Eucalyptus spp., Parthenium hysterophorus, Conocarpus sp. and Prosopis julifora* with the native tree species to revive the native biodiversity.
- The deadwood and leaf should be retained for decomposition by insects, and fungi to developed the food chain and revive the associated species.
- All the ex-situ conservation areas should be theme to adopt one to two native species, provides breeding ground, and fully trained and well equipped for the adaptive species to promote the sustainability.
- The interconnected urban green corridor of wild landscaping should be developed to lower the habitat fragmentation in the city and also designated biodiversity green spaces to promote inhabitance of native species.
- Lahore Zoo is in a highly congested area and space is not sufficient to accommodate large number of animals as per space requirement as per international standards. Animals are also stressed due to noise pollution. It is recommended that strict measures should be taken to minimize the impact of noise pollution on animals, as it affects the behavior and breeding of animals. Another option may be to relocate the zoo to quieter areas to reduce traffic and noise pollution in future.
- The involvement of local communities should be strengthened to promote their acts as custodian of natural areas.
- Engagement of academia and researcher for wildlife well-being should be encourage to promote the sustainability in captive breeding and conservation of native animals.
- Awareness campaign and educational programs should be initiated to highlight the importance of wildlife in ecological sustainability.

7.2. Sustainable Agriculture and Agroforestry

The objective of sustainable agriculture and agroforestry theme is developed to promote agricultural sustainability and farmland health mitigation. The sustainable agriculture and agroforestry will help to promote soil health, climate change resilience, carbon sequestration and resistivity to extreme weather. The trees combine with crops, reduce greenhouse gas emissions and provides natural habitats to key native species in agricultural landscapes to promote biodiversity conservation. Some of the following are the identified actions and strategies to achieve the objective of the theme.

- A carbon credit strategical approach through incentives should be adaptive to promote agroforestry on farmland of community.
- Organic farming practices should be encouraged to reduce pesticide usage for crops and vegetables cultivation which increase the pollinators diversity.
- Initiate the training and awareness campaign to highlight integration of tree based system to conserve the urban biodiversity.
- Farmer should be encouraged to plant native tree species alongside their crops to improve soil health and support wildlife. The trees alongside crops will act as wind barrier to lower wind speed lower crop damage risk.

- Afforestation programs should be launched with fast-growing, climate-resilient fruiting tree species like jamun, amrood, anar etc.

7.3. Wetland and Water Bodies Management

Urban water bodies and wetlands are essential ecological resources that sustain biodiversity, recharge groundwater, regulate microclimates, and buffer flooding. The wetland and water body management theme under Lahore Biodiversity Action Plan (LBAP) is focusing on the conservation, restoration, management, and development of aquatic habitats that aligned with sustainability into urban planning. The water bodies must be protected and revitalized in order to conserve the local aquatic flora and fauna as well as to improve water security, climate resilience, and the city's ecological health. This strategy encourages a move toward blue-green infrastructure and nature-based solutions that benefit urban inhabitants and wildlife. The followings are the key actions to achieved the theme's objectives:

- Establishment of buffer zone along Ravi river to prevent the water pollution and protect the aquatic habitat.
- The River training should be carried to stabilize the river bank and increase the green cover along water runoff.
- Initiate the rehabilitation of contaminated water bodies located in Herbanspura, near Motorway, nearby River Ravi, and near Railway Headquarter, through phytoremediation, floating wetlands, and constructed wetlands.
- Initiate the local community driven task force to launch the water bodies protection campaigns including River Bank cleaning, Plantation, Aquatic Biodiversity protection and Research activities.
- Initiate the development of blue-green infrastructure to conserve and restore the ground water.
- The desiltation and management of previously developed water ponds to improve the water carrying capacity.
- The collaboration with academia and research organization to engage and promote water related research and development.
- The regular surveillance and seasonal wildlife census should be carried to monitor and protect aquatic biodiversity.
- Impose strict rules and regulations to prevent the industrial effluent, waste, and sewerage dumping into waterbodies and river sides.

7.4. Open Spaces Management and Conservation

Urban resilience, public health & wellbeing, and ecological balance all depends on open spaces including urban forests, greenbelts, parks, gardens, and undeveloped natural areas. The theme of open spaces management and conservation focuses on conservation, protection and development of green spaces to sustain urban biodiversity, improve air quality, mitigate urban heat islands, provides recreational

opportunities, and cultural value. Some of the following key actions & strategies are identified to address the theme's objectives.

- Ensure the planting of fruiting and flowering trees likes jamun, shahtoot, Ber, amrood, and loukat, to attract the pollinators and birds within Parks and green spaces.
- Urban afforestation or Miyawaki forests should be developed having native tree plantations, which will habitat to urban biodiversity, improve air quality, increase carbon sequestration and provide aesthetic beauty.
- The IoT based security cameras and tracking system should be installed in parks to improve the watch and ward strategies.
- The IoT based irrigation system i.e. smart sensors and devices should be introduced in parks and green spaces to monitor soil moisture, optimize water usage, and ensure efficient watering of plants in real-time.
- Development of new green spaces and parks to improve the population accessibility for unserved 35% population who don't have 400m accessibility of parks and green spaces as per standard of WHO and UN Habitat.
- Park and Horticulture Authority should ensure the establishment of native flowering bed to attract and promote the native pollinators.
- In Lahore urban area, many vacant state lands with low-density development can be converted into green spaces or mini forests. Similarly, along Ferozepur Road and Canal Road, there are several underutilized spaces that could be transformed into urban green belts to support wildlife.
- Development of designated biodiversity enrich habitat to promote the biodiversity conservation and management within urban centers.
- The urban green corridors and connected network of green spaces and parks should be established to minimize the habitat fragmentation.

7.5. Grey Infrastructure & Built Environment Management

The Grey Infrastructure & Built Environment of an urban area like Lahore includes buildings, bridges, drainage systems, roads, and other man-made structures. The unplanned and rapid urbanization with poorly designed grey infrastructure frequently contributes to pollution, surface water runoff, urban heat islands, habitat fragmentation, and biodiversity loss in Lahore Metropolitan. The transformation of conventional grey infrastructure into climate resilient, and ecofriendly infrastructure will to protect and conserve the urban biodiversity and mitigate the urban impact. The theme can be achieved with the adaptation of following key strategical actions.

- The current and newly constructed building should transform into climate resilient, and ecofriendly infrastructure like vertical gardening, rooftop gardening, and planter will helps to protect and conserve the urban biodiversity and mitigate the urban impact.
- The development of permeable pavements, and bio-retention basins in urban will helps to lower the water runoff, improve stormwater management and water table.

- The roads, underpasses, and highways medians and green belts can be a connected network of green corridors with native, drought-resistant plant species. These plants dense green buffers and corridors with trees will transform concrete-dominated areas into flourishing ecological zones and absorb pollutants, reduce noise, and improve air quality of Lahore.
- The biomaterial manufactured bird friendly artificial nesting boxes should be installed under shaded areas of building to provide sheltering habitat for native birds.
- Enforce annual plantation drives and green structure improvement schemes by housing societies to improve habitat quality.
- The temporary vacant spaces of Lahore that are being undeveloped can be planted with wildflower species to enhance the aesthetic look and improve pollen and nectars availability for native biodiversity.

7.6. Community Engagement and Participation

The theme community engagement and participation are key to biodiversity action plan initiatives, and targeted to high degree of volunteerism and community involvement that can be crucial for the city biodiversity. Thus, the some of the key actions and strategies should be taken to improve community engagement and participation.

- Implementation and structuralizing of frameworks and policies linkage to community multicultural strategies to engage them for conservation and restoration of natural resources.
- The initiation of community volunteering strategies to ensure the community facilitation.
- The development and integrational management of agreement with local communities to take part in conservation and protection.
- The consultation and collaboration with natural areas neighboring land owners should be taken to ensure their interests not be affected.
- Arrange seminars and awareness campaign to engage the local communities, neighboring stakeholders, academia and conservation organization to boost the participation.
- Conservation organization and private stakeholder should be encouraging to initiate the ecological activities and conservation campaign for sustainability of natural resources in city.
- Encourage and offers opportunities for individuals having extensive understanding of the biodiversity and natural resources to collaborate with strategies implementation, share and apply their expertise to enhance city biodiversity conservation and management strategies and also enhance the operational capabilities.

Monitoring & Evaluation Plan

Monitoring and Evaluation (M&E) is a critical component of the Lahore City Biodiversity Action Plan. It enables tracking of progress, measuring the effectiveness of implemented actions, identifying emerging challenges, and ensuring that biodiversity conservation goals are being achieved in a timely and adaptive manner. This chapter outlines the framework, indicators, responsibilities, and reporting mechanisms for M&E to support evidence-based decision-making for urban biodiversity conservation in Lahore. The aim of this plan is to provide a sound framework to identify challenges, track progress and ensure evidence-based decision-making for long-term biodiversity conservation in Lahore.

The prime objective of the M&E Plan is to

- Track Progress: Monitor implementation of action plans across sectors and habitats.
- Evaluate Outcomes: Assess biodiversity trends and ecological health of the city.
- Ensure Accountability: Promote transparency and performance-based planning.
- Support Adaptive Management: Facilitate course corrections based on real-time data and lessons learned.
- Inform Stakeholders: Provide updates to the public, government, and partners on biodiversity status and achievements.

8.1. Monitoring Plan

Each target will be monitored using a Results-Based Management (RBM) approach, with clearly defined outputs, outcomes, indicators, baselines, and targets. The Key Performance Indicators chalked out for the Lahore City Biodiversity Action Plan are presented as under;

Thematic Area	Monitoring Indicators	Description	Frequency	Responsibility
Species Conservation	Species Population Trends	Monitoring population of key species, including plants, birds, insects, mammals, and reptiles	Annually	Punjab Forest, Wildlife and Fisheries Department / PHA, Lahore
Habitat Health	Habitat Condition Scores	Assessment of vegetation cover, species richness, and habitat quality	Annually	Environment Protection Department / Punjab Forest, Wildlife and Fisheries Department / PHA, Lahore
Invasive Species Control	Presence of Invasive Species	Regular detection and mapping of invasive flora and fauna	Semi-annually	Punjab Forest, Wildlife and Fisheries Department / PHA, Lahore
Pollution Monitoring	Air, Water & Soil Quality	Monitoring pollutants (e.g., PM2.5, BOD, pH levels)	Quarterly	EPA Punjab
Urban Pressures	Land Use Change	Tracking urban expansion, infrastructure projects, and encroachment	Quarterly	LDA / PHA / Local Government
Climate Impact	Temperature and Rainfall Trends	Analyzing local climate changes and extreme events	Annually	PMD / EPA
Water Ecosystems	Water Quality Index	Regular testing of key water bodies (Ravi, Lahore Canal, Park ponds)	Monthly	WASA / EPA / Parks Department/ Local Government
Green Connectivity	Connectivity Index of Green Spaces	GIS-based mapping of habitat corridors between parks and forests	Annually	Punjab Forest, Wildlife and Fisheries Department / PHA, Lahore
Ecosystem Services	Service Valuation Metrics	Identification and valuation of key biodiversity contributions	Every 2 years	Environment Department / Academia

Community Engagement	Participation Rates & Outreach Events	Tracking public involvement in conservation activities	Annually	The Urban Unit / NGOs / Local Government/ Punjab Forest, Wildlife and Fisheries Department / PHA, Lahore

Monitoring Methods

Effective biodiversity monitoring in Lahore requires a combination of modern tools and conventional ecological techniques to provide accurate and actionable insights. The following monitoring methods are recommended for assessing biodiversity health and tracking environmental changes:

I. **Field Surveys**: Seasonal field surveys should be conducted to monitor variations in bird and insect populations. Regular vegetation assessments should be carried out to document species composition and abundance across urban green spaces. The population dynamics of mammals can be tracked using non-intrusive techniques such as camera traps installed at strategic locations.
II. **Remote Sensing and GIS Mapping**: Geospatial technologies such as remote sensing and Geographic Information Systems (GIS) are essential for tracking changes in land use, vegetation cover, and fragmentation of habitats. These tools provide a reliable and scalable method to assess spatial patterns and trends in urban biodiversity.
III. **Soil and Water Quality Testing**: Periodic sampling of soil and water from various ecosystems—including parks, rivers, canals, and ponds—should be conducted to evaluate contamination levels and assess ecosystem health. Testing should include parameters such as pH, heavy metals, nutrients, and biological oxygen demand (BOD).
IV. **Drone and Satellite Imagery**: The use of drones and high-resolution satellite imagery enables real-time monitoring of deforestation, vegetation health, and urban expansion. These tools are particularly useful for identifying habitat degradation and encroachments at a landscape level.
V. **Acoustic Monitoring**: Traditional species counts may overlook cryptic or nocturnal species. Bioacoustic sensors offer a non-invasive technique to monitor biodiversity through soundscapes. This method is effective for tracking bird calls, amphibian vocalizations, and insect activity, providing insights into species richness and behavior.
VI. **DNA Barcoding and Environmental DNA (eDNA) Sampling**: Advanced molecular tools such as DNA barcoding and eDNA analysis allow for species detection in complex environments. By analyzing water, soil, or sediment samples, researchers can identify the presence of species—including rare or elusive ones—without direct observation.

8.2. Evaluation Plan

The Evaluation Plan for the Lahore City Biodiversity Action Plan is designed to systematically assess the effectiveness of conservation initiatives and inform adaptive management strategies. It focuses on key criteria such as species diversity and population stability, control of invasive species, habitat quality, pollution reduction, and community engagement. Evaluation methods will include comparisons with

baseline data, stakeholder surveys, and assessments of past conservation interventions. This structured approach ensures that progress is measured over time, gaps are identified, and successful strategies are scaled, ultimately supporting evidence-based decision-making for biodiversity conservation in Lahore. Key evaluation criteria and methods are explained below;

Evaluation Criteria

I. **Species Diversity and Population Stability:** Assessing the number of species in urban green spaces and built-up areas, and the stability of their populations over time.
II. **Control of Invasive Species:** Evaluating the success of measures taken to manage non-native species in previous years.
III. **Improvement or Decline in Habitat Quality:** Analyzing changes (positive or negative) in habitat health and green cover over the period.
IV. **Reduction in Pollution Levels:** Evaluating the success of pollution management efforts in targeted areas over time.
V. **Community Engagement and Awareness:** Assessing the success of awareness campaigns and the level of local community participation in conservation efforts.

Evaluation Methods

I. **Comparison with Baseline Surveys:** Comparing new data with initial survey data to identify trends and changes.
II. **Interviews and Surveys:** Gathering feedback from local communities and conservation teams regarding ongoing efforts and future improvements.
III. **Assessment of Conservation Interventions:** Analyzing the outcomes and effectiveness of specific actions taken in previous years for the protection of biodiversity.

8.3. Data Management

All biodiversity-related data should be systematically collected, validated, and stored within a centralized, integrated data management system to ensure consistency, accessibility, and long-term usability. This system should support seamless data entry, retrieval, and analysis for stakeholders involved in biodiversity planning and monitoring.

To promote transparency and support evidence-based policymaking, non-sensitive datasets should be made openly accessible to researchers, academics, and government institutions through user-friendly platforms. The development of live dashboards and online portals is essential to visualize real-time biodiversity trends, environmental indicators, and spatial analyses, enabling timely and informed decisions.

Furthermore, to facilitate broader comparative analysis and align with global conservation efforts, Lahore's biodiversity data should be interoperable with international biodiversity information platforms (e.g., GBIF, IUCN, UNEP-WCMC). This will enhance knowledge exchange, enable benchmarking, and promote collaboration on regional and global biodiversity goals.

8.4. Reporting and Communication

Effective reporting and communication are key to ensuring transparency, accountability, and the continued success of the Lahore City Biodiversity Action Plan. The following strategies will be implemented to disseminate findings, engage stakeholders, and inform future biodiversity conservation efforts:

I. **Annual Evaluation Reports:** Detailed annual monitoring and evaluation reports will be prepared to track progress, document successes, and identify challenges encountered during the implementation of this plan. These reports will be shared with key stakeholders, including local government agencies, environmental organizations, and policy-makers. The objective is to provide actionable insights that will inform the development of policies and interventions aimed at improving biodiversity conservation and ensuring alignment with urban planning and development goals.

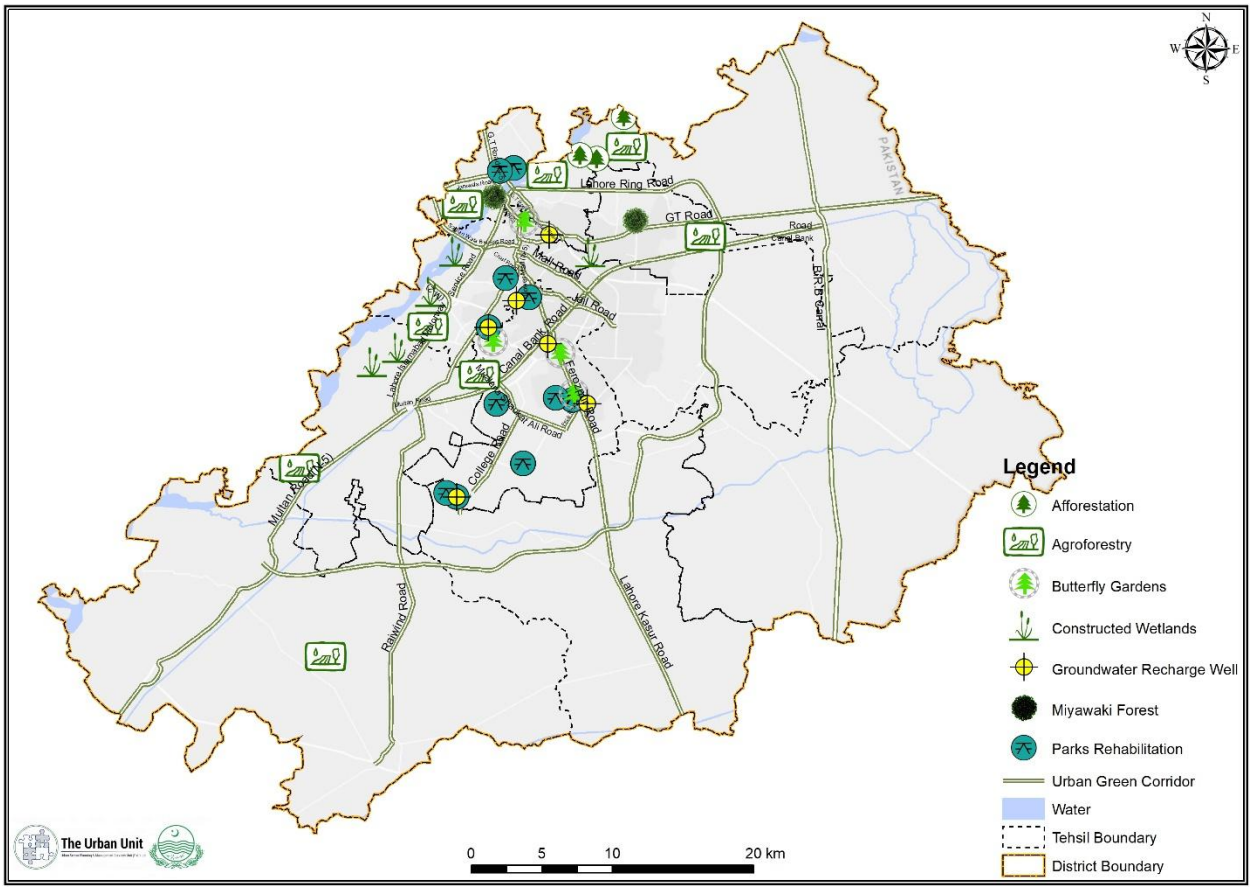
II. **Public Awareness Campaigns:** To foster public support and community involvement, this plan will actively communicate its progress through targeted public awareness campaigns. These campaigns will highlight success stories, share key milestones, and raise awareness about ongoing challenges in biodiversity conservation. By keeping the public informed and engaged, the program will build a stronger connection between citizens and the natural environment, empowering local communities to actively contribute to conservation efforts. Social media, community events, educational workshops, and local media will be key tools in these campaigns.

III. **Policy Recommendations:** Based on annual monitoring and evaluation findings, comprehensive policy recommendation documents will be developed to guide the formulation of future biodiversity conservation strategies. These recommendations will be tailored for both national and international audiences, ensuring that they reflect the most up-to-date scientific research and local realities. They will align with global frameworks such as the United Nations Sustainable Development Goals (SDGs) and the Convention on Biological Diversity (CBD), facilitating the integration of Lahore's biodiversity priorities into global and regional conservation agendas.

IV. **International Collaboration:** Strengthening international collaboration will be a central aspect of this city's biodiversity action plan, reporting and communication strategy. The plan will engage with international organizations, researchers, and policymakers from leading countries in biodiversity conservation. These collaborations will foster knowledge exchange, allow for the sharing of best practices, and encourage the adoption of innovative solutions that can be implemented in Lahore's unique urban context. Participation in international biodiversity forums and conferences will further enhance Lahore's standing as a leader in urban conservation initiatives.

Project Digest/Intervention

Based on comprehensive assessment, desk review, secondary data information, on ground survey, perception and expectation survey, consultations with local community and meetings with key stakeholders of the districts, a detailed actions and strategies defined for the district Lahore to conserve and protect the city biodiversity. A project digest is developed for Lahore from the key actions, which are potential intervention to revive the urban biodiversity and helps to mitigate the leading threats.



Projects Summary				
Sr. #	**Projects**	**Proposed Location**	**Timeline**	**Estimated Cost (Millions Rs.)**
1.	Urban Green Corridors (10 km)	• All Major Roads (Ring Road, Multan Road, GT Road)	**Short term**	**70.7**
2.	Butterfly Gardens (4 Kanal x 02)	• 31.479078, 74.341368 • 31.505326, 74.332845	**Short term**	**5.4**
3.	Agroforestry (30 km)	• 31.491339, 74.281267 • 31.636392, 74.374829 • 31.618620, 74.324445 • 31.599804, 74.270526	**Short term**	**135.0**
4.	Miyawaki Forest	• 31.604405, 74.290426 • 31.589255, 74.380471	**Short term**	**38.4**
5.	Afforestation (50 Acres)	• 31.628779, 74.355774	**Short term**	**110.0**
6.	Groundwater Recharge Well	• 31.538620, 74.304702	**Short Term**	**1.2**
7.	Urban Green Corridors (20 Km)	• All Major Roads (Canal Road, Jail Road, Ferozpur Road, Mulana Shoukat Ali Road)	**Medium term**	**154.0**
8.	Butterfly Gardens (4 Kanal x 02)	• 31.512942, 74.289756 • 31.589081, 74.309799	**Medium term**	**5.4**
9.	Agroforestry (10 km)	• 31.521888, 74.248573 • 31.431936, 74.166648	**Medium term**	**45.0**
10.	Afforestation (50 Acres)	• 31.630938, 74.345168	**Medium term**	**110.0**
11.	Parks Rehabilitation	• 31.622792, 74.302962 • 31.621065, 74.294155 • 31.475337, 74.340564 • 31.476666, 74.329763 • 31.472796, 74.292042	**Medium term**	**117.0**

12.	Constructed Wetlands	• 31.569633, 74.265230 • 31.543954, 74.249785	**Medium Term**	**32.0**
13.	Groundwater Recharge Well	• 31.520181, 74.353336 • 31.511174, 74.324488	**Medium Term**	**2.4**
14.	Afforestation (50 Acres)	• 31.655312, 74.373169	**Long term**	**110.0**
15.	Parks Rehabilitation	• 31.540502, 74.312714 • 31.552796, 74.297917 • 31.521442, 74.286935 • 31.413628, 74.266579 • 31.416277, 74.259992 • 31.434938, 74.308969	**Long term**	**459.1**
16.	Urban Green Corridors (20 Km)	• All Major Roads (Madar-e-Millat Road, College Road, Circular Road Lari adda, BRB Canal, Band Road)	**Long term**	**154.0**
17.	Agroforestry (10 km)	• 31.312065, 74.183130 • 31.579392, 74.425125	**Long term**	**45.0**
18.	Constructed Wetlands	• 31.508482, 74.228654 • 31.499257, 74.212694 • 31.569166, 74.351684	**Long term**	**48.0**
19.	Groundwater Recharge Well	• 31.521532, 74.286830 • 31.58046, 74.325528 • 31.473148, 74.349788 • 31.413628, 74.266579	**Long term**	**4.8**
			Grand Total Amount	**1647.4**

9.1. Urban Green Corridors

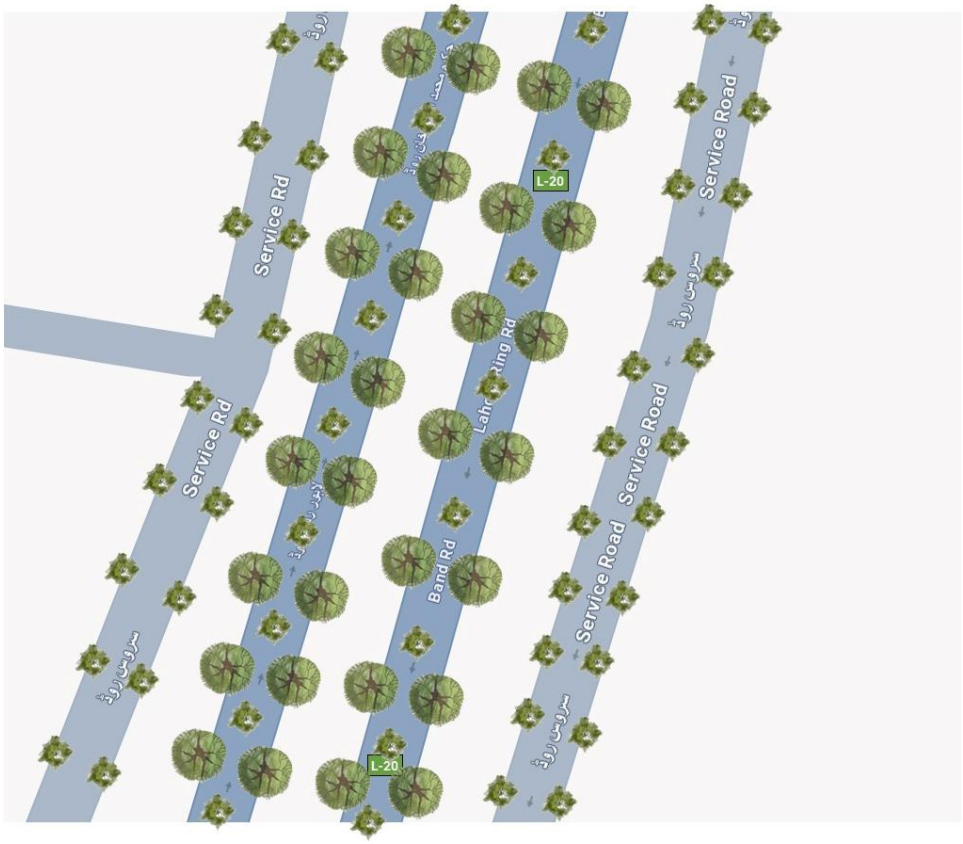
The urban green corridors are the networks of interconnecting green pathway including green spaces, linear parks, linear plantations and green belt, within Lahore city along major roads, water channels, tracks and nullahs to provide the interconnected habitat and enhance environmental qualities of cities. Green corridors help to mitigate the habitat fragmentation, provides pathways for urban biodiversity roaming and also serve as cool air pathways that cool cities and improve air quality. Additionally, green corridors help to improve the aesthetic view of metropolitan areas, offer sustainability and promote the motive of "man with wildlife" in urban center.

Proposed Locations

- All the major roads and water channels including Ring Road, Multan Road, GT Road, Canal Road, Jail Road, Ferozpur Road, Mulana Shoukat Ali Road, Madar-e-Millat Road, College Road, Circular Road Lari adda, BRB Canal, Band Road and patches along the Ravi Rivers.

Conceptual Design

- The green corridor should be a connected network of green cover and green spaces.
- The plantation should be planned and based on stratification including flowering, fruiting, and sheltering to provide habitat and food for urban biodiversity.
- Number of rows based on the availability of spaces along the planting area.
- The placement of vegetation around developments and the maintenance of larger, interconnected green spaces throughout regions should be done to mitigate habitat fragmentation and improve environmental values of Lahore.
- Some patches should also have wild flowering to serve as pollinator ground within the lower congestion areas.



Estimated Cost

THE URBAN UNIT (URBAN SECTOR PLANNING & MANAGEMENT SERVICES UNIT PVT.LTD					
Lahore Biodiversity Action Plan					
Rough Cost Estimate of Establishment of Urban Green Corridors (1 km x 10 m)					
ABSTRACT OF COST					
S.No	**Description of Work**	**Unit**	**Quantity**	**Rate (PKR)**	**Amount (PKR)**
1	**Site Preparation**				
1.1	Clearing, leveling, debris removal	m^2	10,000	25	250,000
1.2	Excavation (1 ft avg. for beds & soil prep)	m^3	2,832	900	2,548,800
1.3	Soil amendment (topsoil, compost, sand mix)	m^3	2,832	1,100	3,115,200
2	**Plantation**				
2.1	Shade trees (spaced ~10 ft)	No	330	800	264,000
2.2	Ornamental shrubs (spaced ~2 ft in clusters)	No	1,650	250	412,500
2.3	Lawn grass plantation (Buffalo/Bermuda mix)	m^2	7,000	120	840,000
3	**Fertilizers**				
3.1	Fertilizers, bio-pesticides, tools	Lot	1	300,000	300,000
				Total Estimated Cost	**7,730,500**
				Amount in Million	**7.7**

9.2. Butterfly Gardens

The pollinators and butterflies are the key to biodiversity niche and indicator of healthy ecosystem services in urban areas. However, habitat fragmentation, exotic species plantation, and low flowering habitat are threatening of their population. The butterfly garden will serve as habitat for butterflies and other pollinators. It also helps to promote community involvement and awareness for urban biodiversity. The butterfly garden is aimed to serve as multifunctional space to promote conservation, ecotourism, revival of pollinators, provide research opportunities and habitat restoration.

Proposed Location

The followings are the potential identified location for butterfly gardens in Lahore.

- 31.479078, 74.341368
- 31.505326, 74.332845
- 31.512942, 74.289756
- 31.589081, 74.309799

Conceptual Design

- The butterfly garden should be considered during interconnected green corridors to inhabit butterfly migration and support genetic diversity conservation.
- The establishment of dense flowering clustering featuring with variety of seasonal flowers.
- Large size sedges at periphery to established transition buffer and act as windbreaker to protect the damage.

SITE FROM GOOGLE EARTH WITH DIMENSIONS

Estimate Cost

THE URBAN UNIT (URBAN SECTOR PLANNING & MANAGEMENT SERVICES UNIT PVT.LTD					
Lahore Biodiversity Action Plan					
Rough Cost Estimate of Butterfly Garden (4 Kanals)					
ABSTRACT OF COST					
S.No	**Description of Work**	**Unit**	**Quantity**	**Rate (PKR)**	**Amount (PKR)**
1	**Site Preparation**				
1.1	Clearing, leveling, and debris removal	m^2	2,023	30	60,690
1.2	Soil amendment (compost, manure, sand mix)	m^3	150	1,200	180,000
2	**Plantation**				
2.1	Butterfly host plants (milkweed, passionflower, etc.)	No.	500	570	285,000
2.2	Nectar plants (lantana, marigold, verbena, etc.)	No.	1,000	650	650,000
2.3	Native flowering shrubs and small trees	No.	100	950	95,000
3	**Water Features & Butterfly Baths**				
3.1	Shallow water basins with pebbles	No.	4	25,000	100,000

3.2	Drip irrigation system	Lot	1	200,000	200,000
4	**Maintenance & Labor (1 Year)**				
4.1	Gardening staff (watering, pruning, pest control)	Month	12	70,000	840,000
4.2	Fertilizers, pesticides, tools	Lot	1	300,000	300,000
				Total Estimated Cost	**2,710,690**
				Amount in Million	**2.7**

9.3. Agroforestry

Agroforestry is to socializing the forest bioscape over agricultural land by integration of trees at agricultural and farm land of the area. Agroforestry is the best practice adopted by the developing countries where forest cover is less than the required statistics. It involves to planting trees alongside crops to provide multiple benefits such as improved soil fertility, enhanced water retention, reduces soil erosion and also diversify native habitat and inhabit the urban biodiversity. Agroforestry also act as wind barrier for weak crops which drop down due to wind flow and cause the great loss of farmers, trees along crops protect ten times larger area's crops than their height from drop down by wind.

Proposed Location

The followings are the potential identified location for agroforestry in Lahore.

- 31.491339, 74.281267
- 31.636392, 74.374829
- 31.618620, 74.324445
- 31.599804, 74.270526
- 31.521888, 74.248573
- 31.431936, 74.166648
- 31.312065, 74.183130
- 31.579392, 74.425125

Conceptual Design

- The mixed indigenous native and fruiting trees plantation at farm land.
- The peripheral bed used for plantation to act as wind barrier and avoid crops breakage.
- Intercropping for sustainable agriculture and promote tree cover in urban areas.

CONCEPT DESIGN FOR AGROFORESTRY :

Estimate Cost

THE URBAN UNIT (URBAN SECTOR PLANNING & MANAGEMENT SERVICES UNIT PVT.LTD					
Lahore Biodiversity Action Plan					
Rough Cost Estimate of Agroforestry (1Km)					
ABSTRACT OF COST					
S.No	**Description of Work**	**Unit**	**Quantity**	**Rate (PKR)**	**Amount (PKR)**
1	**Site Preparation**				
1.1	Soil testing and pit marking	Lot	1	50,000	50,000
2	**Tree Plantation**				
2.1	Tree pits excavation (2 ft x 2 ft x 2 ft)	No.	2,000	110	220,000
2.2	Supply of native and fruit trees (e.g., neem, amaltas, moringa, citrus, ber)	No.	2,000	570	1,140,000
2.3	Tree planting (with manure + soil mix)	No.	2,000	70	140,000
3	**Shrubs & Crop Beds**				
3.1	Agro-shrubs (leucaena, sesbania, etc.)	No.	3,000	70	150,000
3.2	Seasonal crop sowing (fodder, vegetables) – 3 cycles	Acre	9	50,000	450,000
4	**Soil Enrichment**				
4.1	FYM / compost for pits and beds	Ton	50	5,000	250,000
4.2	Mulching and organic cover	m^2	5,000	35	175,000
5	**Irrigation System**				
5.1	Drip or hose irrigation system	m	1,000	600	600,000
5.2	Water tanks and pump set	Set	1	250,000	250,000

6	**Maintenance & Labor (1 Year)**				
6.1	Regular watering, weeding, pruning	Month	12	60,000	720,000
6.2	Tools, pesticides, fertilizers	Lot	1	350,000	350,000
				Total Estimated Cost	**4,495,000**
				Amount in Milliom	**4.5**

9.4. Afforestation

Reforestation or afforestation are aimed to increase the forest cover by planting trees on barren lands, degraded areas and other suitable sites of forest land. Afforestation will help to improve native tree species richness that are suitable to the local climate, soil conditions, and ecological requirements. Planting mixed indigenous tree species and improving forest canopies can help to maintain connectivity between natural habitats and support the survival of various plant and animal species. Forest plantation key source to environment stability, which contribute to carbon sequestration and helps to mitigate climate change.

Proposed Location

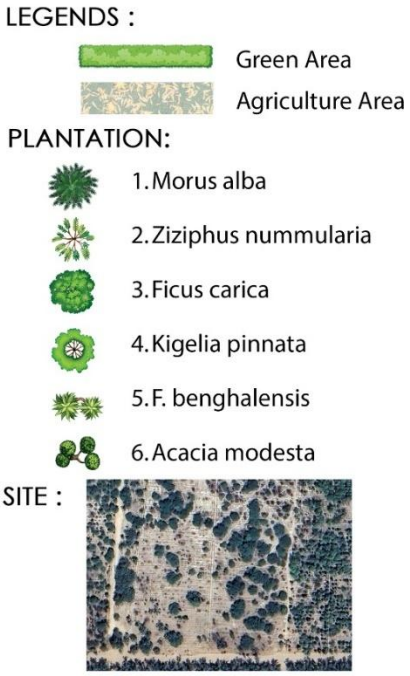
The followings are the potential identified location for afforestation in Lahore.

- 31.628779, 74.355774
- 31.630938, 74.345168
- 31.655312, 74.373169

Conceptual design

- The forest plantation design should be based on mix plantation or polyculture design to attract and conserve the wild diversity of the region.
- The species selection based on indigenous plant species which are native to the division like:
  - *Morus alba* (toot)
  - *Ziziphus nummularia* (Beri)
  - *Ficus carica* (Anjeer)
  - *Kigelia pinnata* (Kagala)
  - *F. benghalensis* (Banyan)
  - *Acacia modesta* (Phulai)
  - *A. nilotica* (Kikar)
- The spacing of line and trees are 10 x 6 feet for the well managed and better growth of plant.
- The gradual removal of invasive species should be carried to maintain the healthy forest ecosystem.

CONCEPT DESIGN FOR AFFORESTATION :



Estimate Cost

THE URBAN UNIT (URBAN SECTOR PLANNING & MANAGEMENT SERVICES UNIT PVT.LTD					
Lahore Biodiversity Action Plan					
Rough Cost Estimate of Afforestation (1 Acre)					
ABSTRACT OF COST					
S.No	**Description of Work**	**Unit**	**Quantity**	**Rate (PKR)**	**Amount (PKR)**
1	**Site Preparation**				
1.1	Clearing and leveling	Acre	1	20,000	20,000
1.2	Soil excavation & loosening (6" depth)	ft^3	6,000	15	90,000
1.3	Soil amendment (compost, manure mixing)	ft^3	6,000	25	150,000
2	**Tree Plantation**				
2.1	Supply of saplings (native species)	No.	1,200	120	144,000
2.2	Digging pits & planting (3 ft x 3 ft spacing)	No.	1,200	50	60,000
3	**Irrigation**				
3.1	Drip irrigation system installation	Lot	1	250,000	250,000
3.2	Water storage tank & pump	Lot	1	200,000	200,000
4	**Mulching & Soil Protection**				
4.1	Mulching material (leaves, straw)	ft^3	2,000	25	50,000
5	**Maintenance (1 Year)**				
5.1	Labor (watering, weeding, pruning)	Month	12	80,000	960,000
5.2	Fertilizers, tools, pest control	Lot	1	300,000	300,000
				Total Estimated Cost	**2,224,000**

	Amount in Million	**2.2**

9.5. Miyawaki Forest

In this forest, a self-sustaining, dense, native, and biodiverse forest ecosystem is established using the Miyawaki technique to promote the conservation and protection of biodiversity in small area. It works well because it follows the principles of natural reforestation, which include indigenous native trees plantation and replicating the processes of natural forest regeneration. When used to smaller afforestation projects, it offers several notable advantages over more conventional forestry techniques and works especially well in urban settings. The trees planted using this technique develop far more quickly, accelerating the process of creating forests and absorbing more carbon. Miyawaki forests have been found to have higher biodiversity than nearby woodlands, making them the perfect way to swiftly establish a variety of forest ecosystems.

Proposed Location

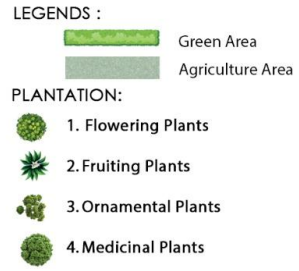
The followings are the potential identified location for Miyawaki in Lahore.

- 31.604405, 74.290426
- 31.589255, 74.380471
- Blank Areas in Parks
- Patches along Roads

Conceptual Design

- The preparation of planting bed by softening soil, applying mulch prepared locally, and also apply humus for well plant growth.
- Collect the seeds from native trees and raise seedling for planting of purchased seedling from local nurseries to ensure well managed growth and development of planted species.
- The planting richness should be doubled than the traditional forestry to create dense canopy.
- The plantation should be in layering to lower the nutrient competition among species.
- Ensue proper watering and weed removal for better health of plantation.

CONCEPT DESIGN FOR ESTABLISHMENT OF MIYAWAKI FOREST :



SITE :

Estimate Cost

THE URBAN UNIT (URBAN SECTOR PLANNING & MANAGEMENT SERVICES UNIT PVT.LTD					
Lahore Biodiversity Action Plan					
Rough Cost Estimate of Establishment of Miyawaki Forest					
ABSTRACT OF COST					
S.No	**Description of Work**	**Unit**	**Quantity**	**Rate (PKR)**	**Amount (PKR)**
1	**Site Preparation**				
1.1	Clearing, leveling, and debris removal	sqft	43,560	5	217,800.00
1.2	Excavation (3 ft depth) for soil amendment	ft^3	217,800	25	5,445,000.00
1.3	Soil mixing (topsoil, compost, farmyard manure, sand)	ft^3	217,800	35	7,623,000.00
2	**Plantation**				-
2.1	Procurement of native saplings	No.	1,500	570	855,000.00
2.2	Labor for digging and planting	No.	1,500	750	1,125,000.00
3	**Irrigation System**				-
3.1	Manual or hose irrigation system	Job	1	200,000	200,000.00
3.2	Water storage (tanks, pump, pipeline)	Lot	1	300,000	300,000.00
4	**Mulching & Composting**				-
4.1	Organic mulch (leaves, husk, straw, wood chips)	ft^3	30,000	30	900,000.00
4.2	Compost for 6 months (top dressing)	ft^3	20,000	25	500,000.00
5	**Fertilizers**				
5.1	Fertilizers, bio-pesticides, tools	Lot	1	250,000	250,000.00
				Total Estimated Cost	**17,415,800.00**
				Per Unit Amount in Million	**17.4**

9.6. Parks Rehabilitation

Urban parks are defined as delineated open space areas, mostly dominated by vegetation, grassy lawns, water bodies, and play areas, generally reserved for public use. Urban parks are a significant component of urban amenity green spaces. These are significant key tools for measuring the sustainability of cities. Green spaces in the cities facilitate sustainable urban planning. Unplanned urban growth with limited green spaces / open public spaces not even decrease the sustainability of the area, decline biodiversity and natural habitat but also negatively impacts human health and wellbeing. The provision of urban green spaces is one of the major priorities in the livable city. The total number of green spaces in a city is one of the important indicators of a sustainable urban ecosystem and quality of urban life.

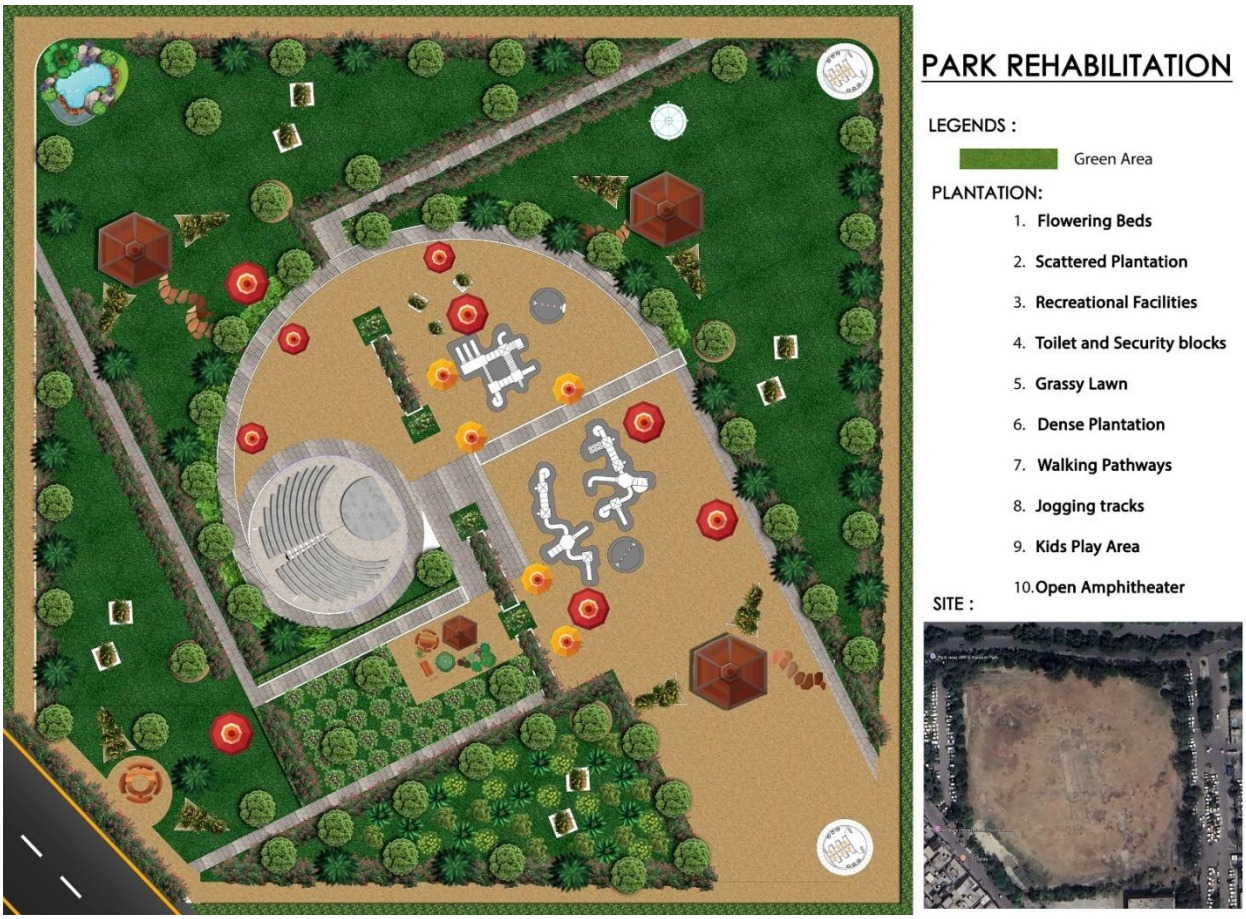
Proposed Location

The followings are the undeveloped parks of Lahore, which can be restored to improve the green health of urban areas.

- 31.622792, 74.302962
- 31.621065, 74.294155
- 31.475337, 74.340564
- 31.476666, 74.329763
- 31.472796, 74.292042
- 31.540502, 74.312714
- 31.552796, 74.297917
- 31.521442, 74.286935
- 31.413628, 74.266579
- 31.416277, 74.259992
- 31.434938, 74.308969

Conceptual Design

- The dense canopy areas established to maintain natural habitat for native biodiversity.
- The scattered plantation should be included to improve tree cover of the city.
- The flowering bed and grassy lawn should also be established for aesthetic beauty.
- The development of missing facilities like banches, toilet block, benches, security room, and play areas.



Estimate Cost

THE URBAN UNIT (URBAN SECTOR PLANNING & MANAGEMENT SERVICES UNIT PVT.LTD					
Lahore Biodiversity Action Plan					
MRS, 1st BI-ANNUAL-2025 (01.01.2025 to 30.06.2025) DISTRICT LAHORE					
ROUGH COST ESTIMATE OF REHABILITATION OF PARKS					
ABSTRACT OF COST					
Sr. #	**Name**	**Type**	**Area (Sqft)**	**Rate per Sqft (PKR)**	**Total Cost (PKR)**
1	NFC Central Park	Park	510,301.51	120	61.2
2	Captain Ali Park	Park	98,427.89	120	11.8
3	Block A1 Park Valencia	Park	175,920.83	120	21.1
4	B Block Park	Park	11,495.18	120	1.4
5	Ittefaq Cricket Ground	Park	179,225.12	120	21.5
6	Itwar Bazar Park Green Town	Park	130,288.07	120	15.6
7	Tomb Of Noor Jahan Park	Park	475,767.22	120	57.1
8	Masjid Maqbara Jahangir	Park	2,789,784.05	120	334.8

9	Rasool Park	Park	59,333.56	120	7.1
10	Stags Cricket Club	Stadium/Play Ground	241,684.40	120	29.0
11	Huma Block Cricket Ground	Stadium/Play Ground	128,810.11	120	15.5
				Total Millions Amount Rs	**576.1**

9.7. Constructed Wetland

The abundance of heavy metals has increased in the environment with the rapid increase of urban sprawl and Industrialization in the past few decades, which raised serious concerns globally. The disposal of residuals and waste products into water bodies may have devastating effects on aquatic ecosystems, posing serious threats to the natural environment and human health. Natural treatment of wastewater systems is the most suitable treatment technology for various types of wastewaters, which has attracted much attention in recent years. The use of plants to purify water supplies makes it both helpful to surrounding employees and communities and environmentally benign. By using plants, bacteria, or other related microbial organisms to absorb toxins from water, it is feasible to purify water and wastewater.

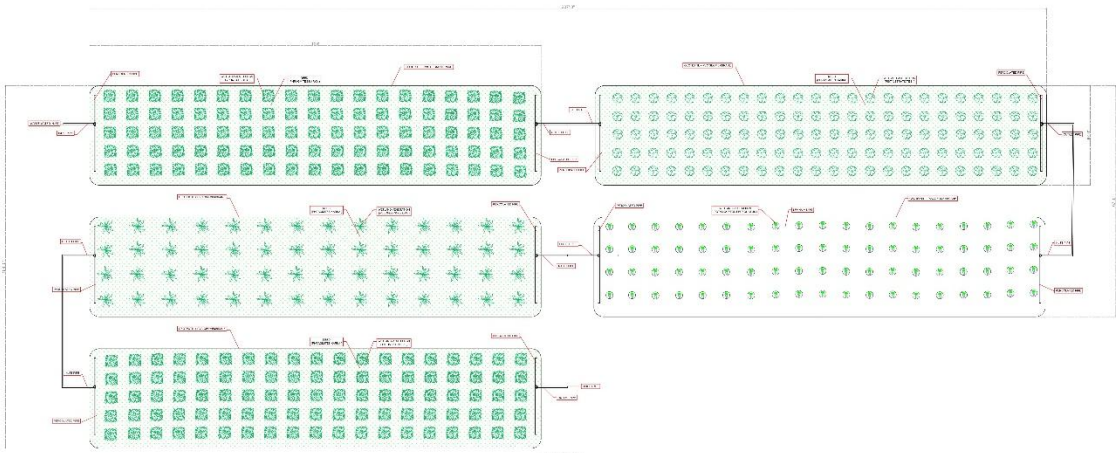
Proposed Location

The followings are the waste water ponds identified during the surveys of Lahore and can be potential water bodies to treat and restored aquatic fauna and flora of Lahore.

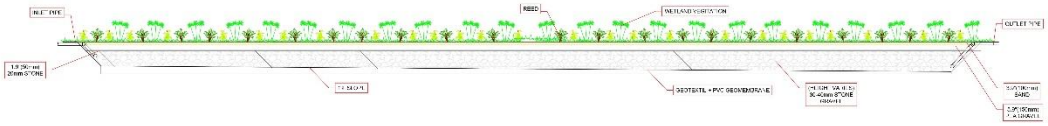
- 31.569633, 74.265230
- 31.543954, 74.249785
- 31.508482, 74.228654
- 31.499257, 74.212694
- 31.569166, 74.351684

Conceptual Design

- Reed bed and planting bed prepared for water purification.
- Introduction of eco-friendly aquatic plant species having the ability of phytoremediation to treat the water.
- The selective proposed plant species for water resource filtration are as follows:
    - *Phragmites karka (Common Reed)*
    - *Typha latifolia (Cattail)*
    - *Potamogeton perfoliatus (Redhead Grass)*
    - *Pistia stratiotes (Water Lettuce)*
    - *Nelumbo nucifera (Indian Lotus)*
    - *Lemna minor (Duckweed)*



PLAN



SECTION

Estimate Cost

THE URBAN UNIT (URBAN SECTOR PLANNING & MANAGEMENT SERVICES UNIT PVT.LTD						
Lahore Biodiversity Action Plan						
MRS, 1st BI-ANNUAL-2025 (01.01.2025 to 30.06.2025) DISTRICT LAHORE						
SCHEDULE ITEMS						
ROUGH COST ESTIMATE OF CONSTRUCTED WETLANDS						
ABSTRACT OF COST						
Sr. #	**Ref-Item**	**Description of Work**	**Unit**	**Quantity**	**Rate**	**Amount (Rs.)**
1		**Site Preparation & Earthworks**				
1.1	3-53	Clearing, grubbing & disposal	1000 Sft.	5,400.0	4,616.90	24,931
1.2	3-21-1-II	Excavation in foundation of building, bridges and other structures, including dagbelling, dressing, refilling in layers around structure with excavated earth, watering and ramming lead upto one chain (30 m) depth upto 5 ft (1.5m). 1 By Manual ii) in ordinary soil.	1000 Cft.	12,420	15,840.0	196,733
1.3		Base compaction & leveling	Cft	5,400	12	64,800

2		**Impermeable Liner Installation**				
2.1		Providing,laying,cutting,jointing,testingand disinfectingHighDensityPolyethylenePipe(HDPE-100 workingpresurepipe,Beta/Dadex/Popular/ IILorapprovedequivalentmanufacturer,incl udingthecostofspecials,intrenches,asappr oved&directedbytheengineerincharge,co mplete in all respects.				
		c) PN-10 (SDR-17				
		110 mm	Per Rft	6,460	502.8	3,248,088
2.2		Geotextile protective layer (top & bottom)	Cft	10,760	150	1,614,000
3		**Inlet & Outlet Structures**				
3.1		RCC Inlet chambers with screens	No	4	300,000	1,200,000
3.2		RCC Outlet chambers with level control	No	4	550,000	2,200,000
3.3	23-26-e	Providing, laying, cutting, jointing, testing and disinfecting PVC/ uPVC pipe line with `B' Class working pressure pipe, in trenches, complete in all respects:- d) 6" i/d (150 mm)	P.Rft	100	983.05	98,305
4		**Gravel & Substrate Layers**				
4.1		Coarse gravel (bed)	Cft	5,300	80	424,000
4.2		Fine gravel/sand mix (plant layer)	Cft	3,530	35	123,550
5		**Vegetation / Planting**				
5.1		Wetland plants (Typha, Canna, etc.)	No	5,000	550	2,750,000
5.2		Labor for planting	No	5,000	750	3,750,000
6		**Walkways, Signage, and Landscaping**				
6.1		Walkways (paver/bricks)	Cft	1,100	250	275,000
6.2		Signboard/Info panel	No	1	30,000	30,000
6.3		Inlet/outlet flushing, pest/disease control	Lot	1	50,000	50,000
					Total Estimated Cost	16,049,407
					Per Unit Amount in Million	**16.0**

9.8. Groundwater Recharge Well

A groundwater recharge well is a technique that intentionally injects water into the earth to replenish aquifers, thus "recharging" the subterranean water source. Rainwater and runoff can be collected by these

wells, filtered, and then reinjected into the aquifer. This technique is especially helpful in places where groundwater levels are dropping or there is a shortage of water.

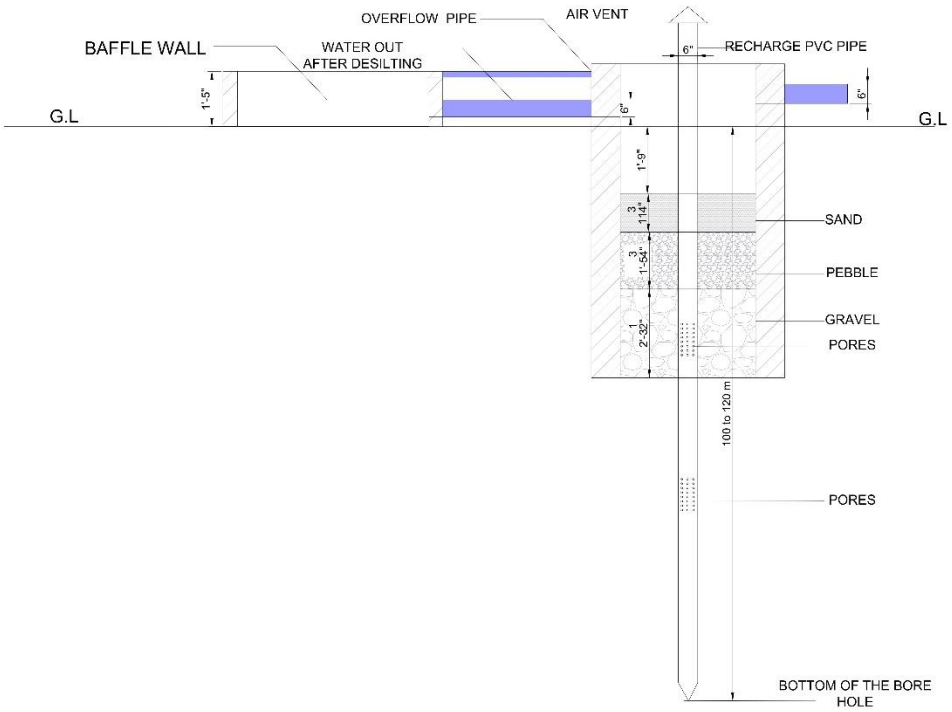
Proposed Location

The followings are the identified locations suitable for the development of groundwater recharge well to restore the water table of Lahore.

- 31.538620, 74.304702
- 31.520181, 74.353336
- 31.511174, 74.324488
- 31.521532,74.286830
- 31.580461, 74.325528
- 31.473148, 74.349788
- 31.413628, 74.266579

Conceptual Design

- A recharge well should be dug into ground to make water percolation ease during raining season.
- The recharge well will be prepared with the filling of stones, pebbles, sand and gravels to maintain the filtration.



Estimate Cost

THE URBAN UNIT (URBAN SECTOR PLANNING & MANAGEMENT SERVICES UNIT PVT.LTD						
Lahore Biodiversity Action Plan						
MRS, 1st BI-ANNUAL-2025 (01.01.2025 to 30.06.2025) DISTRICT LAHORE						
SCHEDULE ITEMS						
ROUGH COST ESTIMATE OF GROUND WATER RECHARGE WELL						
ABSTRACT OF COST						
Sr. #	**Ref-Item**	**Description of Work**	**Unit**	**Quantity**	**Rate**	**Amount (Rs.)**
		Drilling and Excavation				
1	3-21-1-II	Excavation in foundation of building, bridges and other structures, including dagbelling, dressing, refilling in layers around structure with excavated earth,				

		watering and ramming lead upto one chain (30 m) depth upto 5 ft (1.5m). 1 By Manual ii) in ordinary soil.				
		Digging of Pits (6.5 ft x 6.5 ft x 10 ft)	1000 Cft.	422.50	15,840.00	6,692.40
2	23-5-a	Direct Rotary/Reverse Rotary drilling of bore for Recharge wall, in all types of soil except shingle, gravel and rock:- a) from ground level to 250 ft. (75 m) below ground level:- i) 15" to 18" (375 to 450 mm) i/d	P.Rft	250.00	1,249.00	312,250.00
3	23-13-viii	Providing and installing fibre glass blind pipe in Recharge wall bore hole including coupling and jointing with strainer 15" inch dia (6.35 mm thickness)	Rft	100.00	5,087.10	508,710.00
4	23-20	Shrouding with graded pea gravel 3/8" to1/8"(10 mm to 3mm) around Recharge wall bore hole	Cft	106.00	206.50	21,889.00
5	N.s	Filter media (sand, charcoal layers)	Cft	106.00	70.00	7,420.00
		Concrete sealing at top (collar)				
6	6-5-f	Cement concrete plain including placing, compacting, finishing and curing complete (including screening and washing of stone aggregate): (f) Ratio 1: 2: 4	100 Cft.	18.00	50,377.80	9,068.00

		Inlet/Drainage Infrastructure				
7		Construction of inlet channel	Job	1.00	27,500.00	27,500.00
		PVC piping for overflow outlet (6-inch dia)				
8	23-26-e	Providing, laying, cutting, jointing, testing and disinfecting PVC/ uPVC pipe line with ` B' Class working pressure pipe, in trenches, complete in all respects:- d) 6" i/d (150 mm)	P.Rft	33.00	983.05	32,440.65
		Monitoring & Instrumentation				
		Flow Meter	Each	1.00	49,375.00	49,375.00
		Value 8" dia	Each	1.00	62,258.40	62,258.40
9		Water level sensor installation	Each	1.00	80,000.00	80,000.00
10		Data logger with solar power unit	Each	1.00	95,000.00	95,000.00
		Restoration & Finishing				
11		Surface restoration and grating cover	Cft	43.00	210.00	9,030.00
					Sub Total of Amount Rs	**1,221,633.45**
					05 x G-Total of Amount Rs	**6,108,167.27**

ANNEXURES

Annexure A

Sr. #	Common Name	Scientific Name	Status	Wild	Captive
1.	Bank myna	*Acridotheres ginginianus*	**LC**	✓	-
2.	Common myna	*Acridotheres tristis*	**LC**	✓	-
3.	Vulturine guinea fowl	*Acryllium vulturinum*	**LC**	-	✓
4.	Fischers lovebird	*Agapornis fischeri*	**NT**	-	✓
5.	Lilian's lovebird	*Agapornis lilianae*	**NT**	-	✓
6.	Wood duck	*Aix sponsa*	**LC**	-	✓
7.	Chestnut headed babbler	*Alcippe castaneceps*	**LC**	✓	-
8.	Chakor	*Alectoris chukar*	**LC**	-	✓
9.	Panama amazon	*Amazona panamensis*	**LC**	-	✓
10.	Common Teal	*Anas crecca*	**LC**	-	✓
11.	Mallard	*Anas platyrhynchos*	**LC**	-	✓
12.	Greater whitefronted goose	*Anser albifrons*	**LC**	-	✓
13.	Greylag goose (Domestic)	*Anser anser*	**LC**	-	✓
14.	Bar-headed goose	*Anser indicus*	**LC**	-	✓
15.	Indian pipit	*Anthus novaeseelandiae*	**LC**	✓	-
16.	House swift	*Apus affinis*	**LC**	✓	-
17.	Steppe eagle	*Aquil nipalensis*	**LC**	-	✓
18.	Golden eagle	*Aquila chrysaetos*	**LC**	-	✓
19.	Blue-and-yellow macaw	*Ara ararauna*	**LC**	-	✓
20.	Green-winged macaw	*Ara chloropterus*	**LC**	-	✓
21.	Indian Pond Heron	*Ardeola grayii*	**LC**	✓	-
22.	Spotted owlet	*Athene brama*	**LC**	✓	-
23.	Pochard duck	*Aythya ferina*	**VU**	-	✓
24.	New Zealand scaup	*Aythya novaeseelandiae*	**LC**	-	✓
25.	Indian eagle-owl	*Bubo bengalensis*	**LC**	-	✓
26.	Cattle egret	*Bubulcus ibis*	**LC**	✓	-
27.	White-eyed buzzard	*Butastur teesa*	**LC**	-	✓
28.	Sulphur-crested cockatoo	*Cacatua galerita*	**LC**	-	✓
29.	Muscovy duck	*Cairina moschata*	**LC**	-	✓
30.	Southern cassowary	*Casuarius casuarius*	**LC**	-	✓
31.	Greater Coucal	*Centropus sinensis*	**LC**	✓	-
32.	Golden pheasant	*Chrysolophus pictus*	**LC**	-	✓
33.	Pied crested cuckoo	*Clamator jacobinus*	**LC**	✓	-
34.	Blue rock pigeon	*Columba livia*	**LC**	✓	-
35.	Domestic pigeon	*Columba livia domestica*	**LC**	✓	✓

36.	Magpie robin	*Copsychus saularis*	**LC**	✓	-
37.	Indian rollers	*Coracias bengalensis*	**LC**	✓	-
38.	House crow	*Corvus splendens*	**LC**	✓	-
39.	Common quail	*Coturnix coturnix*	**LC**	✓	-
40.	Black swan	*Cygnus atratus*	**LC**	-	✓
41.	Mute swan	*Cygnus olor*	**LC**	-	✓
42.	Black drongo	*Dicrurus macrocercus*	**LC**	✓	-
43.	Golden back woodpecker	*Dinopium benghalense*	**LC**	✓	-
44.	Little egret	*Egretta garzetta*	**LC**	✓	-
45.	Intermediate egret	*Egretta intermedia*	**LC**	✓	-
46.	Black shouldered kite	*Elanus caeruleus*	**LC**	✓	-
47.	Koel	*Eudynamys scolopaceus*	**LC**	✓	-
48.	Common kestrel	*Falco tinnunculus*	**LC**	-	✓
49.	Grey francolin	*Francolinus pondicerianus*	**LC**	-	✓
50.	Eurasian coot	*Fulica atra*	**LC**	-	✓
51.	Western crowned pigeon	*Goura cristata*	**VU**	-	✓
52.	Demoiselle crane	*Grus virgo*	**LC**	-	✓
53.	White breasted kingfisher	*Halcyon smyrnensis*	**LC**	✓	-
54.	Black winged stilt	*Himantopus himantopus*	**LC**	✓	-
55.	Common swallow	*Hirundo rustica*	**LC**	✓	-
56.	Brown shrike	*Lanius cristatus*	**LC**	✓	-
57.	Rufous backed shrike	*Lanius schach*	**LC**	✓	-
58.	Bay backed shrike	*Lanius vittatus*	**LC**	✓	-
59.	Mahratta woodpecker	*Leiopicus mahrattensis*	**LC**	✓	-
60.	Silver pheasant	*Lophura nycthemera*	**LC**	-	✓
61.	Swinhoe's pheasant	*Lophura swinhoii*	**NT**	-	✓
62.	Eurasian wigeon	*Mareca Penelope*	**LC**	-	✓
63.	Gadwall	*Mareca strepera*	**LC**	-	✓
64.	Black Partridge	*Melanoperdix niger*	**VU**	-	✓
65.	Wild turkey	*Meleagris gallopavo*	**LC**	-	✓
66.	Budgerigar	*Melopsittacus undulatus*	**LC**	-	✓
67.	Little green bee-eater	*Merops orientalis*	**LC**	✓	-
68.	Blue cheeked bee-eater	*Merops superciliosus*	**LC**	✓	-
69.	Black kite	*Milvus migrans*	**LC**	-	✓
70.	White wagtail	*Motacilla alba dukhunensis*	**LC**	✓	-
71.	Yellow-headed wagtail	*Motacilla citreola*	**LC**	✓	-
72.	Yellow wagtail	*Motacilla flava*	**LC**	✓	-
73.	Large pied wagtail	*Motacilla maderaspatensis*	**LC**	✓	-
74.	Purple sunbird	*Nectarinia asiatica*	**LC**	✓	-

75.	Guinea fowl	*Numida meleagris*	**LC**	-	✓
76.	Night Heron	*Nycticorax nycticorax*	**LC**	✓	-
77.	Cockatiel	*Nymphicus hollandicus*	**LC**	-	✓
78.	Golden oriole	*Oriolus oriolus*	**LC**	✓	-
79.	House sparrow	*Passer domesticus*	**LC**	✓	-
80.	Indian peafowl	*Pavo cristatus*	**LC**	-	✓
81.	Common blue peafowl	*Pavo cristatus* (variant)	**LC**	-	✓
82.	Black-shouldered peafowl	*Pavo cristatus* (variant)	**LC**	-	✓
83.	Pied peafowl	*Pavo cristatus* (variant)	**LC**	-	✓
84.	White peafowl	*Pavo cristatus* (variant)	**LC**	-	✓
85.	Hybrid peafowl	*Pavo cristatus muticus*	**NE**	-	✓
86.	Emerald peafowl	*Pavo muticus*	**EN**	-	✓
87.	Dalmatian pelican	*Pelecanus crispus*	**NT**	-	✓
88.	Great White pelican	*Pelecanus onocrotalus*	**LC**	-	✓
89.	Grey partridge	*Perdix perdix*	**LC**	-	✓
90.	Little cormorant	*Phalacrocorax niger*	**LC**	✓	-
91.	Common pheasant	*Phasianus colchicus*	**LC**	-	✓
92.	Lesser flamingo	*Phoeniconaias minor*	**NT**	-	✓
93.	Greater flamingo	*Phoenicopterus roseus*	**LC**	-	✓
94.	Black redstart	*Phoenicurus ochruros*	**LC**	✓	-
95.	Brown chiff chaffs	*Phylloscopus collybita*	**LC**	✓	-
96.	Black throated weaver	*Ploceus benghalensis*	**LC**	✓	-
97.	Streaked weaver	*Ploceus manyar*	**LC**	✓	-
98.	Cape parrot	*Poicephalus robustus*	**VU**	-	✓
99.	Indian prinia	*Prinia subflava*	**LC**	✓	-
100.	Coppersmith barbet	*Psilopogon haemacephala*	**LC**	✓	-
101.	Alexandrine parakeet	*Psittacula eupatria*	**NT**	✓	✓
102.	Rose-ringed parakeet	*Psittacula krameri*	**LC**	✓	✓
103.	Blossom-headed parakeet	*Psittacula roseata*	**LC**	-	✓
104.	Grey parrot	*Psittacus erithacus*	**EN**	-	✓
105.	Red-vented bulbul	*Pycnonotus cafer*	**LC**	✓	-
106.	White-cheeked bulbul	*Pycnonotus leucogenys leucotis*	**LC**	✓	-
107.	White browed fantail flycatcher	*Rhipidura aureola*	**LC**	✓	-
108.	Painted snipe	*Rostratula bengalensis*	**LC**	✓	-
109.	Pied bush chat	*Saxicola caprata*	**LC**	✓	-
110.	Indian robin	*Saxicoloides fulicata*	**LC**	✓	-
111.	Red shoveler	*Spatula platalea*	**LC**	-	✓
112.	Collared dove	*Streptopelia decaocto*	**LC**	✓	✓

113.	Little brown dove	*Streptopelia senegalensis*	**LC**	✓	-
114.	Red turtle dove	*Streptopelia tranquebarica*	**LC**	✓	-
115.	Ostrich	*Struthio camelus*	**LC**	-	✓
116.	Pied myna	*Sturnus contra*	**LC**	✓	-
117.	Ruddy shelduck	*Tadorna ferruginea*	**LC**	-	✓
118.	Common wood shrike	*Tephrodornis pondicerianus*	**LC**	✓	-
119.	Paradise fly catcher	*Terpsiphone paradisi*	**LC**	✓	-
120.	Common grey hornbill	*Tockus birostris*	**LC**	✓	-
121.	Green pigeon	*Treron phoenicoptera*	**LC**	✓	-
122.	Wood sandpiper	*Tringa glareola*	**LC**	✓	-
123.	Common sandpiper	*Tringa hypoleucos*	**LC**	✓	-
124.	Common babbler	*Turdoides caudatus*	**LC**	✓	-
125.	Large grey babbler	*Turdoides malcolmi*	**LC**	✓	-
126.	Jungle babbler	*Turdoides striatus*	**LC**	✓	-
127.	Hoopoe	*Upupa epops*	**LC**	✓	-
128.	Red wattled lapwing	*Vanellus indicus*	**LC**	✓	-

In above table LC= Least Concerned; D=Domesticated; VU= Vulnerable; NT= Nearly threatened; EN = Endangered; NE = Not Evaluated.

Annexure B

Sr. No.	Common Name	Scientific Name	Introduced/Local/Invasive
1.	Kikar/Babul	*Acacia nilotica*	Local
2.	Khair/Katha	*Acacia catechu*	Local
3.	Fabaceae	*Acacia modesta*	Local
4.	Rukh-e-Zard	*Acacia retinodes*	Local
5.	Acer/Maple	*Acer negundo*	Introduced
6.	Kiromeli	*Acer oblongum*	Introduced
7.	Chhiku	*Achras sapota*	Introduced
8.	Bel	*Aegle marmelos*	Local
9.	Tree of Heaven/Ailanthus	*Ailanthus excelsa*	Introduced
10.	Tree of Heaven/Ailanthus	*Ailanthus altissima*	Introduced (Invasive)
11.	White Siris	*Albizia procera*	Local
12.	Black Siris	*Albizia lebbek*	Local
13.	Jangli Akhrot	*Aleurites moluccana*	Introduced
14.	Shaitan/Satiyan	*Alstonia scholaris*	Local
15.	Dhoka	*Anogeissus acuminate*	Local
16.	Norfolk Island Pine	*Araucaria heterophylla*	Introduced
17.	Kathal	*Artocarpus integrifolia*	Introduced
18.	Dhew/Dheu	*Artocarpus lakoocha*	Local
19.	Kamrukh/Kamranga	*Averrhoa carambola*	Introduced
20.	Neem	*Azadirachta indica*	Local
21.	Bamboo	*Bambusa spp.*	Local
22.	Sethphala/Samunder phal	*Barringtonia acutangular*	Local
23.	Mahwa	*Bassia latifolia*	Local
24.	Sufaid Kachnar	*Bauhinia alba*	Local
25.	Gulabi Kachnar	*Bauhinia purpurea*	Local
26.	Gulhar	*Benjamina cimosa*	Introduced
27.	Anderkani	*Bischofia javanica*	Introduced
28.	Sumbul/Simal/Silk Cotton Tree	*Bombax malabaricum*	Local
29.	Brachychiton	*Brachychiton diversifolius*	Introduced
30.	Kaghzi tut	*Broussonetia papyrifera*	Introduced (Invasive)
31.	Dhak/Flame of the Forest	*Butea frondosa*	Local
32.	Najor	*Bursera serrata/simaruba*	Local

Sr. No.	Common Name	Scientific Name	Introduced/Local/Invasive
33.	Bottle Brush	*Callistemon citrinus*	Introduced
34.	Amaltas	*Cassia fistula*	Local
35.	Cassia tree/Java Shower	*Cassia javanica*	Introduced
36.	Cassia tree	*Cassia nodosa*	Local
37.	Desert Saroo/Farwan	*Casuarina equisetifolia*	Introduced
38.	Toon/Tun	*Cedrela toona*	Local
39.	Kharak/European Nettle Tree	*Celtis australis*	Introduced
40.	Buddha Tree/Floss Silk Tree	*Chorisia insignis*	Introduced
41.	Buddha Tree	*Chorisia speciose*	Introduced
42.	Chukrassia	*Chukrasia tabularis*	Local
43.	Camphor/Kafoor	*Cinnamomum camphora*	Introduced
44.	Fiddlewood	*Citharexylum spinosum*	Introduced
45.	Gondi	*Cordia gharaf*	Local
46.	Lasura	*Cordia oblique*	Local
47.	Burna	*Crataeva religiosa*	Local
48.	Saroo/Cypress	*Cupressus sempervirens*	Introduced
49.	Shisham	*Dalbergia sissoo*	Local
50.	Trkoli	*Dalbergia lanceolaria*	Local
51.	Aalimi tali	*Dalbergia latifolia*	Local
52.	Gold Mohr	*Delonix regia*	Introduced
53.	Gul-e-Must	*Dillenia indica*	Local
54.	Gab	*Diospyros peregrina*	Local
55.	Loquat	*Eriobotrya japonica*	Introduced
56.	Gul-e-Nishter	*Erythrina suberosa*	Local
57.	Sufeda	*Eucalyptus citriodora*	Introduced (Invasive)
58.	Jaman/Jamu	*Eugenia jambolana*	Local
59.	Bohr/Banyan Tree	*Ficus benghalensis*	Local
60.	Kali Ficus/Kubra	*Ficus benjamina*	Introduced
61.	Rubber Plant	*Ficus elastica*	Introduced
62.	Pilkhan	*Ficus virens*	Local
63.	Krishni	*Ficus benghalensis var.*	Local
64.	Pandurata	*Ficus lyrate*	Introduced
65.	Australian Banyan	*Ficus macrophylla*	Introduced
66.	Silver Oak/Silk Oak	*Grevillea robusta*	Introduced
67.	Dozekh/Honey Locust	*Gleditsia triacanthos*	Introduced

Sr. No.	Common Name	Scientific Name	Introduced/Local/Invasive
68.	Nag Pahli/Beri Pata	*Heterophragma adenophyllum*	Local
69.	Gel-e-Neelam	*Jacaranda mimosifolia*	Introduced
70.	Akhrot	*Juglans regia*	Introduced
71.	Gul-e-Fanoos/Sausage Tree	*Kigelia pinnata*	Introduced
72.	Ipple/Jungle Imli	*Leucaena glauca*	Introduced (Invasive)
73.	Maclura	*Maclura aurantiaca*	Introduced
74.	Kamila	*Mallotus philippinensis*	Local
75.	Amm	*Mangifera indica*	Local
76.	Magnolia	*Magnolia grandiflora*	Introduced
77.	Khirni	*Manilkara hexandra*	Local
78.	Bakain	*Melia azedarach*	Local
79.	Paper Bark	*Melaleuca Leucadendron*	Introduced
80.	Champa Tree	*Michelia champaca*	Introduced
81.	Villayti Shishum	*Millettia ovalifolia*	Introduced
82.	Villayti Naem	*Millingtonia hortensis*	Introduced
83.	Molsari	*Mimusops elengi*	Local
84.	Shohanjana	*Moringa oleifera*	Local
85.	Shehtut	*Morus alba*	Local
86.	Litchi/Lychee Tree	*Nephelium litchi*	Introduced
87.	Oncoba	*Oncoba spinosa*	Introduced
88.	Talwar Pahli	*Oroxylum indicum*	Local
89.	Avocado/Alligator	*Persea americana*	Introduced
90.	Amla	*Phyllanthus emblica*	Local
91.	Chir/Pine	*Pinus roxburghii*	Local
92.	Araishi Pista	*Pistacia chinensis*	Introduced
93.	Kaker/Mastic Tree	*Pistacia integerrima*	Local
94.	Chinar/Plane Tree	*Platanus orientalis*	Introduced
95.	Ulta Ashok	*Polyalthia longifolia*	Introduced
96.	Chota Jand	*Prosopis juliflora*	Introduced (Invasive)
97.	Kanak Champa	*Pterospermum acerifolium*	Local
98.	Putajan	*Putranjiva roxburghii*	Local
99.	Maja Nun/Baid-e-Majnum	*Salix babylonica*	Introduced
100.	Laila	*Salix tetrasperma*	Local
101.	Simbal/Simal	*Salmalia malabarica*	Local
102.	Reetha/Soap Nut Tree	*Sapindus mukorossi*	Local

Sr. No.	Common Name	Scientific Name	Introduced/Local/Invasive
103.	Reetha/Soap Nut Tree	*Sapindus trifoliatus*	Local
104.	Makhan Charbi	*Sapium sebiferum*	Introduced
105.	Ashoka	*Saraca indica/asoca*	Local
106.	Kussum/Samoma/Lac Tree	*Schleichera oleosa*	Local
107.	Shamma	*Sophora secundiflora*	Introduced
108.	Ambar/Ambare/Bahambi	*Spondias pinnata*	Local
109.	Bottle Neck Tree	*Sterculia foetida*	Local
110.	Jungle Badam	*Sterculia colorata*	Local
111.	Gulab Jaman/Rose Apple	*Syzygium jambos*	Introduced
112.	Mahogoni Tree	*Swietenia mahogoni*	Introduced
113.	Imli/Tamarind	*Tamarindus indica*	Local
114.	Taxodium	*Taxodium mucronatum*	Introduced
115.	Sagwan/Teak	*Tectona grandis*	Introduced
116.	Arjun	*Terminalia arjuna*	Local
117.	Urhar/Bhera/Bidda Nut	*Terminalia bellirica*	Local
118.	Jungle Badam/Bhera	*Terminalia catappa*	Local
119.	Tumri/Gamhar	*Trewia nudiflora*	Local
120.	Terminalia invorence	*Terminalia inorence*	Local
121.	Ber/Jujbe/Simli	*Ziziphus jujube*	Local
122.	Ber/Gol Beri	*Ziziphus mauritiana*	Local
123.	Tabebuia (Pink)/Pink Poul	*Tabebuia rosea*	Introduced
124.	Tabebuia (Yellow)/Roble	*Tabebuia rosea*	Introduced
125.	Yew Plum Pine	*Podocarpus spp.*	Introduced
126.	Logwood Tree	*Haematoxylum campechianum*	Introduced
127.	Panna	*Ehretia acuminata*	Local
128.	Wrightia Tungtoria	*Wrightia tinctoria*	Local
129.	Wrightia Coccenia	*Wrightia coccinea*	Local
130.	Jhanvi	*Coupinia spp.*	Local
131.	Sukh Chain	*Pongamia glabra*	Local
132.	Milletia Glasness	*Milletia glabra*	Local
133.	Liza	*Liza spp.*	Local
134.	Stercullia Colorata	*Sterculia colorata*	Local
135.	Lagestomia Tomantoza	*Lagerstroemia tomentosa*	Local
136.	Lagestomia Alba	*Lagerstroemia alba*	Local
137.	Peepal	*Ficus religiose*	Local

Sr. No.	Common Name	Scientific Name	Introduced/Local/Invasive
138.	Indian Elm Tree	*Holoptelea integrifolia*	Local
139.	Ippal Ippal	*Ippal Ippal*	Local
140.	Brychychiten	*Brychychiten spp.*	Local

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